Clinical Results and Physiological Effects of Immobilizing Lung Chamber Therapy in Chronic Pulmonary Tuberculosis*

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Introduction

The mechanism by which a normal pulmonary ventilation was produced in patients with pulmonary tuberculosis without voluntary breathing and without movement of the chest wall was described in 1940. An adequate gas exchange between the lungs and the atmosphere could not be maintained in animals with experimental respiratory paralysis by the alternating pressure method of Thunberg until the bronchial tree was kept open by equalizing the pressures on both sides of the chest wall; by accurately counterbalancing the resistance in the respiratory passageway from the nose to the alveoli, an equal pressure was maintained on the outer and inner surfaces of the thoracic cage and the upper and lower surfaces of the diaphragm. Pressure respiration with constant lung volume was then achieved by varying the density of atmospheric air, with complete arrest of chest movement in patients in whom excessive narrowing of the bronchial tree was not present.

In subsequent clinical reports by the authors and others, this form of lung rest was shown to be responsible for closure of cavity and arrest of disease in cases of pulmonary tuberculosis. The intention of this paper is (1) to describe some of the unique physiological effects of ventilating the lungs without apparent lung movement, and (2) to present the follow-up results of 19 of 29 cases in which arrest of disease took place as a consequence of immobilizing lung chamber therapy.

Circulatory Effects of Immobilizing Lung Chamber Therapy

Among the effects previously reported of residence in the immobilizing lung chamber in patients in whom arrest of all chest

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movement was induced, are a decrease in pulse rate of 7 to 20 beats per minute, a fall in systolic blood pressure of 15 to 20 mm. Hg., and 5 to 10 mm. Hg. in diastolic pressure; in 40 records of the electrocardiogram during two hours residence in the chamber, an average elevation of 0.8 mm. took place in T-1 and T-2.

During the past year, measurements of the cardiac impact were made by the use of the portable ballistocardiograph devised by

![CARDIAC IMPACT](image-url)

**FIGURE 1:** Cardiac impact recorded by Dock-Ballistocardiograph during normal respiration at bed rest (control) and immediately after 30 minutes lung immobilization in chamber. The pulse rate at bed rest (controlled) was 102 per minute and after immobilization 78 per minute. The blood pressure at bed rest was 132/88, and after immobilization 92/68.

![CONTROL](image-url)

![30 MIN. LUNG IMMOBILIZATION](image-url)

**FIGURE 2:** Cardiac impact recorded by Dock-Ballistocardiograph during normal respiration at bed rest (controlled), during breath-holding and immediately after 30 minutes lung immobilization in the chamber. The pulse rate at bed rest (controlled) was 86, during breath-holding 86, and immediately after lung immobilization 80.
Dock. The comparison of a record taken before and at the end of one hour of residence in the immobilizing lung chamber is shown in Figure 1. The records are taken immediately after the current is turned off and represent, therefore, the half minute period immediately following the period of arrested lung movement. The effect of breath-holding in inspiration is also illustrated for comparison in Figure 2. The sharp decrease in systolic cardiac impact after lung immobilization is revealed, as well as the absence of variation of cardiac impact due to normal inspiration and expiration. An analysis of 12 determinations in nine patients tested in this way is shown in Figure 3. An average decrease of 26.8 per cent in the factor used to represent cardiac impact took place as a result of this form of lung rest. According to Starr,10 the Dock ballistocardiograph yields information comparable to that of the body ballistocardiograph. Since this kind of measurement represents in part velocity of the flow of blood from the ventricles, the effect of arrested lung movement in the chamber on cardiac output can only be inferred from these records. The data naturally suggest that a marked reduction in the work of the heart takes place. The factor employed to make relative comparisons of cardiac impact was the slope of \( I \times J \) times the heart rate.

Since the venous pressure was not found to be significantly altered by residence in the chamber, the decreased cardiac impact did not appear to be due to interference with the flow of blood but rather, at least in part, to a lowering of the oxygen consumption or the total metabolic work. Conversely, when studies were made with the Dock ballistocardiograph on the effects of pressure

**EFFECT OF LUNG IMMOBILIZATION ON CARDIAC IMPACT**

![EFFECT OF LUNG IMMOBILIZATION ON CARDIAC IMPACT](image)

**FIGURE 3**: Results of 12 determinations on 9 patients before and immediately after 30 minutes lung immobilization in the chamber.
breathing, the decrease in cardiac impact was found to be accompanied by a parallel elevation of the venous pressure.\textsuperscript{11} In similar current studies on pressure breathing maintained in the dome of the conventional respirator, and by negative pressure in the body of the respirator, the decrease in cardiac impact was at times paralleled by an increase in venous pressure. The reduction in cardiac impact which takes place in the immobilizing lung chamber is thus not due to damming back of blood into the systemic venous reservoir, as it is in pressure breathing, but presumably, at least in part, to a decrease in total oxygen consumption.

**Effects on Serum and Urine Potassium of Residence in the Immobilizing Lung Chamber**

The unique character of bodily and mental rest, which is manifested by patients in whom complete arrest of lung movement takes place, has been previously described. In patients in whom surgery was to be performed Randall et al.\textsuperscript{12} reported that a fall in serum potassium took place the day of the operation; the inference that a state of psychic tension had the effect of decreasing

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**ELEVATION OF SERUM POTASSIUM AFTER ONE HOUR IN IMMobilIZING LUNG CHAMBER**

[Graph showing serum potassium levels before and after immobilization]
serum potassium appeared, at least, to be a working hypothesis. Since the opposite kind of phenomenon, namely exceptional mental relaxation, was observed in patients in the chamber, a study of serum and urine potassium was instituted. In this paper, a preliminary report of the findings will be made. In Figure 4 the response of the serum potassium in 11 cases to residence in the immobilizing lung chamber for one hour is shown in Figure 4. A significant increase in serum potassium takes place, when comparison is made to periods before and after lung immobilization.

*The authors wish to express their appreciation to Dr. H. T. Randall and Dr. G. H. Mudge for their cooperation in carrying out the serum determinations here reported.

CASES WITHOUT ELEVATION OF SERUM POTASSIUM AFTER ONE HOUR IN IMMobilIZING LUNG CHAMBER

<table>
<thead>
<tr>
<th>CASE NUMBER</th>
<th>CONTROL BEFORE OR AFTER IMMobilIZATION</th>
<th>ONE HOUR IMMobilIZATION</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td></td>
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<td>2</td>
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<tr>
<td>4</td>
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Figure 5

Downloaded From: http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/20378/ on 05/25/2017
This increase is at times as high as 1 milliequivalent. In Figure 5 the response of four cases in which elevation of the serum potassium was not found is shown. Elevation of serum potassium does not, therefore, occur in all cases and is especially not apt to take place if some degree of lung movement is present. The decrease in urine potassium excretion after four hours residence in the immobilizing lung chamber, compared to four hours of bed rest.
rest, is revealed in Figure 6. A striking drop in output of potassium took place in five of the six cases, the average decrease being 38 per cent, without, however, a concomitant drop in urine volume.

The decrease in elimination of potassium in the urine was not accompanied by any consistent changes in sodium output in the urine; the mean change was minus 2.3 per cent. The mechanism of this change in serum and urinary potassium may be related to a lessening of the stimulus to the adrenal gland associated with the decrease of psychic tension produced by cessation of respiratory chest excursions. Another explanation, which may play a role of varying degree, is dependent upon the apparent marked decrease in cardiac output, which would result in decreased renal blood flow which in turn might be responsible for a decrease in elimination of potassium. However, this interpretation seems unlikely because the sodium urinary excretion did not react in a similar manner.

Changes in serum potassium and urinary elimination of potassium have been shown to be dependent on alterations in the acid base equilibrium of the blood, especially by Atchley et al., Darrow et al., and others. On the basis of our observation of patients in the chamber carried out 11 years ago, the arterial CO₂ content appeared to be only slightly altered, a fall of 2 mm. having been found in some patients treated at that time. Since the tidal air of patients in the chamber is lower than normal immediately after lung immobilization is stopped, it would seem that the changes in acid base balance would be in the direction of a slight alkaline shift in pH. However, further detailed studies are necessary to determine what alterations in acid base equilibrium actually take place. Marked potassium deficit has been reported with adrenal cortical hormone (desoxycorticosterone acetate) administration by Kuhlmann, Ragan, Ferrebee, Atchley and Loeb and by Ferrebee, Parker, Carnes, Gerity, Atchley and Loeb. Although the precise and full mechanism of decreased potassium elimination in our studies is not completely explained, the inference that it is related to a decreased stimulation of the adrenal gland seems at least a justifiable one from the evidence now at hand.

The elevation of the T-wave, which had been previously difficult

<table>
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<tr>
<th>NUMBER CASES TREATED</th>
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<tr>
<td><strong>Arrested</strong></td>
</tr>
<tr>
<td><strong>Temporary or no Significant Improvement</strong></td>
</tr>
</tbody>
</table>

**FIGURE 7**
to interpret, now appears to be related, at least in part, to the rise in serum potassium in patients in whom complete arrest of lung movement is produced. The concept was originally presented that a local rise in oxygen tension of cardiac muscle may be a factor, produced as a consequence of the maintenance of a normal arterial oxygen saturation with a diminution in oxygen concentration of cardiac tissue.

**TABLE I**

Follow-up Results in 19 Patients with Advanced Pulmonary Tuberculosis. In Whom Arrest of the Disease was Accomplished by Immobilizing Lung Chamber Therapy.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Therapy Ended</th>
<th>Present State</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A.D.</td>
<td>Sep. 1938</td>
<td>Arrested</td>
<td>3 relapses for total of 18 months bed rest.</td>
</tr>
<tr>
<td>2. L.M.</td>
<td>Jul. 1941</td>
<td>Arrested</td>
<td>No relapses 9 years.</td>
</tr>
<tr>
<td>4. W.P.</td>
<td>Jan. 1946</td>
<td>Arrested</td>
<td>Active 3 months in 1949. Arrested with second course.</td>
</tr>
<tr>
<td>17. S.</td>
<td>Jan. 1940</td>
<td>Unknown</td>
<td>Negative 1 year. No follow.</td>
</tr>
</tbody>
</table>
Figure 8: Twenty months after onset of symptoms, first x-ray secured.-Figure 9: After 16 months of pneumoperitoneum therapy and 4 months of chemotherapy (100 mg/m²), x-ray revealed shrinking of right upper lobe without alteration of size of the contained cavity and spread of disease to the left lower lung field.-Figure 10: After 6 months of chamber therapy x-ray revealed clearing of disease in left lung and disappearance of cavity in right upper lobe.
Clinical and Follow-up Results

The clinical results of recently treated cases, added to those previously reported, indicate that of 29 cases of advanced pulmonary tuberculosis, 19 obtained an arrest of the disease characterized by closure of cavity and negative sputum for periods varying between six months and nine years (See Figure 7).

The response in the individual cases is shown in Table I. In five of these 19 arrested cases, the sputum has recently become positive; the original cavity re-opened in two cases, a new cavity appeared in a second case, and in the remaining two cases, no cavity or new infiltration was observed despite the development of positive sputum. In five of the 19 arrested cases, a period of relapse took place since their original chamber treatment. Arrest of the disease is now present in 12 of 19 patients.

An instructive recently treated case is presented in which progressive extension of disease took place during pneumoperitoneum and streptomycin therapy; the conspicuously downhill course was reversed by immobilizing lung chamber therapy in conjunction with administration of para-aminosalicylic acid.

Case 16: A 38-year-old white female. History: Onset of illness three months before admission, with cough, weight loss and fatigue. At the end of 20 months treatment with vitamin injections, x-ray film of lungs revealed evidence of far advanced pulmonary tuberculosis of the right upper lobe (Figure 8). Sputum was positive for acid fast organisms. Pneumoperitoneum was begun in a sanatorium. During the entire course of treatment she complained of digestive disturbances. Her only pulmonary hemorrhage occurred two weeks after initiation of pneumoperitoneum. Beginning six months prior to admission she received streptomycin, one gram daily for 120 days, because of laryngeal tuberculosis.

Figure 11: Planigraphic x-ray after reverse pneumoperitoneum revealed cavity in right upper lobe.—Figure 12: Planigraphic x-ray revealed disappearance of cavity in right upper lobe after 5 months chamber therapy.
Hoarseness improved during the first two months of therapy, but then gradually became almost as severe as prior to streptomycin therapy. In the last month of streptomycin treatment a spread to the left middle and lower lung fields was noted on x-ray inspection. The patient was then referred for immobilizing lung chamber therapy. Physical examination of the lungs revealed dullness over the upper third of the right lung with bronchial and cavernous breathing and egophony. Stereoscopic and planigraphic x-ray films of the lungs on admission revealed a shrunken right upper lobe containing a cavity measuring four centimeters in its greatest diameter and a fresh infiltration in the left middle and lower lung fields. Course: A reverse pneumoperitoneum accomplished the removal of 2,750 cubic centimeters of gas from the peritoneal cavity. Chamber therapy was begun, increasing gradually to 10 hours daily including Sundays. Para-aminosalicylic acid was administered, nine grams daily for three weeks of each month. Routine urine examinations and blood counts remained normal. The patient was afebrile. The erythrocyte sedimentation rate changed from 72 mm. in one hour to 25, and a weight gain of 8 pounds was recorded during the first three months. The first negative smear for acid fast organisms was obtained six weeks after chamber therapy was begun; four negative cultures and two negative guinea pigs were secured before a five months' course of treatment was terminated. The final x-ray films revealed clearing of the recent spread of infiltration into the left lower lobe and disappearance of the old cavity in the atelectatic area in the right upper lobe, as shown in stereoscopic and planigraphic films (Figures 9, 10, 11 and 12). Two months after leaving the hospital the patient was discovered to have a carcinoma of the cervix after a prolonged menstrual flow. Unfortunately, she began to drink excessively, was overactive, and the cavity reopened six months later.

The obvious extension of disease with pneumoperitoneum and streptomycin therapy illustrates the serious nature of this patient's condition when immobilizing lung chamber therapy was instituted. Para-aminosalicylic acid therapy was probably of help in clearing the infiltration in the left lower lobe that developed under streptomycin treatment. The disappearance of the cavity in the area of dense shadow in the right upper lobe, which had persisted for two years, could be ascribed to arrest of lung movement provided by the immobilizing lung chamber, since neither streptomycin nor PAS (in our experience18) has been found to be of value in persisting cavities of this kind in chronic pulmonary tuberculosis. Unfortunately, the overactivity and alcoholism associated with discovery of carcinoma of the cervix resulted in reopening of the cavity.

**Technique of Operation of the Immobilizing Lung Chamber**

The importance of the initial training period of the patient for a week or 10 days has become more and more apparent. In fact, failure to superintend the early management of cases treated with this method may result in failure to achieve continuous arrest of
l lung movement in patients who would otherwise respond well to
immobilizing lung chamber therapy. The patient who has had
good supervision and training during the first 10 days generally
manifests no signs of breathing during the remainder of treatment,
not less than 10 hours a day for four to five months. Even though
complete arrest of the disease may not have taken place during
this period, it has seemed better to stop immobilizing lung chamber
therapy in a few selected cases, and then, if considered de-
sirable, to institute a second course four to six months, or even a
year, later. The chamber now in use has been especially air-condi-
tioned and has employed an alternation of pressure above and
below the atmosphere. A somewhat changed type of chamber in
which 110 volt alternating current can be used is in process of
development. The importance of providing a consecutive period of
10 hours during the day or night, interrupted only by meals, will
be described.

Discussion

The clinical evaluation of immobilizing lung chamber therapy
in pulmonary tuberculosis can only be attempted by carefully ap-
praising the results in an admittedly small number of cases. The
patients selected were, in almost all instances, those in whom the
previous course was either stationary or manifested progressive
extension of the disease. Operative procedures would have been
either impossible or hazardous in all except one or possibly two
cases. Attentive observation of the course and character of cavity
closure, as well as the reappearance of cavity when treatment was
interrupted, has provided ample evidence that this type of lung
rest has a specific influence on closure, collapse and healing of
tuberculous cavities. Inspection of stereoscopic and planigraphic
films during chamber therapy indicates that the cavity generally
collapses in the lateral or side-to-side diameter. Since diaphrag-
matic movement exerts a pull in the vertical diameter, cavity
closure by collapse of the walls laterally would appear to be easier
than from below upward. In recent months the use of abdominal
compression by a belt has been carried out during the period when
the patient is out of the chamber at night. This procedure was
adopted because of our observations above mentioned and because
the studies on abdominal compression with a belt made by Gordon
seemed to be based on sound physiological and clinical evidence.

Although para-aminosalicylic acid was employed in four of the
recently treated patients, streptomycin was used in only one case
during six weeks of chamber therapy. In others previous treatment

*The chamber is manufactured by J. H. Emerson Company, Cambridge,
Massachusetts.
with streptomycin had been carried out until the tubercle bacilli were resistant to the drug at the time of chamber treatment.

The employment of chemotherapy during the period of cavity closure would now appear to be a logical and justifiable procedure which might make less likely the occurrence of relapse under conditions of stress. We have hitherto avoided the use of streptomycin in order to demonstrate the effectiveness of lung immobilizing therapy alone in accomplishing closure and healing of tuberculous cavities. Since the technique of employing streptomycin and PAS together would now allow perhaps two months' administration without the development of resistance, the use of these drugs when the walls of the cavity were collapsing during chamber therapy would seem as justifiable as is the employment of chemotherapy in conjunction with surgical or other collapse procedures.

Clinical and physiological evidence now available concerning chamber-induced rest of the lungs would suggest that a more widespread use of this treatment is indicated, not only for advanced cases, but in patients manifesting less extensive disease. In fact, the trial of properly managed immobilizing lung chamber therapy in preference to pneumothorax and thoracoplasty might have the obvious advantages of inducing clinical recovery without impairment of lung function or structure, and without the risk attendant on other methods of collapse therapy.

The unique mental and physiologic benefits of ventilation without chest movement are revealed by the studies presented in this paper. The decrease in cardiac impact, the lowering of the pulse rate and blood pressure, the lessened excretion of potassium, the increase in serum potassium, the elevation of the T-wave and the indications of decreased total metabolic work, all point to a more restful functioning of the organism than is obtained by bed rest. Furthermore, no instance of spread of disease has happily taken place in our cases during the period of residence in the chamber.

The use of the pressure equalizing chamber for elimination of bronchial secretions, as well as for provision of an adequate gas exchange in the lungs, was recently provided by a change in the design and operation of this apparatus. A mechanically induced effective cough was obtained by introducing in the head end of the chamber, a valve which opened at the height of the cycle of positive pressure in 0.08 seconds. At the same time, a sudden application of an increased differential pressure on the chest and abdomen was initiated by closing the baffle more tightly around the neck. The differential pressure of 40 mm. Hg., in conjunction with an explosive release of pressure at the head end, resulted in elimination of bronchial secretions in patients with bronchiectasis, bronchial asthma and respiratory paralysis due to polio-
myelitis. The possible use of this technique in the drainage of retained muco-purulent material in patients with pulmonary tuberculosis, and perhaps especially in cases with cavity, may represent an additional therapeutic procedure in the management of this disease.

SUMMARY

1) In 19 of 29 cases of advanced pulmonary tuberculosis, arrest of disease took place as a result of immobilizing lung chamber therapy. The course of disease in these patients immediately prior to treatment either revealed a progressive extension of the tuberculous process after bed rest, pneumoperitoneum or streptomycin therapy, the reappearance of cavity after termination of pneumothorax, or failure of benefit from bed rest, pneumoperitoneum or pneumothorax.

2) Properly regulated immobilizing lung chamber therapy, in favorable cases, has a specific effect on collapse and healing of tuberculous cavities. The follow-up results reported in this paper indicate the incidence of relapse and of maintenance of clinical cure. In no instance in the series of cases observed over a period of 13 years did a spread of disease take place during immobilizing lung chamber treatment.

3) The physiological effects of living without voluntary breathing, i.e., lung ventilation without lung movement, appear related, at least in part, to the unique quality of bodily and mental rest initiated by elimination of excursions of the chest ordinarily employed in normal respiration.

4) The effects of residence in the immobilizing lung chamber, in cases in which complete arrest of chest movement is produced, include:

A) A marked decrease in cardiac impact as measured by the Dock ballistocardiograph. When this observation is interpreted in conjunction with the findings of an unchanged venous pressure, a decrease in pulse rate and blood pressure, the conclusion seems justified that the work of the heart is markedly reduced. In addition, the total energy consumption of the individual would appear to be strikingly diminished.

B) The period of residence in the immobilizing lung chamber is characterized by a decreased excretion of potassium in the urine and an increase in serum potassium. These biochemical responses to respiratory, mental and bodily rest would seem to be the result, at least in part, of a lessened stimulus to the adrenal gland. The T-wave of the electrocardiogram, i.e., T-1, T-2 and T-4, is elevated in these patients at the time when the serum K is increased. An additional but less likely explanation of the decreased elimination
of potassium may be, in part, a decreased total and renal blood flow, which appears to be present in these cases as a consequence of the lowering of the total metabolic needs.

5) Modifications in the technique of treatment now in progress may simplify and improve the results of immobilizing lung chamber therapy in the treatment of cavitary pulmonary tuberculosis.

6) A case of far advanced tuberculosis is described in which spread of disease took place during streptomycin and pneumoperitoneum therapy; the initial responses to immobilizing lung chamber therapy, in conjunction with administration of para-aminosalicylic acid, were (1) a favorable clinical reversal of the course; (2) clearing of the infiltrative spread; (3) disappearance of a large cavity in an area of chronic disease.

**RESUMEN**

1) En 19 de 29 casos de tuberculosis pulmonar avanzada se obtuvo el estacionamiento de la enfermedad mediante el tratamiento en la cámara de inmovilización del pulmón. La evolución de la enfermedad en estos pacientes, inmediatamente antes del tratamiento, reveló: (1) una extensión progresiva del proceso tuberculoso subsiguiente al descanso en cama, el neumoperitoneo o la estreptomicinoterapia, (2) la reaparición de cavernas después de terminarse el neumotórax o (3) la falta de beneficio alguno subsiguiente al descanso en cama, el neumoperitoneo o el neumotórax.

2) En casos favorables, el tratamiento en la cámara de inmovilización del pulmón, apropiadamente regulado, ejerce un efecto específico sobre el colapso y la cicatrización de cavernas tuberculosas. Los resultados de la observación subsecuente, que se comunican en este trabajo, indican la frecuencia de recidivas y del mantenimiento de la curación clínica. En ninguno de los casos de esta serie, observados a través de un período de 13 años, ocurrió extensión de la enfermedad durante el tratamiento en la cámara de inmovilización del pulmón.

3) Los efectos fisiológicos de vivir sin respiración voluntaria, esto es, ventilación pulmonar sin movimiento del pulmón, parecen estar relacionados, por lo menos en parte, con la singular cualidad del descanso mental y corporal iniciado por la eliminación de las excursiones del tórax ordinariamente empleadas en la respiración normal.

4) En casos en los que se produce el detenimiento completo de los movimientos del tórax, los efectos de residir en la cámara de inmovilización del pulmón incluyen:

A) Una notable disminución en el choque cardíaco medido por medio del balistocardiógrafo de Dock. Cuando se interpreta esta...
observación conjuntamente con los hallazgos de una presión venosa inalterada, de una disminución del pulso y de la presión de la sangre, parece justificarse la conclusión de que se reduce apreciablemente el trabajo del corazón. Además, parece que disminuye notablemente el gasto total de energía del individuo.

B) El periodo de residencia en la cámara de inmovilización del pulmón se caracteriza por una disminución en la excreción de potasio en la orina y un aumento del potasio en el suero. Estas respuestas bioquímicas al descanso respiratorio, mental y corporal parecen resultar, por lo menos en parte, de una disminución del estímulo de la glándula suprarrenal. La onda T del electrocardiograma, esto es, T-1, T-2 y T-4, está elevada en esos pacientes durante el tiempo en el que está aumentado el potasio del suero. Otra explicación menos probable de la disminución de la eliminación de potasio puede ser, en parte, la disminución en la circulación total y renal que parece existir en esos casos como consecuencia del decremento en las necesidades metabólicas totales.

5) Es posible que las modificaciones en la técnica del tratamiento, que actualmente se están llevando a cabo, simplifiquen y mejoren los resultados de la terapia en la cámara de inmovilización del pulmón en el tratamiento de la tuberculosis pulmonar cavitaria.

6) Se describe un caso de tuberculosis pulmonar muy avanzada en el que se propagó la enfermedad durante la estreptomicino-terapia y el neumoperitoneo. Las respuestas iniciales al tratamiento en la cámara de inmovilización del pulmón, junto con la administración del ácido para-aminosalicílico, fueron: (1) La favorable reversión clínica de la evolución; (2) el limpiamiento de la propagación infiltrativa; (3) la desaparición de una caverna grande en la zona de enfermedad crónica.

RESUME

1) Dans 19 cas de tuberculose pulmonaire avancée sur 29, le traitement par la chambre d'immobilisation pulmonaire a permis d'arrêter l'évolution de la maladie. C'était des malades chez lesquels, immédiatement avant que le traitement fût mis en oeuvre on avait constaté une extension progressive de la tuberculose, malgré cure de repos integral, pneumopéritoine ou streptomycine, la réapparition d'une caverne après qu'on eût cessé le pneumothorax, ou l'échec de l'action du repos, du pneumopéritoine ou du pneumothorax.

2) La chambre d'immobilisation pulmonaire quand elle est convenablement appliquée, a, dans les cas favorables, une action spécifique de collapsus et de guérison sur les cavernes tuberculeuses. La statistique des résultats rapportée dans cette commu-
communication mentre le pourcentage de rechutes et de guerisons cliniques persistantes. Dans tous les cas observés pendant 13 ans, il n'y a pas eu d'extension des lesions au cours meme du traitement par la chambre d'immobilisation.

3) Ce traitement consiste au point de vue physiologique a permettre de vivre sans respiration volontaire, c'est-a-dire par ventilation pulmonaire sans mouvements thoraciques. Son action est essentiellement dominee par la valeur du repos physique et mental provoque par l'absence des mouvements respiratoires habituels.

4) Les auteurs estudient les consequences du sejor en chambre d'immobilisation dans les cas oú l'arrêt complet des mouvements thoraciques a pu être obtenu:

A) Il y a une diminution importante de l'impulsion cardiaque prouvee par la ballistocardiographie de Dock. Comme il y a concurremment une pression veineuse inchangée et une diminution des pulsations et de la tension artérielle, on peut en conclure legitimement que le travail du coeur est considerablement reduit. De plus la consommation totale d'énergie de l'individu serait nettement inférieure à la normale.

B) Le sejor dans la chambre d'immobilisation est caracterisé par une diminution du potassium urinaire et une augmentation du potassium sanguin. Ces consequences biochimiques du repos respiratoire total semblent au moins pour une part, être le resultat d'une excitation des surrenales. L'onde T de l'électrocardiogramme (T1-T2 et T4) est elevee chez les malades pendant la periode ou le potassium sereque est augmenté. A la rigueur on pourrait expliquer la diminution de l'élimination du potassium par une diminution de la masse sanguine totale et de la masse sanguine renale. Cette diminution parait être une consequence ici de l'abaissement de l'ensemble des besoins metaboliques.

5) Des progres dans la technique du traitement pourront simplifier et ameliorer les resultats obtenus par la chambre d'immobilisation dans la tuberculose cavitare.

6) Les auteurs rapportent un cas de tuberculose tres avancee avec dissémination apparue au cours de traitement par streptomycine et pneumopérithoite. L'action de la Chambre d'Immobilisation associee à l'acide para-arnino-salicylique a realise: (1) une evolution clinique favorable; (2) Un nettoyage de la dissémination; (3) la disparition d'une volumineuse cavité.

REFERENCES
Rest to the diseased pulmonary area still remains the corner stone upon which hope for recovery in chronic pulmonary tuberculosis is based. In recognition of this concept, Sunny View Sanatorium, a County institution of 70 beds in Central Wisconsin, installed three lung immobilizing chambers. Over a period of three years, 38 patients classified from minimal to pre-terminal have

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**Discussion**

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Winnebago, Wisconsin

Rest to the diseased pulmonary area still remains the corner stone upon which hope for recovery in chronic pulmonary tuberculosis is based. In recognition of this concept, Sunny View Sanatorium, a County institution of 70 beds in Central Wisconsin, installed three lung immobilizing chambers. Over a period of three years, 38 patients classified from minimal to pre-terminal have
accepted this type of therapy. The period of observation has been sufficient to enable us to evaluate to a reasonable extent the usefulness of this method for intensifying the application of therapeutic rest.

That the chamber provides the means of arresting all respiratory movements has been well demonstrated. Some patients adjust quickly, others require more time, while an occasional one, particularly belonging to the older group, fails entirely. At Sunny View 1,500 hours of lung immobilization, divided into two daily periods of four hours each, is tentatively set as constituting a course of chamber treatment. In no instance has harm resulted and patients find it a rather pleasant, relaxing, experience.

Of the 38 patients reported on, our two minimal cases secured an apparent arrest after 992 and 1,116 hours respectively. Our three moderately advanced cases with cavity formation cleared after 943; 1,042 and 1,500 hours of lung immobilization; seven far advanced bi-lateral cavity cases closed their cavities and became sputum negative on concentrate and culture of gastric washings after from 1,170 to 2,374 hours of chamber residence. Seven other far advanced cases improved sufficiently to change their lesions from surgically non-acceptable to acceptable risk cases. One patient, having difficulty converting the sputum on bed rest following thoracoplasty responded after a short period of lung immobilization. Five patients, unfortunately, voluntarily discontinued chamber treatments after showing definite improvement on chest x-ray films and laboratory findings. Six others are now undergoing lung immobilization with encouraging findings, while the remaining number of the 38 reported were apparently pre-terminal for which nothing could be done.

We have noted the following clinical responses: 1) Subjective symptoms are brought under control in a shorter period of time. 2) Pleuritic pain ceases at once following lung immobilization. 3) Cavity closure is definitely favored and sputum conversion hastened.

Our impressions on the usefulness of the immobilizing chamber in publicly operated and financed sanatoriums are as follows: 1) The chamber offers in recoverable cases the means of materially reducing the period of sanatorium stay. 2) Lung immobilization will increase the diseased resisting potential in marginal cases, thus offering a last opportunity for recovery. 3) Lung immobilization therapy may obviate the necessity for major chest surgery in some cases and prepare others for operative procedures with less surgical risk. 4) Lung immobilization treatment does not preclude the associated use of additional conventional procedures in our efforts to save human lives from chronic pulmonary tuberculosis.