The Pathology and Bacteriology of Resected Lesions in Pulmonary Tuberculosis***

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and

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The advances in surgery of pulmonary tuberculosis combined with proper rest and antimicrobial therapy have revolutionized practically every phase of the tuberculous problem. Among others, bacteriological changes have been phenomenal. Great differences have been recorded in microscopic findings, resistance to antimicrobial agents and virulence for experimental animals. Changes in the primary etiologic agent have correspondingly led to many radical variations in pathology. Less has been written about pathology, but not until surgical resection became proficient was there enough material for complete study. Newer methods of treatment have reduced deaths from tuberculosis and along with the reduction in deaths, there has been a corresponding reduction in bodies for autopsy study. On the other hand, there has been created a wealth of material from surgical resection that has opened new fields for study, not only in bacteriology, but more especially in pathology of the disease. Rapid clearing of infiltrative lesions, encapsulation of tubercles and shrinking of cavities have already been noted and the end is not in sight. Certainly nobody will feel that we are near the end of new discoveries.

Medlar, Bernstein and Steward† reported on significant bacteriological changes in resected lesions. They found that all open cavities had acid fast bacilli, but only 13 per cent of "closed" lesions had acid fast bacilli. Closed lesions included "filled in" cavities or necrotic lesions that had not sloughed. They found practically no "secondary" bacteria, in spite of the fact that the caseous walls of many cavities contained a preponderance of neutrophiles. The conclusion was that tubercle bacilli, in addition to secondary microorganisms may be responsible for the neutrophiles. The same authors also found that a few specimens contained

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This One

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many acid fast bacilli that fail to produce tuberculosis in guinea pigs.

Beck and Yegian found acid fast bacilli in cases not treated with antibiotics that did not grow on cultured media. They concluded that sluggish or inactive forms may be from natural causes, as well as from cases having had drug treatment.

Steenken and Wolinsky observed low virulence in one case not having drug therapy, but in a series of 21 on isoniazid therapy, they were able to show that 14 strains of bacilli lost virulence completely. Nine strains from seven cases were fully virulent. Six of the nine virulent strains were fully resistant to isoniazid. They concluded that there was no relation in the loss of virulence to either time of exposure to isoniazid or to its in vitro resistance. In cultures they were able to cause a total loss of virulence of (H37 RV) by transfers of bacilli in increasing concentrations of isoniazid. As to recovery of bacilli from resected pulmonary lesions, Bernstein and Steenken were unable to grow bacilli from 12 "target point" lesions with positive bacilli on smear and only one culture of five lesions where no bacilli were found on smear. In "non target point" lesions they were able to grow cultures and infect guinea pigs in about two-thirds of the cultures. "Albumen homogenates" yielded little better results than saline solution in preparing specimens.

In a round table discussion by a group at the Los Angeles Meeting of the National Tuberculosis Association in 1953 there was much debate, but not much agreement regarding the viability of the "sleepers" that have been reported by various authors. It was agreed that better culture methods may produce more growths. All were agreed that the lesions were sterilized but not all that the bacilli were dead. Dubos on several occasions offered valid reasons why we could not consider the bacilli dead until more refined methods are used. He suggested the effect of tissue acids especially lactic acid and spermine, as well as toxic substances on the ability of tubercle bacilli to grow. He also mentioned the possibility of exhaustion of a vital metabolite that must be restored before growth and reproduction can take place.

As to the pathologic changes, much less has been reported.

There are many different manifestations of healing that range all the way from a clearing of infiltrates, resorption of small tubercles; encapsulation, calcification and ossification of larger ones; closing of bronchi with collapse and healing of the cavity by fibrosis or inspissation of fluid and pus, which after long intervals may become sterile, caseate and actually calcify. Of these many changes, the most spectacular is the healing of cavities.

It is not our purpose to give a detailed history of healing cavities which were first described by Laennec. Before the antibiotic era, several references were made to healing cavities. Gilbert described two cases where cavities were healed by scar tissue and Sweany discussed several types of cavity closure. The complete closure of a bronchus may lead to a collapse of the cavity wall, and the cavity may close by scar tissue. In the event the cavity wall is too rigid or is held out by
adhesions, pus, and other fluids may be trapped in the cavity. Another
type is the healing from within by a gradual shrinking of the cavity
and a building up of a healing fibrous layer in a centripetal manner
until the lumen becomes essentially closed. Still another is the pressure
of organized pleural fluid on the cavity wall sometimes resulting in
closure. An example of complete healing of a cavity by scar tissue
following collapse by pneumothorax was shown. Auerbach and Green10
described cavity healing in a group of sputum-negative cases. There was
one case followed by ante-mortem roentgenograms which healed by scar
tissue. The pathological changes were minutely detailed in the healing
process. They further described what they called “closed healing” with
“inspissation of the caseous contents.” In contrast to “open healing”
where the bronchus remains open and the cavity gradually closes by the
ingrowth of fibrous tissue and with sometimes a partial covering by
epithelial cells growing out from the bronchial stem. Pinner11 showed
practically the same type of material but rightly took exception to calling
the closure of a cavity by inspissation an anatomically healed lesion. He
admitted error, however, in his earlier contention that closure of the
bronchi played no role in healing.

There are many other isolated references to natural cavity closure,
but for the present purpose only certain well-documented reports are given.

After antibiotic therapy, followed by surgical resection, there are
several important reports on the healing of resected lesions, most of
which deal with clearing of infiltrations, resorption of cellular exudates,
fibrous contractions of lesions, and partial closure of cavities with a great
variety of healing manifestations. Auerbach, Katz and Small12 described
several resected specimens where there was partial and even almost
complete closure of cavities with fibrosis, granulation tissue and clearing
of caseation, and “pyogenic membranes.” They laid great emphasis on
re-epithelialization beginning at the broncho-cavitary junction and ex-
tending out into the cavity wall for varying distances depending on the
chronicity of the process. They state that antibiotic therapy tends to keep
the bronchus open in contrast to the closure that usually occurs without
antibiotics. Altman and Ornstein13 presented similar material in a series
of resected specimens.

Ryan, Medlar and Welles14 reported on the pathological changes in
resected lesions and described “reversible” and “irreversible” pneumonias.
The former cleared leaving the tissues practically intact, while the latter
caused caseation that either excavated or became encapsulated. Some
cavities became compressed into smaller sizes.

Schmidtmann and Liebaldt15 also examined the pathological changes
that took place in resected specimens. They demonstrated closing of
bronchi by ingrowths of granulation tissue. Also they showed that bronchi
become compressed from without until only a compact mass of epithelium
remains.

The study to be reported has to do chiefly with some of the pathologic
changes that take place following antimicrobial therapy in tuberculosis.
TABLE I
ANALYSIS OF 34 CASES HAVING PULMONARY SURGERY

<table>
<thead>
<tr>
<th>No.</th>
<th>Initial</th>
<th>Case Number</th>
<th>Race</th>
<th>Age</th>
<th>Sex</th>
<th>Onset Date</th>
<th>Predominant Sympt. of Onset</th>
<th>Admission Diagnosis</th>
<th>Treatment</th>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td>night sweats</td>
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</tr>
<tr>
<td>5</td>
<td>M.B.L.</td>
<td>2050</td>
<td>C</td>
<td>19</td>
<td>F</td>
<td>10/49</td>
<td>Laryngeal</td>
<td>12/27/49</td>
<td>M.A. Act.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>weakness</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td>Weakness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>M.G.</td>
<td>3003</td>
<td>C</td>
<td>48</td>
<td>M</td>
<td>1/52</td>
<td>Cough, Laryng.</td>
<td>3/12/52</td>
<td>F.A. Act.</td>
</tr>
</tbody>
</table>

fibr. — fibrosis  cas. — caseous  sthzd. — streptohydrazid
<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Sex</th>
<th>Age</th>
<th>Race</th>
<th>Admits</th>
<th>Date of Admission</th>
<th>M.A. Act.</th>
<th>Diagnosis</th>
<th>Comments</th>
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<tr>
<td>16</td>
<td>W.R.</td>
<td>C</td>
<td>42</td>
<td>M</td>
<td>3 Adms.</td>
<td>1/17/53</td>
<td>M.A. Act.</td>
<td>PAS &amp; INAH 1/53 to 10/53</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>W.C.B.</td>
<td>W</td>
<td>38</td>
<td>M</td>
<td>2 Adms.</td>
<td>1/18/53</td>
<td>F.A. Act.</td>
<td>Sthd. c. PAS &amp; INAH alt. days from 8/53 to 3/54</td>
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</tr>
<tr>
<td>19</td>
<td>E.B.</td>
<td>W</td>
<td>37</td>
<td>F</td>
<td>7/53</td>
<td>8/53</td>
<td>M.A. Act.</td>
<td>Pnx. 8/50 to 7/52; Sm. 18 injections in '51</td>
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<tr>
<td>20</td>
<td>W.J.</td>
<td>W</td>
<td>17</td>
<td>F</td>
<td>5/52</td>
<td>8/19/53</td>
<td>F.A. Act.</td>
<td>Sm. PAS. INAH 8/52 to 3/54</td>
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</tr>
<tr>
<td>21</td>
<td>D.S.</td>
<td>W</td>
<td>21</td>
<td>F</td>
<td>9/53</td>
<td>2/10/54</td>
<td>F.A.Q.</td>
<td>Sm. and PAS. 9/53 to 3/54</td>
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<tr>
<td>22</td>
<td>E.S.</td>
<td>C</td>
<td>30</td>
<td>F</td>
<td>12/48</td>
<td>2/9/50</td>
<td>F.A. Act.</td>
<td>Sm. &amp; PAS 3/50 intermit. 4 yrs. INAH 8/52 to 3/20/54</td>
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<tr>
<td>23</td>
<td>M.C.</td>
<td>W</td>
<td>17</td>
<td>F</td>
<td>'53</td>
<td>7/7/53</td>
<td>M.A. Act.</td>
<td>Sm. &amp; PAS. 7/53; Sm. discont. 4/54 INAH 4/54</td>
<td></td>
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<tr>
<td>25</td>
<td>G.R.</td>
<td>C</td>
<td>38</td>
<td>M</td>
<td>2/51</td>
<td>11/19/52</td>
<td>M.A. Act.</td>
<td>PAS &amp; INAH 12/53 to 3/54; Sm. 3/53 to 3/54</td>
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<tr>
<td>27</td>
<td>L.F.</td>
<td>W</td>
<td>30</td>
<td>M</td>
<td>Before '49</td>
<td>1/49 3/19/53</td>
<td>F.A. Act.</td>
<td>Many courses Sm. &amp; PAS. 4 yrs. in different hospitals INAH, PAS., '53 to '54</td>
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<tr>
<td>28</td>
<td>L.W.</td>
<td>C</td>
<td>28</td>
<td>M</td>
<td>'51</td>
<td>'51 6/52</td>
<td>F.A. Act.</td>
<td>Pnp. 12/52 to 2/54; Sm. &amp; PAS. 6/52 to 2/54; INAH 9/52 to 2/54</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>S.C.</td>
<td>W</td>
<td>39</td>
<td>M</td>
<td>'52</td>
<td>1/54</td>
<td>F.A. Act.</td>
<td>Drugs in other hospitals—INAH &amp; PAS. 1/54 to 4/54</td>
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</tr>
<tr>
<td>30</td>
<td>K.J.</td>
<td>C</td>
<td>43</td>
<td>F</td>
<td>5/47</td>
<td>10/5/52</td>
<td>F.A. Act.</td>
<td>Sm. &amp; PAS in other hospitals; Sm. PAS. INAH 10/52 to 1/54</td>
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</tr>
<tr>
<td>31</td>
<td>H.M.</td>
<td>W</td>
<td>39</td>
<td>M</td>
<td>'49</td>
<td>8/19/53</td>
<td>F.A. Act.</td>
<td>Tpy. other hospital, also other drugs Sthd. PAS. INAH 12/53 to 5/54</td>
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</tr>
<tr>
<td>32</td>
<td>L.O.</td>
<td>W</td>
<td>59</td>
<td>M</td>
<td>'50</td>
<td>5/21/51</td>
<td>F.A. Act.</td>
<td>Sm. PAS. INAH 12/53 to 5/54</td>
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<tr>
<td>33</td>
<td>E.W.</td>
<td>W</td>
<td>23</td>
<td>F</td>
<td>'49</td>
<td>1/13/53</td>
<td>F.A. Act.</td>
<td>Pnx. '49 to '50; Pnp. '50 to '51; Sm. &amp; PAS intenmit.; INAH 1/53 to discharge</td>
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(Continued on next page)
<table>
<thead>
<tr>
<th>No.</th>
<th>Initial</th>
<th>Case Number</th>
<th>X-ray</th>
<th>Adm. Sp</th>
<th>Surgery</th>
<th>Hist. of Specimen</th>
<th>Course</th>
<th>Pathology of Specimen</th>
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<tbody>
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<td>1</td>
<td>I.A.</td>
<td>3572</td>
<td>+</td>
<td>Infl. &amp; K</td>
<td>R.U. Lobe 9/53</td>
<td>- Sm. - C</td>
<td>Disch. 6 mos. arr.</td>
<td>Atel. fibr., K. only a slit, no cas. left</td>
</tr>
<tr>
<td>2</td>
<td>W.W.</td>
<td>3053</td>
<td>+</td>
<td>I &amp; K</td>
<td>R.U. Lobe 8/53</td>
<td>- Sm. - C</td>
<td>Disch. 6 mos. arr.</td>
<td>Atel. K. only a slit, no cas. left</td>
</tr>
<tr>
<td>3</td>
<td>R.B.</td>
<td>1582</td>
<td>+</td>
<td>Infl.</td>
<td>L. Pneum &amp; tpy. 1/54</td>
<td>+ Sm. + C</td>
<td>Disch. 6 mos. arr.</td>
<td>Atel. upper, fibr., cas. masses lower</td>
</tr>
<tr>
<td>4</td>
<td>C.H.</td>
<td>2091</td>
<td>+</td>
<td>I &amp; Ks</td>
<td>L. Pneum &amp; tpy. 10/53</td>
<td>+ Sm. + C</td>
<td>Disch. 6 mos. arr.</td>
<td>Atel. fibr., stellate scar; 3 cm. K., encap. masses</td>
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<td>M.B.L.</td>
<td>2050</td>
<td>+</td>
<td>I &amp; Ks</td>
<td>R.U. Lobe 12/82</td>
<td>- Sm. - C</td>
<td>Disch. 6 mos. arr.</td>
<td>Atel. lobe, scars, calc. tub., no Ks.</td>
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<tr>
<td>8</td>
<td>N.L.</td>
<td>3415</td>
<td>+</td>
<td>I &amp; K</td>
<td>Ap. &amp; Post Seg. R.U. 1/54</td>
<td>+ Sm. + C</td>
<td>Disch. 6 mos. arr.</td>
<td>Sm. K. in center segment, soft walled</td>
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<tr>
<td>13</td>
<td>D.V.W.</td>
<td>3447</td>
<td>+</td>
<td>I &amp; K</td>
<td>L. Pn. 3/54</td>
<td>+ Sm. + C</td>
<td>Disch. 5 mos. arr.</td>
<td>Lg. 7 cm. K.; sm. 2 cm. cavities; cas. &amp; calc. tub.</td>
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<td>14</td>
<td>M.G.</td>
<td>3003</td>
<td>+</td>
<td>I &amp; K</td>
<td>L.U. Lobe &amp; Sup. Seg. L.L. 12/53</td>
<td>+ Sm. + C</td>
<td>Died 30 days, pul. embolism</td>
<td>Lg. 7 cm. K. in upper c thck wall; encapsulated tub.</td>
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<td>Vol.</td>
<td>No.</td>
<td>Date</td>
<td>A. M.</td>
<td>Tissue</td>
<td>Pathology</td>
<td>Description</td>
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<tr>
<td>16</td>
<td>2950</td>
<td>I &amp; Ks</td>
<td>R.U. Lobe c tpy.</td>
<td>Sm. - C</td>
<td>Disch. 6 mos. arr.</td>
<td>Lg. thick walled K., smaller Ks., tubercles</td>
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<tr>
<td>17</td>
<td>2665</td>
<td>I &amp; K</td>
<td>R.U. Lobe 3/54</td>
<td>Sm. + C</td>
<td>Disch. 6 mos. arr.</td>
<td>Sm. residual K., encap. tub.</td>
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<td>18</td>
<td>3615</td>
<td>I &amp; Lg. K</td>
<td>R.U. Lobe 3/54</td>
<td>Sm. - C</td>
<td>Disch. 5 mos. arr.</td>
<td>Large stellate scar under adhesion, encap. tub.</td>
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<tr>
<td>20</td>
<td>3192</td>
<td>I &amp; K</td>
<td>R.U. Lobe 3/54</td>
<td>Sm. + C</td>
<td>Disch. 5 mos. arr.</td>
<td>Lg. flat, thick walled K. c lung stone; partly re-epith.</td>
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<tr>
<td>21</td>
<td>3760</td>
<td>I</td>
<td>Ap. Post Seg. L.U. 4/54</td>
<td>Sm. + C</td>
<td>Disch. 6 mos. arr.</td>
<td>Lg. soft mass opening into bronch; several soft masses</td>
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<td>22</td>
<td>2107</td>
<td>I &amp; Lg. Ks</td>
<td>Pn. &amp; Tpy. 3/54</td>
<td>Sm. - C</td>
<td>Disch. arr.</td>
<td>Lg. 10 cm. K. in upper c several small Ks—all smooth walls; fibr., some atel.</td>
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<td>25</td>
<td>3304</td>
<td>K &amp; K</td>
<td>R.U. Lobe c decorct. 3/54</td>
<td>Sm. - C</td>
<td>Disch. arr.</td>
<td>Soft infiltration throughout; Lg. soft walled K. in upper; pleuritis; empyema</td>
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<tr>
<td>26</td>
<td>3530</td>
<td>I</td>
<td>Wedge R.U. 3/54</td>
<td>Sm. + C</td>
<td>Disch. 4 mos. arr.</td>
<td>A fibr. mass c residual K. 1 x 1½ cm. thick pl.</td>
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<td>27</td>
<td>1534</td>
<td>I &amp; Ks</td>
<td>L. Pn. &amp; tpy 5/54</td>
<td>Sm. + C</td>
<td>Disch. 5 mos. arr.</td>
<td>Sm. residual K 1 x 1½ cm.</td>
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<td>28</td>
<td>3135</td>
<td>I &amp; K</td>
<td>R.U. Lobe 2/54</td>
<td>Sm. - C</td>
<td>Discharged arr.</td>
<td>Many Ks, fibr., atel., tub.</td>
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<tr>
<td>30</td>
<td>379</td>
<td>I &amp; Ks</td>
<td>L.U. Lobe 1/54</td>
<td>Sm. - C</td>
<td>Pneumothorax, but disch. 8 mos. as arr.</td>
<td>Large stellate scar, encap. tub. bronchiectasis</td>
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<tr>
<td>31</td>
<td>3567</td>
<td>I &amp; K</td>
<td>Post tpy. L.U. Lobe 5/54</td>
<td>Sm. - C</td>
<td>Disch. arr.</td>
<td>Insipissated K. and 2 scars of healed Ks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>3374</td>
<td>I &amp; K</td>
<td>R. Pn. c tpy. 2/5/53</td>
<td>Sm. - C</td>
<td>Disch. 10 mos. arr.</td>
<td>Downward course of Pneumatothorax, but disch. 8/10/53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>2684</td>
<td>I &amp; K</td>
<td>R.U. Lobe 3/6/53</td>
<td>Sm. - C</td>
<td>Disch. arr.</td>
<td>Several residual Ks.; fibr.; atel.; endobronchitis; stellate scars</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Large stellate scar with many encap. tub.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There is perhaps nothing that has not happened before, and actually been described before, but the difference is in the number of occurrences and the reduced time in which they occur. In fact, one of the authors (H. C. S.) and others have described practically every change to be described subsequently in this paper. The difference is that, following the best antimicrobial therapy with proper collateral treatment, there is a gradual healing of tuberculous lesions up to the point of emergence of resistance, or to the break of the patient's strict regimen in one way or another when a reversal of the healing tendency may result. It may be stated rather dogmatically that the majority of untreated cases of tuberculosis may be brought to healing by vigorous and proper treatment. The principal failures are due to improper treatment, or to disease that is too far advanced or too chronic at the beginning. Even far advanced lesions may be brought to a point of freedom from tubercle bacilli. Large caseous foci or fibrotic and encapsulated lesions, however, may shield bacilli for long intervals so that only partial healing will result with prolongation of activity, continuance of the presence of acid fast bacilli and even exacerbation and extension of the disease as a result of the emergence of resistant bacilli.

The material in this study is a representation of various types of healing, some of which would have recovered without resection, but most of the cases were brought to an arrest by the intervention of surgery following, and along with, antimicrobial therapy.

It should be mentioned that there were a rather large number of resections carried out before bacteriological control methods were established, but it was thought better to work with a smaller series where more complete work was done, than with a larger series with incomplete studies.* Unfortunately it was not possible to complete the virulence studies on the 15 positive cultures in this series.

There are 34 cases in the groups which are listed in Table I. Many details are included, some of which are worthy of discussion. Others are statistical or only of academic interest.

There were 18 females—12 white and six colored; 16 males—nine white and seven colored. The average age of the females was 28.8 years—27.3 for the white and 32 for the colored. The average age of the males was 38.6 years—39.2 for the white and 38.0 for the colored.

There was evidence of cavity on x-ray film in 29 cases—some had huge and multiple cavities.

All cases but two had positive sputum on admission. They had been positive at an early date. The onset of symptoms were uneventful and about as expected from many former reports. Drug treatment was generally adequate and satisfactory, but several cases had been treated most irregularly.

The course of the disease was favorable, ending in arrest in about six months in all but three cases.

*At this juncture we should like to pay tribute to our colleague Dr. Leffie Carlton, who did most of the early resections and several in this series.
As to the type of the surgery performed, six (3, 4, 13, 22, 27, 33) had pneumonectomy, only one (13) without concomitant thoracoplasty. Two were on the right (22, 33) and four were on the left (3, 4, 13, 27). All survived and were discharged as arrested within six to 10 months. Eight (1, 2, 5, 17, 18, 20, 28, 34) had simple right upper lobectomies and all were discharged within five to eight months as arrested. Two (16, 32) had right upper lobectomies with thoracoplasties, one died following bronchopleural fistula and thoracoplasty, the other was discharged, arrested within six months. One (25) had right upper lobectomy with decortication that was discharged as arrested. Another, (24) had right upper lobectomy with decortication followed by broncho-pleural fistula and thoracoplasty but succumbed to a Ps. 

aruginosa infection. Another, (9) had right upper lobectomy with a wedge of the right lower and was discharged in 6 months. There was one (26) having a wedge resection of the left upper that was discharged within four months as arrested. There were only three (10, 30, 31) left lobectomies of which one, (31) was post-thoracoplasty. All of these were discharged before 10 months as arrested—one after hemathorax with recovery. There was one (14) left upper lobectomy with a superior segment of the left lower that died within 30 days of a pulmonary embolus. The patient was making an uneventful recovery. One (29) had had left upper lobectomy, followed within 30 days with right upper lobectomy. This patient was discharged within three months after the second operation as arrested.

Two (8, 19) had apical posterior segmental resections, the latter (19) with decortication. Both were discharged as arrested.

Five (6, 11, 12, 21, 23) had left apical posterior segment removed, five were discharged within six months as arrested, one was A.M.A. within six weeks, but was in good condition when he left.

There was one (7) having an apical posterior segment of the left upper, with a wedge of the superior segment of the left lower, that was discharged in six months as arrested. One (15) had apical posterior and anterior segment of the left upper with decortication and ultimately discharged as arrested.

Seventeen of the operations were on the left side and 16 on the right side. One was bilateral. The tendency seemed to run toward right upper lobectomies, with segmental operation on the left. There was usually more good lung tissue left on the left side than on the right. Otherwise, the two sides had no essential difference.

Bacteriological results are tabulated in greater detail in Table II.

There were 15 specimens negative on smear and culture; 12 positive on smear and culture; four negative on smear and positive on culture, and

<table>
<thead>
<tr>
<th>TABLE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>BACTERIOLOGICAL FINDINGS IN RESECTED SPECIMENS</td>
</tr>
<tr>
<td><strong>Negative Smear and Culture</strong></td>
</tr>
<tr>
<td>15</td>
</tr>
</tbody>
</table>
three positive on smear and negative on culture. Virulence tests were not completed. Results of the three cases negative on culture, but positive on smear were similar to the findings of others and were not greatly unlike the findings in patients not treated with antimicrobials. There is no doubt a more sudden and detrimental effect on the bacilli produced by the drugs, but it probably represents, in part at least, only an accelerated process of the same phenomenon. Many times bacteria may be shut off from oxygen and nourishment so that they may be thought of as existing in a gradually progressive dormant state until death finally ensues. It is possible that many of the bacilli may be revived from this state with proper enrichment of culture media and improvement of environment, but undoubtedly a time will come, perhaps rather suddenly in bacilli exposed to antimicrobials, when it is impossible to elicit growth and reproduction by any known method.

The problem is largely an academic one, since most of the bacilli

<table>
<thead>
<tr>
<th>Pathologic State of the Resected Lesions</th>
<th>Number</th>
<th>Percentage</th>
<th>Bacteriologic Findings</th>
<th>Surgical Needs</th>
<th>Case Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cavities on X-ray and none found after surgery —essentially healed</td>
<td>2</td>
<td>5.9</td>
<td>1 + Sm + C</td>
<td>Questionable need, except to remove useless and dead tissue, but justifiable</td>
<td>3, 23</td>
</tr>
<tr>
<td>Cavities and tubercles closed by fibrous tissue completely or with only residual slits</td>
<td>9</td>
<td>26.4</td>
<td>8 — Sm — C</td>
<td>No apparent need except to remove dead tissue</td>
<td>1, 2, 5, 6, 10, 12, 18, 29, 34</td>
</tr>
<tr>
<td>Cavities closed to apparently 1 cm. in diameter</td>
<td>5</td>
<td>14.7</td>
<td>All + C 2 + Sm</td>
<td>Justifiable but—may have recovered without surgery</td>
<td>7, 8, 11, 17, 26</td>
</tr>
<tr>
<td>“Cystic Lung” residue—otherwise healed</td>
<td>1</td>
<td>3.0</td>
<td>1 — Sm — C</td>
<td>Necessary to remove, future threats of a non-specific nature</td>
<td>22</td>
</tr>
<tr>
<td>Large caseous masses—two with no cavities on X-ray, but did not show beginning cavities pathologically. One was old cavity with inspissated pus</td>
<td>3</td>
<td>8.8</td>
<td>1 + Sm — C 1 — Sm + C</td>
<td>Absolutely necessary</td>
<td>19, 21, 30</td>
</tr>
<tr>
<td>Various combinations of large cavities—thick walled or containing inspissated pus—with or without atelectasis, en-capsulated caseous or calcified tubercles—recovered</td>
<td>11</td>
<td>32.4</td>
<td>6 + Sm + C 1 + Sm — C</td>
<td>Imperative for survival</td>
<td>4, 9, 13, 16, 15, 20, 25, 27, 28, 31, 33</td>
</tr>
<tr>
<td>Same as preceding, but fatal within 60 days or less</td>
<td>3</td>
<td>8.8</td>
<td>2 + Sm + C</td>
<td>Imperative</td>
<td>14, 24, 32</td>
</tr>
</tbody>
</table>

| | | 34 | 100.0 |
probably go on in time to death. Although there may be certain signs of life in the protoplasm for periods of time long after growth reactions have ceased. It may be compared to higher forms of life. The cells of a tree do not die immediately after it is cut down and the cells of an animal live long after the heart stops beating.

The analysis of the 34 resected lesions with regard to the nature of the pathology and the prognosis at the time of operation is presented in Table III.

There were nine (1, 2, 5, 6, 10, 12, 18, 29, 34) having complete closure of cavities with encapsulation and resorption of all foci. These cases showed at the most only thin slits or small inconsequential cavities in a few millimeters in diameter. Some of the cavities were completely filled in with granulation tissue. In retrospect, it is apparent that most of these cases probably would have recovered without surgery, since only one had a positive culture on the resected specimen.

Two (3, 32) that showed no cavities on x-ray films, cleared almost entirely, but one specimen was positive on smear and culture and the other on smear. The need for surgery was doubtful, but justifiable in view of the bacillary findings. It is likely that both cases would have recovered in time without operation.

The third group was represented by five (7, 8, 11, 17, 26) where there were definite cavities remaining but they were shrunken to less than 1½ cm. in diameter. All specimens were positive on culture and two were positive on smear. In view of the positive cultures, surgery was entirely justifiable, although most of these cases may have recovered in time, especially if proper rest and antimicrobial therapy were applied.

One case represents a group that needs special consideration. It is the acute pneumatic type that responds well to drug therapy—so well that there is a disappearance of sputum and tubercle bacilli. This case (22) was negative for a year previous to operation. The cavities did not disappear, but remained open, perhaps by valvular mechanism. Some appeared to have become “tension” types—assuming the appearance of a cystic process. The walls of these cavities tend to become thin plates of connective tissue with no epithelium. In fact the surface is smooth and free of all caseation and granulation tissue. As the illustration shown by the case of B. L. No. 3414, these “bullae” may form, enlarge and disappear and the whole process may gradually shrink upwards towards the apices.

The next group of three (19, 21, 30) represents the group containing large, caseous masses, caseous “unresolved” infiltrates, or shrunken cavities containing inspissated pus and “tuberculomas” of several types. These cases rarely recover spontaneously, but remain a threat for years and even decades. Surgery is not only justifiable, but mandatory in spite of the fact that the case (30) with inspissated pus in the old cavity revealed no tubercle bacilli in the specimen.

The most important group of all includes many types of pathology with large, and sometimes many thick walled cavities, some containing
Figure 1: An A. P. roentgenogram of Case 34, taken April 23, 1951, showing an 8 cm. annular shadow in the right apex. There is a residual pneumoperitoneum seen earlier in January, 1951. There is some asymmetry of the right hemidiaphragm and a small pleural effusion.

Figure 2: A. P. roentgenogram of Case 34, taken March 29, 1956, showing an 8 cm. annular shadow in the left apex and an extension of an infiltrate into the left midfield. This exacerbation followed a disciplinary discharge.

Figure 3: An A. P. roentgenogram of Case 34, taken February 27, 1956, showing an 8 cm. annular shadow in the right apex and a similar shadow in the left apex.
inspissated pus, some with areas of atelectasis, some with diffuse fibrosis, some with many encapsulated masses, other with caseous and calcified tubercles and many other combinations. Most of these cases have destroyed lungs that must be removed by pneumonectomy. Others need lobectomy alone, or with added segmental or wedge resection. Others may only need single or multiple segmental resection, but all have a grave prognosis and their salvation depends almost entirely on surgery.

The greatest problem in tuberculosis hospitals today is to treat these far advanced, mostly bilateral cases until they become amenable to surgery and the greatest challenge of the chest surgeon is to devise ways and means of operating on these "salvage," or at least serious types of case. Of this group of 11 (32.4 per cent of the series) (4, 9, 13, 16, 16, 20, 25, 27, 28, 31, 33) six were positive on smear and culture. One was positive on smear alone, and in four no tubercle bacilli could be found. In spite of the favorable bacteriologic finding in the last four, the surgery was mandatory since there were large numbers of unhealed tubercles, cavities, and other pathology that would have been a long time in healing if it ever would heal.

The last group of three (14, 24, 32) are those that died. One (24) succumbed to a *Ps. aeruginosa* infection that was apparently present at the time of operation and which did not yield to the measures adopted. A broncho-pleural fistula developed for which thoracoplasty was done. There was not realization of the seriousness of this infection either before operation or during the first days after. In fact, the patient was practically lost before the bacterial diagnosis was made. Another case (14) died 30 days after operation as a result of a pulmonary embolus. This

*Figure 4:* Same case on December 15, 1952, after readmission with a sharp outline of a smaller cavity in apex and a clearing of midfield.—*Figure 5:* Same case on February 17, 1953, with an A. P. planogram, showing a sharply outlined annular shadow.
Patient was a fine risk before and after operation, but the patient followed a rest program so well that the thrombi developed in the femoral veins unbeknown to anyone. The other case (32) was a poor risk before operation, developed a bronchopleural fistula, followed by thoracoplasty, but succumbed within 60 days of the first operation. It belonged to the group of cases that must remain as the “calculated risk” in tuberculosis.

In order to illustrate in greater detail some of the chief pathological changes, seven cases will be given in more detail, one of which was not operated on, but it is intended to represent a special type of cystic lung similar to one of the operated cases.

The six operated cases illustrated different types of involvement from complete healing of large cavities to a heterogeneous mixture of healing, partial healing, arrest of healing and many other types of pathology.

The various cases will progress in the reverse order of healing rather than in sequence in numbers. For example, those showing the most striking healing will be given first.

Case 34: A. L. C., 32 year old colored female, was admitted to the Southwest Florida Tuberculosis Hospital on June 19, 1951, with a diagnosis of far advanced, active pulmonary tuberculosis. Onset of tuberculosis was apparently in February, 1951, at which time the patient was diagnosed as having influenza. She failed to respond to the usual symptomatic treatment and x-ray films subsequently disclosed tuberculosis.

Antibiotic therapy consisted of isoniazid (INAH) daily from November 14, 1952;

FIGURE 9: Gross specimen of Case 34. Note the large depression in the upper aspect with attachment of adhesion. The depression in the mid-zone is artefact.
Figure 10: Low power microphoto of a section through the depression shown in Fig. 9. Note stellate scar with only a few slits remaining. The whole scar was several centimeters in length. The roof of the cavity seemed to have fallen in. X6 H & E—

Figure 11: A higher power magnification of the area outlined in the rectangle. Note the remaining slits with fibroblasts on each side and heavier bands of connective tissue. X80. H & E.
para-aminosalicylic acid (PAS) daily since August 13, 1951, and streptomycin twice weekly since August 13, 1951. All three drugs were continued through the period of surgery and for several months subsequent to surgery. Right upper lobectomy was performed on March 26, 1953, for residual tuberculous atelectasis and "cavitation."

**Pathologic Findings:** The specimen consisted of a right upper lobe. There was an adhesion on the upper aspect of the lobe with a deep depression beneath it. On section there were many strands of fibrous tissue on the cut surface. The principal fibrous remnant was beneath the depression in the pleura.

The microscopic specimen revealed the depression in the pleura and the heavy band of fibrous tissue running irregularly throughout the specimen. The main band of tissue ran parallel to the surface of the pleura. There were many branches running out from the main band, like skeins of yarn. A higher magnification reveals a thin slit with fibroblasts forming on each side to bridge the gap. All caseous material has been resorbed along with all polymorphs and other constituents of a pyogenic membrane.

**Case 18:** F. H., 29 year old colored female, was admitted to Southwest Florida Tuberculosis Hospital on October 13, 1953, with a diagnosis of moderately advanced, active pulmonary tuberculosis. Sputum on admission was positive. Onset of disease occurred in May, 1952, at which time she noticed loss of weight, malaise, cough and expectoration. She was hospitalized from June, 1952 to January, 1953, in another institution and received 250 mgs. daily of INAH at that time. She showed considerable improvement but was discharged in a disciplinary status and apparently did not remain under treatment until admission to this institution.

Antibiotic therapy given prior to surgery consisted of INAH, PAS, from October 25, 1953, until March 18, 1954. Bacteriological studies of the resected specimens were negative on smear and culture for acid-fast organisms. Convalescence was uneventful and she was subsequently discharged as an arrested case.

**Pathologic Findings:** The specimen was the upper lobe of the right lung. A few fresh tubercles were noted and in the upper part of the lobe, there

![FIGURE 12](Image)

**Figure 12:** A print of an A. P. roentgenogram of Case 18, taken on June 30, 1952, showing involvement of the whole right upper lobe with a 10 by 12 cm. cavity.

![FIGURE 13](Image)

**Figure 13:** Same as Fig. 12, taken on March 16, 1954, just before surgery. There is little left of the infiltration and the cavity is not visible.
was a stellate scar measuring about 1½ to 2 cm. across with projections running out into the tissues, indicating the site of previous cavitation. The cavity had apparently become entirely filled in with granulation tissue.

**FIG. 14**

*Figure 14:* A low power microphoto of a section through a spider-shaped scar in the upper part of the resected lung lobe. The scar was about 0.5 by 1.5 by 2.5 cm. in dimensions. X6 H & E.—**Figure 15:** A higher magnification of the outlined area in Fig. 14. Note the caseous central area and the ring of lymphocytes around all that is left of the cavity. Bands of fibrocytes are outside the lymphocytes. X30 H & E.
In other areas of the specimen, complete healing was noted. There was a small homogeneous mass in the center with a ring of cells arranged in elliptical manner.

The microscopic section revealed a tangled mass of organized connective tissue with a small central caseous focus surrounded by lymphocytes. There had apparently been complete obliteration of the pyogenic membrane on the surface of the cavity, with a replacement of the neutrophiles by lymphocytes and a gradual closing of the opening until nothing was left but a small area of caseation that was being resorbed by a centripetal encroachment of lymphocytes.

*Case 6*: J. B., 55 year old white male, was admitted to the Southwest Florida Tuberculosis Hospital on December 20, 1952, with a diagnosis of far advanced, active pulmonary tuberculosis. Sputum was positive for acid-fast bacilli on admission. Onset of illness began two years prior to admission with progressive weakness, loss of weight, and cough. Chest roentgenograms revealed cavitation in the left upper lobe and an infiltrative process in the right apex.

Antibiotic therapy consisted of streptohydrazide from January 8, 1953 until November 27, 1953; streptomycin from November 27, 1953 to December 4, 1953. This was continued subsequently to surgery as has been routine in all cases. Sputum converted to negative in March, 1953.

Resection of the apical-posterior segment of the left upper lobe was performed on December 4, 1953, for residual infiltrative and fibrotic disease. Bacteriological studies of the resected specimen were negative on smear and culture for acid-fast bacilli. Subsequent course was uneventful and the sputum remained negative until he was discharged.

*Pathologic Findings*: The specimen consisted of an apico-posterior segment of the left upper lobe containing a large central stellate scar. This unquestionably represented the site of the previously noted large apical cavity that had undergone complete healing. The area of the scar was filled with solid granulation tissue. A small secondary cavity

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**FIGURE 16**

*Figure 16*: An A. P. roentgenogram of Case 6, taken on December 23, 1952. Note the large cavity in the left upper and infiltration in the right apex.—**FIGURE 17**: Same case as Fig. 16, taken on November 30, 1953. Note the clearing of infiltrations with no sign of a cavity wall shown in Fig. 16.
Figure 18: A low power microphoto of the fibrous scar in the upper part of the specimen. There is only a 3 mm. cavity left. X6 H & E.—Figure 19: A higher magnification of area outlined in rectangle in Fig. 18. Note the clearing caseation with atrophic granulation tissue. X30 H & E.
with a ragged center was noted in the extreme apex and this measured approximately $1\frac{1}{2}$ cm. in diameter. There were no tubercles found in the lymph nodes, or tuberculous ulcers in the bronchial tree.

The low power microscopic view consisted of a field of solid fibrous tissue with a 2-3 mm. opening in the center. A higher magnification of the wall of this opening revealed atrophic granulation tissue. There were "ghosts" of capillaries and fibroblasts remaining with no caseation, nor other cellular remnants. The small cavity in the apex was typical of a static process with disintegrating cellular debris, undergoing caseation. The large cavity had all but closed, but the small sub-pleural cavity had not entirely closed.

Case 3414: (Figs. 20 to 23 incl.) A 19 year old colored female was admitted to the Southwest Florida Tuberculosis Hospital on January 18, 1953. Admission diagnosis was far advanced active pulmonary tuberculosis. She was extremely ill at the time

**FIGURE 20**  
**FIGURE 21**

**FIGURE 22**  
**FIGURE 23**

*Figures 20, 21, 22, 23:* A. P. roentgenograms of patient B. L., Case 3414, showing a remarkable clearing of the pneumonic caseation and infiltration shown in Fig. 20. The dates of the x-rays are February 10, 1953; November 25, 1953; February 5, 1954; and May 13, 1954. It will be observed that bullae form and enlarge, due perhaps to a valvular mechanism of the draining bronchi. The patient has been bacillus negative for over 18 months. The net result is a cystic lung. This case is similar to Case 22.
of admission and the prognosis was considered poor. Her sputum was positive for tubercle bacilli.

Her history was one of progressive cough, expectoration, fever, weight loss and night sweats for the previous six month period. Chest roentgenogram on admission showed

FIGURE 24: Same as Figs. 20-23 on January 13, 1955. Note the shrinking of the cavities in the left upper. This process has no doubt been augmented by the Monaldi drainage.

FIGURE 25: An A. P. roentgenogram of Case 22, taken on February 10, 1950, showing a pneumonic consolidation of the whole right lung with much infiltration in the left base.—Figure 26: Same as Fig. 25, taken on March 2, 1954, showing clearing of most of the infiltrations with huge residual cavities in the upper and lower lobes. The cavities were essentially bullae with smooth and shining walls and no caseation or granulation tissue. The lung after removal was a collection of many dark, reddish brown, flaccid bullae, with walls of one to several mm. in thickness.
diffuse tuberculosis pneumatic consolidation and infiltration throughout both lung fields. There was a definite family history of tuberculosis, one of the brothers having recently died of tuberculosis in a tuberculosis hospital. Her father had also succumbed to tuberculosis several years ago. She was immediately placed on streptomycin, PAS and INAH, due to the critical nature of her illness.

Following one month of therapy there was excellent radiographic improvement. The therapy conference at the end of six months noted that her improvement had been dramatic, although the case still presented many problems.

On September 7, 1954, Monaldi drainage was performed for the purpose of decreasing the size of a large left upper lobe cavity. This attempt was not entirely successful and she appeared to tolerate the drainage tube poorly. As of the present time, she continues to show progressive improvement although there is still large visible bilateral apical bullae. In time, one side may clear enough to permit surgery on the other. Rarely these large bullae may close spontaneously. Sweeny, Perez and Dietrich reported a case where the whole left upper lobe was excavated, but closed so that an opening of no more than a cm. remained. At present there are probably 25 per cent of advanced cases that are not amenable to surgery, but by patient and correct drug treatment, many will in time become operable and even arrested. One of the greatest challenges of the tuberculosis physician today is to bring as many of these cases to surgery as possible. On the part of the surgeon, it is his challenge to devise ways and means to operate on such cases successfully.

The medical therapy was as follows:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosage</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Streptomycin</td>
<td>0.75 Gm. biweekly</td>
<td>2-21-53 to 11-30-53</td>
</tr>
<tr>
<td>INAH</td>
<td>1000 mg. daily</td>
<td>2-21-53 to 2-25-54</td>
</tr>
<tr>
<td></td>
<td>500 mg. daily</td>
<td>2-25-54 to 12-24-54</td>
</tr>
<tr>
<td></td>
<td>800 mg. daily</td>
<td>12-27-54 to 1-1-55</td>
</tr>
<tr>
<td></td>
<td>200 mg. daily</td>
<td>1-2-55 to 1-8-55</td>
</tr>
<tr>
<td></td>
<td>200 mg. daily</td>
<td>1-9-55 to ___</td>
</tr>
<tr>
<td>PAS</td>
<td>12 Gm. daily</td>
<td>2-21-53 to 1-9-55</td>
</tr>
</tbody>
</table>

(INAH and PAS are still being administered and lung not yet resected.)

Case 22: E. S., a 30 year old colored female, was admitted to the Southwest Florida Tuberculosis Hospital on February 9, 1950, with a diagnosis of far advanced, active pulmonary tuberculosis. Sputum was positive on admission. Onset occurred in December, 1948, with a severe pleuritic type of pain in the right chest. There was also cough, fever and night sweats. X-ray films revealed extensive bilateral disease which was diagnosed as tuberculosis pneumatic.

In addition to modified bed rest, hospital treatment consisted of streptomycin and PAS beginning March 7, 1950 and given intermittently during the subsequent four years. INAH was started on August 6, 1952. Following the institution of the INAH therapy, a remarkable clinical and radiological improvement was noted. The previously consolidated destroyed right lung became a mass of large blebs and bullae. This lung was considered to be a functionless, destroyed, multicavitary organ and represented the characteristic method of healing frequently seen following administration of INAH. Right pneumonectomy and concomitant thoracoplasty was performed on April 29, 1954. Bacteriological studies of the resected specimen were negative on smear and culture for acid-fast organisms. Post-operative course was uneventful and she was subsequently discharged as an arrested case.

Pathologic Findings: The specimen represented a destroyed right lung. The lung was completely consolidated and carified and there was evidence in the bronchi of old healed bronchitis. Scars of former ulceration could still be seen. There was extensive bronchiectasis involving the lower lobe and the entire apical area was replaced by a large cavity measuring 10 centimeters in diameter. This apparently had been completely sterilized. The wall of this cavity composed of a slick surface resembling that of any mucous membrane. There was no caseation remaining, nor any signs of inflammatory reaction.

Microscopic: The wall of the large cavity was a compact layer of fibrous connective tissue with what appeared like a remnant of a venous sinus in the center. The exposed surfaces had no evidence of epithelium whatever. It was bare connective tissue that had developed a smooth surface.
This phenomenon has been described by Bernard and associates\textsuperscript{17} in four cases with \textquoteleft\textquoteleft recent, acute and exudative type lesions,\textquoteright\textquoteright following antibiotic treatment.

Pruvost and associates,\textsuperscript{19} Simonin and associates,\textsuperscript{20} Bernou,\textsuperscript{21} Jacob and associates\textsuperscript{22} and others have also recorded the phenomenon.

Galy\textsuperscript{18} and associates described three resected specimens which were interesting pathologically. The walls of the \textquoteleft\textquoteleft bullae\textquoteright\textquoteright were composed of smooth connective tissue with no secretions or epithelial covering.

The formation of \textquoteleft\textquoteleft bullous cavities\textquoteright\textquoteright seems to be due to several factors. First, there is a recent acute infection where nothing but rapidly growing bacilli are present. These bacilli are attacked by the antibiotic, especially INA, and seem to be wiped out in toto before resistant forms can appear. It is the same result Steenken obtained in rabbits where he felt that he had sterilized the lesions and that all bacilli were dead. Furthermore, there were no \textquoteleft\textquoteleft dormant\textquoteright\textquoteright bacilli or \textquoteleft\textquoteleft granules\textquoteright\textquoteright left to light up an infection later, or to develop into resistant forms.

After the sterilization of the lesions the cavities remain open because the bronchi entering the cavities protrude into the lumen as valve-like mechanisms. This causes a gradually increasing tension within the cavity. As a result the cavities become much enlarged. In the case reported there was a case of adhesive pleuritis that kept the whole lung from

\begin{figure}
\centering
\includegraphics[width=\textwidth]{Figure27.png}
\caption{A microscopic photograph of a section through the walls of two adjacent bullae. There are two surfaces of bare connective tissue. There is no sign of epithelium. X190.}
\end{figure}
collapsing. There must be free pleural surfaces before such lesions can close out. When there is such a chance the lesions shrink and actually become closed, as reported by Sweany, Perez and Dietrich. On the other hand, they may remain or actually enlarge as bullae.

Case 28: L. W., 28 year old colored male, was admitted to the Southwest Florida Tuberculosis Hospital on June 21, 1952, with a diagnosis of far advanced, active pulmonary tuberculosis. Sputum on admission was positive. Onset of illness apparently occurred in the early part of 1951 at which time the patient was in another tuberculosis hospital for several months. In December, 1952, pneumoperitoneum was instituted and maintained until the time of surgery. Streptomycin and PAS were started in June 1952 and continued until

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Figure 28: An A. P. roentgenogram of Case 28, taken on July 15, 1952, several years after the disease was first found and after several courses of antimicrobials. There is much contraction towards the apex. —Figure 29: Same as Fig. 28, taken on February 9, 1964. There has been much clearing of the infiltrations and a shrinking of the cavities to oblong slits.

Figure 30: A low power of a section of Case 28 taken through the walls of some of the cavities. The smear of the caseation was positive, but the culture was negative. This patient had almost 4 years of intermittent antimicrobial therapy before surgery, part of time under commitment. X6 H & E.
February 12, 1954. INAH was added from September, 1952, until the present period. Although there was remarkable improvement in the inflammatory disease noted in the right lung, planigrams still revealed evidence of residual right upper lobe disease. On February 13, 1954, right upper lobectomy was performed. Bacteriological studies of the resected specimen were positive on smear and negative on culture for acid-fast organisms. Subsequent course was uneventful and he was discharged as an arrested case.

Pathologic Findings: The specimen consisted of a right upper lobe which contained almost complete healing of the tuberculous process. What was once a cavity measuring about 8 cm. in diameter had contracted down to a puckered area measuring 1 1/2 to 2 cm. and filled with granulation tissue. A few small cyst-like areas were seen surrounding this zone and might still have represented part of the original cavitary process. The bronchi were slightly dilated throughout. The lobe itself consisted of atelectatic tissue with a slight amount of fibrous reaction around the bronchi. No active lesion could be found despite the fact that smears were positive.

Microscopic: The section shown is only one-half the whole specimen because of the size of the piece of tissue. The microscopic view revealed a heavy fibrous wall around a long thin slit of caseous material surrounded by a disappearing layer of granulation tissue.

The original cavity was reduced to a slit about 5 mm. at its greatest dimensions with several other caseous pockets in the specimen.

Case 33: E. W., 23 year old white female, was admitted to the Southwest Florida Tuberculosis Hospital on January 13, 1953, with a diagnosis of far advanced, active pulmonary tuberculosis. She had previously been a patient at the Tallahassee Tuberculosis Hospital in November, 1949 and was transferred here for surgery. Her original complaints had been chronic fatigue, productive cough, high sweats and hemoptysis.

Collapse therapy between 1949 and 1953 consisted of one year of artificial pneumothorax, left, and six months of pneumoperitoneum. Streptomycin and PAS had been administered intermittently during the four year period and was continued throughout her course of surgery. INAH was started upon admission to this institution and con-

![FIGURE 31](image1)
![FIGURE 32](image2)

**Figure 31:** An A. P. roentgenogram of Case 33, taken on January 14, 1953, showing a diffuse involvement of the whole right lung with some clear spaces that appear to be cavities. There are also discrete shadows in the left midfield.—**Figure 32:** Same as Fig. 31, taken on February 3, 1953, with an increase in the densities on the right and an enlargement of the annular shadows.
continued until the time of discharge, approximately 10 months later. X-ray findings prior to surgery showed a completely destroyed and atelectatic right lung with some nodular apparently healed disease throughout the left mid-lung field.

Right pneumonectomy and concomitant thoracoplasty were performed on February 5, 1953 uneventfully. Her subsequent course was satisfactory and she was discharged as an arrested case 10 months following pneumonectomy.

Pathologic Findings: The specimen consisted of an entire lung which was atelectatic, fibrotic and non-functioning. There were scattered nodules in varying sizes and varying ages of lesions throughout the lung. Some contained caseous material while others represented apparently healed scars. Several areas of open cavitation remained. Definite endobronchial disease was noted.

Figure 33: A low power microphoto from Case 33. (Figs. 31 & 32). There are many encapsulated tubercles, some clearing of the infiltrative areas and an increase in fibrous tissue throughout. X6 H & E.

Figure 34: A small cavity from another part of the lung. Some parts of the cavity wall are caseous with a partial clearing of the pyogenic wall. X6 H & E.
Microscopic: The microscopic appearance varied in different parts of the lung. The tubercles were heavily encapsulated with giant cells in the walls; there were strands and skeins of heavy fibrous tissue, and areas of resorption showing a more reversible type of infiltration. In one section there was an oblong cavity measuring 0.5 by 2 cm. In one end of the cavity was a remnant of a pyogenic wall with resorption of most of the cellular material. Part of the caseation still remained as a solid mass. In the other end of the opening was a remnant of granulation tissue. The caseation had apparently been replaced by granulation tissue and this in turn was disintegrating.

Discussion

There is little in the bacteriologic findings that needs comment. In fact, there were only three cases that were positive on smear, but negative on culture. This result could be accounted for in many ways: to technical variations, to chance, to inadequate culture methods, etc. The fact that 15 specimens were negative for all tests for bacilli, is only what could be expected in healing tuberculosis. I believe under the existing circumstance we are justified in saying that most of the tubercle bacilli in the samples taken were dead. While some of the bacilli grew, we do not know how many of the acid fasts showing on smear, were past the point where recovery of growth were possible. In fact, it seemed in some cases, there were many more bacilli on smear than appeared as colonies on culture.

What might have been found if every part of the specimens were

Figure 35: Higher magnification of section of the caseous wall, showing giant cells and a gradual changing of the caseous pyogenic membrane of polymorphs and monocytes with a residue of lymphocytes and fibroblasts extending towards the inner margin of the cavity wall. X30 H & E.—Figure 36: Another view, showing fibroblasts extending towards the edge of the cavity. X30 H & E. Case 33.
cultured, or what exists in other parts of the body after operation is still an open question. The fact remains that no bacilli were demonstrated either in the specimen tested, or in the bronchial secretions.

Likewise the positive smear and culture in 12 specimens and positive culture, with negative smear, in four specimens is only to be expected.

The three positive smears and negative on cultures is not at all unusual. They may have become "lethargic" or actually have reached the death point because of the antimicrobials, but it could have happened naturally.

The pathologic changes were interesting and we believe worthy of the detailed descriptions we have given. We frankly were surprised to find such a high percentage of large cavities that were not only closed, but filled in with fibrous tissue. That is, the "pathologic target point" was reached and they could be classed as completely healed. Others were near to healing. In all but one of these, tubercle bacilli were not found. This one case had only a positive culture. In the two cases without visible cavities, one was positive on smear and another was positive on both smear and culture.

The pathologic changes generally parallel the degree of sterilization of the tubercle bacilli in the organ. In the acute infiltrative types that have not progressed too far, and have not caused the devastating intoxication of the organ with caseation and excavation, the relatively few bacilli are eliminated and the process resorbs much like the clearing of lobar pneumonia. Consolidations may be due to many things. "Infiltrates" may be caused in several ways; by pneumonic process; allergy; atelectasis, or by any other process that causes accumulation of fluid or cellular material in the lungs. The damage done depends upon the amount of tuberculotoxin present in the particular process, which in turn depends on the number of bacilli. The tissue cells are damaged in proportion to the toxic action by tuberculotoxin and perhaps allergy. The epithelium and parenchymatous cells are damaged first, then come circulating blood and lymph cells and last the connective, reticular and elastic tissue. Although the elastic tissue is not at first destroyed, its elasticity is impaired or destroyed to such a degree that varying grades of emphysema result. This has been called by Sweany the "emphysema of healing." It is due to a loss of function of the elastic tissue so that it is unable to regain its normal position after constant stretching during normal or forced respiration. Practically all tuberculous lesions that have cleared show some degree of this emphysema.

In cases with tuberculous pneumonia, destruction of the tissues has progressed much further and in places there is softening and excavation. In these specimens there are usually a larger number of tubercle bacilli and the time element is much longer than in the early tuberculous infiltrations.

In more chronic cases there are varying degrees of healing as shown by proliferation of fibrous tissue, carnified lung tissue and heavier cavity walls.
Re-epithelialization was only observed in one or two specimens. Had each bronchus been studied, especially at its entrance into the cavity, there would, no doubt, have been more cases found as Auerbach has shown. In large, recently excavated cavities, however, there has not been time enough for epithelium to proliferate. This is probably a good thing because the presence of epithelium would tend to, if not actually prevent, a closure of the cavity. In the closed cavities there was no sign of epithelium.

The cases with “open” cavities were practically all positive on culture and some on smear. Enclosed masses or tubercles and cavities were frequently negative. This result was of no practical importance, because the caseous masses are always a threat and had every particle been examined, bacilli may have been found. Besides, the caseous or fibro-caseous masses were a liability from mechanical reasons alone. Soft, caseous masses, or empty cavities are subject to abscess development later.

There is an important lesson from this work and that is that the specimen and even the sputum does not need to be negative to obtain a good surgical result. The principal criterion is the clinical condition of the patient with an advance of favorable factors to, or near the clinical and x-ray film “target point.” Of the cases discharged as arrested, 14 had positive cultures in the specimens and only three had positive smears with negative cultures. Of 15 specimens totally negative on bacteriological examination, 14 were discharged as arrested exactly the same number with positive bacterial findings. Of the three fatal cases, one was entirely negative and two were completely positive.

Another important lesson is that there are approximately 25 per cent of ulcerative, moderately advanced and far advanced cases treated with antimicrobials and rest, and brought up for surgery, will recover without surgery at all. Although these cases may not have needed excisional surgery for recovery, there is a finality of surgery that helps to convince everyone that there are no dangerous residues remaining. The assurance to both patient and physician is of much value. If mortality can be kept to near zero, it is a great morale builder and a time saver in most cases.

It will be in order at this point to attempt a breakdown of admissions in an average tuberculosis hospital with respect to the number of cases that are amenable to surgery. Some hospitals still have a majority of far-advanced cases, others have “come nearer to the bottom of the barrel” of the material and admit more early cases. Depending upon the admission policy, therefore, the figures for patients not needing any consideration of surgery varies between rather wide limits with an average perhaps around 50 per cent. This group will respond to rest and drugs alone. The other 50 per cent are sufficiently far advanced to be considered for surgery, after short or long courses of antimicrobials. Some cases may take many months and even years to clear up sufficiently on one side, or in two or even three lobes for operations on the remaining side or lobes.

From the group of cases analyzed in this study and which are fairly
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representative of our surgical philosophy at this time, it appears that approximately 15 to 20 per cent of all cases, or 30 to 40 per cent of those cases selected for surgery might subsequently recover without surgical intervention. On the other hand, 15 to 20 per cent of all cases depend entirely upon surgery for eventual salvation if they can be salvaged at all. The remaining cases, variable in each hospital, will in time die of old age, complications (as cancer, heart disease, mental disease, etc.,) or advanced tuberculosis. While all cases were discharged as arrested, it will take 5 years to be certain.

SUMMARY

1. A pathologic and bacteriologic report has been made on resected specimens from 34 patients who received some form of pulmonary resection. One advanced case was included that did not receive surgery, but received antimicrobial therapy.

2. The most important observation was that rest and antimicrobial therapy not only clears up infiltrations in tuberculous cases, but allows the healing of over 25 per cent of recently developed advanced cases by filling in the cavities with granulation tissue and fibrosis, leaving only stellate scars. This group actually does not need surgery, except as assurance to remove any doubts in the minds of the physician, and give satisfaction to the patient. It will give him a shorter convalescence and protect him against any possibility of recurrence of his disease.

3. Another 10-15 per cent may recover without surgery, but for many valid reasons given before, surgery is advisable.

4. The remainder of seriously ill cases (about 60 per cent) need surgery for recovery, if recovery is possible. About half of these are sent home within six months to a year's time after operation as arrested. This group includes more chronic disease where fibrous adhesions and thick walled cavities prevent the closure of cavities. The other cases of this group represent salvage cases, some of which may be prepared for surgery over longer intervals and ultimately operated on; others belong to the various complications; others are too old; while there is a residue of advanced chronics who have little prospect of ever recovering and who will pass away over the years to come.

5. The bacteriologic findings were not unusual. Only three cases were found where there was a positive smear with negative culture. There were 15 negative and 16 positive cultures made from the resected specimens.

6. The various pathologic changes have been discussed.

RESUMEN

1. Se presenta una información patológica y bacteriológica de 34 enfermos a quienes se hizo algún tipo de resección. Se incluye un caso avanzado que no se sujetó a la cirugía, pero recibió terapia antimicrobiana.

2. La observación más importante fue que el reposo y la terapia antimicrobiana no sólo limpió las infiltraciones en los casos de tuberculosis, sino que permitieron la curación de más del 25 por ciento de los casos avanzados de reciente evolución llenando las cavidades con tejido de granu-
lación y fibrosis, dejando sólo cicatrices estelares. Este grupo de hecho no necesita cirugía excepto como un modo de asegurarse y quitar toda duda al médico y dar satisfacción al enfermo. Esto le proporcionará convalecencia más breve y protección contra recurrencia de la enfermedad.

3. Otro 10 a 15 por ciento puede recuperarse sin la cirugía, pero por muchas razones válidas ya dadas, sería la cirugía aconsejable.

4. El resto de los enfermos seriamente enfermos (alrededor del 60 por ciento) necesitan cirugía para recuperarse si es posible.

Alrededor de la mitad de estos son enviados a sus hogares dentro de 6 meses a un año después de la operación, clasificados como detenidos. Este grupo incluye enfermedad más crónica donde las adherencias fibrosas y cavidades de paredes gruesas impiden el cirre de cavidades.

Los otros enfermos de este grupo representan casos de rescate algunos de los cuales pueden ser preparados para cirugía por intervalos largos y después operados; otros corresponden a varias complicaciones; otro grupo es de demasiado viejos y hay un residuo de crónicos avanzados que tienen pocas probabilidades de recuperarse y que morirán en los años venideros.

5. Los hallazgos bacteriológicos no son inusitados. Sólo tres casos se encontraron en los que había un frotis positivo con cultivo negativo. Hubo 15 negativos y 16 positivos al cultivo con material tomado de las piezas resecadas.

6. Se discuten los aspectos anatomopatológicos diversos encontrados.

RESUME

1. Les auteurs rapportent l'examen anatomo-pathologique et bactériologique des pièces opératoires provenant de 34 malades, qui subirent une résection pulmonaire. Ils y ont ajouté le cas d'un malade porteur de lésions très graves qui ne subit pas d'intervention mais reçut une thérapeutique antimicrobienne.

2. La constatation la plus importante fut que le repos et la thérapeutique antimicrobienne non seulement permettent d'effacer les infiltrations tuberculeuses, mais amènent la guérison de plus de 25% des cas de tuberculose d'apparition récente en combiant les cavités de tissu de calcification, et de fibrose, laissant seulement une cicatrice étoilée. Ce groupe de malades n'a pas besoin actuellement d'intervention chirurgicale, à moins qu'on ne veuille enlever tout doute dans l'esprit du médecin et donner satisfaction au malade. Cela lui permettra une convalescence plus courte, et le protégera contre toute possibilité de rechute de la maladie.

3. Un autre groupe de 10 a 15% des malades peut guérir sans intervention, mais pour beaucoup de raisons des plus solides qui ont été énoncées auparavant, la chirurgie est souvent souhaitable.

4. Le reste des malades (environ 60%) comprenant les formes sévères doit être soumis à la chirurgie pour guérir si la guérison est possible. Environ la moitié d'entre eux peuvent être renvoyés à leur domicile dans un délai de 6 mois à un an après l'intervention. Ce groupe comprend surtout des malades chroniques, avec lésions fibreuses et cavités à parois
épaisses empêchant leur fermeture. Les autres cas de ce groupe représentent des cas rebelles, et quelques-uns d’entre eux peuvent être opérés après une préparation plus longuement poursuivie au terme de laquelle l’intervention est devenue possible. D’autres présentent des complications diverses. D’autres sont trop âgés. Enfin, il y a quelques chroniques gravement atteints, qui ont peu d’espoir de jamais guérir, et qui décéderont dans les années à venir.

5. Les constatations bactériologiques furent inhabituelles. Ce n’est que dans trois cas que l’examen sur lame se montra positif alors que les cultures restaient négatives. Il y eut 15 cultures négatives et 16 cultures positives à partir des pièces résectées.


ZUSAMMENFASSUNG

1. Ein pathologischer und bakteriologischer Untersuchungsbefund wurde vorgelegt über Resektionspräparate von 34 Kranken die irgend eine Form von Lungenresektion bekommen hatten. Ein fortgeschrittener Fall wurde einbezogen, der keine chirurgische, wohl aber antimikrobielle Therapie erhalten hatte.


3. Weitere 10-15% können sich ohne Eingriffe erholen, aber aus vielen triftigen zuvor aufgeführten Gründen ist der Eingriff anzuraten.


5. Die bakteriologischen Befunde waren nicht ungewöhnlich. Es wurden nur 3 Fälle gefunden, bei denen ein positiver Ausstrich zusammen mit
einer negativen Kultur vorkam. Es ergaben sich 15 negative und 16 positive Kulturen bei der Verarbeitung der Resektionspräparate.

6. Die verschiedenen pathologischen Veränderungen werden besprochen.

REFERENCES