load on the left ventricle which it is incapable of handling. Wolf and co-workers, reviewed atrial septal defects in patients over 45 years of age, and noted that in 4 out of 15 patients who underwent surgical closure of the defect, signs of increased pulmonary venous congestion developed either in the immediate postoperative period or up to several years after operation. They attributed this to the presence of left ventricular disease in these patients. Similar cases were found in the series reported by Arnfred, by Cohn and associates, and by Tikoff and colleagues. Most recently, Davies and co-workers also reported on seven patients (ages 21 to 44 at operation) who developed signs of left heart dysfunction after operation.

This situation is similar to that which can occur in Lutembacher's syndrome. Gross, in a series of 166 patients operated on for atrial septal defect, reported three patients in whom concomitant mitral stenosis was overlooked and in whom closure of the septal defect produced severe pulmonary venous congestion leading to fatality within 24 to 48 hours. Similarly, Steinbrunn and colleagues, in their review and reevaluation of Lutembacher's syndrome, emphasized the protective influence an atrial septal defect exerts by decompressing the left atrium, and described one case in which fatal pulmonary edema developed following closure of an atrial septal defect, and a second case in which the increased left atrial pressure led to the spontaneous reopening of the defect. It is worth mentioning in this respect, that prior to the development of the techniques for direct surgical correction of mitral stenosis, operative production of an atrial septal defect was sometimes practiced. Such a procedure has also been shown to be effective in the alleviation of left ventricular failure.

In the case herein reported the presence of left axis deviation suggested to us the diagnosis of partial atrioventricular canal and for this reason associated myocardial disease was not sufficiently appreciated.

In view of the lesson learned from this case as well as from similar cases reported in the literature, as noted above, it should be emphasized that closure of an atrial septal defect may be deleterious in the presence of left ventricular disease.

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**Acute Lupus Pneumonitis: Response to Azathioprine Therapy**

Richard A. Matthay, M.D., Leonard D. Hudson, M.D., and Thomas L. Petty, M.D., F.C.C.P.

An 18-year-old girl developed an acute, fulminating lupus pneumonitis manifested by severe shortness of breath, cyanosis, fever, profound hypoxemia and diffuse pulmonary infiltrates. When the patient failed to improve significantly with prednisone, azathioprine therapy was instituted. Marked clinical, x-ray and physiologic improvement followed and the patient has remained well for 15 months. These results suggest a role for azathioprine in treating acute lupus pneumonitis not responding to steroids.

Lupus pneumonitis, a well recognized manifestation of systemic lupus erythematosus, usually responds to corticosteroid therapy. This study concerns a patient with a fulminant lupus pneumonitis who failed to improve significantly with corticosteroid therapy. However, after azathioprine was begun, the chest roentgenogram cleared and the ventilatory studies improved markedly. To the best of our knowledge, the use of azathioprine in lupus pneumonitis has not been previously reported.

**Case Report**

The patient, an 18-year-old Mexican-American girl, was admitted to Colorado General Hospital in September, 1970, with severe shortness of breath and marked cyanosis. Three months prior to admission the patient noted an evanescent red rash over her face, transient arthralgias and stiffness with swelling of her distal interphalangeal joints and ankles. One week before admission, while being treated with azogranisin...
Table 1—Ventilation and Arterial Blood Gas Determinations following Admission

<table>
<thead>
<tr>
<th>Day</th>
<th>O_2</th>
<th>Rest</th>
<th>Exercise</th>
<th>VC (Liters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Room air</td>
<td>20</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 L</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mask)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>.490</td>
</tr>
<tr>
<td>14</td>
<td>10 L</td>
<td>62</td>
<td>580</td>
<td></td>
</tr>
<tr>
<td>(nasal)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Azathioprine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Room air</td>
<td>61</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>2 mo</td>
<td>Room air</td>
<td>61</td>
<td>49</td>
<td>1.70</td>
</tr>
<tr>
<td>10 mo</td>
<td>Room air</td>
<td>71</td>
<td>68</td>
<td>2.36</td>
</tr>
</tbody>
</table>

*(Range of normal for Denver 65-75)
(Range of normal 3.2 ± 0.84)

for a urinary tract infection, she developed a fever (104° F) and oral penicillin was substituted for azograntrisin. Three days prior to admission the red facial rash reappeared. Progressive severe shortness of breath followed and she was admitted to the intensive respiratory care unit.

Physical examination revealed a markedly cyanotic, tachypneic woman with a blood pressure of 100/70, pulse 144, respirations 42 and temperature 102.5° F. An erythematous malar eruption was present. Decreased breath sounds were noted bilaterally with rales at both lung bases. Cardiac examination revealed a right ventricular lift and an accentuated pulmonic closure; no pericardial friction rub was observed. No hepatosplenomegaly or joint involvement was noted.

Laboratory examination showed a normal hemoglobin, WBC count and differential. The blood urea nitrogen, serum creatinine and urinalysis were within normal range. The erythrocyte sedimentation rate (Wintrobe Method) was 46 mm/hr, LE prep was positive, antinuclear antibody was positive, revealing an homogeneous pattern, anti-DNA antibodies were present and a biopsy of uninvolved skin was positive for immunofluorescence. Admission arterial blood gas values were Pco_2 21, Po_2 20, O_2 saturation 31 percent and pH 7.52 while breathing room air; on high flow oxygen (12 liters per minute by face mask) the Pco_2 only increased to 42 mm Hg with a Pco_2 of 34 mm Hg (Table 1). Anteroposterior chest roentgenogram (Fig 1) revealed a diffuse infiltrate, greatest at the lung bases, and bilateral pleural effusions.

Electrocardiogram showed occasional ventricular premature beats. Blood and urine cultures revealed no growth; sputum and throat cultures produced normal flora. Viral cultures of blood, nasopharynx and stool were negative. The tuberculin skin test (PPD intermediate) gave negative results; the intradermal mumps skin test was positive.

A diagnosis of acute, fulminating lupus pneumonitis was made and treatment was initiated with nasal oxygen, tetracycline (two grams daily for seven days) and intravenous hydrocortisone (400 mg per day). The temperature returned to normal by the fourth hospital day and respirations were slightly less labored. The patient still required high flow nasal oxygen to maintain an adequate PaO_2 and the chest x-ray

Table 2—Pulmonary Function Tests 10 Months after Onset

<table>
<thead>
<tr>
<th></th>
<th>Patient</th>
<th>Mean, 2 SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC</td>
<td>2.56</td>
<td>3.20 ± 0.84 L</td>
</tr>
<tr>
<td>FEV_1</td>
<td>2.42</td>
<td>2.08 ± 0.74 L/sec</td>
</tr>
<tr>
<td>MMF</td>
<td>2.92</td>
<td>4.51 ± 1.66 L/sec</td>
</tr>
<tr>
<td>MVV</td>
<td>136</td>
<td>106 ± 21 L/min</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO_2</td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td>71</td>
</tr>
<tr>
<td>*Exercise</td>
<td>68</td>
</tr>
<tr>
<td>Paco_2</td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td>30</td>
</tr>
<tr>
<td>*Exercise</td>
<td>28</td>
</tr>
<tr>
<td>O_2/V</td>
<td></td>
</tr>
<tr>
<td>Rest</td>
<td>28</td>
</tr>
<tr>
<td>*Exercise</td>
<td>38</td>
</tr>
<tr>
<td>Dco (sa)</td>
<td></td>
</tr>
<tr>
<td>*Exercise</td>
<td>15</td>
</tr>
</tbody>
</table>

*6 min, 4% grade, 2.25 mph.
ACUTE LUPUS PNEUMONITIS

Christian described the involvement with systemic lupus erythematosus (SLE) as marked tendency toward complete resolution of the infiltrates. However, it may vary in extent and location from one lung to the other, depending on the stage of the disease. 

In spite of high doses of corticosteroids for 14 days, the patient's vital capacity was only 580 ml (16 percent of normal) and high flow nasal oxygen was still required to maintain adequate oxygenation (Table 1). The chest roentgenogram revealed the continued presence of bilateral pulmonary infiltrates and pleural effusions. At this time azathioprine (150 mg per day orally, 2 mg/kg) was added to the steroid therapy. Marked improvement with less dyspnea and reduced oxygen flow requirements followed. The patient was discharged on the 39th hospital day on azathioprine (75 mg daily) and prednisone (30 mg per day) with a vital capacity of one liter (27 percent of normal) and a PaO₂ of 61 mm Hg without nasal oxygen (Table 1). The chest roentgenogram (Fig 2) showed resolution of the effusions and substantial clearing of the bilateral infiltrates.

Ten months after admission the patient's vital capacity was 2.56 liters (70 percent of normal) and the PaO₂ 71 and 67.5 mm Hg at rest and with exercise respectively (Table 2). The chest roentgenogram (Fig 3) was normal. Fifteen months following hospitalization the patient remains asymptomatic. Medications are azathioprine 50 mg and 25 mg on alternate days, and prednisone 8 mg daily.

Discussion

The reported incidence of intrinsic pulmonary involvement with systemic lupus erythematosus (SLE) has varied widely. Harvey and co-workers reported 46 of 105 patients with this manifestation. Twenty had changes considered to be lupus pneumonitis while the other 26 patients had bacterial pneumonias. Dubois and Tuffanelli reported 250 patients with SLE of which only 0.9 percent appeared to have lupus pneumonitis. Recently Levin analyzed 111 cases of SLE and found three patients with lupus pneumonitis and Estes and Christian described 14 patients with lupus pneumonitis in a series of 150 with SLE.

Both acute and chronic manifestations of lupus pneumonitis have been described. Patients with the much more common chronic form have a hacking, dry and occasionally productive cough, with scattered rales on auscultation. The chest roentgenogram may reveal no abnormalities, elevation and fixation of one or both diaphragms with areas of plate-like atelectasis, pleural effusions or migratory pulmonary infiltrates predominantly located in the lower lobes. Pulmonary function tests reveal impairment of diffusion capacity with a restrictive pattern or respiratory and alveolar hyperventilation.

Patients suffering from acute lupus pneumonitis characteristically present extremely ill with tachypnea, dyspnea, cyanosis, tachycardia and a high fever (102 to 106°F). There are minimal physical alterations which may be limited to scattered rales in the lungs. The chest x-ray film is nonspecific but often shows a diffuse infiltration most prominent in the lung bases with or without evidence of pleuritis. The sedimentation rate is rapid, the WBC count is usually normal, but may be slightly reduced or elevated and the LE prep is positive. Search for an infectious etiology is in vain and antibiotics fail to favorably alter the clinical course. The response to steroids is usually dramatic with rapid return to normal temperature, pulse and respiratory rate and clearing of pulmonary infiltrates.

In spite of treatment with steroids and an accompanying early improvement clinically, these patients experience chronic or recurrent pneumonitis and suffer from a residual moderate to severe restrictive lung disease.

Unlike most reported cases of acute lupus pneumonitis, our patient's respiratory status failed to improve markedly after 14 days of steroids. The sulfonamide therapy received by the patient prior to hospitalization may have aggravated the underlying disease causing more severe presenting symptoms. Rich noted that the pulmonary manifestations of sulfonamide hypersensitivity may mimic those of SLE. Rakov and Taylor described a patient with lupus pneumonitis whose condition worsened with sulfonamide therapy.

Azathioprine therapy was instituted in our case to alleviate persistent respiratory insufficiency and to prevent, if possible, residual restrictive lung disease. Steady improvement occurred and ten months after azathioprine was begun, the patient had a normal chest x-ray film (Fig 3), a mild restrictive ventilatory defect, moderate diffusion defect and a normal resting and exercise oxygen tension (Table 2).

Several authors have reported variable results with immunosuppressive drugs, particularly azathioprine, to treat lupus nephritis when steroids were ineffective alone or contraindicated. However, to our knowledge, use of azathioprine in acute lupus pneumonitis has not been previously reported. The positive results obtained in this case suggest a role for an immunosuppressive agent, such as azathioprine, in reversing manifestations of acute, severe lupus pneumonitis not responding adequately to steroid therapy. Steroids remain the initial treatment for nonbacterial pneumonitis in...
patients with SLE. If the respiratory symptoms do not regress or a restrictive pulmonary defect remains, immuno-suppressive therapy would appear to be indicated.

ADDENDUM

This patient remains well two years after the original illness.

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3 Dubois EL, Tuffanelli DL: Clinical manifestations of systemic lupus erythematosus. JAMA 190:104-111, 1964

Post Superior Vena Cava-Right Pulmonary Artery Shunt: Total Surgical Correction of Ebstein's Anomaly with Starr-Edwards Prosthesis*

Maria H. Balkoura-Christopoulos, M.D. and C. Frederick Kittle, M.D.

Total surgical correction of Ebstein's anomaly was successfully done in a patient with a previous Glenn shunt by replacing the rudimentary tricuspid valve with a Starr-Edwards mitral prosthesis and closing the atrial septal defect. During the four-year follow-up, the patient has shown marked improvement in exercise tolerance and disappearance of clinical cyanosis and polycythemia. Control of his congestive heart failure and arrhythmias has been easier. This illustrates the feasibility of total correction in patients with Ebstein's anomaly who have had little benefit from a Glenn shunt.

A superior vena cava to right pulmonary artery shunt was introduced by Glenn1 in 1954 as a palliative procedure for the treatment of Ebstein's anomaly. Hunter and Lillehei2 in 1958 proposed a plastic procedure for correction of this anomaly by realigning the downward displaced tricuspid leaflets to the normal annulus, which was successfully applied later by Hardy and associates.3 Total surgical correction of Ebstein's anomaly with a prosthetic valve was first described by Barnard and Schrire4 in 1963 and nine other patients have been reported.6-11

CASE REPORT

The patient is a 21-year-old white man. At age four, he developed exercise intolerance, dyspnea and aching pain over his left chest. Clubbing and cyanosis on exertion had been present since early life. At age 16, the diagnosis of Ebstein's anomaly was made by cardiac catheterization and intracardiac electrocardiography (Table 1).

A superior vena cava-right pulmonary artery anastomosis was performed in January 1963 when he was 17. He improved initially, but deteriorated slowly during the following three years. Congestive heart failure, polycythemia, and many episodes of arrhythmias with blurred vision and syncope occurred. Therapy consisted of digitalis, diazepam (Vallum) and monthly phlebotomies.

Admission examination revealed a tall, asthenic man with cyanosis and clubbing of digits. Blood pressure was 108/78 mm Hg, pulse 102/min and regular. The jugular venous pulse showed a prominent V wave. There was mild pectus excavatum with a narrow A-P diameter. The heart was enlarged with the point of maximal impulse at the fifth left intercostal space, 2 cm outside of the midclavicular line. A

*From the Departments of Medicine and Surgery, University of Chicago, Pritzker School of Medicine, Chicago.
Supported by US Public Health Service Grant HE-05793-04.
Reprint requests: Dr. Kittle, University of Chicago Hospitals, 350 East 59th Street, Chicago 60637

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