Pregnancy in a Woman with Severe Pulmonary Fibrosis Secondary to Hard Metal Disease*  

David Ratto, M.D.,† John Balmes, M.D., F.C.C.P.;‡ Tom Boyle, M.D.; and Om P. Sharma, M.D., F.C.C.P.||

The effect of interstitial pulmonary fibrosis on pregnancy is unclear. We present the findings in a 31-year-old woman with severe pulmonary fibrosis (vital capacity, 37 percent of predicted) secondary to hard metal disease who went through a successful term pregnancy. The patient was a grinder of tungsten-carbide drill bits who developed pneumonitis and subsequent fibrosis. Her therapy required steroids and cyclophosphamide for stabilization of her pulmonary function prior to her pregnancy. At six months gestation, right heart catheterization showed normal cardiac output and pulmonary arterial and wedge pressures. Stage 2 exercise study demonstrated a maximum oxygen consumption of 1.17 L/min (53 percent of predicted). The patient was able to exercise to a maximum workload of 300 kpm/min (32 percent of predicted). She became hypoxemic (arterial oxygen pressure, 54 mm Hg) at 150 kpm/min. Her pregnancy concluded with an uncomplicated normal vaginal delivery requiring only supplemental oxygen and spinal anesthesia. Review of the few similar cases suggests that a woman can have a successful pregnancy despite severe pulmonary dysfunction.

References
4 Mohan K, Dass SI, Kemble EE. Actinomycosis of pericardium. JAMA 1974; 229:321
5 Ramsdale DR, Gautam PL, Pereira B, Charles RG. Cardiac tamponade due to actinomycosis. Thorax 1984; 39:473-74
6 Konig A. Inaugural dissertation. Berlin, 1884
9 Cornell A, Shookhoff HB. Actinomycosis of the heart simulating rheumatic fever: report of three cases of cardiac actinomycosis with a review of the literature. Arch Intern Med 1944; 74:11-27

Hard metal disease is an occupational pulmonary disease causing pneumonitis and subsequent interstitial fibrosis. It is generally found in patients who work as grinders of materials made from tungsten-carbide. The offending agent is the cobalt dust generated by grinding these materials. The course of a pregnancy in a woman with this disease is described.

Case Report
A 31-year-old Ecuadorian woman first presented to one of our affiliated hospitals for evaluation of bilateral upper lobe interstitial pulmonary disease in December 1982. In January 1983, hard metal disease was diagnosed by scanning electron microscopic analysis by Jerold Abrams, M.D., at Upstate Medical Center in Syracuse, NY. Since December, the patient had no further exposure to cobalt. Her treatment consisted of prednisone and cyclophosphamide. The cyclophosphamide and prednisone were stopped in December 1983 because of hematuria and stabilized pulmonary function. The vital capacity (VC) then was 1.27 L (34 percent of predicted). The forced expiratory volume in one second equaled VC. Exercise studies performed during this period showed desaturation at low workloads (300 kpm/min). The patient's exercise tolerance and arterial oxygen saturation improved with supplemental nasal oxygen.

In July 1985, the patient's pregnancy was diagnosed. The obstetrician believed that the patient had an intrauterine pregnancy and was at 16 to 18 weeks of gestation in August. There was concern as to the safety of maintaining the pregnancy to full term because of the patient's history of respiratory insufficiency and failure to gain weight over the first trimester. An increased pulmonic second sound was noted on auscultation. Our concern arose as to whether the patient had developed pulmonary hypertension. In view of her desire to continue with the pregnancy, right heart catheterization and stage 2 exercise study were performed at six months (Table 1).

Pulmonary artery catheterization showed the following values: pulmonary artery pressure, 18/8 mm Hg; pulmonary capillary wedge pressure, 3 to 5 mm Hg; cardiac output, 6.3 L/min; and cardiac index, 4.8 L/min/m². The exercise study by treadmill showed a resting oxygen consumption (V̇O₂) of 0.2 L/min, which increased to 1.17 L/min maximally (53 percent of predicted). Her minute ventilation (V̇E) increased from 8.9 L/min at rest to 26.9 L/min maximally. Her arterial oxygen pressure (PaO₂) decreased from 81 mm Hg to 54 mm Hg on room air. Arterial carbon dioxide tension (PaCO₂) increased only mildly to 38 mm Hg from 36 mm Hg. The patient

Table 1—Results of Exercise Study and Right Cardiac Catheterization at Six Months

<table>
<thead>
<tr>
<th>Data</th>
<th>Actual Value</th>
<th>Predicted Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate, beats per min</td>
<td>67</td>
<td>...</td>
</tr>
<tr>
<td>Maximum</td>
<td>133</td>
<td>...</td>
</tr>
<tr>
<td>V̇O₂, L/min</td>
<td>0.2</td>
<td>...</td>
</tr>
<tr>
<td>Resting</td>
<td>1.17</td>
<td>2.1</td>
</tr>
<tr>
<td>Maximum</td>
<td>26.9</td>
<td>24.0</td>
</tr>
<tr>
<td>V̇E, L/min</td>
<td>8.9</td>
<td>5.7</td>
</tr>
<tr>
<td>Resting</td>
<td>300</td>
<td>950</td>
</tr>
<tr>
<td>Maximum</td>
<td>18/8</td>
<td>...</td>
</tr>
<tr>
<td>Pulmonary arterial pressure, mm Hg</td>
<td>3-5</td>
<td>...</td>
</tr>
<tr>
<td>Cardiac output, L/min</td>
<td>6.5</td>
<td>...</td>
</tr>
<tr>
<td>Cardiac index, L/min/m²</td>
<td>4.8</td>
<td>...</td>
</tr>
</tbody>
</table>

*From the Departments of Pulmonary Medicine and of Medicine, Los Angeles County, University of Southern California Medical Center, Los Angeles, and the Department of Medicine, University of California, San Francisco.  
†Fellow, Department of Pulmonary Medicine.  
‡Assistant Professor of Medicine, University of California, San Francisco.  
§Associate Professor of Medicine, Los Angeles County, University of Southern California Medical Center.  
||Acting Chief, Pulmonary Medicine.  
Reprint requests: Dr. Ratto, 1200 West State Street, Room II-900, Los Angeles 90033
achieved a workload of 300 kpm/min (32 percent of predicted) with a maximum heart rate of 133 beats per minute. She stopped because of fatigue and desaturation.

In view of the lack of evidence to support the diagnosis of pulmonary hypertension and the patient’s ability to increase her \( V_O_2 \) sixedfold with only mild hypoxemia, we believed that she should be able to carry her pregnancy to term. She was instructed to wear nasal oxygen (1 L/min) while doing any exertional activity.

Studies of pulmonary function done at the same time revealed a slightly increased VC of 1.4 L and total lung capacity (TLC) of 2.8 L (Fig 1). The duration of the pregnancy was complicated by moderate morning production of sputum associated with mild dyspnea until physically cleared. In the absence of significant symptoms, the patient was allowed to enter active labor with supplemental oxygen and spinal anesthesia. Arterial blood gas analysis and oximetry revealed no evidence of hypoxemia or desaturation throughout labor (Table 2). On Jan 22, 1986, she delivered a 3,500-g healthy female infant after 24 hours of labor. Apgar scores were 9/9. At nine months of age, the child is still a healthy growing girl.

Spirometry one week prior to delivery showed a VC of 1.38 L. Six weeks after delivery, the VC was 1.1 L (Fig 1).

**DISCUSSION**

There are minimal data on pregnancy in the woman with respiratory insufficiency. Most reports in the literature are on patients with tuberculosis, sarcoïdosis, or scoliosis. We were able to find only three cases in which the patient had severe pulmonary fibrosis due to other diseases.

This patient presented us with multiple issues of concern. One issue was whether the pregnancy itself would be deleterious to the patient and whether it should be terminated. If the pregnancy were to continue to term, what would be the best means of delivery of the child? Pulmonary hypertension was a major concern. Primary pulmonary hypertension is associated with a 50 percent mortality. Little is known about secondary pulmonary hypertension in pregnancy.

The effects of a growing fetus on the patient’s pulmonary function were unknown. In the normal woman the TLC decreases slightly, and VC is unchanged. Airway resistance is decreased. In this patient the TLC increased initially and then decreased near term. Her VC increased approximately 200 ml or 16 percent. Noted also was a decreased \( PaCO_2 \) and increased \( PaO_2 \). The most likely explanation is increased alveolar ventilation and \( V_E \).

**Hemodynamic studies** have demonstrated increases in cardiac output of 40 percent during pregnancy. Cardiac output peaks at the third trimester and declines as term approaches. After delivery under spinal anesthesia, cardiac output may increase 60 percent. This is mostly attributed to increased venous return secondary to removal of the inferior vena caval obstruction and augmented blood volume.

Oxygen consumption increases 15 to 20 percent at rest during pregnancy. Additionally, \( V_O_2 \) is also increased similarly during exercise. Estimated increase in \( V_O_2 \) during labor is 200 ml/min with epidural anesthesia.

We did no further studies of gas exchange on our patient because of her ability to increase her \( V_O_2 \) by sixedfold with only mild hypoxemia. Based on our knowledge of the cardiac and respiratory demands of pregnancy and labor, we believe that if a women could triple her resting \( V_O_2 \) with correctable hypoxemia, she would be able to tolerate the pregnancy.

Previous reviews of pregnancy complicated by respiratory insufficiency have indicated such pregnancies can be success-

---

### Table 2—Arterial Blood Gas Levels during Labor and after Delivery

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>( PaO_2 ) (mm Hg)</th>
<th>( PaCO_2 ) (mm Hg)</th>
<th>pH</th>
<th>Oxygen, L/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/21/86</td>
<td>7.40 PM</td>
<td>98</td>
<td>37</td>
<td>7.42</td>
<td>Room Air</td>
</tr>
<tr>
<td>1/22/86</td>
<td>12.15 PM</td>
<td>145</td>
<td>37</td>
<td>7.43</td>
<td>4</td>
</tr>
<tr>
<td>1/22/86</td>
<td>8 PM</td>
<td>119</td>
<td>35</td>
<td>7.37</td>
<td>4</td>
</tr>
<tr>
<td>1/23/86</td>
<td>11:16 PM</td>
<td>137</td>
<td>33</td>
<td>7.41</td>
<td>4</td>
</tr>
<tr>
<td>Postpartum</td>
<td>2:05 AM</td>
<td>194</td>
<td>34</td>
<td>7.38</td>
<td>4</td>
</tr>
<tr>
<td>1/23/86</td>
<td>6:25 PM</td>
<td>174</td>
<td>31</td>
<td>7.41</td>
<td>4</td>
</tr>
<tr>
<td>1/23/86</td>
<td>8:40 AM</td>
<td>189</td>
<td>39</td>
<td>7.42</td>
<td>4</td>
</tr>
<tr>
<td>1/24/86</td>
<td>8:05 AM</td>
<td>79</td>
<td>41</td>
<td>7.43</td>
<td>Room Air</td>
</tr>
</tbody>
</table>

---

**Figure 1.** Changes in \( PaO_2 \), TLC, and VC during treatment with cyclophosphamide and steroids and during subsequent pregnancy.
ful. The children may be of low birth weight, usually due to premature delivery, but are apparently without other ill effects. The underlying condition affecting the mother generally worsened as the pregnancy continued. Successful management included supplemental oxygen and other types of therapy as needed. Most infants were delivered vaginally.

These limited studies, as well as our patient, demonstrate that despite the increased respiratory and cardiac demands of pregnancy, women with severe pulmonary fibrosis can have a manageable pregnancy with a normal outcome.

REFERENCES
3 Jones NL, Campbell EJM. Clinical exercise testing. Philadelphia: WB Saunders Co, 1982
8 Pritchard MG, Musk AW. Adverse effects of pregnancy on familial fibrosing alveolitis. Thorax 1984; 39:319-20
13 Prowse CM, Gensler EA. Respiratory and acid base changes during pregnancy. Anesthesiology 1965; 25:381-92

Epithelioid Hemangioendothelioma*
A Rare Tumor with Variable Prognosis Presenting as a Pleural Effusion

Frederick A. Bevelaqua, M.D., F.C.C.P.;† Quentin Valensi, M.D.;‡ and Donald Hulnick, M.D.§

The chest x-ray film a 22-year-old man showed a large right-sided pleural effusion that was grossly hemorrhagic when aspirated. A computerized tomographic scan showed a complex mass with cystic components contiguous with the diaphragm. On thoracotomy the mass was found to be arising from the diaphragm and had the consistency of an organizing hematoma. Pathologic studies showed the mass to be an epithelioid hemangioendothelioma. This rare tumor has never been reported previously as arising from the diaphragm. It has a variable prognosis, but surgery remains the treatment of choice. In this report, we review the clinical and pathologic characteristics of this unusual tumor, as well as the distinctive roentgenographic findings with which it presented.

Epithelioid hemangioendothelioma is a rare tumor which is characterized by an "epithelioid" endothelial cell that demonstrates many of the features of normal endothelium, including the presence of factor VIII-associated protein. This tumor tends to have an angiocentric location and may occur in either superficial or deep soft tissue. It has occasionally been reported as arising in liver, lung, and mediastinum; however, to our knowledge, this tumor has never previously been reported as arising from the diaphragm. The findings from the computerized tomographic scan in this case were quite unusual and showed a large cystic mass contiguous with the diaphragm. This tumor is generally thought to follow a clinical course intermediate between that of a hemangio and angiosarcoma. Although there are certain histologic characteristics that may suggest a more malignant potential, the clinical course in most instances remains unpredictable.

CASE REPORT

A 22-year-old man was admitted to another hospital because of low-grade fever of several days' duration and a right-sided pleural effusion. His past medical history was otherwise unremarkable. A thoracentesis revealed a serosanguineous exudative effusion. Cyto logic findings were negative for malignancy. The level of glucose and pH were normal. Gram stain, acid-fast stain, and cultures were negative. Testing with purified protein derivative of tuberculosis (PPD) was unreactive. The patient then underwent a pleural biopsy, which showed only acute and chronic inflammation. Because of his persistent pleural effusion, he underwent a repeat thoracentesis

![Figure 1. Computerized tomographic scan of chest shows well-defined but slightly irregular multicystic mass (M) inseparable from liver (L) or diaphragm. Note soft-tissue components in wall of lesion and separating low-density regions. H, Heart.](http://journal.publications.chestnet.org/pdfaccess.ashx?url=/data/journals/chest/21575/ on 04/26/2017)