The Use of Valvular Bronchial Blocking in Complicated Lung Tuberculosis

Guidelines for Doctors
A. V. Levin, E. A. Tseimakh, P. E. Zimonin

The Use of Valvular Bronchial Blocking in Complicated Lung Tuberculosis

Guidelines for Doctors
2nd publication

Barnaul 2008
The Guidelines for Doctors are written by the State Educational Institution of Higher Professional Education “Altai State Medical University” and Territorial State Institution of Health Service - “Altai Krai Tuberculosis Dispensary”.

Approved and recommended for publishing by Scientific Coordination Committee of Altai State Medical University and Coordination Committee in Surgery of the Central Department for Healthcare and Pharmaceutics of Altai Krai

Reviewers:
Professor V. A. Krasnov — Director of the Federal State Institute “Novosibirsk Tuberculosis Research Institution”, Honoured Doctor of the Russian Federation, Doctor of Medical Sciences

Dr. D. B. Giller — Head of Surgical Department of the State Institute “Central Tuberculosis Research Institution of Russian Academy of Medical Sciences”, Doctor of Medical Sciences

A. V. Levin, E. A. Tseimakh, P. E. Zimonin

The method of treatment of lung tuberculosis and its complications by means of the endobronchial valve was developed on the basis of the long-term research conducted in Barnaul and clinical experiments carried out in clinics of Moscow, St.-Petersburg, Novosibirsk, Tomsk, Tyumen, Kemerovo, and other locations. Creation of hypoventilation and atelectasis in a damaged lung area with preservation of the draining function of the blocked bronchus and the destruction cavity is the novelty of this method.

© Medlung, LTD, 2008
Introduction

Number of severe, rapidly progressing lung tuberculosis forms often leading to a lethal outcome has recently increased in Russia as well as in many other countries.

Among other reasons, it is caused by the increased frequency of cases caused by drug-resistant strains of tuberculosis mycobacteria. Treatment of such cases is rather difficult and ineffective; patients often continue to be bacteria-discharging and keep destructive alterations in lungs for a long duration of time. The role of non-medicated slightly invasive methods of treatment, e.g. artificial pneumothorax, is growing in these conditions.

However, there are some contraindications for the treatment of artificial pneumothorax: acute progressive forms of lung tuberculosis (cheesy pneumonia and fibrous cavernous lung tuberculosis), bronchial tuberculosis, exudative pleurisy, pleural empyema, complete obliteration of pleural cavity, impairment of blood clotting, acute coronary pathology. According to some authors, pleural empyema is a common complication of ineffective artificial pneumothorax among patients with lung tuberculosis.

Lung hemorrhage is a severe, often fatal complication of different diseases. Some clinicists prefer conservative therapy of lung hemorrhage, others go with the surgical methods of treatment. There exists an opinion that the common haemostatic therapy is effective only for hemorrhages of diapedetic nature (hemoptysis) and insignificant hemorrhages. But the effectiveness of this therapy in case of medium and severe recurrent hemorrhages is rather doubtful.

Blood asphyxia with development of hemaspiration pneumonia is one of primary causes of aggravation of patients with lung hemorrhage. It can often cause death. In most cases asphyxic hemorrhage does not appear immediately; usually it is the final stage of various lung hemorrhages lasting from several hours to several days. At the same time, the endovascular occlusion of bronchial arteries is a method that is not available for most clinics due to the high prices of this kind of equipment.

In unanimous opinion of all researches, bronchial fistula and postoperative pleural empyema are the most frequent and severe complications in thoracic surgery having impact on surgery outcomes and follow-ups and more often on a patient’s life. Presence of bronchial fistula interferes with the process of making vacuum necessary for
lung straightening. Thus, it makes treatment of pleural empyema difficult and empyema cavity sanation impossible to be exercise. Surgical procedures which eliminate empyema cavity are characterized by traumatism, frequent post-surgery complications, recanalization of bronchopleural fistula and tuberculosis reactivation. Early and effective closure of bronchopleural fistula is the indispensable condition of successful treatment of pleural empyema and complete lung straightening as it helps us avoid the second surgical procedure.

These guidelines are devoted to improvement of efficiency of complex treatment of the most frequent and severe complications of destructive tuberculosis.
Design of Valvular Bronchial Blocking

The new method of treatment of lung tuberculosis and its complications by means of endobronchial reverse valve was developed by us and successfully used since 2000 (Fig. 1).

Fig. 1. The design and appearance of endobronchial valves.

The principal novelty of the method of treatment of tuberculosis of lungs that we propose, including such forms of it as drug-resistant forms, is the creation of the therapeutic hypoventilation in a damaged lung area with the preservation of drainage function of a blocked bronchus and cavity of destruction. The valve is made of a rubber compound (registration certificate # FC 01032006/5025-06 of December 21, 2006) which is indifferent to a human organism in a shape a hollow cylinder (Fig. 2). The internal valve opening has a round smooth shape on one side, and on the other side it is designed a collapsible petal-like valve, which is blocked by excessive outer pressure and material’s own elastic properties, of which it is made of. Two thirds of the outer surface of a valve consist of a thin plate-shaped radial petals that hold the valve inside the bronchus.

The valve may be installed both with the help of rigid bronchoscope and bronchofiberscope. Valve size depends on the site of tuberculosis process and the diameter of
draining bronchus where it is set into (lobar, segmental, sub-segmental), and should exceed the diameter of bronchus’ opening by 1.2–1.5 times (Fig.10). The valve allows the air, sputum and other bronchial content to be released from the damaged area with expiration or cough. At the same time, no air returns to the damaged lung area, thus the condition of the therapeutic hypoventilation and atelectasis of lung tissue is gradually attained (Fig. 3).

**Fig. 2.** Design of the endobronchial valve
1. Hollow cylinder
2. Internal valve opening
3. Bridge that holds the valve
4. Radial petals that allows fixation of the valve inside of a bronchus
5. Collapsible petal-like valve

**Fig. 3.** The mechanism of endobronchial valve functioning
1. During expiration
2. During inspiration
Valvular Bronchial Blocker Installation Procedure

Endobronchial blocking is installed under general or local anesthesia. Diameter of a bronchial orifice for a valve to be set into is estimated after examination and sanitation of a bronchial tree. Bronchoscope is removed and the valve of a certain size is set on its distal end; the head of a bronchoscope is preliminary lubricated with glycerin (Fig. 4).

The valve is set into the best position after an adequate examination of the surrounding area. If a combined bronchoscopy is used, a valve pre-lubricated with glycerin is carried to the setting place through the cone of rigid bronchoscope. In case of local anesthesia, the valve set on the bronchofiberscope is carried through the oral blocker, oral cavity, pharynx. At a deep breath, the valve is carried through the fissure of glottis to the trachea and the blocked bronchus (Fig. 5, 6, 7)

Fig. 4. Endobronchial valve is set on the top of the bronchofiberscope.

Fig. 5. The endobronchial valve is carried to the setting place.
It is important to install the valve in such a way that the orifice lumens of the distal bronchus can be seen to make sure they are not to be obturated (Fig. 8). Then the fiberscope is removed from the valve when the latter is still held in a bronchus with the help of biopsy forceps. The forceps are opened and removed from the valve under visual control. An endoscopist asks a patient to cough thus estimating the reliability of the valve’s fitting into a bronchus and its functioning. During coughing the valve’s petal’s opening is visible and thus allowing the air out (Fig. 9). At this point the installation procedure is finished and the fiberscope is removed.
The X-raying of the chest at frontal and lateral projections is made to control the effectiveness of the valvular bronchial blocker on the next day and later by indications.

Endobronchial valve is removed under local and general anesthesia with the help of the endoscopic tools (biopsy forceps or polyectomy loop).
**Fig. 10.**
Valve Sizes (Ø mm) and Frequency of Their Use

- **Right proximal bronchus**
  - 7 — 8 (3.0 %)
  - 9 — 12 (4.6 %)
  - 10 — 6 (2.3 %)
  - 11 — 83 (31.7 %)
  - 12 — 93 (35.5 %)
  - 13 — 46 (17.6 %)
  - 14 — 14 (5.3 %)
  - Total — 262 (100 %)

- **Right main bronchus**
  - 14 — 1 (33.3 %)
  - 15 — 1 (33.3 %)
  - 20 — 1 (33.3 %)
  - Total — 3 (100 %)

- **Bronchus S6 of the right bronchus**
  - 6 — 4 (6.3 %)
  - 7 — 41 (65.1 %)
  - 8 — 18 (28.6 %)
  - Total — 63 (100 %)

- **Middle lobar bronchus**
  - 7 — 3 (30.0 %)
  - 8 — 2 (20.0 %)
  - 9 — 5 (50.0 %)
  - Total — 10 (100 %)

- **Basal bronchus of the right lung**
  - 9 — 1 (20.0 %)
  - 10 — 1 (20.0 %)
  - 11 — 1 (20.0 %)
  - 12 — 1 (20.0 %)
  - 14 — 1 (20.0 %)
  - Total — 5 (100 %)

- **Intermediate bronchus**
  - 13 — 4 (6.7 %)
  - 14 — 2 (3.3 %)
  - Total — 6 (100 %)
In total 648 endobronchial valves were installed. In some isolated cases 32 endobronchial valves were installed into the other segmental bronchus, 23 — with the outer diameter of 7mm, 9 — with the outer diameter of 8mm.
Indications and Contraindications for the Valvular Bronchial Blocking

A list of most frequent lungs pathologies, in a complex treatment of which the use of valvular bronchial blocking is the most reasonable:

1. Lung tuberculosis;
2. Pleural empyema and residual pleural cavities with the bronchopleural fistulas;
3. Acute lung abscesses complicated with:
   — hemorrhages,
   — pyopneumothorax;
4. Lung cancer complicated with hemorrhage;
5. Lung emphysema;
6. Lung cysts;
7. Spontaneous pneumothorax.

Indications for the treatment of lung tuberculosis

1. Infiltrated tuberculosis;
2. Fiber cavernous tuberculosis;
3. Drug resistance of tuberculosis mycobacteria;
4. Progressing tuberculosis;
5. Relapses and exacerbations of tuberculosis;
6. Constant bacteria discharging;
7. Poor tolerance of tuberculosis medications;
8. Senior age;
9. Associated pathology (pancreatic diabetes, stomach and duodenum ulcer, liver and kidney diseases, HIV);
10. Undisciplined patients.

Indications for treatment of lung tuberculosis complications

1. Lung hemorrhage
2. Bronchopleural fistula
3. Spontaneous pneumothorax
Comparative contradictions in lung tuberculosis

1. Purulent bronchitis;
2. Expiratory bronchial stenosis.

Description of patients

So far 648 patients have undergone the valvular bronchial blocking (Fig.10). 58 patients with indications for installation of the bronchial valve have had lung hemorrhage, 52 had bronchopleural fistula, 63 had drug resistant tuberculosis, and others had various forms of destructive tuberculosis.

The Results of Own Research on Lung Hemorrhage

We have analyzed the results of the treatment of 111 patients with lung hemorrhage. Fiber cavernous lung tuberculosis caused hemorrhage in 62 (55.9%) cases, infiltrated tuberculosis with a breakdown caused 37 cases (33.3%), tuberculoma with a breakdown caused 5 cases (4.5%), caseative pneumonia caused 2 cases (1.8%), and chronic disseminated tuberculosis caused 5 cases (4.5%).

One-sided tuberculosis was revealed in 62 (55.9%) cases, two-sided tuberculosis was revealed in 49 cases (44.1%). 95 (85.6%) patients had the obsemination phase.

38 (34.2%) patients had complications of lung tuberculosis (pneumothorax — 2 (1.8%) patients, empyema of pleural cavity — 2 (1.8%), cor pulmonale — 34 (30.6%) patients).

93 (83.8%) patients were bacteria-discharging. Drug-resistant tuberculosis was revealed in 35 (31.5%) patients, and 27 (24.3%) were reported to have multiple drug resistance.

40 (36.0%) patients had stage I hemorrhages (by classification of V. I. Struchkov et.al., 1985), 40 (360%) patients had stage II hemorrhages and 27 (24.4%) had stage III hemorrhages.

58 (52.3%) out of 111 analyzed patients had valvular bronchial blocker installed in a complex treatment of destructive lung tuberculosis with hemorrhage and bronchogenic dissemination (primary group), and a temporary bronchial occlusion by a foam rubber obturator saturated with antibiotics was carried out on 53 (52.0%) patients (comparative group).
Both groups were relative in sex and age, long-standing and extended pathological processes, in forms of lung tuberculosis, severity of their condition, volume of hemorrhage and the character of the performed operations.

Occlusion in the primary group lasted in average 224.3±95.2 days, maximum time being 515 days. Occlusion in the comparative group lasted accordingly 9.3±6.4 and 30 days. The average time of occlusion in the primary group was 24.1 times higher than in the comparative one (P<0.05). Increase of occlusion time and a concurrent hypoventilation and atelectasis of the blocked part of a lung allows to attain stabilization of the tuberculosis process and to stop lung hemorrhage more effectively.

The criteria for removal of the blocker were the effective stoppage of lung hemorrhage as well as arising complications related to the bronchial occlusion.

As results of the temporary bronchial occlusion were compared, it was revealed that 20 (34.5%) patients from the primary group had various complications and there were 46 (86.8%) patients with complications from the comparative group, which was 2.5 times higher than the corresponding index of the primary group (P<0.001). An obturating purulent endobronchustis and the increase of the destruction in the blocked part of the lung appeared in 34 (64.2%) patients of the comparative group, which caused the removal of the obturator. That complication appeared only in 7 (12.1%) patients of the primary group where the reversed endobronchial valve with the preserved drained function of the blocked bronchus was used, which is 5.3 times lower than in the comparative group (P<0.001). 12 (11.8%) patients had decubitus of the bronchus mucous and the enlargement of granulaton tissue.

This complication was found in 9 (17.0%) patients of the comparative group and 6 (10.3%) patients of the primary group where the endobronchial valve was placed into a bronchial tree for more than 368 days (P>0.5). 5 patients of the comparative group were noted to have a foam rubber obturator, which was located in a bronchial tree for more than 14 days, in-grown, which later caused difficulties in removal of the obturator.

Migration of the endobronchial valve in the primary group was evident in 4 (6.9%) patients, in the comparative group it remained the same – in 4 (7.5%) patients (P>0.5).

Hemoaspirating pneumonia was the most severe complication, which occurred in 20 (18.0%) patients. 3 (5.2%) patients being in the primary group and 17 (32.0%) in the comparative group that was 6.2 times higher than in the primary one (P<0.01).

The symptoms of lung hemorrhage after the temporary bronchial occlusion appeared in 27 (24.3%) cases: 7 (12.1%) in the primary group and 20 (37.7%) in the comparative one, which caused the necessity of repeated emergency bronchoscopy in the comparative group 3.1 times more often than in the primary group (P<0.001).

After removal of a blocker, lung hemorrhage reoccurred in 10 (9.0%) cases: 2 (3.4%) patients in the primary group and 8 (15.1%) in the comparative group, which was 4.4
times higher than in the primary one (P<0.05).

A negative roentgenological dynamics (the increase of infiltration, appearance of a new foci and destruction cavities) was noted in 9 (15.5%) cases in the primary group and 29 (54.7%) in the comparative group, which is 3.5 times higher than in the primary group (P<0.001). A positive roentgenological dynamics (reduction and resorption of foci and infiltration, reduction and closure of destruction cavities in lungs) was noted in 40 (69.0%) cases of primary group and 8 (15.1%) of comparative group (4.6 times higher than in the primary group) (P<0.001).

Urgent indications required two surgeries (3.4%) in primary group and 16 surgeries (30.2%) in the comparative group, which was 8.9 times higher than in the primary group (P<0.001). Lethality rate after urgent surgeries in the comparative group was 12.5% (2 patients). There were no lethal outcomes in the primary group.

In the process of complex treatment the termination of bacteria-discharging was noted in 37 (63.8%) patients of the primary group, being 11.2 times higher than in the comparative group (3 (5.7%) patients in the comparative group) (P<0.001).

Lethality made up 17.1% (19 patients) in both groups. At the stage of in-patient treatment 3 (5.2%) patients died in the primary group and 16 (30.2%) in the comparative one, which makes this rate 5.8 times higher than in the primary group (P<0.01).

Thus, the use of endobronchial valve is effective for termination of lung hemorrhage of lung tuberculosis. The forming of a long-term therapeutic hypoventilation and atelectasis at a damaged lung area with an endobronchial valve contributes the stabilization and regression of the tuberculosis process, prophylaxis of blood asphyxia and recurrence of lung hemorrhage.
The Results of Own Research in Bronchial Fistula

The results of the treatment of 110 patients operated for destructive lung tuberculosis were analyzed. The primary group contained 52 (47.2%) patients who were set the valvular bronchial blocking made by own method. The comparative group contained 58 (52.8%) patients treated with traditional methods: puncture, drainage of pleural cavity, occlusion of fistular bronchus by foam rubber obturator saturated with antibiotics. The analyzed groups of patients had similar sex, age, forms and complications of lung tuberculosis, associated pathology and the character of the performed operations. 32 (61.5%) patients of the primary group and 35 (60.3%) patients of the comparative group had fiber cavernous tuberculosis. Lung tuberculomas were found in 19 (36.6%) patients of the primary group and 21 (36.2%) patients of the comparative group. 1 (1.9%) patient of the primary group and 2 (3.5%) patients of the comparative group had cirrhotic tuberculosis.

Both lungs of 25 (48.1%) patients in the primary group and 14 (24.1%) in the comparative one (P<0.01) were damaged.

39 (75.0%) patients in the primary group and 42 (72.4%) in the comparative one were bacteria-discharging, it being maintained before the operation in 28 (53.8%) patients in the primary group and 30 (51.7%) in the comparative one.

All patients underwent various surgeries for lung tuberculosis (Table 1). 16 (30.8%) patients in the primary group and 11 (19.0%) in the comparative one went through superior lobectomy. 16 (30.8%) patients in the primary group and 21 (36.2%) in the comparative one underwent segmental resections.

20 (38.4%) patients in the primary group and 26 (44.8%) in the comparative group underwent combined lung resections.

The puncture of the postresectional empyema and the residual cavity with its following drainage was performed to all patients of both groups to eliminate the complications.

The drainage was combined to the active aspiration with a daily pleural cavity lavage with the antiseptic and antibiotic solutions. The guarantee for successive application of the temporary fistular bronchial occlusion method is its effective visualization. The traditional method of dye injecting into the residual pleural cavity for fistula detecting is not always informative, especially at the small fistular opening and the absence of fluid pressure in the pleural cavity. We developed the method of fistula visualization by means of the transthoracic injecting of the mixture (3% hydrogen peroxide solution with 1% brilliant green solution ratio of 10:1) into empyema cavity (certificate #2173098 of September 10, 2001). When foaming, such solution increases pressure in the cavity...
Table 1.
The extent of lung resection in the analyzed patients

<table>
<thead>
<tr>
<th>Extent of the Operation</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs.</td>
<td>%</td>
<td>Abs.</td>
</tr>
<tr>
<td>Lobectomy</td>
<td>16</td>
<td>30,8</td>
<td>11</td>
</tr>
<tr>
<td>Segmental resection</td>
<td>16</td>
<td>30,8</td>
<td>21</td>
</tr>
<tr>
<td>Combined resection</td>
<td>20</td>
<td>38,4</td>
<td>26</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
<td><strong>100,0</strong></td>
<td><strong>58</strong></td>
</tr>
</tbody>
</table>

and provides the access of the dye into the fistular bronchus that is controlled through the bronchofiberscope (Fig. 11).

In valvular fistula mechanism when the air can enter only the pleural cavity we use Bobrov jar with the watery fold for detecting fistular bronchus (Fig. 12). Drainage is set to the tube, the internal opening of which is placed into the fluid, and the second tube is set to the active aspiration with the pressure of 0,2 atmosphere (air vesicles are seen to be discharged from the drainage). At searching valvular bronchial blocking it can be seen that the intensity of air-discharging with the help of drainage is changing. The stoppage of discharging of the air vesicles and the hermitism appearing verifies the correct occlusion of fistular bronchus. The advantage of these methods for the diagnostics of bronchopleural fistula is the opportunity to perform them with the local anesthesia.

The perspective method, in our opinion, is the method of the bronchopleural fistula...
visualization with the help of balloon catheter. This method is effective in valvular fistula mechanism, easy to perform under local anesthesia while bronchofibroscopy is being made and does not take much time.

Bronchial fistula of lobar bronchus was found in 1 (1.9%) patient in the primary group and 1 (1.7%) in the comparative group. Bronchial fistula of segmental bronchus was found in 19 (36.6%) patients in the primary group and 17 (29.3%) in the comparative group. Bronchial fistulae of the small bronchus were found in 32 (61.5%) patients in the primary group and 40 (69.0%) in the comparative group (Table 2).

Valvular bronchial blocking of a bronchial fistula was performed to the patients of the primary group after determining the bronchial fistula localization. For the elimination of the bronchial fistula 41 (78.9%) patients had single bronchial blocking, 9 (17.3%) had double blocking, 2 (3.8%) — triple blocking, in 2 (3.8%) patients having been detected 3 bronchial fistulae and 1 patient having had 2 bronchial fistulae.

29 (55.8%) patients were set the valvular bronchial blocking in 10 days after the operation, 19 (36.5%) patients in 11-20 days and 4 (7.7%) over 21 days.

In the primary group the valvular bronchial blocking of the segmental bronchus was set to 25 (48.1%) patients, the blocking of the lobar bronchus — to 27 (51.9%) patients. The valve was located in the bronchus from 10 to 66 days depending on the dynamics of the residual cavity closing and the general condition of the patient. The average time for the bronchial blocking was 29.4±3.2 days.

Together with the postresectional empyema the patients of the comparative group were made the temporary bronchial occlusion with a foam rubber obturator. The obturator was applied to 32 (55.2%) patients once, 26 (44.8%) patients underwent this procedure twice. After operation 30 (51.7%) patients were made the temporary occlusion in 10 days, 16 (27.6%) patients — from 11 to 20 days and 12 (20.7%) patients — over 20 days.

The obturator was placed in the bronchus from 7 to 30 days depending on the general condition of the patient and the time of local complication development in the tem-
Table 2.
Patients’ distribution according to the bronchial blocking localization.

<table>
<thead>
<tr>
<th>Fistula localization</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs.</td>
<td>%</td>
<td>Abs.</td>
</tr>
<tr>
<td>Lobar bronchus</td>
<td>1</td>
<td>1,9</td>
<td>1</td>
</tr>
<tr>
<td>Segmental bronchus</td>
<td>19</td>
<td>36,6</td>
<td>17</td>
</tr>
<tr>
<td>Small bronchus</td>
<td>32</td>
<td>61,5</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
<td><strong>100,0</strong></td>
<td><strong>58</strong></td>
</tr>
</tbody>
</table>

Table 3.
The ratio of the operative and conservative methods of patients’ treatment in the compared groups.

<table>
<thead>
<tr>
<th>Method of treatment</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs.</td>
<td>%</td>
<td>Abs.</td>
</tr>
<tr>
<td>Operative</td>
<td>4</td>
<td>7,7</td>
<td>18</td>
</tr>
<tr>
<td>Conservative</td>
<td>48</td>
<td>92,3</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>52</strong></td>
<td><strong>100,0</strong></td>
<td><strong>58</strong></td>
</tr>
</tbody>
</table>

Temporary bronchial occlusion (the average time of occlusion was 10.3±7.4 days) (P>0.5).

In the primary group 2 (3.8%) patients had the enlargement of pathological granulations at the valve location.

After the temporary bronchial occlusion with a foam rubber obturator 55 (94.8%) patients in the comparative group had such complications as purulent bronchustis and dicubital ulcers at the obturator location with the enlargement of pathological granulations (P<0.001).

In the primary group 4 (7.7%) patients required operations for the elimination of empyema in the residual cavity. In the comparative group 18 (31.0%) patients required such operation (Table 3).
Evaluation of the Results and Follow-up Treatment Issues

Evaluating the results of treating patients with the method of valvular bronchial blocking of the fistular bronchus with postresectional empyemae and the residual cavities, we took into consideration the following criteria:

— good result — attaining complete clinical effect in the treatment of the empyema: cavity closing and elimination of bronchial fistula;

— satisfactory result — decreasing of the bronchial fistula and empyema cavity;

— unsatisfactory result — preserved empyema cavity with a bronchial fistula which became the indication for the operation.

During the hospital period as a result of the valvular bronchial blocking setting 48 (92.3%) patients developed lung straightening and the closing of the bronchial fistula functioning (Table 4). In the comparative group 33 (56.9%) patients developed such conditions achieved with the conservative methods that is 1,6 times lower than in the primary group (P<0.001).

At the discharge from the hospital in the primary group good clinical effect was noted in 44 (84.6%) patients, satisfactory — in 5 (9.6%) and 3 (5.8%) had unsatisfactory results.

In the comparative group good results were noted in 34 (58.6%) patients (P<0.01), 12 (20.7%) patients had satisfactory results, 12 (20.7%) — unsatisfactory results (P<0.02) and 2 (3.4%) patients died (Table 5).

At present we have the data of the follow-up treatment issues of 15 patients in the primary group in a period of 1-3 years. The results of the treatment of 16 patients in the comparative group in a period of 1-3 years are known. After hospital period some

### Table 4.
The frequency of bronchial fistulae closing without operation during the hospital period.

<table>
<thead>
<tr>
<th>Received clinical effect</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs</td>
<td>%</td>
<td>Abs</td>
</tr>
<tr>
<td>Fistula closing without operation</td>
<td>48</td>
<td>92,3</td>
<td>33</td>
</tr>
<tr>
<td>Preserved fistula and the residual cavity</td>
<td>4</td>
<td>7,7</td>
<td>25</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>52</td>
<td>100,0</td>
<td>58</td>
</tr>
</tbody>
</table>
Table 5.
The results of the treatment of the patients with the bronchial fistulae.

| Received clinical effect | Primary group | Comparative group |  
|-------------------------|---------------|-------------------|----------------|
|                         | Abs | %  | Abs | %   | P   |
| Good                    | 44  | 84,6 | 34  | 58,6 | <0,01 |
| Satisfactory            | 5   | 9,6 | 12  | 20,7 | >0,1 |
| Unsatisfactory          | 3   | 5,8 | 12  | 20,7 | <0,02 |
| **Total**               | **52** | **100,0** | **58** | **100,0** |

patients (1 (6.7%) in the primary group and 6 (37.5%) in the comparative one (P<0.02)) preserved empyema of the residual pleural cavities. So, they required such operation as extrapleural fragmentated thoroplastics for the elimination of the complication.

The complete clinical effect was obtained in 14 (93.3%) patients and the chronic empyema of the residual cavity with the bronchial fistula was preserved in 1 (6.7%) patient of the primary group. In the comparative group the complete clinical effect was obtained in 10 (62.5%) patients, the preserved empyema of the residual cavity — in 5 (31.5%) patients, 1 patient died from progressive lung tuberculosis (Table 6).

According to the follow-up observations (see Table 6) the complete clinical effect in the primary group was attained 1.5 times more often (P<0.05).

Thus, the valvular bronchial blocking of the fistular bronchus develops certain conditions for the lung straightening, the elimination of the postresectional empyema, residual cavity and bronchial fistulae after resections.
Table 6.
The follow-up results of the treatment of the patients with bronchial fistulae and the residual cavities.

<table>
<thead>
<tr>
<th>Received clinical effect</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs</td>
<td>%</td>
<td>Abs</td>
</tr>
<tr>
<td>Fistula closing, elimination of the residual pleural cavity</td>
<td>14</td>
<td>93,3</td>
<td>10</td>
</tr>
<tr>
<td>Preserved residual cavity with a bronchial fistula</td>
<td>1</td>
<td>6,7</td>
<td>5</td>
</tr>
<tr>
<td>Death</td>
<td>—</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>15</td>
<td>100,0</td>
<td>16</td>
</tr>
</tbody>
</table>
The Results of Own Research in Drug-Resistant Lung Tuberculosis

The results of the treatment of 108 patients (74 men and 34 women) with the extensive lung tuberculosis were analyzed. The patients were treated in the Chest Surgery and Therapeutic Departments of the Altai Krai Antituberculosis Dispensary. The age of the patients varied from 16-67 years. The distribution of the patients according to the tuberculosis forms is presented in Table 7.

All patients were bacteria-discharging. All patients were noted to have drug-resistant lung tuberculosis, 85 (78.7%) having multiple drug-resistance.

Bronchogenic dissemination was noted in 44 (40.7%) patients. The tuberculosis process was complicated with the lung hemorrhage in 28 (25.9%) patients. 12 (11.1%) patients suffered from the pancreatic diabetes.

In the complex treatment of 108 patients with the destructive forms of the drug-resistant tuberculosis the valvular bronchial blocking was used in 63 (58.3%) patients (primary group), the artificial pneumothorax was used in 45 (41.7%) patients (comparative group). Both groups had the similar sex and age, long-standing and extensive pathological processes, forms of lung tuberculosis, severity of condition, volume of hemorrhage and the character and the frequency of the complications. The effectiveness of the treatment was estimated by clinical-roentgenologic dynamics in the course of treatment and by preserving the frequency of bacteria-discharging.

In three months after the valvular bronchial blocking 57 (90.5%) patients attained stabilization and the positive dynamics in the course of the tuberculosis process that was 1.5 times higher than the similar index in the comparative group (P<0.001) (Table 8). It should be noted that 6 (9.5%) patients in the primary group were estimated to have the closing of the disintegration cavities in the roentgenologic examination. There were no such patients in the comparative group.

Negative clinical — roentgenologic dynamics (the enlargement in size of the infiltration shadowing and disintegration cavities) was noted in 5 (7.9%) patients of the primary group and 6 (13.3%) patients of the comparative group (P>0.5).

In three months after starting of the complex treatment the bacteria-discharging termination was obtained in 58 (92.1%) patients in the primary group and 34 (75<6%) patients in the comparative group (P<0.05).

In six months after starting of the complex treatment the bacteria-discharging termination was obtained in 61 (96.8%) patients in the primary group and 36 (80.0%) patients in the comparative one (P<0.01).

At the valvular bronchial blocking the complications were noted in 5 (7.9%) patients
in the primary group. Two patients with the fiber-cavernous tuberculosis at the upper part of the right lung developed in that area chronic multiple abscesses turning into pneumocirrhosis. Three patients with the purulent bronchustis were noted to have the enlargement of the destruction cavity in the capacity at the blocked part of the lung and fluid presence in it. The complications in the comparative group were noted in 23 (51.1%) patients, that was 6.5 times higher than in the primary group (P<0.001). In 17 (37.8%) patients the artificial pneumothorax was complicated with exudative pleurisy, 3 (6.7%) patients acquired rigid pneumothorax, 3 (6.7%) patients were noted to have iatrogenic pneumothorax.

The occlusion duration in the primary group made up on average 212.3±12.2 days, the maximum occlusion time being 365 days. In the comparative group the duration of the treatment with the artificial pneumothorax was 198.2±16.3 days (P>0.5), the maximum term — 378 days.

Among 108 patients 13 (12.0%) were operated on, 4 (6.3%) in the primary group and 9 (20.0%) in the comparative group (P<0.05). Moreover, 4 operations were performed to 4 patients in the primary group (2 had thoracoplasty, 2 — lung resection). In the comparative group 16 operations were performed to 9 patients (2 pneumoectomy, 4 thoracoplasty, thoracocaustic, 3 lung resection, 2 pleurostomy, 1 cavernostomy). One patient was performed 4 operations, 1 had 3 operations and 2 were operated twice.

Lethality in the primary group made up 2 (3.2%) patients and 2 (4.4%) patients in the comparative group (P>0.5).

Thus, the valvular bronchial blocking is the effective slightly invasive and non-medicated method of treatment of various forms of lung tuberculosis, including drug-

<table>
<thead>
<tr>
<th>Tuberculosis forms</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs</td>
<td>%</td>
<td>Abs</td>
</tr>
<tr>
<td>Fiber-cavernous tuberculosis</td>
<td>33</td>
<td>52,4</td>
<td>16</td>
</tr>
<tr>
<td>Infiltrated tuberculosis in the disintegrating phase</td>
<td>30</td>
<td>47,6</td>
<td>28</td>
</tr>
<tr>
<td>Tuberculosis in the disintegrated phase</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>63</strong></td>
<td><strong>100</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>
Table 8.
Clinical-roentgenologic dynamics in the treatment course of the analyzed patients after three months.

<table>
<thead>
<tr>
<th>Clinical-roentgenologic dynamics</th>
<th>Primary group</th>
<th>Comparative group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Abs</td>
<td>%</td>
<td>Abs</td>
</tr>
<tr>
<td>Decrease of infiltration and disintegration cavities in capacity</td>
<td>51</td>
<td>81,0</td>
<td>27</td>
</tr>
<tr>
<td>Closing of the disintegration cavities</td>
<td>6</td>
<td>9,5</td>
<td>—</td>
</tr>
<tr>
<td>Without positive dynamics</td>
<td>1</td>
<td>1,6</td>
<td>12</td>
</tr>
<tr>
<td>Negative dynamics</td>
<td>5</td>
<td>7,9</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>63</td>
<td>100</td>
<td>45</td>
</tr>
</tbody>
</table>

Resistance forms and its most frequent complications such as lung hemorrhage and bronchopleural fistulae. It should be noted that the valvular bronchial blocking is not the alternative to the traditional methods of treatment of lung tuberculosis and its complications.

It should be applied in a complex therapy of the certain pathology. We would like to emphasize the importance of the combination of the valvular bronchial blocking and the therapeutic pneumoperitoneum in the extensive destructive lung tuberculosis.
List of Major Publications


Medlung, LTD,
the manufacturer of endobronchial valves.

phone: +7 3852 68-85-42
fax: +7 3852 68-56-00

cellular: +7 903 910-17-34

www.medlung.org
sales@medlung.org
Multimedia Disk