Predictive factors of severe multilobar pneumonia and shock in patients with influenza

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ABSTRACT

Purpose To identify risk factors present at admission in adult patients hospitalised due to influenza virus infection during the 2009/10 and 2010/11 seasons—including whether infection was from pandemic or seasonal influenza A infections—that were associated with the likelihood of developing severe pneumonia with multilobar involvement and shock.

Methods Prospective cohort study. Patients hospitalised due to influenza virus infection were recruited. We collected information on sociodemographic characteristics, pre-existing medical conditions, vaccinations, toxic habits, previous medications, exposure to social environments, and EuroQoL-5D (EQ-5D). Severe pneumonia with multilobar involvement and/or shock (SPAS) was the primary outcome of interest. We constructed two multivariate logistic regression models to explain the likelihood of developing SPAS and to create a clinical prediction rule for developing SPAS that includes clinically relevant variables.

Results Laboratory-confirmed A(H1N1)pdm09, EQ-5D utility score 7 days before admission, more than one comorbidity, altered mental status, dyspnoea on arrival, days from onset of symptoms, and influenza season were associated with SPAS. In addition, not being vaccinated against seasonal influenza in the previous year, anaemia, altered mental status, fever and dyspnoea on arrival at hospital, difficulties in performing activities of daily living in the previous 7 days, and days from onset of symptoms to arrival at hospital were related to the likelihood of SPAS (area under the curve value of 0.75; Hosmer–Lemeshow p value of 0.84).

Conclusions These variables should be taken into account by physicians evaluating a patient affected by influenza as additional information to that provided by the usual risk scores.

BACKGROUND

A new strain of influenza A (H1N1) virus (A (H1N1)pdm09) caused the influenza pandemic in 2009–2010 and was responsible for worldwide social concern. Although influenza usually manifests as a benign influenza-like syndrome, the new influenza virus infected younger and healthier individuals and was more severe than the seasonal influenza virus. Sometimes A(H1N1)pdm09 infected patients who were younger and with fewer or no reported comorbidities,[1] causing in some cases severe pneumonia, primary or secondary (normally due to co-infection with *Streptococcus pneumoniae)* in apparently healthy subjects, creating social concern.[2]

Since 2009, various studies have examined the possible predictive factors of complications in patients infected with A(H1N1)pdm09. Analytical and microbiological factors have been identified as predictors.[3–6] However, 25–50% of patients with severe disease who were hospitalised or died reported no medical condition, in contrast with people affected by seasonal influenza, who more often have underlying conditions.[1 7]

Pneumonia is one of the most common complications of influenza.[8] Studies have shown that patients with pneumonia were less likely to have received an antiviral agent within 2 days of illness onset than patients without pneumonia.[6] Therefore, earlier prescription of an antiviral agent could prevent or slow the progression of pneumonia. At present, prompt initiation of antiviral agents is recommended by CDC guidelines in cases of illness requiring hospitalisation and progressive, severe or complicated illness, and in patients at high risk of complications.[8 9]

We examined the relationship between sociodemographic/clinical variables and patient-reported measures and the development of severe pneumonia with multilobar involvement and/or shock (SPAS) in order to determine other predictors of risk of severe pneumonia and, when this occurs, provide prompt preventive and therapeutic interventions.

The aim of this study was to identify risk factors present at admission in adult patients hospitalised due to influenza virus infection during the 2009–2010 and 2010–2011 seasons, including whether infection was from pandemic or seasonal influenza A infections that were independently associated with the likelihood of developing SPAS and to create and validate a prediction score to aid clinical decision-making.

METHODOLOGY

A multicentre study was carried out in 36 hospitals from seven Spanish regions.[10] We recruited hospitalised patients between July 2009 and February

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2010 and between December 2010 and March 2011. Patients hospitalised for >24 h with influenza A(H1N1) infection confirmed by real-time reverse transcription PCR (RT-PCR) were selected. Patients with nosocomial infection and those who did not provide written informed consent were excluded. Participating hospitals had protocols for systematic swabbing of patients admitted with influenza-like illness defined as sudden onset of any general symptom (fever or feverishness, headache, myalgia) in addition to any respiratory symptom (cough, sore throat, shortness of breath).

Influenza A 2009 virus infection and influenza A other than A (H1N1)pdm09 were laboratory confirmed by real-time RT-PCR. In the second influenza season, confirmation of other influenza viruses in addition to influenza A was included.

All information collected was treated as confidential, in strict observance of legislation on observational studies. The study was approved by the ethics committees of the hospitals involved. Written informed consent was obtained from all patients included.

Data collection

Specifically trained personnel administered a structured questionnaire to all patients included. We collected information on sociodemographic characteristics, pre-existing medical conditions, vaccinations, toxic habits (smoking, alcohol and drug consumption), previous medications, exposure to social environments that could contribute to infection, and the adoption of measures to prevent influenza. Pre-existing medical conditions and vaccination were determined from and verified by review of medical records. We also administered the EUROQoL-5D (EQ-5D) questionnaire at admission and measured health status in the 7 days before admission. The EQ-5D, a general health assessment instrument, gives a score between 0 and 1 and gives an overall value for the quality of life of the participant by means of five questions about their state of health that measure mobility, self-care, performance of usual activities, pain or discomfort, and anxiety or depression. Each dimension is rated on a three-level scale from 1 (no problem) to 3 (inability to perform or extreme problem). The EQ-5D has been shown to be reliable and valid and has been translated into Spanish and validated for the Spanish population.[11] Proxies were asked to respond to questionnaires for patients who were too ill to respond themselves during an acute period, but the patient responded when recovered enough to do so.

Possible predictive variables considered

The following demographic variables and pre-existing medical conditions were measured: age, sex, previous hospital admission, history of pneumonia in the preceding 2 years, obesity (body mass index (BMI)≥30), morbid obesity (BMI≥40), pregnancy in women aged 15–49 years, smoking, alcoholism, comorbidities (chronic obstructive pulmonary disease, asthma, other chronic respiratory diseases, cardiovascular disease, renal failure, diabetes, liver disease, HIV infection, disabling neurological disease, rheumatological diseases, cancer, immunodeficiency, asplenia), influenza (pandemic and/or seasonal) and *S pneumoniae* vaccination, previous treatment, days from onset of symptoms (categorised as ≤3 days and >3 days), and clinical data at admission: anaemia, altered mental status, dyspnoea and fever. For each vaccine, a patient was considered vaccinated if they had received the vaccine at least 15 days before the onset of symptoms. We also considered as a predictive variable the EQ-5D score 7 days before admission as reported by the patient retrospectively during admission or after discharge.

Outcomes

SPAS was the primary outcome of interest. Pneumonia was defined as pulmonary infiltrates on chest radiographs taken during admission, not known to be old, and symptoms that were consistent with pneumonia, including cough, dyspnoea, fever, and/or pleuritic chest pain, and it was considered severe if radiological multilobar affectation or shock was present: systolic blood pressure <90 mm Hg without antihypertensive drugs and/or the need for vasopressor agents. Respiratory physicians who attended patients in participating centres diagnosed SPAS using radiological imaging and clinical information. Doubtful cases were confirmed with radiologists.

Statistical analysis

Descriptive statistics were expressed as frequency tables and mean (SD). Patient characteristics were compared according to the influenza season. Categorical variables were compared using the χ^2 test and Fisher's exact test, and continuous variables were compared using the Student t test or the non-parametric Wilcoxon test.

Univariate logistic regression analysis was carried out to identify risk factors associated with SPAS. A multivariate logistic regression model was constructed to identify the statistical significance of each possible predictive factor. The dependent variable was SPAS, and the independent variables were factors with a significance of $p<0.15$ in the univariate analysis. OR and 95% CI were calculated. Possible interaction between variables was also examined. The predictive accuracy of the model was determined by calculating the area under the receiver operating characteristics curve (discrimination) and by comparing predicted and observed mortality using the Hosmer–Lemeshow test (calibration).

We constructed two multivariate logistic regression models—the first to explain the likelihood of developing SPAS considering all possible factors, and the second to provide a clinical prediction rule for developing SPAS that includes clinically relevant variables. On the basis of the second model, we developed a risk score to predict SPAS. To develop the influenza risk score, we first assigned a weight to each risk factor in relation to each β parameter based on the multivariate logistic regression model. We then added up the weights of each of the risk factors presented by a patient, with a higher score corresponding to a higher likelihood of SPAS. In addition, we attempted to validate the risk score by K-fold cross-validation, which uses a portion of the available data to fit the model, and a different portion to test it—that is, the model is validated in a random subsample not involved in the development of the model. This process is repeated sequentially for all partitions of the original sample. Thus we split the data into K=10 roughly equal-sized parts; we fitted the model with K−1 parts of the data, and validated it by predicting the remaining *k*th part of the data. This procedure was repeated for each K part, until the 10 groups were all used in the validation, meaning that all cases were used once in the validation of the risk score.[12]

Multilevel analysis with generalised estimated equations was also carried out to determine whether the effect of the participating Spanish regions changed the result of the predictive variables.

All effects were considered significant at $p<0.05$, unless otherwise stated. All statistical analyses were performed using SAS for Windows statistical software, V.9.2 and R software V.2.13.0.

RESULTS

Of the 1385 eligible patients considered for inclusion, 29 were excluded because influenza was acquired after hospital admission and 169 because they did not give consent to participate. Therefore 1187 patients hospitalised with influenza virus infection were finally included. Patient characteristics and outcomes according to influenza season are shown in table 1. We found significant differences by season in age, gender, proportions of active and health workers, nursing home residents, number of cohabitants, people hospitalised in the preceding year, smoking, alcoholism, comorbidities, pandemic and seasonal influenza vaccination, and fever and dyspnoea at admission. The mean age was 48.60 years (SD 15.72) for influenza season 2009–2010 and 52.59 (SD 16.18) for season 2010–2011 ($p<0.0001$). Of the 320 women included, aged 15–49 years, 48 (7.8% of the total sample) were pregnant. In the second season, 232 women were included, of whom 36 were pregnant. Seventy-six patients (6.9%) had pneumonia with multilobar involvement and/or shock.

In the univariate analyses, a confirmed diagnosis of A(H1N1) pdm09, comorbidities, number of cohabitants, EQ-5D utility score 7 days before admission and seasonal influenza vaccination were significantly associated with the likelihood of SPAS (table 2).

In the multivariate analysis for the explicative model, seven factors were independently associated with SPAS (table 3): laboratory-confirmed A(H1N1)pdm09, EQ-5D utility score 7 days before admission, more than one comorbidity, altered mental status, dyspnoea at admission, days from onset of symptoms, and influenza season. In the multivariate analysis for the predictive model, seven variables were associated with the likelihood of SPAS: no vaccination against seasonal influenza in the previous year, anaemia, altered mental status, fever and dyspnoea at admission, difficulties in performing activities of daily living in the preceding 7 days, and days from onset of symptoms to admission (table 4). The logistic model showed good discrimination, with an area under the curve (AUC) value of 0.75. The model was also well calibrated, with a Hosmer–Lemeshow p value of 0.84.

The significance of each predictive variable in both models remained after adjustment by Spanish region.

On the basis of the multivariate logistic model, a weight was assigned to each risk factor in relation to each β parameter (table 4). By adding up the weights assigned to each predictive variable, an individual risk score was given to each patient, ranging from 0 to 14, with a higher score corresponding to a greater likelihood of SPAS. The risk score was significantly associated with the likelihood of SPAS (OR 1.39; 95% CI 1.24 to 1.56; $p<0.0001$) and was well calibrated (Hosmer–Lemeshow, $p=0.5318$). The influenza risk score showed fair discrimination, with an AUC of 0.69 (95% CI 0.63 to 0.75), in addition to the fair results shown by the K-fold cross-validation, which had an AUC of 0.68 (95% CI 0.62 to 0.74) (figure 1).

Table 1 Characteristics and outcomes of patients hospitalised with influenza A (H1N1) virus infection (N=1187)

Characteristic	Influenza season 2009–2010 (N=618)	Influenza season 2010–2011 (N=569)	p Value
Age, groups			0.0022
≤45 years	275 (44)	205 (36)	
46–65 years	242 (39)	231 (41)	
>65 years	101 (16)	132 (23)	
Gender (male)	298 (48)	337 (59)	0.0001
Health worker	20 (3)	8 (1)	0.0377
Nursing home resident	10 (2)	55 (11)	<0.0001
Smoking			0.0002
No	308 (50)	222 (40)	
Yes	176 (29)	171 (31)	
Ex smoker	127 (21)	165 (29)	
Alcoholism	44 (7)	81 (15)	<0.0001
Confirmed diagnosis of H1N1 (yes)	372 (60)	213 (37)	<0.0001
Comorbidities			0.0096
0	240 (39)	171 (30)	
1	172 (28)	195 (34)	
2	115 (19)	107 (19)	
>2	91 (15)	96 (17)	
Vaccination (pandemic)	10 (2)	67 (12)	<0.0001
Vaccination (seasonal)	151 (26)	108 (19)	0.0049
EQ-5D utility index*	0.78 (0.34)	0.74 (0.37)	0.03
Anaemia	38 (6)	52 (9)	0.06
Altered mental status	37 (6)	47 (8)	0.17
Fever	527 (86)	461 (81)	0.0123
Dyspnoea	404 (68)	432 (76)	0.0024
Outcomes			
Multilobar affectation	35 (6)	50 (9)	0.04
Shock	10 (2)	55 (11)	<0.0001
Death	5 (1)	20 (4)	0.017

Data are given as n (%) unless otherwise stated. Percentages exclude patients with missing data.
*Continuous variables are expressed as mean (SD).
EQ-5D, EUROQoL-5D.

Table 2 Risk factors significantly associated with SPAS (N=1187)

Characteristic	Available data*	SPAS†	OR (95% CI)	p Value
Sociodemographic				
Age, in groups	1187			
≤45 years		32 (6.65)	Ref	
46–65 years		32 (6.67)	1.02 (0.61 to 1.69)	0.94
>65 years		17 (7.30)	1.10 (0.60 to 2.03)	0.75
Gender	1187			
Female		34 (6.16)	0.82 (0.52 to 1.30)	0.40
Male		47 (7.40)	Ref	
Health worker	1118			
Yes		4 (14.29)	2.26 (0.76 to 6.67)	0.14
No		75 (6.88)	Ref	
Nursing home resident	1100			
Yes		4 (6.15)	0.88 (0.31 to 2.48)	0.80
No		72 (6.96)	Ref	
Epidemiological information				
Confirmed diagnosis	1187			
Yes		74 (12.65)	12.31 (5.62 to 26.96)	<0.0001
No		7 (1.16)	Ref	
Season 2009–2010	1187			
Yes		37 (5.99)	0.76 (0.48 to 1.20)	0.23
No		44 (7.73)	Ref	
Pandemic flu vaccination	1137			
Yes		2 (2.60)	0.36 (0.09 to 1.50)	0.16
No		73 (6.89)	Ref	
23-valente pneumococcal vaccine in last 5 years	1073			
Yes		1 (1.41)	0.18 (0.03 to 1.31)	0.0900
No		74 (7.39)	Ref	
Seasonal flu vaccination	1146			
Yes		9 (3.47)	0.45 (0.22 to 0.91)	0.03
No		66 (7.44)	Ref	
Background				
Comorbidities	1187‡			
0		39 (9.49)	Ref	
1		18 (4.90)	0.49 (0.28 to 0.88)	0.02
≥2		24 (5.87)	0.60 (0.35 to 1.01)	0.05
Asthma	1183			0.11
Yes		6 (3.87)	0.51 (0.22 to 1.20)	0.12
No		75 (7.30)	Ref	
Systemic corticosteroids	1182			
Yes		10 (6.71)	0.98 (0.49 to 1.94)	0.94
No		71 (6.87)	Ref	
Patient-reported measures				
EQ-5D utility index	1102	–	0.25 (0.12 to 0.52)	0.0002
ADL in the previous 7 days	1127			
No problems		42 (5.36)	Ref	
Moderate problems		24 (9.02)	1.75 (1.04 to 2.95)	0.0357
Severe problems		12 (15.38)	3.21 (1.61 to 6.39)	0.0009
Clinical information				
Altered mental status	1166			
Yes		12 (14.29)	2.53 (1.31 to 4.88)	0.006
No		67 (6.19)	Ref	
Dyspnoea	1164			
Yes		73 (8.73)	3.83 (1.82 to 8.03)	0.0004
No		8 (2.44)	Ref	
Anaemia	1181			
Yes		13 (14.44)	2.54 (1.34 to 4.80)	0.004
No		68 (6.23)	Ref	

Continued

Table 2 Continued

Characteristic	Available data*	SPAS†	OR (95% CI)	p Value
Fever	1178			
Yes		77 (7.79)	3.95 (1.43 to 10.93)	0.008
No		4 (2.09)	Ref	
Days from onset	1099			
≤3 days		29 (5.18)	Ref	
>3 days		49 (9.09)	1.83 (1.14 to 2.95)	0.0126

*Available data (n) from the total cohort without missing values.
†Data are given as n (%). Percentages exclude patients with missing data.
‡Since missing data were <1% in each comorbidity, for the development of the comorbidity index, missing data were assumed to be absence of the comorbidity.
ADL, activities of daily living; EQ-5D, EUROQoL-5D; Ref, Reference group in the logistic regression models; SPAS, severe pneumonia with multilobar involvement and/or shock.

DISCUSSION

Various variables that could explain the development of SPAS were identified.

1. Altered mental status and dyspnoea were predictive of a poor prognosis in any kind of pneumonia and are also reported by other authors as clinical variables independently associated with severe disease.[13 14]
2. Patients with influenza in the 2010–2011 season were more likely to develop SPAS, supporting the results from other studies that found that more patients suffered poor outcomes or died than in the pandemic season. These findings may be explained by a relative relaxation in the 2010–2011 season, resulting in later consultation by patients and later referrals and fewer prescriptions of antiviral drugs by physicians.[15] We collected no data about the delay in referral from primary care to hospitals or the time from onset of symptoms to antiviral prescription and this may be a limitation of the study.
3. Asthma was found to be a protective factor against severe outcomes of A(H1N1)pdm09 infection.[14 16–18] We analysed each comorbidity separately and confirmed that asthma was the main protective factor. Other authors have found that systemic corticoids were a confounder in the relationship between asthma and poor outcomes, because of earlier admission of patients with asthma on hospital arrival and earlier prescription of antiviral drugs in these patients.[14] We found a significant interaction between having asthma and the use of systemic corticosteroids, and therefore corticosteroids and the more frequent prescription of antiviral and antibiotics in these patients may play a possible protective role against SPAS. We have no reliable data on the use of antiviral agents or antibiotics in our patients and therefore cannot confirm this hypothesis. In Spain, pandemic influenza virus vaccination is offered to pregnant women and people with risk factors defined by the WHO.[19] People with comorbidities are offered vaccination, and this might explain the protective role in such patients. Both vaccination against seasonal and pandemic influenza and vaccination against *S pneumoniae* were considered to be independent variables in the multivariate analysis but were not significant in the final model.
4. Quality of life measures are not widely used in clinical practice, although they have been identified as predictors of poor outcomes in infectious diseases such as community-acquired pneumonia.[20] These results indicate that global health status plays a role in the development of SPAS in patients with influenza.
5. Days from onset of symptoms to arrival at hospital may be related to early prescription of antivirals/antibiotics to treat severe respiratory infection in patients consulting health services earlier.[20 21] As commented, we collected no data about this kind of prescription and this may be a limitation of our study.

Table 3 Multivariate analysis for the explicative model of developing SPAS (N=1187)

Risk factors	β parameter	OR (95% CI)	p Value
Intercept	−5.03		
Confirmed H1N1	2.61	13.66 (6.10 to 30.59)	<0.0001
EQ-5D utility index	−1.13	0.32 (0.14 to 0.73)	0.0068
Comorbidities ≥1	−0.77	0.46 (0.28 to 0.76)	0.0028
Altered mental status	0.84	2.33 (1.11 to 4.89)	0.0257
Dyspnoea on arrival	1.43	4.17 (1.94 to 8.99)	0.0003
Flu season 2010–2011	0.54	1.72 (1.04 to 2.85)	0.0359
Days from onset >3 days	0.59	1.81 (1.08 to 3.02)	0.0230

All risk factors were examined jointly.
β parameter, estimated β coefficient; EQ-5D, EUROQoL-5D; SPAS, severe pneumonia with multilobar involvement and/or shock.

Table 4 Multivariate analysis for the predictive model of developing SPAS (N=1187)

Risk factor	β parameter	OR (95% CI)	p Value	Weight
Intercept	−6.41			
No seasonal influenza vaccination	0.86	2.36 (1.14 to 4.91)	0.0214	2
Anaemia	0.96	2.61 (1.32 to 5.16)	0.0060	2
Altered mental status	0.95	2.59 (1.28 to 5.25)	0.0082	2
Fever	1.40	4.04 (1.43 to 11.42)	0.0086	3
Dyspnoea on arrival	1.35	3.86 (1.82 to 8.20)	0.0004	3
Difficulties in ADL in the previous 7 days (EQ-5D)	0.56	1.75 (1.08 to 2.84)	0.0235	1
Days from onset >3 days	0.64	1.90 (1.16 to 3.11)	0.011	1
AUC		0.75		
Hosmer–Lemeshow p value*		0.8445		

All risk factors were examined jointly.
*A significant value for the Hosmer–Lemeshow statistic indicates a significant deviation between predicted and observed outcomes.
β parameter, estimated β coefficient; ADL, activities of daily living; AUC, area under the curve; EQ-5D, EUROQoL-5D; SPAS, severe pneumonia with multilobar involvement and/or shock.

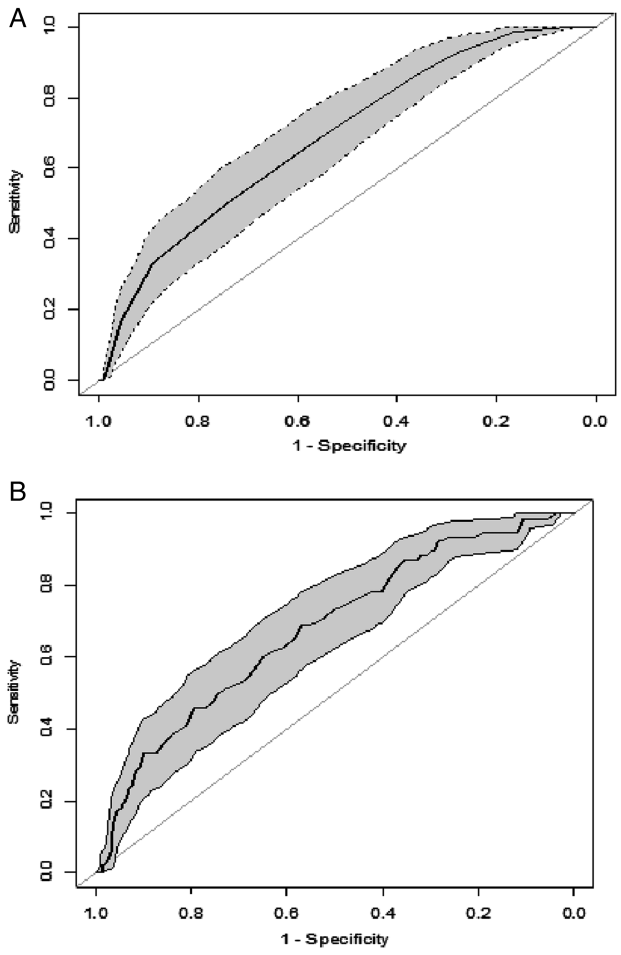

Figure 1 Receiver-operating characteristics curve of predicting severe pneumonia with multilobar involvement and/or shock according to the individual influenza risk score (A) and the 10-fold cross-validation model (B). (A) area under the curve (AUC) (95% CI), 0.69 (0.63 to 0.75); (B) AUC (95% CI), 0.68 (0.62 to 0.74).

In addition to an explicative model, we developed and validated a predictive model, entering variables with clinical significance in addition to the epidemiological variables entered in the explicative model in order to develop a score to help physicians make decisions based on variables that are easily collectable upon arrival at hospital.

As far as we know, no other prospective studies has been conducted in order to predict risk of severe pneumonia due to influenza during pandemic and first post-pandemic season, where A (H1N1)pdm09 was the predominant virus. Talmor *et al*[22] developed a model to help physicians identify which patient variables were associated with in-hospital mortality in 2007. They used a retrospective design in the same way as Adeniji *et al*[23] in 2011, who derived the Simple Triage Scoring System (STSS), also used as a triage system for admission in critical care units. STSS was compared with Sepsis-related Organ Failure Assessment (SOFA) score with regard to their ability to predict mortality, need for intensive care admission, and requirement for mechanical ventilation. Neither was evaluated to predict severe pneumonia. Chien *et al*[24] conducted a retrospective study to characterise patients hospitalised with pneumonia in the pandemic season and explored as a primary end point the development of respiratory failure. They identified a SOFA score ≥4 at admission, lymphopenia and duration of symptom onset to initiation of antiviral agents as predictors of respiratory failure. We developed our model with a prospective design and a large sample size. Nevertheless, we have been able to construct a predictive model that is just as fair, as its AUC of ~0.75 indicates. This preliminary predictive model may be of clinical use, but further studies are required to improve it, taking other variables into account—for instance, variables identified in other models as candidate variables (SOFA score, complete blood count, time from onset to prescription of antiviral agents, and type of antiviral).

One strength of our study is that it was a prospective, multicentre study with a large sample of patients in both the pandemic and post-pandemic seasons. To our knowledge, this is the first time that patient-reported measures have been evaluated as indicators of the prognosis of A(H1N1)pdm09 influenza and underlines the importance of incorporating this kind of measure into daily clinical practice.

The limitations of the study include those inherent to observational studies. In addition, no assumptions were created for missing data, and variables with more than 10% of missing data were excluded from the analysis. Thus other potential confounders, such as the prescription of antiviral drugs or administration of systemic corticoids, could not be analysed in our models. Likewise, the EQ-5D was administered retrospectively, with patients answering questions about their health status during the preceding 7 days on admittance or discharge from hospital. In addition, proxies responded to questionnaires for patients who were too ill to respond during an acute period, with the patient responding when recovered enough to do so. This fact may have skewed the results, but less than missing data or statistical imputation, and contributed important information about the clinical situation of the patient on their arrival at the emergency department. Moreover, differences in EQ-5D scores between patients and proxies have shown random variability.[25] Our prediction models were created and validated in the same cohort of hospitalised patients by influenza infection. Further studies are required to externally validate them before implementation in daily clinical practice.

In conclusion, we created two models based on the same methodology by means of logistic regression. When we constructed the first model, confirmation of H1N1, EQ-5D scores and flu season were significant variables explaining the probability of developing severe pneumonia. However, these variables are sometimes unavailable in clinical routine where the model should be applied. This model could be used by public health researchers and managers. To provide physicians with models that are easy to use, we tried to create a predictive model based on variables that are easily collected in clinical practice. These variables should be used by physicians evaluating patients affected by influenza as additional information to that provided by the usual risk scores. Further research is needed to validate our results in other settings.

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Predictive factors of severe multilobar pneumonia and shock in patients with influenza

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