Meningococcal Pneumonia: Characterization and Review of Cases Seen Over the Past 25 Years

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Fifty-eight cases of meningococcal pneumonia were included in this review. Fifty cases previously described in the literature from 1974 through 1998 and 8 new cases were included in this series. The median age of patients was 57.5 years, and pleuritic chest pain was described in 21 (53.9%) of 39 cases. Blood cultures were positive in 42 (79.3%) of 53 cases for which results were mentioned. Despite the presence of bacteremia, patients did not develop the syndrome of meningococcemia with its associated complications. Serogroup Y meningococci were most commonly recovered and accounted for 44.2% of identified isolates. Therapy has dramatically changed over the past 25 years; prior to 1991, penicillin antibiotics were most often used. Since 1991, 12 (80%) of 15 patients received cephalosporin antibiotics. Only 5 (8.62%) of 58 patients died. Secondary cases of meningococcal infections following exposure to patients with meningococcal pneumonia were noted in 2 instances.

Neisseria meningitidis is an uncommon cause of pneumonia. Defining N. meningitidis as the etiologic agent of pneumonia is problematic because of the apparent rarity of meningococcal pneumonia and the prevalence of asymptomatic carriage of the organism in the upper respiratory tract. Isolation of meningococci from sputum cultures could reflect the presence of the organism in the throat. N. meningitidis has been recovered from ~10% of throat culture specimens from asymptomatic outpatients [1].

In cases of pneumonia in which cultures of blood and pleural fluid yield N. meningitidis, the etiologic diagnosis is established. Results of gram-staining of sputa or transtracheal aspirates can also support an etiologic diagnosis of meningococcal pneumonia. Because no reviews of meningococcal pneumonia have been published recently and the incidence of meningococcal disease may be increasing [2], we present 8 new cases and review the literature examining the syndrome. The following case report has been included to provide a more detailed characterization of the disease.

Case Report

An 18-year-old male undergraduate student presented to the emergency department at the University of Tennessee Medical Center at Knoxville, complaining of productive cough and pleuritic chest pain. The cough began ~7 days before presentation. The chest pain was initially noticed 3 days before presentation and had worsened. The pain was exacerbated by coughing and lying down. He had had a fever for 2 days but had no headache or neck pain. Physical examination findings were remarkable for decreased breath sounds in both lung bases. Chest radiography showed bilateral lower-lobe infiltrates, multisegmental on the left but not as extensive on the right.

The peripheral leukocyte count was 15.4 × 10^9/L, with a left shift. Blood culture specimens were drawn and the patient was admitted for empirical intravenous antibiotic treatment with ceftriaxone (1 g daily) and azithromycin (500 mg daily). He was discharged on the third hospital day.

On the evening of the day of discharge, the microbiology laboratory reported that both sets of blood cultures had yielded N. meningitidis serogroup Y. The patient was then contacted and readmitted. He was placed in respiratory isolation, and ceftriaxone therapy was reinstituted. He was released on the third hospital day and was to complete a 9-day outpatient regimen of oral levofoxacin (500 mg/d).

Close contacts were given prophylaxis with either rifampin (600 mg orally twice daily for 2 days) or single oral doses of ciprofloxacin (500 mg). Those given prophylaxis included his roommate, several students who were neighbors (on the same floor) in his dormitory, and his parents. No cases of meningococcal disease were detected among close contacts of the patient.

The patient had a follow-up examination after 3 weeks and had no abnormal physical examination findings. The multifocal infiltrates that had been seen on the chest radiograph at initial presentation had resolved. He received the meningococ-
<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age (y), sex</th>
<th>Signs and symptoms (duration)</th>
<th>Temp °C</th>
<th>Pulmonary examination</th>
<th>Chest radiograph</th>
<th>WBC/ mm³</th>
<th>Blood culturesb</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 [11], 1974</td>
<td>19, M</td>
<td>F/C, cough, PCP (2 w)</td>
<td>39.4 DTP, rales, B bases</td>
<td>RLL infls</td>
<td>10.3</td>
<td>+</td>
<td></td>
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<tr>
<td>2 [12], 1974</td>
<td>22, M</td>
<td>F/C, PC, NN (3 d)</td>
<td>40</td>
<td>B pulmonary infls</td>
<td>13</td>
<td>4/4</td>
<td></td>
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<tr>
<td>3 [13], 1974</td>
<td>19</td>
<td>C, L PCP (sudden onset)</td>
<td>39</td>
<td>LLL infl</td>
<td>22.7</td>
<td>+</td>
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<td>4 [13], 1974</td>
<td>24</td>
<td>Concomitant adenovirus 4 infection</td>
<td></td>
<td></td>
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<td>5 [13], 1974</td>
<td>20, M</td>
<td>Concomitant adenovirus 7 infection</td>
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<td>6 [14], 1974</td>
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<td></td>
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<td></td>
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<tr>
<td>7 [14], 1974</td>
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<td></td>
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<tr>
<td>8 [14], 1974</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>9 [15], 1975</td>
<td>16, F</td>
<td>F/C, myalgia, NCP (3 w)</td>
<td>38.8</td>
<td>Consolidation of anterior segment, LUL</td>
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<tr>
<td>10 [15], 1975</td>
<td>17, M</td>
<td>F, malaise, NPC (2 w)</td>
<td>38.3</td>
<td>RLL superior-segment infls</td>
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<tr>
<td>11 [15], 1975</td>
<td>19, M</td>
<td>F/C, R PCP, PC (2 w)</td>
<td>38.3</td>
<td>Multiple air-fluid levels, RLL</td>
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<td>12 [16], 1975</td>
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<td>Comatose (phenycyclidine overdose)</td>
<td>40</td>
<td>RLL consolidation</td>
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<td>10.6</td>
<td>1/3</td>
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<td>13 [17], 1975</td>
<td>34, M</td>
<td>F, PC (2 d)</td>
<td>38.3 Decreased BS (B)</td>
<td>LLL infls with L PLEf</td>
<td></td>
<td>0/6</td>
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<td>14 [18], 1978</td>
<td>F/C, cough, PCP (4 d)</td>
<td>Vaccinated for group A and C</td>
<td>36.8</td>
<td>Cardiac shadow, B Pn</td>
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<td>3/3</td>
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<td>15 [19], 1979</td>
<td>52, M</td>
<td>Cough, fever, resp distress (6 d)</td>
<td>38.1</td>
<td>Lymphoma</td>
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<td>1.7</td>
<td>+</td>
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<td>16 [20], 1979</td>
<td>16, F</td>
<td>N/V, HA, cough (1 d)</td>
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<td>Decreased BS, DTP, R base</td>
<td></td>
<td>RLL consolidation</td>
<td>22.6</td>
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<td>17 [21], 1981</td>
<td>66, M</td>
<td>PC, C (2 d)</td>
<td>38</td>
<td>Increased BS, DTP</td>
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<td>2/2</td>
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<tr>
<td>18 [22], 1981</td>
<td>69, M</td>
<td>F, PC (4 d)</td>
<td>38</td>
<td>Suprapharinal infls, hydropneumothorax</td>
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<td>0/1</td>
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<td>19 [22], 1981</td>
<td>87, M</td>
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<td>39.6</td>
<td>Rhoenchi, R base</td>
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<td>RLL infl</td>
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<tr>
<td>20 [23], 1981</td>
<td>70, F</td>
<td>C, PC, PC (6 d)</td>
<td>37.7</td>
<td>B basal rales</td>
<td></td>
<td>RUL infls</td>
<td>8.2</td>
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<td>21 [24], 1981</td>
<td>19, M</td>
<td>F/C, PC, PCP (3 h)</td>
<td>38</td>
<td>Decreased BS, B bases; R post-friction rub</td>
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<td>RML, RLL infls</td>
<td>8.3</td>
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<td>22 [24], 1981</td>
<td>62, F</td>
<td>F/C, NPC, PCP (1 d)</td>
<td>39.5</td>
<td>Consolidation of L mid-lung</td>
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<td>PC, SOB (3 d)</td>
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<td>DTP, decreased BS, rales</td>
<td></td>
<td>RLL infls</td>
<td>13.9</td>
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<td>24 [25], 1981</td>
<td>82, F</td>
<td>PCP, F (10 d)</td>
<td>38.8</td>
<td>B basal rales</td>
<td></td>
<td>LUL, LLL infls</td>
<td>27</td>
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<tr>
<td>25 [25], 1981</td>
<td>56, F</td>
<td>PCP, F (4 d)</td>
<td>38.6</td>
<td>DTP, decreased BS on R</td>
<td></td>
<td>RUL, RLL infls, PLEf</td>
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<td>26 [26], 1981</td>
<td>75, F</td>
<td>L PCP, dyspnea, F</td>
<td>RUL lobelesency for <em>Myelobacterium intracellulare</em> Infection in past</td>
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<td>27 [26], 1981</td>
<td>59, F</td>
<td>PCP, F, hemoptysis (12 h)</td>
<td>39</td>
<td>DTP, decreased BS on R</td>
<td></td>
<td>RUL, LLL, LLL infls</td>
<td>+</td>
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<td>28 [27], 1981</td>
<td>20, M</td>
<td>PC, HA, N/V (5 d)</td>
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<td>Decreased B BS</td>
<td></td>
<td>RML, RLL infls</td>
<td>13.5</td>
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<td>29 [28], 1985</td>
<td>72, F</td>
<td>PC, R PCP</td>
<td>Treated for TB in the past, bronchiectasis, multiple myeloma</td>
<td>38</td>
<td>B basal rales</td>
<td></td>
<td>RML consolidation</td>
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<tr>
<td>30 [29], 1986</td>
<td>4, F</td>
<td></td>
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<td></td>
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<td>31 [30], 1986</td>
<td>82, F</td>
<td>R PCP (several d)</td>
<td>38.2</td>
<td>Bronchi, decreased BS on R</td>
<td></td>
<td>RML, RLL infls, PLEf</td>
<td>15.9</td>
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<td>32 [31], 1987</td>
<td>67, F</td>
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<tr>
<td>33 [32], 1991</td>
<td>29, M</td>
<td>F, NPC, SOB, PCP (5 d)</td>
<td>38.8</td>
<td>Decreased BS, R base</td>
<td></td>
<td>RML abnormality</td>
<td>10.3</td>
</tr>
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<td>34 [33], 1995</td>
<td>19 mo, M</td>
<td>Irritability, whooping cough (3 d)</td>
<td>40</td>
<td>Rales, RL lung field</td>
<td></td>
<td>RLL superior-segment infls</td>
<td>4.4</td>
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<td>35 [34], 1995</td>
<td>11, M</td>
<td>PC (8 d), F/C</td>
<td>39.2</td>
<td>RLL Pn</td>
<td></td>
<td>RLL Pn</td>
<td>20</td>
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<tr>
<td>36 [35], 1997</td>
<td>88, F</td>
<td>Dyspnea, R PCP</td>
<td></td>
<td></td>
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<tr>
<td>37 [35], 1997</td>
<td>50</td>
<td>Dyspnea, hemoptysis, R PCP</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>38 [35], 1997</td>
<td>19, M</td>
<td>C, R PCP (1 d)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>39 [36], 1997</td>
<td>94, F</td>
<td></td>
<td></td>
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<tr>
<td>40 [36], 1997</td>
<td>23, M</td>
<td>Pleurisy</td>
<td></td>
<td></td>
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<td>41 [36], 1997</td>
<td>92, F</td>
<td>Pleurisy</td>
<td></td>
<td></td>
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<td>42 [36], 1997</td>
<td>1, F</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>43 [36], 1997</td>
<td>82, M</td>
<td>COPD</td>
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Table 1. Clinical, microbiological, and treatment features of 58 cases of meningococcal pneumonia.
<table>
<thead>
<tr>
<th>Sputum</th>
<th>Other specimen</th>
<th>Sero group</th>
<th>Treatment*</th>
<th>Complication(s)</th>
<th>Outcome</th>
<th>Case no.</th>
</tr>
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<tbody>
<tr>
<td>PMN, icl and ecl GND</td>
<td>+</td>
<td>Y</td>
<td>Amp, 2 g iv q6; then Pen 1 MU iv q6 × 9 d</td>
<td>S</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PMN, GND</td>
<td>+</td>
<td>C</td>
<td>Csp iv, Km im; Pen, 5 MU iv q6b</td>
<td>D</td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td>Y</td>
<td>Em po × 1 d; then Pen po; then 24 MU PenG iv q.d.</td>
<td>S</td>
<td>3</td>
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<tr>
<td>Icl GND</td>
<td></td>
<td>Y</td>
<td>Tet × 1 d; then Amp, 6 g iv q.d.</td>
<td>S</td>
<td>4</td>
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<tr>
<td></td>
<td></td>
<td>TTA +</td>
<td>Mino</td>
<td>S</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>TTA +, lung asp +</td>
<td>Mino</td>
<td>S</td>
<td>6</td>
<td></td>
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<tr>
<td></td>
<td>Lung asp, GnatC</td>
<td>Y</td>
<td>Pen, 3 MU iv q4h; Gm, 80 mg im q4h × 5 d; then Pen iv × 4w; then Pen po × 3 w</td>
<td>Pericarditis</td>
<td>S</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>Y</td>
<td>Chln, 1.5 g iv q6h, Gm, 70 mg iv q6h × 2 d; then Oxa, 1 g iv q6h, and Amp, 2 g iv q6h</td>
<td>Resp arrest requiring resuscitation</td>
<td>D</td>
<td>8</td>
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<tr>
<td>PMN, GND</td>
<td>+</td>
<td>Y</td>
<td>Procaine PenG, 600,000 U im q 12 h × 10 d</td>
<td>S</td>
<td>9</td>
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<tr>
<td>PMN, GND</td>
<td>+</td>
<td>Y</td>
<td>Pen, 1 MU iv q6h × 10 d</td>
<td>S</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>W-135</td>
<td>Y</td>
<td>Pen, 2 MU iv q6h × 2 w</td>
<td>S</td>
<td>11</td>
<td></td>
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<tr>
<td>PTA: PMN, GND</td>
<td>+</td>
<td>B</td>
<td>Cm, 300 mg iv q6h; Gm, 80 mg iv; then Chln, 2 g iv q6h</td>
<td>S</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Many PMN and GND</td>
<td>+</td>
<td>TTA +</td>
<td>Chl, 1 g iv q6h × 2 w</td>
<td>S</td>
<td>13</td>
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<tr>
<td>Bronchial asp GND</td>
<td>CSF –</td>
<td>Y</td>
<td>Pen, 3 MU iv q4h; Gm, 80 mg im q4h × 5 d; then Pen iv × 4w; then Pen po × 3 w</td>
<td>Pericarditis</td>
<td>S</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>+</td>
<td>Y</td>
<td>Chln, 1.5 g iv q6h, Gm, 70 mg iv q6h × 2 d; then Oxa, 1 g iv q6h, and Amp, 2 g iv q6h</td>
<td>Resp arrest requiring resuscitation</td>
<td>D</td>
<td>15</td>
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<tr>
<td>PMN, GND</td>
<td>+</td>
<td>Y</td>
<td>Procaine Pen, 1.2 MU im × 1; Pen po × 10 d</td>
<td>S</td>
<td>16</td>
<td></td>
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<tr>
<td>PMN, GND</td>
<td>+</td>
<td>Y</td>
<td>Pen, 1.2 MU iv q6h × 10 d</td>
<td>S</td>
<td>17</td>
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<tr>
<td></td>
<td>W-135</td>
<td>B</td>
<td>Pen, 1.2 MU iv q6h × 10 d</td>
<td>S</td>
<td>18</td>
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<td>PTA: PMN, GND, GPC</td>
<td>+</td>
<td>B</td>
<td>Pen, 1.2 MU iv q6h × 10 d; then Pen po × 5 d</td>
<td>S</td>
<td>19</td>
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<td>PMN, icl GND</td>
<td></td>
<td>C</td>
<td>Chln, 4 g iv q.d.; then Chl, 2 g iv q.d.</td>
<td>S</td>
<td>20</td>
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<td></td>
<td>W-135</td>
<td>Y</td>
<td>Pen, 1.6 MU iv q6h × 8 d; then Pen po × 6 d</td>
<td>S</td>
<td>21</td>
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<tr>
<td></td>
<td>TTA +</td>
<td>Z</td>
<td>Amp × 7 d</td>
<td>S</td>
<td>22</td>
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<td></td>
<td>CSF –</td>
<td>Y</td>
<td>Pen, 20 MU iv q6h × 7 d; then Pen po × 7 d</td>
<td>S</td>
<td>23</td>
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<td>Pleural fluid +</td>
<td>W-135</td>
<td>Y</td>
<td>Pen × 14 d</td>
<td>S</td>
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<td></td>
<td>W-135</td>
<td>Y</td>
<td>Pen × 14 d; then Pen, 2 MU iv q4h</td>
<td>S</td>
<td>25</td>
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<td>PMN, icl and ecl GND</td>
<td>Pleural fluid +</td>
<td>W-135</td>
<td>Pen, 1.2 MU iv q6h; then Pen, 3 MU q6h × 9 d</td>
<td>Leukopenia, day 9; Pen discontinued; Res</td>
<td>S</td>
<td>26</td>
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<td></td>
<td>Pleural fluid +</td>
<td>Y</td>
<td>Phenoxymethyl Pen, 250 mg po q6h; then Amp, 500 mg q6h × 14 d</td>
<td>S</td>
<td>27</td>
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<td></td>
<td>Pleural fluid +</td>
<td>Y</td>
<td>Em</td>
<td>S</td>
<td>28</td>
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<td>Pleural fluid +</td>
<td>B</td>
<td>Naf, Chl iv; then Pen po</td>
<td>S</td>
<td>29</td>
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<td></td>
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<tr>
<td>Pleural fluid +</td>
<td>C</td>
<td>Pen, 0.6 MU iv q6h; then Pen, 12 MU iv q6h, and Mox</td>
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<td>30</td>
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<td>PMN, GND, GPC</td>
<td>W-135</td>
<td>Y</td>
<td>Ctri; then Pen, 24 MU iv q6h × 12 d</td>
<td>S</td>
<td>31</td>
<td></td>
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<tr>
<td></td>
<td>Y</td>
<td>B</td>
<td>Amp iv; then Pen po 250 mg × 10 d; Rif, 240 mg bid × 2 d</td>
<td>S</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>C</td>
<td>Clar × 1 d; then Pen iv, and Em po</td>
<td>S</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>B</td>
<td>Cfur, 750 mg iv q8h</td>
<td>S</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>C</td>
<td>Cfur, 1.5 g iv q6h; Em, 500 mg iv q6h</td>
<td>S</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>C</td>
<td>Cfur, 750 mg iv q6h; Clm, 500 mg po q12h; Mtz, iv q6h; then Ccl, Rif, 600 mg q12h × 2 d</td>
<td>S</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y</td>
<td>C</td>
<td></td>
<td>S</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>B</td>
<td></td>
<td>S</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>B</td>
<td></td>
<td>S</td>
<td>39</td>
<td></td>
</tr>
</tbody>
</table>

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of pneumonia due to microbiological, and radiological criteria [3] to support a diagnosis were compiled per an EIN request. Insofar as possible, we included cases that had certain clinical, microbiological, and radiological criteria [3] to support a diagnosis of pneumonia due to *N. meningitidis*. In a number of cases, however, we were forced to accept the authors’ assurance of the diagnosis when specific case data were not mentioned in the publications. One published case [4] was excluded because the patient did not have clinical manifestations of lower respiratory tract infection. Other cases were excluded if demographic features for individual patients were not described [5–9]. A large series [10] of cases of group Y meningococcal pneumonia in military recruits was not included in the present review because it would have biased the present characterization of the illness, since all cases in the series involved previously healthy young men. That series, which included 68 cases of pneumonia, will be addressed in the accompanying discussion.

Results

Fifty-eight cases were included in this review; 50 cases were published elsewhere [11–37]. Because specific clinical infor-
<table>
<thead>
<tr>
<th>Sputum</th>
<th>Other specimen</th>
<th>Sero group</th>
<th>Treatment</th>
<th>Complication(s)</th>
<th>Outcome</th>
<th>Case no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram stain</td>
<td>Culture</td>
<td>Gram stain</td>
<td>Culture</td>
<td>B</td>
<td>Septic shock</td>
<td>S</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>W135</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48</td>
</tr>
<tr>
<td>W135</td>
<td></td>
<td></td>
<td></td>
<td>Ctx, 2 g t.i.d.</td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>Many GPC in pairs and clusters</td>
<td>+</td>
<td>Pleural fluid −; CSF −</td>
<td>Y</td>
<td>Ctri, 1 g q12h × 9 d; then Pen po × 10 d</td>
<td>S</td>
<td>51</td>
</tr>
<tr>
<td>PMN, mixed flora</td>
<td>+</td>
<td></td>
<td>Y</td>
<td>Ctri, 1 g iv q.d.; Azm, 500 mg iv q.d. × 5 d; then Lfx, 500 mg po q.d. × 9 d</td>
<td>S</td>
<td>52</td>
</tr>
<tr>
<td>Many PMN and GND</td>
<td>+</td>
<td></td>
<td>Y</td>
<td>Ctri, 1 g iv q24h × 5 d; then Cfp, 200 mg iv q12h × 4 d</td>
<td>S</td>
<td>53</td>
</tr>
<tr>
<td>PMN, many GND, few GPC</td>
<td>+</td>
<td></td>
<td></td>
<td>Ctri, 1 g iv q24h × 1 d; then Crid, 2 g iv q8h × 2 doses, and Gm, 120 mg × 1 dose; then Ctri, 2 g iv q12h × 7 d; then Ctri, 1 g iv q24h</td>
<td>S</td>
<td>55</td>
</tr>
<tr>
<td>PMN, many GND, rare GNR, few GPC</td>
<td>+</td>
<td></td>
<td></td>
<td>TMP-SMZ, 2 DS po × 21 d, and Pen, 500 mg po q.d. × 10 d</td>
<td>S</td>
<td>56</td>
</tr>
<tr>
<td>Sheets of PMN, many GND</td>
<td>+</td>
<td></td>
<td></td>
<td>Ctri, 2 g iv q.d. × 7 d; then Amox/Clv, 250 mg po q8h × 7 d</td>
<td>S</td>
<td>57</td>
</tr>
<tr>
<td>Many PMN and GND, few GNR, occasional GN coccobacilli</td>
<td>+</td>
<td>Pleural fluid −</td>
<td>Y</td>
<td>Cfp, 400 mg iv q12h; then Cfp, 750 mg po b.i.d. (total, 7 d); Gm, Rif, 600 mg iv × 1 dose</td>
<td>Exudative PLEf</td>
<td>S</td>
</tr>
</tbody>
</table>

Mention was not available for every case, the denominator was <58 in most analyses of demographic features.

**Sex and age.** Twenty-seven (52.9%) of 51 patients were male, and the median age was 57.5 years (mean age, 48.1 years). Ages ranged from 1 year to 94 years (table 1). A bimodal age distribution of cases was seen: 22 patients were aged <30 years and 26 patients were aged ≥60 years. In contrast, only 6 patients were aged between 30 and 59 years.

**Underlying medical conditions.** Twenty-nine patients had underlying medical conditions before the development of meningococcal pneumonia. Five patients had other recent or concomitant infections. Four patients each had diabetes mellitus and chronic obstructive lung disease. Three patients received chronic treatments with corticosteroids, of whom 2 had asthma and 1 had systemic lupus erythematosus. Three patients had myeloma or lymphoma. Other underlying conditions included HIV infection (2 cases) and, prior right-upper-lobe lobectomy, previously treated tuberculosis and bronchiectasis, sickle cell anemia, recent hip fracture, and drug-induced coma (1 case each). Complement deficiency was not listed as a risk factor for meningococcal disease among the 58 cases.

**Place of residence.** There was mention of place of residence in 15 cases: 8 patients lived in military barracks, 2 patients were in a nursing home, 1 patient lived in a college dormitory, and 4 patients were in the hospital (and acquired their infection nosocomially).

**Signs and symptoms of disease.** The most common presenting symptoms of meningococcal pneumonia were fever and/or chills, which occurred in 24 (61.5%) of 39 patients. Pleuritic chest pain was less commonly reported (21 [53.9%] of 39 cases). Other complaints included productive cough (31%) and shortness of breath (23%). The mean duration of symptoms before presentation was 5.5 days and ranged from 1 to 21 days. Eighty-four percent (32 of 38) had documented fever (temperature >37.8°C).

**Chest radiography.** Chest radiographic findings were mentioned for 45 cases, and in 9 (20%) there was bilateral involvement. Infiltrates were limited to the right lung in 25 cases (55.6%) and to the left lung in 11 (24.4%). One report of radiographic findings described a retrocardiac density without localizing it to the left or right lung. The right lower lobe was involved in 20 of 25 cases when the right lung was demonstrated to be radiographically abnormal. Six patients (13.3%) had radiographically evident pleural effusions.

**Laboratory analyses.** The mean peripheral WBC count at admission was 14,300/mm³, within a range of 1700 to 27,800/mm³. Blood culture findings were reported in 53 cases, 42 (79.3%) of which were positive. Sputum cultures were positive in 15 (83.3%) of 18 cases for which sputum culture results were mentioned. Sputum gram-stain results were reported for 17 cases; gram staining in each case demonstrated polymorphonuclear leukocytes, and in 14 cases, gram-negative diplococci were the predominant organisms.

Other specimens that were cultured included CSF (5), per-
cutaneous transtracheal aspirate (7), and pleural fluid (6). All CSF cultures were negative. All 7 cultures of percutaneous transtracheal aspirates and all 6 pleural fluid cultures yielded *N. meningitidis*.

**Serogrouping.** Fifty-two isolates were serogrouped (table 1). The most common serogroup identified was Y (44.2%, n = 23). The next most common was the W-135 serogroup, identified in 10 cases (19.2%). Serogroup B, C, and Z meningococci were recovered in 9 (17.3%), 8 (15.4%), and 2 (3.8%) cases, respectively. No serogroup A cases were identified.

**Treatment.** The patients received a variety of antibiotic therapies for meningococcal pneumonia (table 1). Penicillin was given to 24 (80%) of 30 patients seen from 1974 through 1990. In contrast, 12 (80%) of 15 patients seen from 1991 through 1998 were treated with cephalosporins. Duration of therapy was mentioned in 27 cases. The shortest course of treatment was 5 days; the longest was almost 8 weeks and was administered to the patient who had pericarditis (table 1).

**Complications and outcome.** Complications among the 58 patients included septic shock in 2 patients and, in 1 patient each, lung abscesses, respiratory arrest, exudative pleural effusions, pericarditis that spontaneously resolved, and drug-induced neutropenia. Five (8.62%) of 58 patients died. The average age of the 5 patients who died (65.6 years) was almost 20 years greater than that of 49 patients who survived the illness (47.8 years; *P* = .2479).

**Discussion**

The current review of meningococcal pneumonia includes cases from the past 25 years. The last review [25] was published almost 20 years ago and included cases from as far back as 1945. A large series [10] of Air Force recruits with group Y meningococcal pneumonia who were seen in the early 1970s was not included in the current review but will be cited for comparative purposes in this section.

Pneumonia due to *N. meningitidis* appears to impact an older population, according to the results of the current investigation and earlier work [25]. In both series of cases, the average age of patients was >40 years. This is in contrast to the known epidemiology of other, more common syndromes of meningococcal disease, including meningitis and meningococcemia, which mostly occur in patients aged <20 years [38]. Moreover, the highest rate of both biminnitig and nonminnitig meningococcal disease is among infants aged <1 year [38]. The bimodal distribution of pneumonia cases in the current investigation is uncharacteristic of more common syndromes of meningococcal disease [38] and remains unexplained.

Despite the fact that meningococcal pneumonia occurred in an older population, complications and death were infrequent. Fewer than 10% of patients died in both our series and the earlier published review [25]. A similar mortality rate has been observed [39] among patients with meningitis due to *N. meningitidis*. Moreover, none of the 68 Air Force recruits [25], who were aged 17–24 years, died of pulmonary infection. Those who died in the present series, however, were almost 20 years older than the average age of the patients who survived.

The blood culture positivity rate in our case series (87%) was much higher than that reported in the earlier review (20%) [25]. It should be noted, however, that blood culture results were not reported for many of the cases but were included in prevalence calculations in the previously published series. If only cases with known blood culture results are analyzed and the Air Force recruit population [10] is studied separately, then 57% of cases (12 of 21) had positive blood cultures. In 10 (14.7%) of 68 cases involving Air Force recruits, blood cultures were positive.

Thus the reported blood-culture-positivity rate is wide-ranging, and the reason for this has not been determined. It is possible that cases were more likely to be defined and reported as meningococcal pneumonia when blood culture confirmation was done, since there is a potential loss of diagnostic specificity when sputum cultures are used to define a case. It is also possible that the relatively high bacteremia rate associated with meningococcal pneumonia was due, in part, to the increased age of patients seen in the current and previously published case series [25], compared with the much younger military recruits [10].

In spite of the predominance of meningococci in blood culture specimens from patients in the present review, a meningococcemia syndrome associated with numerous complications was not seen among the bacteremic patients. Reido et al. [39] noted this phenomenon and stated that the condition of patients with this syndrome may improve even if they receive no antibiotics until cultures become positive. Despite the possibility that such improvement may occur before recognition of bacteremia, all patients should be treated with appropriate antibiotics. Differences in host and microbiological features no doubt account for this disparity in clinical manifestations of meningococcemia.

Forty-four percent of serogrouped isolates in our review were of serogroup Y. Reviews of isolate-surveillance records indicate that serogroup Y accounted for an increased proportion of meningococcal cases during the 1990s [2, 40] in several areas of the United States. In 4 active surveillance areas during 1992–1995 [40], pneumonia was 4 times more likely to be diagnosed in cases due to serogroup Y meningococci than in cases due to meningococci of other serogroups.

Meningococcemia colonization of the nasopharyngeal mucosae is a critical initial step in the pathogenesis of systemic infection. Several cell surface structures have been identified [41] that function as adhesins in attachment of meningococci to respiratory epithelial cells. After nasopharyngeal colonization, microaspiration of upper respiratory tract secretions containing *N. meningitidis* probably occurs, with the subsequent development of pneumonia. Which virulence factors are operative
in the production of lung infection and whether they are unique to serogroup Y meningococci are unknown. In addition, the conditions accounting for the increase in serogroup Y infections remain undefined.

Carrier rates of serogroup Y strains versus strains of other serogroups have been low in past surveys [42–44]. Because of this, some investigators [2] have speculated that immunity to serogroup Y meningococci has waned, which accounts for the recent increase in the number of serogroup Y infections. Alternatively, more invasive strains of serogroup Y could be producing an increased number of meningococcal infections.

Treatment regimens used in the 1990s differ from those used in earlier years. From 1991 through 1998, 80% of patients were administered a cephalosporin antibiotic. This is in contrast to patients treated before 1991, of whom 80% received a penicillin. Unlike other clinical scenarios in which a change in therapy has been prompted by the development of antibiotic resistance among pathogens, penicillin-resistance among N. meningitidis isolates has been infrequently reported in this country [45], and penicillin G remains the drug of choice for treatment of meningococcal infection. Nevertheless, relative resistance (MIC, 0.12–1 mg/L) to penicillin was identified in at least 1 case (number 51 in table 1) in the current investigation and has been widely reported in variable frequencies in other countries [46].

As evidenced in the case report included in this paper, the use of empirical antibiotic therapy for community-acquired pneumonia has become routine, and administration of cephalosporins has been a treatment of choice, particularly among patients treated before 1991, of whom 80% received a penicillin. Unlike other clinical scenarios in which a change in therapy has been prompted by the development of antibiotic resistance among pathogens, penicillin-resistance among N. meningitidis isolates has been infrequently reported in this country [45], and penicillin G remains the drug of choice for treatment of meningococcal infection. Nevertheless, relative resistance (MIC, 0.12–1 mg/L) to penicillin was identified in at least 1 case (number 51 in table 1) in the current investigation and has been widely reported in variable frequencies in other countries [46].

As evidenced in the case report included in this paper, the use of empirical antibiotic therapy for community-acquired pneumonia has become routine, and administration of cephalosporins has been a treatment of choice, particularly among patients requiring hospitalization [47,48]. Patients with meningococcal pneumonia have been initially treated with cephalosporin antibiotics, and this therapy has continued even after specimen cultures define N. meningitidis as the pathogen.

Person-to-person transmission of N. meningitidis is a legitimate concern in light of the fact that patients with pneumonia are coughing and are thus capable of producing respiratory droplets that contain meningococci. In 3 instances [16,19,22] nosocomial transmission of infection was thought to have occurred. In 2 [19,22] of the 3, secondary cases were epidemiologically linked to pneumonia cases. Molecular typing, however, was not performed in any of the occurrences, and it is possible that nosocomial infection transmission did not occur. Louie et al. [49], for example, used molecular typing of strains isolated from 2 hospitalized patients who had been epidemiologically linked to the nosocomial transmission of N. meningitidis and demonstrated that the 2 isolates were not clonally related.

A recent poll of the IDSA’s EIN members was conducted to query about secondary cases of meningococcal infection associated with meningococcal pneumonia (Larry J. Strausbaugh, personal communication). Only 6 (1.66%) of 361 physicians who responded to the questionnaire indicated that they had seen a case of meningococcal disease in which they were able to identify a close contact who previously had had meningococcal pneumonia diagnosed.

Pneumonia due to N. meningitidis is infrequently seen, and most patients with this illness will present with community-acquired pneumonia that is clinically indistinguishable from other syndromes of bacterial pneumonia. Patients often develop bacteremia, but the syndrome of meningococcemia, with its potentially serious complications, is not a feature of meningococcal pneumonia. The mortality rate is low, and human-to-human transmission of N. meningitidis infection due to meningococcal pneumonia, while reported, appears to be rare.

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References


