

# Admission to hospital in the UK at a weekend does not influence the prognosis of adults with community-acquired pneumonia

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## ABSTRACT

Outcomes for adults with community-acquired pneumonia (CAP) admitted to hospital at the weekend were compared with those admitted during weekdays using data from the British Thoracic Society national CAP audits. Of 31 400 cases, 40.7% were weekend admissions; these patients were older (mean age 72 vs 71.3 years,  $p=0.001$ ) and more likely to have high severity CAP (28.9% vs 27.1%,  $p$  trend 0.003) but had slightly lower adjusted 30-day inpatient mortality (aOR 0.94 95% CI 0.88 to 1.01) compared with those admitted during weekdays. More patients in the weekend group received antibiotics within 4 hours of admission (70.3% vs 68.7%, aOR 1.07 95% CI 1.01 to 1.12). We did not observe increased mortality for adults admitted at the weekend with CAP.

## INTRODUCTION

The 'weekend effect', an increased risk of mortality for patients admitted on a Saturday or Sunday compared with a weekday, has garnered attention since 2001. Studies have provided evidence for it in differing healthcare systems, although causes remain unclear and evidence for a correlation between intensity of specialist hospital staffing and weekend mortality is lacking.<sup>1,2</sup>

Community-acquired pneumonia (CAP) remains a common reason for emergency medical admission in the UK and carries a high mortality of 10%–15%.<sup>3</sup> Unlike some acute emergency conditions that require rapid access to specialist services, the optimal management of CAP, as described in guideline recommendations, can be delivered by acute medical staff of varying grades.<sup>3,4</sup> As such, clinical outcomes are not expected to be influenced by weekend admission. Our aim was to assess whether outcomes and processes of care for CAP differ between adults admitted at the weekend compared with the weekday.

## METHODS

Aggregate data from six British Thoracic Society national adult CAP audits (winters 2009/10, 10/11, 11/12, 12/13, 14/15, 18/19) including cases as defined in previous work were used.<sup>5</sup> Cases were identified by participating institutions via ICD10 codes mapping to a primary discharge diagnosis of pneumonia (J12.0–J18.0) and selected for eligibility against inclusion criteria to confirm a clinical and radiographic diagnosis of CAP. The primary outcome of interest was 30-day inpatient mortality.

Secondary outcomes included 7-day and 3-day inpatient mortality, time to discharge in days, critical care admission and readmission within 30 days of discharge. Process of care measures analysed were CXR and receipt of antibiotics within 4 hours of admission, use of guideline concordant antibiotics and time to senior review.

The cohort was divided into two groups based on time and date of first presentation to hospital. Definitions for out-of-hours are taken from the NHS services website:<sup>6</sup> weekday was defined as 08:00 Monday to 18:29 Friday; weekend was defined as 18:30 Friday to 07:59 Monday. Patients admitted on a holiday (defined as 18:30 on the day prior to 07:59 on the next working day) were included in the weekend group.

Descriptive statistics were used for group comparison and adjusted ORs calculated using a mixed-effects multivariate logistic regression models for each outcome variable. Following review of published literature, minimum sufficient adjustment variable sets were defined using directed acyclic graphs.<sup>7</sup> The adjustment set for mortality included age, binary constituent parts of the CURB65 score, presence or absence of comorbidities and admitting hospital as a random effect. Analysis of time to discharge was performed using a competing risks analysis to obtain a HR for discharge within 30 days. Inpatient death was treated as a competing event. Patients who remained an inpatient at 30 days were censored from the analysis at this time point.

Cases were excluded from the analysis if the time of admission, primary outcome or variables within the minimal adjustment set were missing (<7% of data from each variable). All statistical analyses were performed using STATA 15.

## RESULTS

Of 34 194 cases, those missing key data (admission time ( $n=1008$ ), status on discharge ( $n=193$ ) and age ( $n=683$ )) were excluded leaving 32 984 for descriptive analysis. Patients who presented at the weekend (40.7%) were older (72 vs 71.3 years; OR 1.002), more likely to reside in a care home (14.8% vs 12.8%; OR 1.13), be admitted via the emergency department (84.8% vs 73.2%; OR 2.04) and have high severity pneumonia than those admitted during weekdays (table 1).

Of 31 400 cases with available data for multivariate analysis of the primary outcome, adjusted mortality in the weekend group was slightly lower



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**Table 1** Population characteristics by cohort group—weekday vs weekend admissions

	Weekday admissions N (%)	Weekend admissions N (%)	P value
Number of patients	19552 (59.5)	13432 (40.7)	
Demographics			
Age (mean)	71.3	72	<b>0.001</b>
Gender (male)	9353 (47.8)	6506 (48.4)	0.28
Usual residence care home	2493 (12.7)	1992 (14.8)	<b>0.0002</b>
Severity by CURB65 category			
Low (Score 0–1)	8017 (43.0)	5333 (41.7)	
Moderate (Score 2)	5558 (29.9)	3753 (29.4)	
High (Score 3–5)	5053 (27.1)	3686 (28.9)	<b>0.003 (trend)</b>
Admitted via ED (%)	14012 (73.2)	11146 (84.8)	<b>&lt;0.0001</b>
Admitted overnight (%)	6431 (32.9)	6947 (51.7)	<b>&lt;0.0001</b>
Comorbidity present			
Cardiac failure	1726 (8.8)	1179 (8.8)	0.95
Other chronic heart disease (excluding hypertension)	4578 (23.4)	3112 (23.2)	0.57
Cerebrovascular disease	1853 (9.5)	1398 (10.4)	<b>0.005</b>
Liver disease	236 (1.2)	160 (1.2)	0.83
Chronic kidney disease	1741 (8.9)	1007 (7.5)	<b>&lt;0.0001</b>
Malignancy	1503 (7.7)	948 (7.1)	<b>0.04</b>
Chronic obstructive pulmonary disease	4626 (23.7)	3053 (22.7)	0.05
Other chronic lung disease	2667 (13.7)	1752 (13.0)	0.89
Diabetes	2392 (12.2)	1738 (12.9)	0.06
Dementia	1557 (8.0)	1229 (9.2)	<b>0.02</b>

Population characteristics in the weekday and weekend groups are presented as number, % and p-values. P-values of <0.05 are displayed in bold. ED, emergency department.

at 30 days (15.4% vs 15.5%; aOR 0.94, 95%CI 0.88 to 1.01) and 7 days (10.3% vs 10.4%; aOR 0.95, 95%CI 0.87 to 1.03) but equal at 3 days (6.2% vs 6.2%; aOR 0.96, 95%CI 0.87 to

1.06). No differences were found in rates of critical care admission (6% vs 5.8%; aOR 1.05, 95%CI 0.95 to 1.16) or readmission within 30 days of discharge (12.9% vs 11.1%; aOR 0.99, 95%CI 0.92 to 1.07). Results for each outcome were similar when analysed by severity category (results available on request). Patients admitted at the weekend had a 2% higher probability of discharge at any point from admission to 30 days than the weekday group (adjusted Hazards Ratio 1.02 95%CI 1.00 to 1.05,  $p=0.05$ ).

Patients admitted at weekends were more likely to receive antibiotics within 4 hours (70.3% vs 68.7%; aOR 1.07, 95%CI 1.01 to 1.12), but less likely to be reviewed by a senior clinician within 12 hours of admission (71.7% vs 74.7%; aOR 0.85, 95%CI 0.80 to 0.89). There were no differences in performance of CXR within 4 hours (85.9% vs 86%; aOR 1.01, 95%CI 0.94 to 1.08) or use of guideline concordant antibiotics (57.6% vs 57%; aOR 0.99, 95%CI 0.94 to 1.04) (table 2).

## DISCUSSION

Our main finding is that 30-day inpatient mortality, adjusted for disease severity and comorbidities, was slightly lower for adults admitted to hospital with CAP at weekends compared with weekdays. This is in contrast to published evidence on the 'weekend effect', much of which is not disease-specific. Evidence related to pneumonia is mixed. In Japan, Uematsu *et al* found a 10% higher adjusted total inpatient mortality for weekend admissions with severe pneumonia.<sup>8</sup> In Australia, Baldwin *et al* found no association between day of week admitted and mortality.<sup>9</sup> In England, analysis of administrative inpatient data linked to mortality data from 2004 to 2012 found marginally increased mortality for patients with pneumonia presenting at the weekend (aOR 1.037, 95%CI 1.035 to 1.049).<sup>10</sup> Unlike administrative datasets, our study cohort comprised cases with radiologically confirmed CAP together with data on co-morbidity and severity of CAP on admission, thus reducing misclassification bias (from inclusion of patients without CAP) and allowing for appropriate case-mix adjustment. These features may explain the difference of our findings to previous studies. The slightly lower adjusted mortality in the weekend group may reflect more rapid access to time-critical aspects of care, as evidenced by increased access to

**Table 2** Outcomes and process of care measures in the weekend and weekday groups

	Weekday admissions N (%)	Weekend admissions N (%)	OR (95% CI)	Adjusted OR* (95% CI)	P value
Outcomes					
Inpatient death within 30 days	3037 (15.5)	2062 (15.4)	0.99 (0.93 to 1.05)	0.94 (0.88 to 1.01)	0.08
Inpatient death within 7 days	2027 (10.4)	1380 (10.3)	0.99 (0.92 to 1.06)	0.95 (0.87 to 1.03)	0.19
Inpatient death within 3 days	1210 (6.2)	835 (6.2)	1 (0.92 to 1.10)	0.96 (0.87 to 1.06)	0.41
Median LOS (IQR)	5 (3–9)	5 (3–10)			0.23
Critical care admission	1110 (5.8)	789 (6.0)	1.04 (0.95 to 1.14)	1.05 (0.95 to 1.16)	0.32
Readmission within 30 days of discharge	2054 (13.1)	1402 (12.9)	0.99 (0.92 to 1.06)	0.99 (0.92 to 1.07)	0.89
Process of care measures					
Senior review within 12 hours	13409 (74.7)	8797 (71.7)	0.86 (0.81 to 0.90)	0.85 (0.80 to 0.89)	<b>&lt;0.0001</b>
CXR within 4 hours	15544 (86.0)	10763 (85.9)	0.99 (0.93 to 1.06)	1.01 (0.94 to 1.08)	0.77
Antibiotics within 4 hours	11713 (68.7)	8296 (70.3)	1.08 (1.02 to 1.13)	1.07 (1.01 to 1.12)	<b>0.02</b>
Guideline concordant antibiotics:	10740 (57.0)	7480 (57.6)	1.03 (0.98 to 1.07)	0.99 (0.94 to 1.04)	0.80

Unadjusted Odds Ratios, adjusted ORs (aOR) and p values are presented. The baseline group for comparison is the weekday admission group. P-values <0.05 are displayed in bold.

\*All outcomes are adjusted for age, CURB65 score constituents (except age), cardiac failure, other chronic heart disease (excluding hypertension), cerebrovascular disease, liver disease, chronic kidney disease, malignancy, COPD, other chronic lung disease, diabetes, dementia and hospital of admission.

CXR, chest radiograph; LOS, length of stay in days.

antibiotics within 4 hours of admission.

A limitation of this study is a lack of microbiological data. A higher proportion of antibiotic-resistant, or more virulent, pathogens within the sicker weekend group, compared with the weekday group, cannot be excluded. If present, the direction of bias would be towards a higher weekend mortality and would mean the study findings are conservative. In this analysis, we did not adjust for vaccination status due to the unavailability of robust vaccination data. In the UK, priority groups for influenza and pneumococcal vaccination are identified according to older age and presence of comorbid illnesses. Overall, there were no major baseline differences between the two groups that would suggest a large difference in relation to eligibility for vaccination although we cannot exclude the possibility that vaccine uptake may have been higher in one of the groups.

We found no evidence of increased mortality for adults admitted at the weekend with CAP despite these patients being older and having higher severity pneumonia than patients admitted at weekdays. These results are reassuring and do not support a need for special 'weekend measures' in the management of CAP.

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