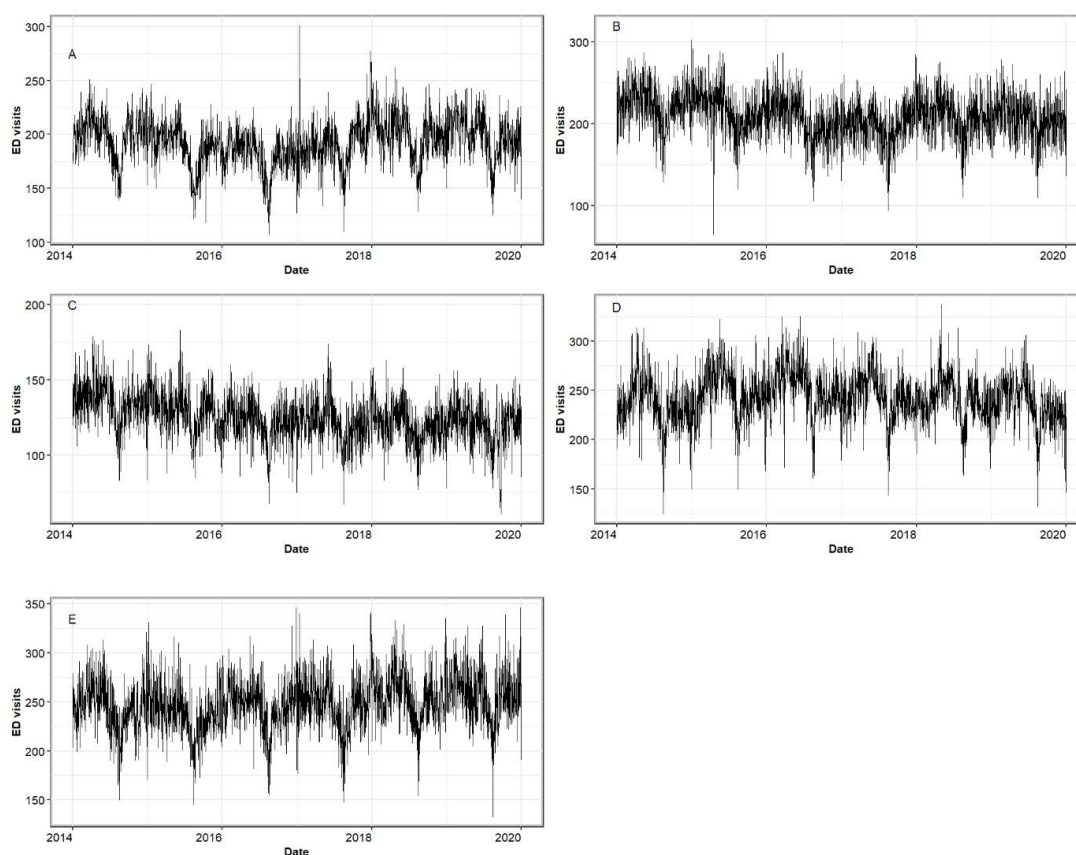


Description of Training and validation sets

Patients were mostly female (50.6%), with a mean age of 44 years (standard deviation s.d. of 26 years). The mean number of daily visits was similar in genders. Higher ED accesses volumes were found among people aged over 65 years than the others ages. During the study period, mean temperature was 16°C, mean RH was 63%, and there was precipitation on 31% of the days. Mean level of NO₂ exceeded the European limit (40 µg/m³), with a mean of 46 µg/m³, while mean PM₁₀ was lower than the European limit, with a mean of 35 µg/m³, during the observed period. On days-before and after festivities, we measured a higher number of visits, while on festivity days there was a lower number of visits compare to normal days. Training and validation sets were similar according to meteorological factors, but there were mild differences in air pollution and ILI rates (supplementary Table 1). The year 2019 was in fact characterized by significantly higher levels of pollution (t-test p-values<0.001) and lower ILI rates (t-test p-value<0.01) compared to the previous years. Patients were slightly younger in the training set than in the validation set, the mean age being 43 years in the former and 45 in the latter. The number of ED accesses was statistically different across age groups between days: children (0-14 years) tended to visit ED more likely on weekends (20% higher on Sundays compared to other days) while adults and senior people (15-65 and >65 years) on Mondays (14% and 11% higher than other days) (Anova test for mean differences p-values<0.001). August was the months with smaller ED accesses volumes, with a 14% decrease compared to the average of the other months.



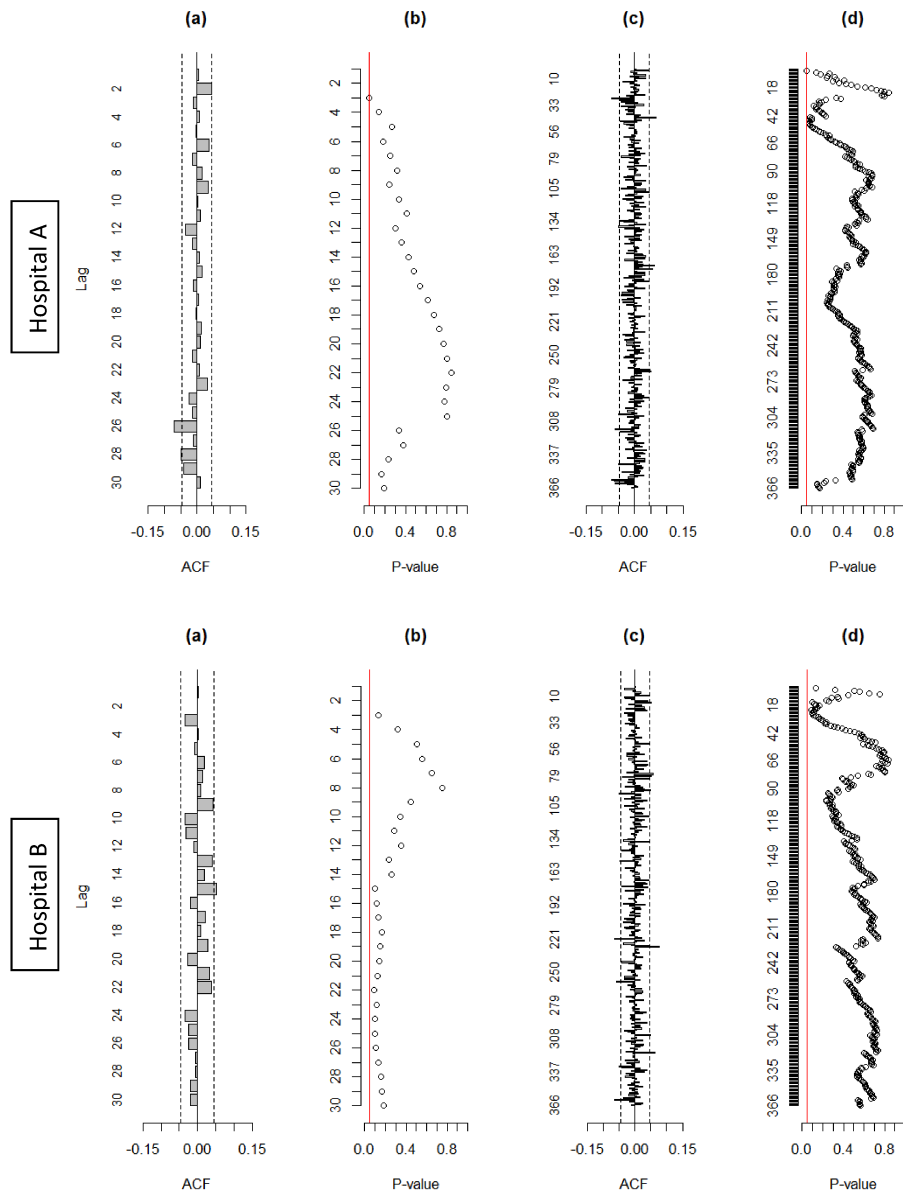
Supplementary Table 1

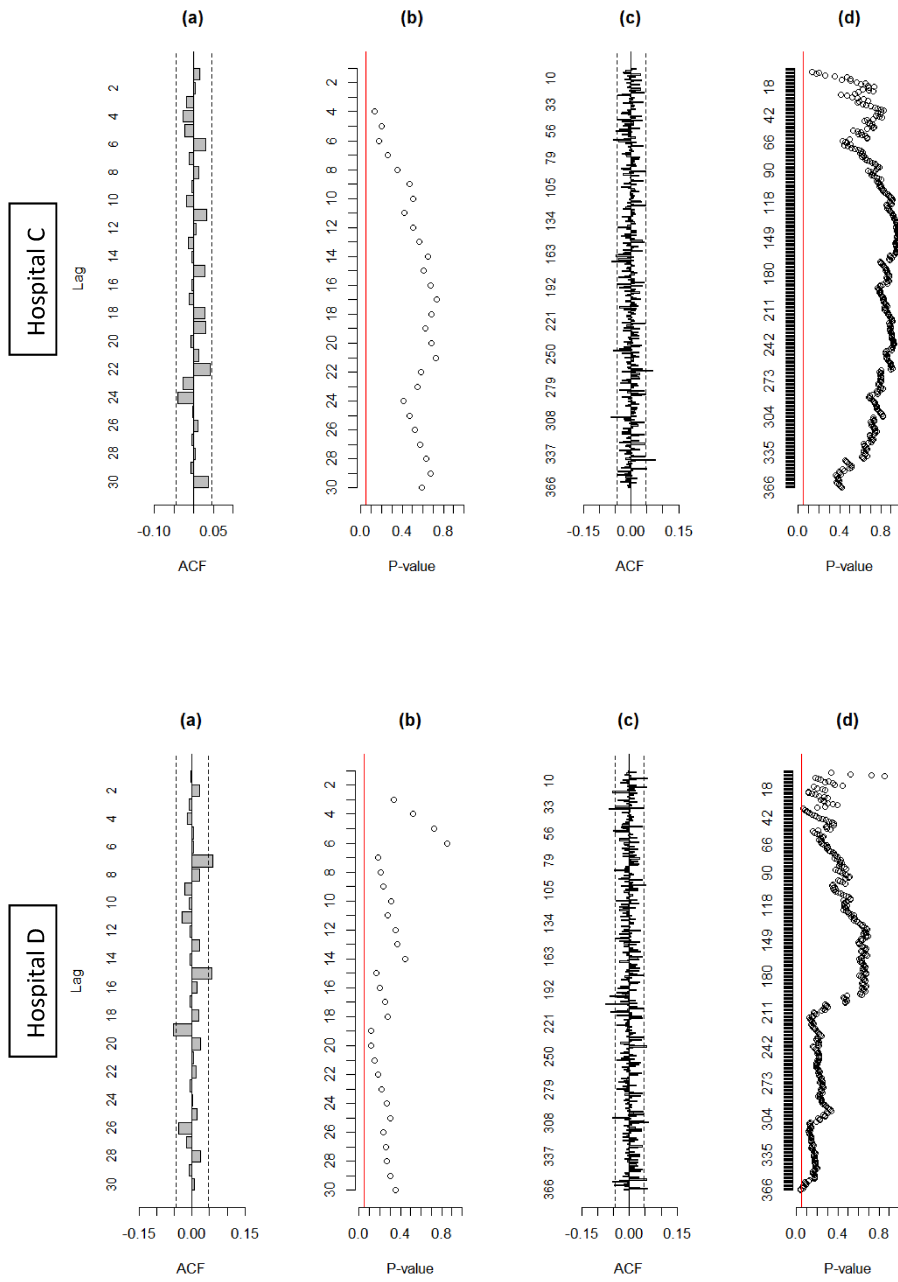
Mean, standard deviation and t-test for mean difference between training and validation sets by covariates.

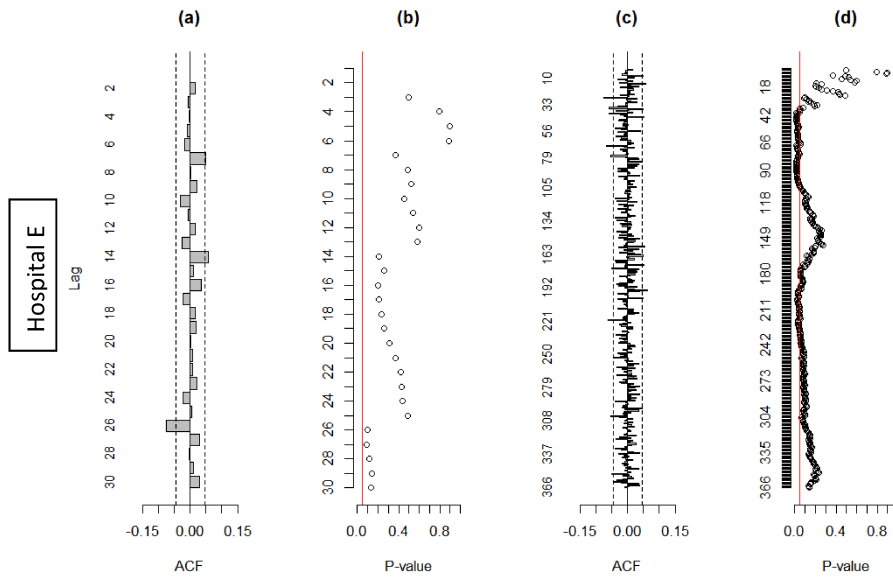
	Mean (s.d.)		t-test p-value
	Training	Validation	
Female (%)	50.6	50.4	-
Age (years)	43 (26)	45 (26)	<0.001
Temperature (°C)	15.7 (8)	16.4 (8)	0.1257
Relative Humidity (%)	63.4 (17)	62.3 (17)	0.2765
Cumulative Precipitation (mm)	2.3 (6.6)	2.2 (5.8)	0.7155
NO ₂ (µg/m ³)	47 (19)	39 (17)	<0.001
PM ₁₀ (µg/m ³)	36 (21)	30 (18)	<0.001
ILI (new cases per 1,000 inhabitants)	1.9 (3)	2.6 (3.8)	<0.001
S.d.=standard deviation ILI=Influenza-Like-Illness			

Supplementary Figure 1

Autocorrelation function (ACF) and correlation among residuals according to the Ljung-Box test (LB) by hospital: (a) ACF up to lag 30; (b) LB test up to lag 30; (c) ACF up to lag 366; (d) LB test up to lag 366.







Supplementary Table 2

Auto-regressive integrated moving average (ARIMA) parameters, indicators of performance (accuracy of predictions in the validation sets, and accuracy of high demand classification), Akaike Information Criteria (AIC) and relative error mean for outliers.

	Number of outliers' days*	Mean temperature					Minimum Temperature					Maximum Temp					Apparent Temperature				
		Beta (se)	MAPE	Accuracy (%)	Relative error mean**	AIC	Beta (se)	MAPE	Accuracy (%)	Relative error mean**	AIC	Beta (se)	MAPE	Accuracy (%)	Relative error mean**	AIC	Beta (se)	MAPE	Accuracy (%)	Relative Error mean*	AIC
Hospital A	2	1.29 (0.15)	5.9	72	55.3	14861	1.13 (0.15)	5.9	73	55.1	14882	1.03 (0.12)	5.9	72	55.1	14864	1.03 (0.13)	5.9	72	55.5	14870
Hospital B	6	1.23 (0.14)	5.7	72	44.7	14847	1.02 (0.15)	5.7	74	44.1	14874	0.98 (0.11)	5.7	73	45.6	14850	1.04 (0.12)	5.7	73	44.9	14846
Hospital C	5	0.68 (0.11)	8.1	67	36.5	13928	0.57 (0.11)	8.1	67	36.8	13941	0.55 (0.09)	8.1	66	36.5	13925	0.54 (0.09)	8.1	66	36.8	13934
Hospital D	7	1.16 (0.18)	5.5	76	22.3	15506	1.00 (0.18)	5.6	76	22.6	15516	0.96 (0.15)	5.6	75	22.4	15508	0.88 (0.15)	5.5	76	22.3	15511
Hospital E	6	1.84 (0.18)	6.1	74	24.4	15624	1.68 (0.19)	6.1	73	24	15649	1.5 (0.14)	6.1	73	24.9	15622	1.53 (0.16)	6.3	71	24.2	15811

*Number of outliers' days replaced by the mean of the observations of the same day in the other years for normalization of results
**Relative error mean of observed vs predicted values calculated for outliers (in the training sets only) which were replaced by the mean of the observations of the same day in the other years for normalization of residuals

Supplementary Table 3

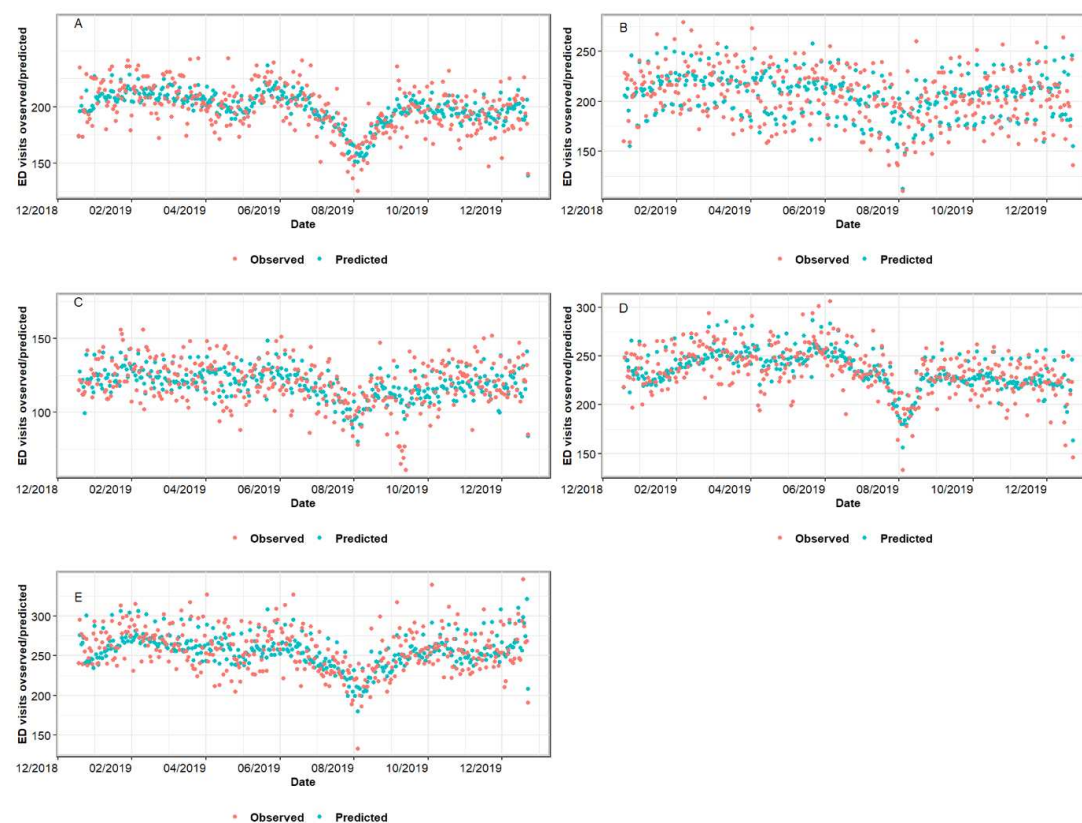
Model comparisons between the regression model with ARIMA errors and: a simple regression model (M1) and a generalized linear model (M2).

	Linear model (M1 ^a)		Likelihood ratio test*		Generalized linear model (M2 ^b)		Likelihood ratio test**	
	MAPE	Accuracy (%)	LRT (df)	p-value	MAPE	Accuracy (%)	LRT (df)	p-value
Hospital A	17.4	52	3957 (34)	<0.001	11.9	56	2618 (2)	<0.001
Hospital B	25.3	49	5610 (36)	<0.001	13.2	60	3318 (2)	<0.001
Hospital C	20.8	51	3975 (35)	<0.001	14.4	58	2662 (3)	<0.001
Hospital D	13.5	51	3289 (40)	<0.001	9.8	57	2164 (2)	<0.001
Hospital E	23.9	55	5222 (38)	<0.001	12.3	57	2909 (2)	<0.001

^aM1: linear model with only meteorological, environmental and festivities covariates
^bM2: generalized linear model with meteorological, environmental, festivities covariates and Fourier terms to control for seasonality
*Likelihood ratio test (LRT) comparing the regression model with ARIMA errors with M1
**Likelihood ratio test (LRT) comparing the regression model with ARIMA errors with M2

Supplementary Figure 2

Observed and predicted ED visits in the validation sets (from the 1st of January 2019 to the 31st of December 2019) by date and hospital.



Supplementary Table 4

Indicators of performance (accuracy and sensitivity of high demand classification) by different definition of high demand: the number of visits exceeded the median of the preceding 7, 14 and 21 days (4a), the number of visits exceeded the mean of the preceding 7, 14, 21 and 31 days (4b), and high demand defined by the Lombardy Region as exceeding thresholds based on previous year percentiles (4c).

4a	Median of the preceding 7 days					Median of the preceding 14 days					Median of the preceding 21 days				
	Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)			Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)			Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)		
			Green	Yellow	Red			Green	Yellow	Red			Green	Yellow	Red
Hospital A	72	Green	95	5	0	73	Green	95	5	0	73	Green	95	5	0
		Yellow	84	16	0		Yellow	71	21	8		Yellow	72	21	7
		Red	58	32	10		Red	59	31	10		Red	46	34	20
Hospital B	75	Green	97	2	1	75	Green	97	3	0	76	Green	96	4	0
		Yellow	80	9	11		Yellow	80	8	12		Yellow	75	16	9
		Red	38	14	48		Red	32	19	49		Red	41	10	49
Hospital C	64	Green	91	6	3	66	Green	90	6	4	67	Green	91	6	3
		Yellow	66	16	18		Yellow	63	23	14		Yellow	72	15	13
		Red	59	22	19		Red	56	22	22		Red	47	23	30
Hospital D	75	Green	92	6	2	74	Green	90	7	3	76	Green	92	6	2
		Yellow	68	18	14		Yellow	81	11	8		Yellow	73	16	11
		Red	47	14	39		Red	32	16	52		Red	29	10	61
Hospital E	70	Green	91	5	4	72	Green	92	6	2	74	Green	91	6	3
		Yellow	77	4	19		Yellow	69	9	22		Yellow	64	16	20
		Red	40	23	37		Red	39	20	41		Red	38	17	45

ED=Emergency Department

4b	Mean of the preceding 7 days					Mean of the preceding 14 days					Mean of the preceding 21 days					Mean of the preceding 31 days				
	Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)			Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)			Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)			Accuracy (%)	Observed ED high demand	Predicted ED high demand (% Sensitivity)		
			Green	Yellow	Red			Green	Yellow	Red			Green	Yellow	Red			Green	Yellow	Red
Hospital A	70	Green	96	4	0	72	Green	96	4	0	73	Green	94	5	1	74	Green	94	4	2
		Yellow	87	10	3		Yellow	78	15	7		Yellow	76	21	3		Yellow	65	27	8
		Red	63	30	7		Red	60	34	6		Red	49	27	24		Red	44	31	25
Hospital B	73	Green	92	6	2	72	Green	91	9	0	73	Green	90	10	0	76	Green	91	8	1
		Yellow	74	13	13		Yellow	74	16	100		Yellow	71	21	8		Yellow	68	23	9
		Red	29	19	52		Red	26	20	54		Red	30	17	53		Red	24	15	61
Hospital C	65	Green	90	7	3	67	Green	93	4	3	66	Green	91	5	4	69	Green	91	5	4
		Yellow	74	15	11		Yellow	68	21	11		Yellow	71	18	11		Yellow	72	17	11
		Red	55	27	18		Red	53	23	24		Red	54	20	26		Red	49	19	32
Hospital D	73	Green	92	6	2	77	Green	92	5	3	78	Green	93	6	1	76	Green	93	6	1
		Yellow	74	10	16		Yellow	76	14	10		Yellow	72	15	13		Yellow	63	26	11
		Red	51	17	32		Red	35	16	49		Red	32	12	56		Red	36	18	46
Hospital E	76	Green	94	4	2	75	Green	93	5	2	75	Green	92	6	2	75	Green	93	5	2
		Yellow	70	9	21		Yellow	66	17	17		Yellow	64	21	15		Yellow	68	15	17
		Red	46	22	32		Red	44	18	38		Red	39	23	38		Red	30	30	40

ED=Emergency Department

4c	Mean of the preceding 7 days					
			Predicted ED high demand (%, Sensitivity)			
	Accuracy (%)	Observed ED high demand	Low	Middle	High	Very high
Hospital A	53	Low	62%	36%	1%	1%
		Middle	26%	56%	14%	4%
		High	8%	37%	33%	22%
		Very high	0%	20%	23%	57%
Hospital B	64	Low	79%	21%	0%	0%
		Middle	14%	73%	12%	1%
		High	0%	62%	24%	14%
		Very high	0%	15%	18%	67%
Hospital C	50	Low	66%	31%	3%	0%
		Middle	21%	60%	14%	5%
		High	6%	56%	19%	19%
		Very high	4%	20%	38%	38%
Hospital D	55	Low	67%	30%	3%	0%
		Middle	33%	53%	11%	3%
		High	11%	28%	44%	17%
		Very high	0%	41%	9%	50%
Hospital E	54	Low	56%	42%	2%	0%
		Middle	17%	66%	15%	3%
		High	3%	54%	26%	17%
		Very high	0%	20%	20%	60%

ED=Emergency Department