# 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 to those admitted during weekdays using data from the British Thoracic Society (BTS) 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 0.88-1.01) compared to 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 1.01-1.12). 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 to 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.[1][2]

Community Acquired Pneumonia (CAP) remains a common reason for emergency medical admission in the UK and carries a high mortality of 10-15%.[3] 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.[3][4] 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 to the weekday.

## Methods

Aggregate data from six BTS 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.[5] 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: seven and three-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 four 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[6]: 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 odds ratios 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 (DAGs).[7] The adjustment set for mortality included: age, binary constituent parts of the CURB65 score, presence or absence of co-morbidities and admitting hospital as a random effect. Analysis of time to discharge was performed using a competing risks analysis to obtain a hazards ratio 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), age (n=683)) were excluded leaving 32,948 for descriptive analysis. Patients who presented at the weekend (40.7%) were older (72 vs 71.3years; 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 at thirty-days (15.4% vs 15.5%; aOR 0.94, 95%CI 0.88-1.01) and seven-days (10.3% vs 10.4%; aOR 0.95, 95%CI 0.87-1.03) but equal at three-days (6.2% vs 6.2%; aOR 0.96, 95%CI 0.87-1.06). No differences were found in rates of critical care admission (6% vs 5.8%; aOR 1.05, 95%CI 0.95-1.16) or re-admission within thirty-days of discharge (11.7% vs 11.8%; aOR 0.99, 95%CI 0.92-1.07). 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 (aHR 1.02 95%CI 1.00-1.05, p=0.05).

Patients admitted at weekends were more likely to receive antibiotics within four hours (70.3% vs 68.7%; aOR 1.07, 95%CI 1.01-1.12), but less likely to be reviewed by a senior clinician within twelve hours of admission (50.6% vs 57.4%; aOR 0.74, 95%CI 0.70-0.77). There were no differences in performance of CXR within four hours (85.9% vs 86%; aOR 1.01, 95%CI 0.94-

1.08) or use of guideline concordant antibiotics (57.6% vs 57%; aOR 0.99, 95%CI 0.94-1.04) (Table 2).

## Discussion

Our main finding is that 30-day in-patient mortality, adjusted for disease severity and co-morbidities, was slightly lower for adults admitted to hospital with CAP at weekends compared to 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.[8] In Australia, *Baldwin et al.* found no association between day of week admitted and mortality.[9] In England, analysis of administrative inpatient data linked to mortality data from 2004-12 found marginally increased mortality for patients with pneumonia presenting at the weekend (aOR 1.037, 95%CI 1.035-1.049).[10] 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 antibiotics within four 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 to 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 co-morbid 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

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at weekdays. These results are reassuring and do not support a need for special 'weekend measures' in the management of CAP.

# Tables

## Table 1

*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 | **0.001** |
| Gender (male) | 9353 (47.8) | 6506 (48.4) | 0.28 |
| Usual residence care home | 2493 (12.7) | 1992 (14.8) | **0.0002** |
| **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) | **0.003 (trend)** |
| Admitted via ED (%) | 14012 (73.2) | 11146 (84.8) | **<0.0001** |
| Admitted overnight (%) | 6431 (32.9) | 6947 (51.7) | **<0.0001** |
| **Co-morbidity 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) | **0.005** |
| Liver Disease | 236 (1.2) | 160 (1.2) | 0.83 |
| Chronic Kidney Disease | 1741 (8.9) | 1007 (7.5) | **<0.0001** |
| Malignancy | 1503 (7.7) | 948 (7.1) | **0.04** |
| 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) | **0.02** |

## Table 2

*Table 2 – Outcomes and process of care measures in the weekend and weekday groups. Unadjusted odds ratios, adjusted odds ratios and p-values are presented.*

| | Weekday admissions N (%) | Weekend admissions N (%) | Odds Ratio (95% CI) | Adjusted OR* (95% CI) | p value |
|---|---|---|---|---|---|
| **Outcomes:** | | | | | |
| Inpatient death within 30 days | 3037 (15.5) | 2062 (15.4) | 0.99 (0.93-1.05) | 0.94 (0.88-1.01) | 0.08 |
| Inpatient death within 7 days | 2027 (10.4) | 1380 (10.3) | 0.99 (0.92-1.06) | 0.95 (0.87-1.03) | 0.19 |
| Inpatient death within 3 days | 1210 (6.2) | 835 (6.2) | 1 (0.92-1.10) | 0.96 (0.87-1.06) | 0.41 |
| Median LOS (IQR) | 5 (3-9) | 5 (3-10) | | | 0.23 |
| Critical care admission | 1110 (5.8) | 789 (6.0) | 1.04 (0.95-1.14) | 1.05 (0.95-1.16) | 0.32 |
| Readmission within 30 days of discharge | 2054 (13.1) | 1402 (12.9) | 0.99 (0.92-1.06) | 0.99 (0.92-1.07) | 0.89 |
| **Process of care measures:** | | | | | |
| Senior review within 12 hours | 10322 (57.5) | 6206 (50.6) | 0.76 (0.72-0.79) | 0.74 (0.70-0.77) | **<0.0001** |
| CXR within 4 hours | 15544 (86.0) | 10763 (85.9) | 0.99 (0.93-1.06) | 1.01 (0.94-1.08) | 0.77 |
| Antibiotics within 4 hours | 11713 (68.7) | 8296 (70.3) | 1.08 (1.02-1.13) | 1.07 (1.01-1.12) | **0.02** |
| Guideline concordant antibiotics: | 10740 (57.0) | 7480 (57.6) | 1.03 (0.98-1.07) | 0.99 (0.94-1.04) | 0.80 |

The baseline group for comparison is the weekday admission group. *All outcomes are adjusted for Age, CURB65 score constituents (except age), cardiac failure, other chronic heart disease (excluding hypertension), cerebrovascular disease, liver disease, chronic kideney disease, maligancy, copd, other chronic lung disease, diabetes, dementia and hospital of admission.

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