Incidence of Contralateral Pulmonary Atelectasis After Thoracotomy; An Evaluation of Preventive Aftercare*

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CONTINUOUS EFFICIENT TRACHEOBRONCHIAL TOILET after thoracotomy is universally recognized as an important feature of patient care to promote rapid recovery of respiratory stability and prevent complication. This is accomplished by unhesitating application of vigorous methods to stimulate frequent cough and deep breathing. The contrast between the aggressive attitude toward respiratory economy of the post-thoracotomy patient and the sometimes semi-neglectful attitude toward the post-surgical patient, may be strikingly demonstrated by the incidence of roentgenographic atelectasis occurring in these two groups of surgical patients. A preliminary prospective roentgenographic survey of abdominal surgery cases attended at this hospital revealed a 50 per cent incidence of pulmonary atelectasis. This unacceptably high rate of pulmonary complication was favorably influenced by adoption of an aggressive preventive attitude which included administration of the mucolytic agent acetylcysteine. By impression, the incidence of post-thoracotomy atelectasis did not seem to be alarming; however, this investigation was undertaken to more accurately determine the rate of occurrence, and to assess the clinical usefulness of the mucolytic agent, acetylcysteine, employed as an adjunct in management of thoracic surgical patients.

MATERIAL AND METHODS

One hundred ninety-two patients who submitted to 198 thoracic operations at this hospital during the period July 15, 1963 through April 13, 1966 were included in the study. The ages of these patients ranged from 17 to 72 years. Men predominated in a ratio of six to one, as anticipated for a military practice. Two operative procedures were performed on six of the individuals included in the study. Four of these six patients required staged bilateral operations and two needed staged unilateral operations. Two patients succumbed within 30 days of operation. One died of bronchopleural fistula and empyema three weeks after post-irradiation pneumonectomy. The second death resulted from precipitous hepatic failure after pneumonectomy. Surgery was done in an attempt to control bronchogenic carcinoma in both instances. Contralateral pulmonary atelectasis was diagnosed by chest roentgenogram. This was accomplished by review of comparative pre-and daily postoperative chest roentgenograms without reference to the clinical condition of the patient. Portable roentgenograms of these patients were made daily until chest drainage tubes were removed, or for the first week after operation if prolonged drainage was necessary. The contralateral lung field only was evaluated for presence of atelectasis to avoid inaccurate interpretation of surgically induced changes roentgenographically apparent in the violated pleural space. The appearance of any 2 to 3 mm thick horizontal or curvilinear tissue density tapering peripherally was judged to be atelectasis.

A retrospective review of postoperative chest roentgenograms after 84 consecutive thoracic procedures was made as an initial survey. This was accomplished to establish the incidence of post-thoracotomy contralateral pulmonary atelectasis. Postoperative nursing care included frequent assisted coughing, transnasal tracheal aspirations and occasional bronchoscopy. The patients submitting to the subsequent 84 thoracic
surgical procedures were prospectively studied and the postoperative care altered to include administration of acetylcysteine. Immediately, as thoracotomy was completed, a PE 50 polyethylene catheter was percutaneously placed in the trachea as described by Radigan and King. Acetylcysteine was administered as a 10 per cent solution through the catheter 2 ml every two hours the first day and with decreasing frequency thereafter for three to five days until the pleural drainage tubes were removed or drainage subsided. Catheter placement failures and complications among the treated patients were insignificant; however, premature dislodgement did occur occasionally. The mucolytic agent was administered as an aerosol by intermittent positive pressure breathing apparatus if the catheter was displaced or failed to function.

Upon completion of the aforementioned series of cases, postoperative management was modified to permit administration of the mucolytic agent by intermittent positive pressure breathing apparatus. Therefore, in the final 30 patients studied to elicit the presence of contralateral pulmonary atelectasis, placement of an intratracheal catheter was not employed; however, the amount and frequency of 10 per cent acetylcysteine administered was not changed.

**RESULTS**

The relationship between the various surgical procedures and incidence of contralateral pulmonary atelectasis in the cases studied is presented in Fig. 1. A higher incidence of atelectasis seemed to attend lobectomy, but with equal frequency whether patients received acetylcysteine or not. The addition of the mucolytic agent administered in the manners described did not influence the incidence of atelectasis remarkably, either within groups of patients having similar operations, or between the treated and untreated groups. For the total series of 198 operative procedures studied, a 14 per cent incidence of contralateral, subsegmental roentgenographic atelectasis was recorded. Contralateral lobar atelectasis was not observed; however, ipsilateral collapse of a complete lobe was noted on two occasions.

**DISCUSSION**

Voluminous literature has accumulated on the subject of pulmonary atelectasis. It

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**SURGICAL PROCEDURE AND OCCURRENCE OF ATELECTASIS**

<table>
<thead>
<tr>
<th>PROCEDURE</th>
<th>NO. CASES WITH ATELECTASIS/TOTAL CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PNEUMONECTOMY</td>
<td>2/11</td>
</tr>
<tr>
<td>2. LOBECTOMY</td>
<td>11/53</td>
</tr>
<tr>
<td>3. SEGMENTECTOMY</td>
<td>1/32</td>
</tr>
<tr>
<td>4. SUBSEGMENTECTOMY</td>
<td>5/30</td>
</tr>
<tr>
<td>5. BIOPSY</td>
<td>9/48</td>
</tr>
<tr>
<td>6. DECOMICATION</td>
<td>0/10</td>
</tr>
<tr>
<td>7. MISCELLANEOUS</td>
<td>1/14</td>
</tr>
</tbody>
</table>

**Figure 1**
is sufficient for the purpose of this communication to suggest that hypoventilation coincident with stagnation of tracheobronchial secretions results in frequent atelectasis. A multitude of contributing factors may be present in a given patient, such as preexisting respiratory disease, habitual smoking, age, obesity, anesthetic management, incisional pain and reluctant aftercare. However, atelectasis can be minimized as a surgical complication by aggressive attention to the importance of immediate adequate elimination of tracheobronchial secretions and frequent ventilation of the entire alveolar bed. It is of interest to observe that during a period of roentgenographic survey in this hospital, the incidence of atelectasis among patients submitting to abdominal procedures was 50 per cent, while the incidence of contralateral atelectasis among thoracotomized patients was considerably less. Although these are not comparable observations, the same nursing personnel administered postoperative care to all of the patients. The addition of therapeutic mucolysis after abdominal surgery resulted in a dramatic reduction in pulmonary atelectasis, whereas the same dramatic effect was not demonstrated after thoracotomy.

Although it was hoped that a reduced incidence of atelectasis after thoracotomy might result from the addition of mucolytic therapy, the outcome was not completely unexpected. The attention of both physicians and nurses has always been orientated to the respiratory function of the thoracic surgical patient.

Prompt elimination of tracheobronchial secretions after thoracotomy is of greatest importance. This can usually be accomplished by frequent assisted coughing, transnasal tracheal aspirations and occasionally bronchoscopy in a difficult situation. The addition of a mucolytic agent to promote rapid transport of secretions and increase effectual coughing should be helpful. Acetylcysteine was selected for this purpose because reported clinical experiences have been encouraging; it does have a distinct mucolytic property and it does not have a deleterious effect on pulmonary surfactant. This study did not demonstrate a reduction in incidence of contralateral atelectasis in the group of cases receiving acetylcysteine. However, the nursing care of treated cases was simplified. Direct intratracheal administration of the mucolytic agent frequently stimulated effective secretion-clearing cough and transnasal tracheal aspiration was less often required. However, some patients complained of nausea and anorexia, attributed to the constant offensive odor and taste of acetylcysteine administered in this way. Greater patient acceptance of the mucolytic agent given by intermittent positive pressure breathing apparatus was achieved. The apparent therapeutic effectiveness of the agent was not compromised by this modification of management.

The necessity for intermittent deep inspiration, sighing, to avoid hypoventilatory pulmonary atelectasis is widely recognized by anesthesiologists. However, postoperative patients find it difficult to breathe deeply even when encouraged to do so. Logically, intermittent positive pressure assisted breathing should overcome resistance to full inspiration. However, clinical investigations directed toward eliminating postoperative atelectasis employing assisted ventilation did not demonstrate substantial benefit. Intermittent positive pressure breathing was freely employed in the group of cases reviewed retrospectively who did not receive acetylcysteine. Direct intratracheal instillation of the mucolytic agent was employed to eliminate any complimentary benefit of positive pressure breathing in the initial evaluation of mucolysis. Upon completion of the comparative study, the program of management was modified to take advantage of the potential benefits of both ventilatory assistance and mucolysis.

It is interesting to observe that through this entire period of special interest and emphasis on postoperative pulmonary atelectasis, the incidence of this complication
occurring in the contralateral lung has remained constant. Speculation as to the explanation for this refractory incidence is tempting. Presumably, recognition of the magnitude of the problem and appropriate therapeutic measures are sufficient to avoid progression to more serious and threatening complications. At the present time we reserve placement of a transtracheal catheter for patients in whom a difficult problem in tracheobronchial toilet is anticipated or develops in the postoperative period.

**Summary**

A comparative investigation of the incidence of contralateral roentgenographic pulmonary atelectasis was made in three groups of post-thoracotomy cases. The first 84 cases received adequate aftercare with good tracheobronchial toilet without emphasis on mucolysis. The second 84 cases received acetylcysteine administered by direct intratracheal instillations in 10 per cent concentration in addition to accepted aftercare. The third group of 30 cases received the mucolytic agent administered by intermittent positive pressure breathing apparatus. The incidence of contralateral pulmonary atelectasis for the total series of cases was 14 per cent and did not vary significantly between the groups studied.

The incidence of atelectasis is recognizably related to moment by moment supervision of tracheobronchial toilet after thoracotomy, rather than a specific technique or therapeutic agent. However, the addition of acetylcysteine may be a valuable adjunctive agent to promote easier and more rapid elimination of undesirable secretions.

**Acknowledgement:** The acetylcysteine (Mucomyst) used in this investigation was supplied by Dr. Max D. Davis, Associate Medical Director, Mead-Johnson Laboratories.

**Resumen**

En tres grupos de post-thoracotomizados se practicó la investigación sistemática radiológica de la atelectasia contralateral. Los 84 primeros recibieron tratamiento postoperatorio adecuado con efectiva toilet traqueobronquial, sin insistencia en el empleo de agentes mucolíticos. Los segundos 84 casos recibieron acetylcysteine administrada por instilación directa traqueo-bronquial en concentración al diez por ciento, además de la debida atención postoperatorio. El tercer grupo de 30 casos recibió el agente mucolítico administrado por medio del aparato de respiración a presión positiva intermitente. La incidencia de atelectasia pulmonar contralateral en el total de casos fue de un catorce por ciento, sin variaciones significativas entre los distintos grupos. La incidencia de atelectasia está relacionada con la atención sostenida a la toilet traqueobronquial en el postoperatorio de los traqueotomizados, más bien que con técnica alguna o con el empleo de determinado agente terapéutico. Sin embargo, la adición de acetylcisteina puede ser útil en cuanto a facilitar la eliminación rápida de secreciones perjudiciales.

**Zusammenfassung**

In 3 Gruppen von Patienten nach Thorakotomie wurde eine vergleichende Untersuchung angestellt über das Vorkommen kontralateraler, pulmonaler röntgenologisch erfaßter Atelektase.

Die ersten 84 Patienten erhielten eine entsprechende postoperative Betreuung mit befriedigender Toilette des Tracheobronchialbaums ohne, daß auf die Mucolyse besonders geachtet worden wäre. Die zweiten 84 Fälle bekamen Acetylcystein und zwar durch direkte intratracheale Installationen einer 10% igen Lösung zusätzlich zu der anerkannten postoperativen Betreuung. Die dritte Gruppe von 30 Patienten erhielt einen schleimlösenden Stoff, der durch ein Gerät mit intermittierender positiver Druckatmung zugeführt wurde. Das Vorkommen einer kontralateralen pulmonalen Atelektase lag für die gesamte Fallreihe bei 14% und zeigte zwischen den einzelnen Gruppen keine signifikanten Variationen. Das Vorkommen einer Atelektase ist wie leicht zu erkennen, eng verknüpft mit der pausenlosen Überwachung der Toilette des Tracheobronchialbaums nach der Thorakotomie und zwar in weit stärkerem Ausmaß als die im einzelnen angewandte Technik oder das Heilmittel angeht.

Es kann jedoch der Zusatz von Acetylcystein eine weitaus größere Unterstützung darstellen, um eine leichte und schnelle Elimination unerwünschter Sekretbildungen zu fördern.
GONADOTROPIN-PRODUCING CARCINOMAS

Four men smokers with gynecomastia had clinical findings typical of bronchogenic carcinoma. Necropsies were done in each case. Some microscopic sections of the tumor resembled choriocarcinoma, but serial sections of the testes failed to reveal tumor or "burned-out" choriocarcinoma and extensive search did not yield evidence of extra-genital trophoblastic neoplasia. The pathologic diagnosis in each case was anaplastic large-cell carcinoma of the lung. Urinary excretion of gonadotropic activity was elevated in all four patients, but not in ten others with bronchogenic carcinoma who did not have gynecomastia. When tissue and blood were available, gonadotropic activity was recovered from lung tumor (three cases) and from plasma (two cases). The pituitary glands from three of the patients were studied and showed depletion of gonadotropic activity. Urinary estrogens were determined in three patients and were increased. These cases probably represent the first documented examples of gonadotropin production by a bronchogenic carcinoma.


EXTRINSIC COMPRESSION OF ESOPHAGUS BY TUBERCULOUS ADENOPATHY

The authors report a case of dysphagia due to extrinsic compression of the esophagus in a 23-year-old woman. The compression was caused by a tuberculous subcarinal adenopathy. Radiologic and esophagoscopic findings were consistent with a benign intramural tumor. Right thoracotomy, esophagomyotomy, block resection of the subcarinal lymph nodes and extramucosal esophagorraphy of the muscular layers were successfully carried out. The diagnosis and therapy are discussed.


PULMONARY ALVEOLAR PROTEINOSIS

A case of pulmonary alveolar proteinosis, pulmonary nocardiosis and chronic granulocytic leukemia is reported. This is the first case reported from Puerto Rico and the sixth in which pulmonary alveolar proteinosis has been complicated by pulmonary nocardiosis. This case supports the concept that this association is one of enhanced susceptibility to infection by specific agents.