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Accessibility
Diagnosis of influenza from lower respiratory tract sampling after negative upper respiratory tract sampling

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In this retrospective cohort study, we demonstrate that PCR-confirmed diagnoses of influenza were made solely by lower respiratory sampling in 6.9% of cases, as traditional upper respiratory tract tests were negative, indeterminate or not performed. Clinical features of these cases are presented. Clinicians should consider lower respiratory tract sampling in select cases of influenza-like illness for diagnosis.

Introduction

Clinicians are often faced with the challenge of patients presenting with an influenza-like syndrome despite negative routine influenza investigations. These investigations usually include nasal or nasopharyngeal rapid influenza screens, direct fluorescent antibody (DFA) or PCR tests. Occasionally these diagnostic tests may be falsely negative due to their low sensitivity, as in the case of many rapid-influenza tests,¹ poor technique in specimen collection, delayed transport to the laboratory or the presence of viral inhibitors.² Clinicians rely heavily on these investigations as they are readily available and guide therapeutic decisions.

Most influenza infections affect the upper respiratory tract, while lower tract infection typically represents extension from upper airways and may be diagnosed with lower respiratory sampling such as bronchoscopy.²,³ Occasionally a diagnosis of influenza is missed with upper respiratory tract sampling if pulmonary symptoms are present, and concerns have been raised regarding missing pandemic strain of H1N1⁴ and Avian influenza A (H5N1), which have both been shown to infect the lower respiratory tract.²,⁵,⁶ We present data from our institution where lower respiratory tract sampling aided the diagnosis of influenza and discuss clinical features of these patients.

Methods

The Institutional Review Board at the Massachusetts General Hospital reviewed and approved this study. We performed a retrospective cohort analysis of all cases of PCR-confirmed influenza between December 2009 and April 2011 at the Massachusetts General Hospital [Simplexa™ Influenza A H1N1 (2009), Focus Diagnostics]. We identified all patients where lower respiratory sampling (induced sputum, endotracheal aspiration or bronchoscopy) was used to diagnose influenza. Only cases that were confirmed as PCR-positive were included. Using a standardized data collection form, we recorded patient demographics, influenza diagnostic testing, radiographic features, oxygenation supplementation, clinical features, accompanying comorbid conditions, and outcomes. Obesity was defined by body mass index (BMI) equal to or greater than 30. Patients were defined as immunocompromised if they were taking prednisone (or equivalent) > 15 mg per day for over 2 mo, on active chemotherapy, HIV with CD4 T cell counts less than 200 cells/ml or on other immunomodulatory medications such as biologic therapies like tumor necrosis factor α antagonists.

Results

One hundred and sixteen patients were identified with PCR-confirmed influenza virus between December 2009 and April 2011. Forty-six were typed as pandemic H1N1 and 70 as seasonal influenza A. The average age was 56.6 y (range 1–95) with 60 (51.7%) females. Ninety-four patients (81%) were hospitalized and a total of 6 (5.1%) of died. Sixty-seven (57.8%) had a comorbid condition portending severe influenza. Of these 116 PCR-positive patients, 15 (12.9%) underwent lower respiratory sampling to aid in diagnosis [age range 11–81 y]. Ten of these 15 patients (66.7%) were positive for influenza virus in lower respiratory samples. Of these 10, a diagnosis of influenza was made solely by lower respiratory sampling in eight cases (6.9% of total PCR positive cases), as rapid tests, nasopharyngeal DFA or PCR tests were either negative, indeterminate or not performed.

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Influenza viruses initially infect the upper airways but can directly extend to the lower airways in severe cases, resulting in a viral pneumonia with significant morbidity and mortality. Patients initially present with upper respiratory symptoms, but typically deteriorate from a respiratory standpoint if lower tract symptoms develop, frequently requiring hospitalization or intensive care. Clinicians should be aware that sampling of the upper airways might not be adequate to diagnose these cases. In our series, 6.9% of PCR-documented influenza has negative upper airway sampling, and were diagnosed by either BAL, endotracheal aspiration, or induced sputum. Certain influenza strains such as Avian H5N1 virus are reported to infect lower airways, and the average white blood cell count on presentation was 7.3 cells/ml (range 3.2–16.2) on admission. Radiographic features included 6 (60%) with acute respiratory distress syndrome (ARDS), and 3 (30%) with single or multi lobar consolidative processes. One patient had no obvious radiographic changes from his underlying interstitial lung disease. Eight (80%) patients required care in an ICU and two (20%) patients ultimately died of their illness.

**Discussion**

Influenza viruses initially infect the upper airways but can directly extend to the lower airways in severe cases, resulting in a viral pneumonia with significant morbidity and mortality. Patients initially present with upper respiratory symptoms, but typically deteriorate from a respiratory standpoint if lower tract symptoms develop, frequently requiring hospitalization or intensive care. Clinicians should be aware that sampling of the upper airways might not be adequate to diagnose these cases. In our series, 6.9% of PCR-documented influenza has negative upper airway sampling, and were diagnosed by either BAL, endotracheal aspiration, or induced sputum. Certain influenza strains such as Avian H5N1 virus are reported to infect lower airways, and the average white blood cell count on presentation was 7.3 cells/ml (range 3.2–16.2) on admission. Radiographic features included 6 (60%) with acute respiratory distress syndrome (ARDS), and 3 (30%) with single or multi lobar consolidative processes. One patient had no obvious radiographic changes from his underlying interstitial lung disease. Eight (80%) patients required care in an ICU and two (20%) patients ultimately died of their illness.

**Table 1. Characteristics of patients with lower respiratory specimens positive for influenza A (pandemic and seasonal)**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (y)</th>
<th>Sex</th>
<th>Rapid test</th>
<th>NP DFA</th>
<th>NP PCR</th>
<th>Comorbidities</th>
<th>Lower respiratory tract sampling</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31</td>
<td>F</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>n/a</td>
<td>Nil</td>
<td>ETA</td>
<td>Died</td>
</tr>
<tr>
<td>2</td>
<td>59</td>
<td>F</td>
<td>n/a</td>
<td>2 (2)</td>
<td>n/a</td>
<td>Renal transplant</td>
<td>BAL</td>
<td>Survived</td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>F</td>
<td>n/a</td>
<td>2 (2)</td>
<td>+</td>
<td>Pregnant, obese</td>
<td>BAL</td>
<td>Survived</td>
</tr>
<tr>
<td>4</td>
<td>49</td>
<td>F</td>
<td>n/a</td>
<td>n/a</td>
<td>+</td>
<td>ILD</td>
<td>BAL</td>
<td>Survived</td>
</tr>
<tr>
<td>5</td>
<td>54</td>
<td>F</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>i(1)</td>
<td>Nil</td>
<td>BAL</td>
<td>Survived</td>
</tr>
<tr>
<td>6</td>
<td>26</td>
<td>F</td>
<td>2 (2)</td>
<td>2 (2)</td>
<td>-1 (1)</td>
<td>Nil</td>
<td>BAL</td>
<td>Survived</td>
</tr>
<tr>
<td>7</td>
<td>73</td>
<td>M</td>
<td>n/a</td>
<td>n/a</td>
<td>1 (1)</td>
<td>ILD</td>
<td>BAL</td>
<td>Died</td>
</tr>
<tr>
<td>8</td>
<td>37</td>
<td>F</td>
<td>n/a</td>
<td>n/a</td>
<td>1 (1)</td>
<td>Nil</td>
<td>ETA</td>
<td>Survived</td>
</tr>
<tr>
<td>9</td>
<td>81</td>
<td>M</td>
<td>n/a</td>
<td>1 (1)</td>
<td>n/a</td>
<td>Nil</td>
<td>BAL</td>
<td>Survived</td>
</tr>
<tr>
<td>10</td>
<td>52</td>
<td>M</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>HIV, asthma</td>
<td>IS</td>
<td>Survived</td>
</tr>
</tbody>
</table>

NP, nasopharyngeal; DFA, direct fluorescent antibody; i, indeterminate; BAL, bronchoalveolar lavage; ETA, endotracheal aspirate; IS, induced sputum; ILD, interstitial lung disease
nasopharyngeal sampling techniques must be employed, and such tests may ultimately be negative due to inadequate specimen collection. Other possibilities include low levels of viral shedding in the nasopharynx at the time of sampling as the infection has progressed to the lower respiratory tract. Animal models demonstrate more viral replication in the trachea, bronchi and bronchioles with pandemic H1N1 compared with seasonal H1N1, which is restricted primarily to the nasopharynx. Lastly, those with risk factors for severe influenza such as obesity, an immunocompromised state, asthma or pregnancy may be at greater risk of lower respiratory tract involvement and a poor prognosis. Future prospective studies should assess diagnostic characteristics of influenza in relation to the time of sample collection, risk factors for severe disease and clinical disease progression.

Traditional nasopharyngeal diagnostic techniques may miss cases of influenza affecting the lower respiratory tract. Clinicians should have a high degree of suspicion in patients with lower-tract symptoms and a syndrome compatible with influenza, particularly in the setting of pregnancy, obesity or in immunocompromised states. Empiric antiviral therapy is often warranted and sampling of the lower tract by bronchoscopy, endotracheal aspirate or induced sputum may yield a diagnosis.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

References