Imaging Findings of Influenza A (H1N1) Virus Pneumonia in 2013/14 Influenza Season

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Learning objectives

The authors aim to review the main radiologic findings in patients with laboratorial confirmation of influenza A (H1N1) virus infection, in Lisbon North Hospital Centre, during 2013/14 influenza season, and correlate it with patient's outcome. It is also our purpose to assess whether they have kept a similar radiologic pattern to the ones described in previous studies.
Background

In December 2013, the Centers for Disease Control and Prevention (CDC) reported a number of cases of severe respiratory illness among young and middle-aged adults. Many of them were diagnosed as being infected with influenza A (H1N1) pdm09 (pH1N1) virus, the same strain that caused the 2009 influenza pandemic. The pH1N1 virus that emerged in 2009 caused more illness in children and young adults, compared to older adults, although severe illness was seen in all age groups. CDC has not yet detected any significant changes in pH1N1 viruses to suggest increased virulence or transmissibility. If pH1N1 virus continues to be the predominant circulating virus in 2013/14 influenza season, there are concerns that the illness may disproportionately affect young and middle-aged adults. [1-3]

Whereas children and young adults are the most susceptible to the infection, the high risk groups regarding possible complications are pregnant women, adults older than 65 years, children younger than 5 years, patients with underlying conditions such as chronic obstructive pulmonary disease (COPD), cardiovascular or neurological diseases, immunosuppression, hematological disorders, chronic liver diseases, chronic renal failure and metabolic diseases. Patients with conditions that confer some degree of immunosuppression can be at high risk of secondary invasive infections such as pneumococcal or methicillin-resistant *Staphylococcus aureus* pneumonia. The most important complications are lower respiratory tract involvement, acute respiratory failure and acute lung injury or respiratory distress syndrome with refractory hypoxemia. [4-6]

We retrospectively reviewed the imaging findings and clinical outcomes of 32 patients, of Lisbon North Hospital Centre, that had both a positive RT-PCR confirmation of influenza A (H1N1) pdm09 virus infection and imaging examinations - chest radiographs (CxRs) alone or combined with chest computed tomography (CTs) - stored at PACS, between the period from December 2013 to March 2014. One patient with tuberculosis sequelae was excluded from the original sample, because of the difficulty to differentiate the findings caused by lung viral infection. Of the 31 patients included in the study, 11 were males and 20 females, ranging in age from 7 to 90 years old, mean age of 52 (only one child was included).
Imaging findings OR Procedure details

The majority of the patients were healthy at the time of influenza A (H1N1) pdm09 virus infection diagnosis (20 patients), including one pregnant woman. The remaining had COPD (three patients); three had cardiac disease; five had some acquired degree of immunosuppression, given by human immunodeficiency virus(HIV)/hepatitis C virus (HCV) co-infection (1 patient), oncologic disease (2 patients), systemic connective-tissue disease (2 patients). (Table 1)

<table>
<thead>
<tr>
<th>Previously healthy</th>
<th>20</th>
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<tr>
<td>COPD</td>
<td>3</td>
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<tr>
<td>Cardiac disease</td>
<td>3</td>
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<tr>
<td>Acquired Immunosuppression</td>
<td>5</td>
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Table 1: Patient's relevant clinical history.

References: A. I.S. Ferreira

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A total of 17 out of the 31 patients had normal radiological CxRs (55%), meaning that this was the most common presentation (Fig. 1 on page 9). The remaining patients had a bilateral alveolar disease pattern, either presenting as tracheobronchitis (6 patients, 19%) (Fig. 2 on page 9, Fig. 3 on page 10), or as bronchopneumonia (8 patients, 26%) (Fig. 4 on page 11, Fig. 5 on page 12), with bilateral multifocal consolidations and/or nodules/reticular opacities. (Table 2)
Table 2: Main radiological finding in CxRs.

References: A. I.S. Ferreira

Table 2: Main radiological finding in CxRs.

Chest CTs were performed in four patients that both had a CxR showing bronchopneumonia and belonged to the risk group for complications. The CT findings included bilateral consolidations and ground-glass opacities, both with a multifocal distribution, as well as crazy-paving in one case; bilateral pleural effusion complicated of unilateral empyema was found twice; in one case there was also infracarinal and pulmonary hilar enlarged lymph nodes; other patient presented simultaneously with peripheral pulmonary thromboembolism. Additionally, bilateral pneumatoceles were visible at chest CT of a patient that developed *Staphylococcus aureus* superinfection.

All the patients with normal radiological findings were previously healthy, except for one with COPD, two with cardiac disease and one with oncologic disease. All the subjects in this group had a favorable outcome; the mean age was 48 (ages between 24-80 years old). (Table 3)

A favorable outcome was also registered in the group with tracheobronchitis. This group was constituted of three healthy patients, two with COPD and one with known cardiac disease. The mean age was 72 (ages between 39-90 years old), which was higher compared to the former group. (Table 3)
The bronchopneumonia group (total of 8 patients) included the 7 year-old child, the pregnant woman, two other previously healthy adult patients, and four patients with some degree of acquired immunosuppression [systemic connective-tissue diseases (2 patients), oncologic disease (1 patient) and the HIV/HVC co-infection (1 patient)]; the ages ranged between 7 and 64; mean 45. (Table 3) All of the three patients that needed mechanical ventilation - reflecting a severe clinical course - had a pattern of bronchopneumonia. One of them was the pregnant women that recovered after two months of hospitalization; the other two included an oncologic patient and a previously healthy individual (with 53 years old), both died in the course of the disease. Additionally, bacterial superinfection was only documented in the bronchopneumonia group, with a case of *Pseudomonas aeruginosa* in the pregnant women and two cases of *Staphylococcus aureus* in patients with some degree of acquired immunosuppression, one of whom died. Finally, it was also registered a pneumomediastinum, in the 7 year-old child, that completely resolved in the course of the disease.

Concerning the patients with CODP, one had a pattern of tracheobronchitis overlapping abnormalities related the chronic pulmonary disease and two had no relevant findings apart from the ones expected from CODP. (Table 3)

Regarding the patients with cardiac disease, two had normal CTs except for the finding of cardiogenic pulmonary edema; the other developed tracheobronchitis and had no other abnormalities attributed to cardiac failure. (Table 3)
Table 3: Correlation between radiological pattern and patient data.

References: A. I.S. Ferreira

Table 3: Correlation between radiological pattern and patient data.

CxR is usually the first and sometimes the only imaging modality performed. The majority of the patient had no CxR abnormal findings, thus a normal CxR does not exclude an influenza A (H1N1) pdm09 virus infection. The main CxR findings in influenza pneumonia comprise tracheobronchitis, consolidations and/or nodules/reticular opacities (bronchopneumonia).

CT is often performed when there is a high clinical suspicion of pneumonia and normal or dubious radiological findings. It can be useful, for instance, to distinguish between influenza A pneumonia and pulmonary cardiogenic edema, in the setting of acute respiratory symptoms. The predominant CT imaging features include airspace consolidation and/or ground-glass attenuation with a lobular distribution. These aspects are considered to be the expression of diffuse hyaline membrane formation in the peribronchiolar alveoli, associated of pulmonary congestion, edema, hemorrhage, inflammatory infiltration and bronchiolitis often evolving into organizing pneumonia. [7] Bilateral involvement with a multifocal distribution is often common.
Most of our subjects (94%) had a favorable outcome. Only the patients with bronchopneumonia experienced need of mechanical ventilation, bacterial superinfection and a fatal outcome. Additionally, most of the patients in the bronchopneumonia group belonged to the high risk group for complications. In conclusion, patients presenting with a normal CxR or tracheobronchitis in the setting of Influenza A (H1N1) pdm09 infection seem to have a more indolent clinical course, as opposed to patients with bronchopneumonia, particularly those with a higher risk of complications, which may have a more severe disease, occasionally requiring mechanical ventilation.

Similar radiological features have been described in previous studies, including some differences between cases of mild and severe illness. [8-15]
Fig. 1: Normal CxR in patient with Influenza A virus infection.

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**Fig. 2:** CxR of patient with Influenza A virus infection, showing bilateral tracheobronchitis.

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Fig. 3: CxR of a different patient with Influenza A virus infection, showing bilateral tracheobronchitis.
Fig. 4: CxR and axial enhanced chest CT. Patient with bilateral bronchopneumonia. Bilateral multifocal pulmonary lesions such as left lower lobe consolidation, nodules and ground glass opacities.

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**Fig. 5:** CxR and contrast enhanced chest CT (axial views and coronal MPR. Patient with bilateral bronchopneumonia. Bilateral multifocal pulmonary consolidations including crazy-paving pattern, as well as bilateral pleural effusion that progressed to unilateral empyema.

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Conclusion

A normal CxR does not exclude an influenza A virus infection, as most of the patients present with a normal CxR. The main findings include a bilateral multifocal alveolar pattern, presenting as tracheobronchitis or bronchopneumonia, and are similar to the radiological features that have been described in previous studies. Patients with bronchopneumonia tend to belong to a high-risk group for complications and experience a more severe clinical course.

The spectrum of illness observed thus far in the 2013/14 season has ranged from mild to severe cases and is consistent with that of other influenza seasons, according to the CDC. However, continuous monitoring of the radiologic patterns of influenza A (H1N1) virus infection is valuable, as it might reflect changes of the circulating viruses. Furthermore, recognition of characteristic radiologic findings may help narrowing the differential diagnosis.
References


