

Chest radiography findings in adults with pandemic H1N1 2009 influenza

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ABSTRACT. The current pandemic of a novel influenza A (H1N1) virus, commonly referred to as “swine flu”, began in Mexico in March 2009 and reached the UK in April 2009. By 21 July 2009, more than 850 suspected cases of influenza had been seen at Birmingham Heartlands Hospital (BHH), including 52 adults with laboratory-confirmed pandemic H1N1 influenza who were admitted. Of seven patients (13%) requiring intensive care, six needed mechanical ventilation, two needed extra-corporeal membrane oxygenation (ECMO) and one died. Of the 52 admitted adults, 42 (81%) had respiratory symptoms or signs and positive PCR tests for novel Influenza A (H1N1) virus. These patients also had chest radiographs (CXR) taken, which were abnormal for 12 patients (29%). Of these, six patients had bilateral consolidation, which was bibasal in three and widespread in three; all six had pleural effusions. A further six patients had unilateral consolidation with predominantly basal changes; one of these patients had a pleural effusion. The odds ratio for requiring intubation and ventilation with H1N1 influenza and an abnormal CXR was 29.0 (95% confidence interval 2.93–287.0). CXR changes were not common in swine flu, but a significant minority of those requiring admission had consolidation on their CXR. Those who required admission and had CXR changes are more likely to require intubation and ventilation than those without abnormalities on CXR.

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The current pandemic of a novel influenza A (H1N1) virus, commonly referred to as “swine flu”, began in Mexico in March 2009 and reached the UK in April 2009. The World Health Organization declared a global influenza pandemic on 11 June 2009. International reporting of individual cases was abandoned on 6 July 2009, by which date there had been 94 512 laboratory-confirmed cases and 429 deaths worldwide, mostly in the USA, Mexico, Canada and the UK [1]. By 21 July 2009, there were 17 181 European cases, 10 649 (67%) in the UK [2], of which most were in the West Midlands and London areas [3]. By 21 July 2009, 850 suspected cases of influenza had been seen at Birmingham Heartlands Hospital (BHH), including 52 adults with laboratory-confirmed pandemic H1N1 influenza whose admission was required [4] according to UK Department of Health criteria [5]. Of the seven (13%) who required intensive care, six required mechanical ventilation, 2 needed extra-corporeal membrane oxygenation (ECMO) and one died [6]. The proportions of patients requiring hospitalisation and intensive care are similar to those reported previously [7, 8]. We reviewed the radiography findings in adult patients admitted to our hospital with laboratory-confirmed pandemic H1N1 influenza, and compared these with previous reports from influenza outbreaks and pandemics.

Pandemic influenza

The Asian flu pandemic of 1957–58 was the first influenza pandemic during which chest radiographs (CXR) were readily available. Data from 406 influenza patients admitted to hospital in Liverpool, UK, were reported after this pandemic [9]. Of these patients, 193 had clinical signs of pneumonia and 112 had CXR changes. No microbiological confirmation of influenza was made. Of those with changes on CXR, 80% had “bronchopneumonic consolidation”, approximately half of which was unilateral. Lobar and segmental consolidation was seen in about 5% of cases, 12% had pleural effusion (in one case, unilateral) and there was one case of lung abscess.

Thirty-three patients were admitted to a New York Hospital during the same pandemic with serologically confirmed influenza and involvement of the lower respiratory tract [10]. Four pulmonary syndromes were identified:

- 1) influenza with lower respiratory symptoms and clinical signs, with normal chest radiograph;
- 2) influenza with secondary bacterial infection, the majority of which cases showed lobar distribution and had bacteria identified in the sputum, but no virus identified in the throat washings;
- 3) an acute, rapidly progressing pneumonia apparently produced by the influenza virus alone; the CXRs showed diffuse nodular perihilar infiltrates, no significant bacteria were isolated from the

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sputum, and virus was identified from throat washings of half of the patients;

- 4) concomitant viral and bacterial pneumonia in which both lobar consolidation and bilateral nodular perihilar infiltrates were seen on CXR; the majority of patients had both virus and bacteria identified in their sputum.

Thirty cases of Hong Kong flu were described in British Columbia, Canada, during the 1968 pandemic [11]. Serological diagnosis was not made in most cases. Eight patients had no abnormality on the CXR, 10 had pulmonary infiltrates, two had bronchopneumonia, six had consolidation (four with effusion), two had segmental atelectasis and two had other changes, *e.g.* heart failure.

Seasonal influenza

Radiological changes in 35 patients with seasonal flu were described in Washington DC in 1999–2000 [12]. Of 35 patients admitted with PCR-confirmed influenza A, 17 were classified as having pneumonia defined as new pulmonary infiltrates. Bilateral diffuse interstitial or alveolar infiltrates were seen in nine patients and lobar consolidation in seven.

Outbreaks of H5N1 influenza

More recently, the emergence of H5N1 avian influenza provoked concern that this could become an epidemic strain. Outbreaks have occurred throughout South East Asia and Turkey, but to date these have remained sporadic and geographically contained.

Twelve patients were confirmed as infected with H5N1 influenza by PCR in an outbreak in Hong Kong in 1997 [13]. Five patients had consolidation or pneumonia at presentation, three of whom also developed an effusion. Four of these five patients went on to develop adult respiratory distress syndrome (ARDS). One patient with normal CXR at presentation went on to develop progressive bilateral pneumonia and ARDS.

Ten patients were described during an outbreak in Vietnam in 2003–4, all with PCR-confirmed H5N1 infection [14]. No breakdown of CXR findings were given, but all of the CXRs for these patients were reported to be abnormal on admission. The major abnormalities were “extensive infiltration bilaterally, lobar collapse, focal consolidation and air bronchograms”.

Following an outbreak in Thailand in 2004, 12 PCR-confirmed cases of H5N1 were described. All of these patients had abnormal CXRs at presentation [15]: 10 had patchy lobar infiltrates (varying from a single affected lobe to multi-lobe, sometimes bilateral, infiltrates) and 2 had interstitial infiltrates. Nine of the patients went on to develop CXR changes consistent with ARDS.

An outbreak of H5N1 occurred in Turkey in 2005–6, during which eight patients had PCR-confirmed disease [16]. Seven of these patients developed clinical signs of pneumonia and had abnormal CXRs, all with interstitial infiltrates in the initial stages. Disease was multifocal in

six patients and bilateral in five. Four patients went on to develop ARDS.

Methods and materials

Patients presenting at BHH with suspected influenza from April 2009 onwards were admitted if they met UK Department of Health criteria [5] and tested positive for novel influenza A (H1N1) virus in PCR tests carried out at the Health Protection Agency (HPA) West Midlands Regional Virology Laboratory [17]. Patients admitted with respiratory symptoms or signs had a chest radiograph (CXR) performed, and these were reviewed by a consultant radiologist (A.K.B.) for this study. A literature search on radiography findings in influenza was performed using PubMed and Google Scholar.

Results

From 7 June to 21 July 2009, 52 adult cases of pandemic H1N1 influenza were admitted to BHH. CXRs were performed on 42 (81%) of these patients, of which 12 (29%) were reported as abnormal. Ten patients had abnormal CXRs at the time of presentation, and two more patients developed consolidation during their admission. There were six patients with bilateral consolidation, which was bibasal in three and widespread in three, and all of these had pleural effusions. A further six patients had unilateral consolidation, for which the CXR changes were usually basal, except for one case with right mid-zone consolidation and another with right upper lobe consolidation. One patient with unilateral consolidation also developed a pleural effusion. The progression of consolidation was sometimes

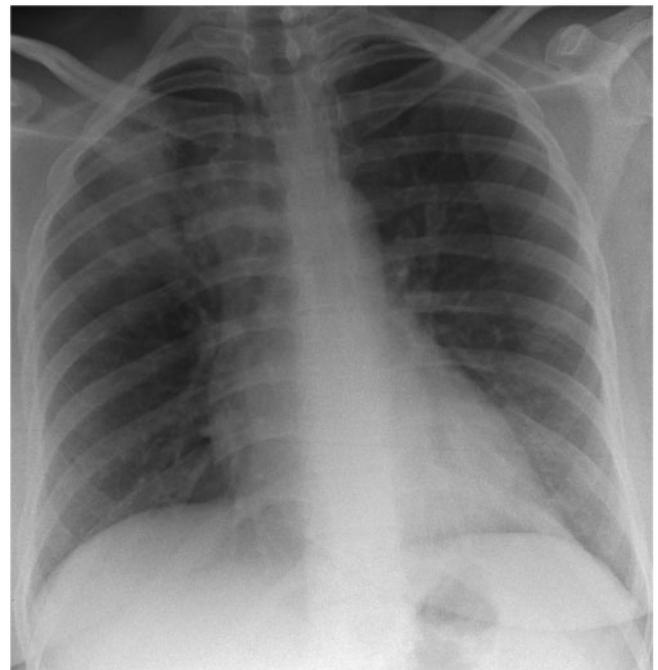


Figure 1. CXR of a previously healthy pandemic influenza patient on admission showing consolidation in the right upper lobe.

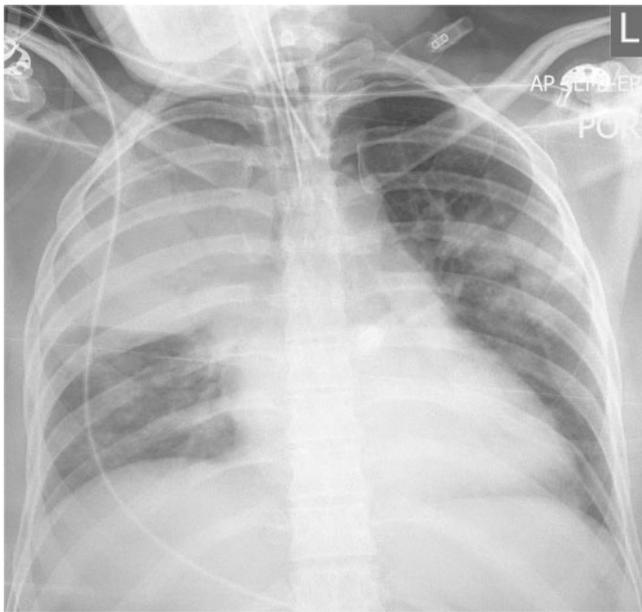


Figure 2. CXR of a previously healthy pandemic influenza patient on the day after admission showing progression of right upper lobe consolidation and new left upper lobe shadowing. The patient has been intubated.

rapid as shown in Figures 1–4. More subtle changes, such as atelectasis or interstitial/alveolar infiltrates, were not seen, and there were no cases of pneumothorax. Two patients underwent a chest CT scan with intravenous contrast; both scans showed bilateral basal effusions and patchy consolidation (Figure 5).

Of the 52 influenza patients, 36 (69%) were female and the median age was 28 (range, 16–80) years. Of the 12 patients with abnormal CXRs, however, 10 (83%) were female and the median age was 36 (range, 19–80) years. Of these 12 patients, six (50%) required intensive care, and of



Figure 3. CXR of a pregnant pandemic influenza patient on admission showing consolidation in the right and left lungs.

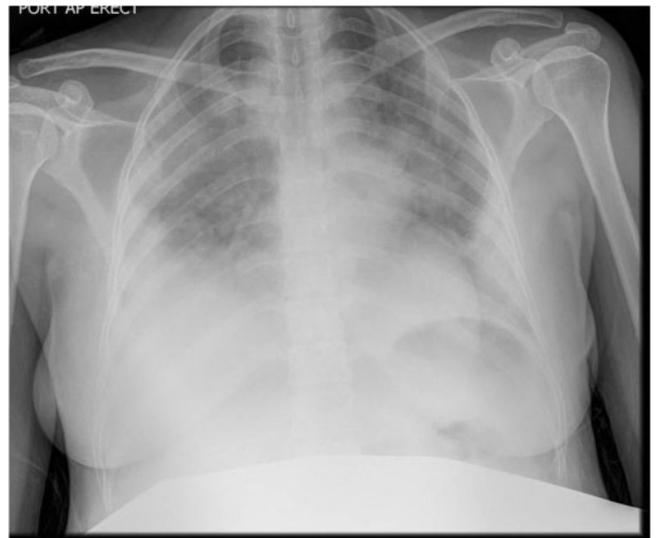


Figure 4. CXR of a pregnant pandemic influenza patient on the day after admission showing progression of the consolidation and bilateral effusions.

seven pandemic influenza cases that required intensive care, six (86%) had abnormal CXRs and the other had myasthenia gravis. Of the six influenza cases with abnormal CXRs that required intensive care, five (83%) required prolonged ventilation, two (33%) required extracorporeal membrane oxygenation (ECMO) therapy and one (17%) died. The odds ratio for requiring intubation and ventilation if admitted to hospital with H1N1 influenza and an abnormal CXR was 29.0 (95% confidence interval 2.93–287.0).

Discussion

A comparison of the previously published papers and our data is summarised in Table 1. In our series, patients with H1N1 influenza were likely to have a normal CXR,

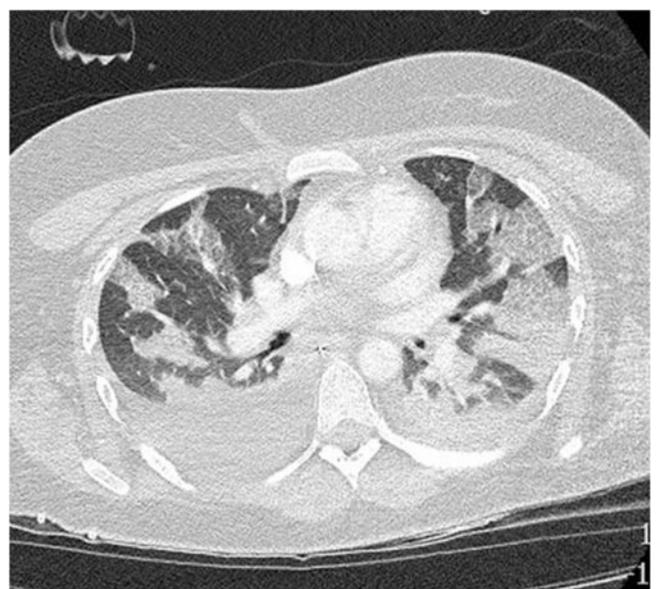


Figure 5. Chest CT scan showing bilateral basal effusions and bilateral patchy consolidation.

Table 1. Present and past studies of pandemic influenza

Paper	Type of influenza	No. of cases hospitalised	No. with abnormal CXR (% of cases)	Bilateral	Unilateral	Pleural effusion	Pneumothorax	Comments	Deaths
Present study Birmingham, UK	H1N1, Jun.–Jul. 2009	52	12 (23.1%)	6	6 (3 right, 3 left)	6 (3 bilateral, 2 right, 1 left)	0	Predominantly basal changes	1
Dawood et al [7], USA (41 states)	H1N1, Apr.–May 2009	36 hospitalised, clinical data available on 22	11 (50%)	Not noted	Not noted	1 empyema	1 pneumomediastnum	11 radiologically confirmed pneumonia	1, 2 remained critically ill
Sinclair et al [11], Victoria, Canada	Influenza A pandemic, Dec. 1968–Jan. 1969	30 hospitalised (clinical diagnosis only)	22 (73.3%)	Not noted	Not noted	4	0	9 infiltrates, 2 broncho- pneumonia, 6 consolidation, 2 segmental atelectasis, 2 other	3
Louria et al [10], New York, USA	Influenza A pandemic, Sep. 1957–Jan. 1958	33 (serological diagnosis)	30 (90.9%)	Not noted	Not noted	2	0	15 lobular/lobar changes only, 8 bilateral diffuse infiltrates mainly bibasal, 7 bilateral infiltrates and lobular/lobar changes	10
Galloway et al [9], Liverpool, UK	Influenza A pandemic, Jun.–Nov. 1957	406 (clinical diagnosis only)	112 (27.6%)	39%	41%	12% (all but 1 unilateral)	Not noted	Lobar/segmental consolidation 5%; 5 cases of tuberculosis, 1 case with a lung abscess	33
Oliveira et al [12], Washington DC, USA	Influenza A seasonal, Dec. 1999–Feb. 2000	35 hospitalised	17 (48.6%)	10 bilateral, 9 described as bilateral diffuse interstitial/ alveolar infiltrates	7 unilateral, 6 right lower lobe consolidation	Not noted	Not noted		5
Yuen et al [13], Hong Kong	H5N1, May–Dec. 1997	12	6 (50%)	4, 3 progressed to ARDS	3, all progressed to bilateral changes and ARDS	3	0		5, 2 still critically ill

Table 1. Continued

Paper	Type of influenza	No. of cases hospitalised	No. with abnormal CXR (% of cases)	Bilateral	Unilateral	Pleural effusion	Pneumothorax	Comments	Deaths
Tran et al [14], Vietnam	H5N1, Dec. 2003–Jan. 2004	10 confirmed cases	10 (100%)	Not noted	Not noted	0	2 mechanical ventilation	Abnormalities included extensive infiltration bilaterally, lobar collapse, focal consolidation and air bronchograms	8
Chotpitayasunondh et al [15], Thailand	H5N1, Jan.–Mar. 2004	12 confirmed cases	12 (100%)	Not noted	Not noted	0	1 mechanical ventilation	2 interstitial infiltrates, 10 patchy lobar infiltrates with variety of patterns, 9 developed radiological picture of ARDS	8
Bay et al [16], Turkey	H5N1, Dec. 2005–Feb. 2006	8	7 (87.5%)	5	2	0	0	Predominantly mid and lower zones affected	4

even in cases requiring hospital admission. The proportion of CXRs that were abnormal varies widely among the studies of pandemic influenza reviewed here. Differences in diagnostics, admission criteria and health-care systems may all play a part in this. The recent US review on swine flu has a significant proportion of the data missing, making it difficult to compare to our data. In addition, the focus of that paper were the clinical features rather than the radiology.

In our series of radiological changes in influenza, unilateral and bilateral consolidation were seen in similar proportions and with no predilection for either side. Pleural effusions were seen in half of the patients with abnormal CXRs and seem to be associated with more severe disease. Progression from initially normal CXR at the time of admission to pneumonic changes was also seen. The CXR changes in our series appear less extensive than the average for H5N1, and this correlates with disease severity.

Patients with H1N1 influenza who require admission to hospital and who have an abnormal CXR appear to be at greater risk of requiring intubation and ventilation than those with normal CXRs, although we cannot accurately describe that risk because of the low numbers of individuals involved in this study.

Conclusion

Chest radiograph changes are an uncommon complication in swine flu, in keeping with previous pandemics and seasonal influenza. A significant minority of patients requiring admission for swine flu will, however, have consolidation evident on their admission CXR or soon afterwards. As would be expected, those who require ventilatory support have more widespread changes on their CXRs, and pleural effusions seem to be more common in this cohort.

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