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Effect of time and day of admission on hospital care quality for patients with chronic obstructive pulmonary disease exacerbation in England and Wales: single cohort study

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ABSTRACT

Objective To evaluate if observed increased weekend mortality was associated with poorer quality of care for patients admitted to hospital with chronic obstructive pulmonary disease (COPD) exacerbation.

Design Prospective case ascertainment cohort study.

Setting 199 acute hospitals in England and Wales, UK.

Participants Consecutive COPD admissions, excluding subsequent readmissions, from 1 February to 30 April 2014 of whom 13 414 cases were entered into the study.

Main outcomes Process of care mapped to the National Institute for Health and Care Excellence clinical quality standards, access to specialist respiratory teams and facilities, mortality and length of stay, related to time and day of the week of admission.

Results Mortality was higher for weekend admissions (unadjusted OR 1.20, 95% CI 1.00 to 1.43), and for case-mix adjusted weekend mortality when calculated for admissions Friday morning through to Monday night (adjusted OR 1.19, 95% CI 1.00 to 1.43). Median time to death was 6 days. Some clinical processes were poorer on Mondays and during normal working hours but not weekends or out of hours. Specialist respiratory care was less available and less prompt for Friday and Saturday admissions. Admission to a specialist ward or high dependency unit was less likely on a Saturday or Sunday.

Conclusions Increased mortality observed in weekend admissions is not easily explained by deficiencies in early clinical guideline care. Further study of out-of-hospital factors, specialty care and deaths later in the admission are required if effective interventions are to be made to reduce variation by day of the week of admission.

Strengths and limitations of this study

- ► Reported higher mortality rates for weekend hospital admissions have been attributed by some to poorer quality of care. We studied care quality given to patients admitted with chronic obstructive pulmonary disease exacerbation in a cohort who had higher mortality for weekend admissions at a level of detail not previously reported.
- ► This is a clinical study with comprehensive coverage of acute hospitals in England and Wales. Most previous studies have used database sources for analysis.
- ► This is an observational study and not a randomised prospective trial. Only 59% of the estimated total admissions during the study period were included in the cases entered into the database. The findings may be condition specific or reflect the care pathways adopted in the two countries studied.

BACKGROUND

A number of studies have demonstrated that outcomes for patients admitted as emergencies to hospital at weekends are worse than for patients admitted during the core working week.[1–5] Other research has suggested that this effect may apply only to certain medical conditions.[6–8] No previous studies have explored this effect for chronic obstructive pulmonary disease (COPD), the cause of an estimated 1.1 million admissions per year in Europe alone.[9] It is hypothesised that poorer outcomes for patients may be a result of delayed senior clinical review and or access to urgent diagnostic services, while others have argued that case-mix confounders reflecting diminished community and primary care support at weekends are equally relevant.[10 11] Subsequently, doubt has been cast on the accuracy of data collected for administrative purposes analysed to determine factors that relate to mortality by day of admission.[12]

High-quality care for patients admitted to hospital with COPD exacerbation is well defined in the UK within condition-specific guideline documents,[13 14] and recently National Health Service (NHS) England has

laid out standards for medical supervision and diagnostic access for all patients admitted as emergencies to be applied 7 days a week.[15] In this study derived from the England and Wales national audits of the care received by patients admitted to hospital with COPD exacerbation, we use clinician collected data to explore the relationship between care qualityincluding specialty service availability, with day and time of admission.

METHODS

The data were taken from the 2014 National COPD audit for England and Wales of patients admitted to hospital with exacerbations. All admitted cases of clinically made diagnosis of acute COPD exacerbations between 1 February and 30 April 2014 were eligible for inclusion, but repeat admissions of this cohort during the study period were excluded. Data were submitted via the British Thoracic Society (BTS) web-based audit data collection system, Westcliff Solutions Ltd (Bournemouth, UK). At the end of the data collection period, the BTS made contact with units to clarify issues with unsubmitted, missing and inconsistent data before the dataset was analysed.

Datasets

The audit comprised two datasets: the first is a cross-sectional survey of resources and organisational items for each unit; the second mapped clinical care process items to the National Institute for Health and Care Excellence (NICE) COPD management guidelines[14] and COPD Quality Standards.[16] Particular emphasis was placed on the first 24 hours of admission and specialty care. Demographic factors and the day and time of admission with the recording of further times of critical interventions were an integral component of this data set.

Information about processes of care and in-hospital outcomes (mortality and length of hospital stay (LOS)) was prospectively collected. The full dataset can be found at: *https://www.rcplondon.ac.uk/projects/outputs/copd-who-cares-matters-clinical-audit-2014*. A modified prognostic score (Dyspnoea, Eosinopenia, Consolidation, Acidaemia, Atrial Fibrillation (DECAF))[17] was calculated where data were available. It was not possible to distinguish between Medical Research Council (MRC) Dyspnoea grades of 5a (DECAF score=1) and 5b (DECAF score=2) so where MRC grade 5 was recorded, a score of 1 was given as agreed by the clinical steering committee of the audit.

Definitions

The term 'unit' was used to describe participating organisations and was defined as 'a hospital that admits acute unselected emergency COPD admissions'. Trusts with more than one hospital, where acute COPD admissions were being managed separately at each hospital, were encouraged to treat each site as a separate 'unit'. However, there were instances where patients were regularly managed by more than one hospital within a Trust, the organisations preferring to audit collectively. In these cases, two or more hospitals entered data as one 'unit'. An admission was defined as 'an episode in which a patient with an acute COPD exacerbation was admitted to a ward and stayed for 4 hours or more (this includes emergency medicine centres, medical admission units, clinical decision units or similar, but excludes accident and emergency units)'. A stay in hospital of less than 4 hours was excluded. Time zero was defined as that recorded for the patient's arrival in the unit, either the accident and emergency department or an admissions facility.

Ethics

Section 251 approval was gained via the National Confidentiality Advisory Group for the collection of certain patient identifiable data. Caldicott Guardian approval was obtained from each participating unit before access to the online audit web tool was granted.

Statistical analysis

Tabular presentation is by day of week of patient admission and by three specific time periods: admissions during usual working hours (9:00–17:00, Monday–Friday), admissions out of usual hours (Monday–Thursday) and weekend admissions (17:00 Friday to Sunday midnight). The Kruskal-Wallis test compared patient subgroups according to how long patients waited to be seen by health professionals and the duration of their hospital stay. The χ^2 test compared patient groups in categorical measures. SPSS V.19 was used for these analyses. Missing data are reflected by differing denominators.

Random effects logistic regression (STATA V.13, xtlogit procedure) was used to assess the timing of admission with inpatient mortality, first by whether patients were admitted at the weekend (Saturday, Sunday or Easter holiday period) and second by whether patients were admitted over a wider weekend (Friday 00:01 hours through to Monday 24:00 hours).[18] ORs, p values and CIs were obtained and were adjusted for a predetermined list of case-mix variables with hospital clustering effects also accounted for by using the cluster option within the xtlogit procedure. Random effects logistic regression gave an intraclass class correlation estimate of 0.046. As the mortality rate is low (4.3% overall), the OR should provide a reasonable approximation of the risk ratio. Case-mix variables comprised age (<55, 55–64, 65–69, 70–74, 75–79, 80–84,≥85 years), gender, deprivation (national quintile of English/Welsh Index of Multiple Deprivation (IMD) score), daytime or night-time admission (08:00–19:59 and 20:00-07:59), ethnicity (white, other including mixed and not known), chest X-ray consolidation (yes, no, not known from chest X-ray and no chest X-ray), smoking status (current, ex, never and not known), atrial fibrillation comorbidity (yes or no), atrial fibrillation demonstrated on ECG (yes, no, not known from ECG and no ECG), diabetes, malignancy and cardiovascular comorbidities (each yes or no), total number of comorbidities (0, 1, 2, 3 and ≥4), estimated preadmission MRC dyspnoea score (grades 1 through 5

and not known), Global Initiative for Chronic Obstructive Lung Disease (GOLD) stage for predicted forced expiratory volume in 1 s (FEV_1) (≥80%, 50%–79%, 30%–49%,<30% and not known), admission pH (<7.26, 7.26–7.34, ≥7.35, and no blood gases taken), partial pressure of carbon dioxide (pCO_2) (≤6.0, >6.0 and no blood gases taken) and modified DECAF score (0–2, 3–5 and not known). Unknown data were coded to preserve the full sample size in the regression, notably affecting GOLD stage (60% unknown), modified DECAF score (42%), MRC grade (41%), pH (23%), pCO_2 (23%) and ethnicity (10%). Due to the number of tests performed, statistical significance was regarded as p<0.001.

RESULTS

All 148 eligible Trusts/Health Boards participated, and data on 13 414 patients were analysed from 199 units, median (IQR): 61 (38–85) admissions per unit. Units were asked for their total number of eligible cases (coded COPD admissions) during the study period, and from 178 responses, an estimated 59% (12 327/20 827) were audited, median (IQR): 67% (48%–91%) per unit. Inpatient mortality was 4.3% (576/13 414), with median time to death 6 days, 32% of deaths occurring within 72 hours and 22% of deaths 15 or more days after admission. Median (IQR) LOS to discharge of survivors was 4 (2–8) days.

Median (IQR) age was 72 (65–80) years, and 51% (6842) of the COPD samples were female. One-third (33%, 4289/13 074) lived in postcode areas within the 'most deprived' national IMD (2010 England, 2011 Wales) quintile and 57% (7408/13 074) in the two most deprived quintiles. Almost all, 93% (12 520) were known to have had COPD prior to the index audit admission, and 37% (4528/12 390) were documented as current smokers. A wide range of concurrent morbidities were recorded: 31% (4215) hypertension, 21% (2798) ischaemic heart disease, 16% (2142) diabetes, 12% (1553) atrial fibrillation, 11% (1517) locomotor problems and 11% (1447) had mental health disorders. The median (IQR) count of documented comorbidities was 2 (1–3), range 0–11, mean 2.06. The MRC dyspnoea score was known for 8118, with 35% (2818) classed as grade 4 and 35% (2850) as grade 5. The modified DECAF score was known for 42% (5583), with 9.5% (529) scoring 3, 4 or 5. There was a record of spirometry within the last 5 years for 46% (6123), of which GOLD I: 5%, GOLD II: 28%, GOLD III: 42% and GOLD IV: 25%. Variation between days of the week ranged as follows: % females: 49–53, median age: 72–73 years, current smoker: 37%–38%, mean number of significant comorbidities: 2.01–2.12, MRC score 5: 33–37%, MRC score 4–5: 67–72%, modified DECAF score 3–5: 8%–12%, median FEV_1 %predicted: 39%–42%, acidotic on admission pH <7.35: 19–25% and hypercapnic on admission partial pressure of arterial carbon dioxide ($PaCO_2$) >6.0 kPa: 43%–46%.

There were significant differences in the number of patients admitted from day to day during the week (goodness of fit test, p<0.001, figure 1) but no notable differences in arrival times within each day (χ^2 test, p=0.05). Monday was the busiest day for COPD admissions, with numbers tailing off as the week progressed and rising on Sunday. However, far fewer patients were discharged on Saturdays and Sundays (figure 2).

The ratio of discharges to admissions was highest on a Friday (1.39) and lowest on Saturdays (0.53) and Sundays (0.36) with the lowest number of discharges also on a Sunday; the ratio was 0.89 for Monday and 1.15–1.21 for Tuesday to Thursday. About one-third of patients (33%, 4385) arrived between 9:00 and 17:00 Monday to Friday, one-third (36%, 4849) out of hours Monday to Thursday and one-third (31%, 4180) during the weekend, that is, after 17:00 on Friday or at any time on Saturday or Sunday. There were no notable differences in regard to the case-mix variables including those of severity of illness, between these three subgroups or by day of week of admission per se.

Early care mapped to clinical guideline standards (table 1)

The proportion of cases where clinical guideline standards were met was variable across the standards. The proportion of patients who received guideline standard care for some processes, for example, ECG, chest X-ray and arterial blood gas (ABG), was slightly lower on Mondays and during week days' core working hours than at weekends. There was a slightly higher use of non-invasive ventilation (NIV) on Sundays in acidotic (pH <7.35) patients but not inappropriate use in non-acidotic patients.

Day and time of week of presentation did not associate with whether patients were seen by a respiratory consultant (57%, 7453/13 030 overall), but there were differences in time to when they were seen. Fewer patients were seen by a respiratory nurse or other member of the COPD/respiratory team if admitted on Friday or Saturday, and if seen, the waiting time for review was longer. Provision of smoking cessation advice, offer of pulmonary rehabilitation and discharge to an early discharge scheme were all lower for Friday and Saturday admissions (table 2).

LOS and mortality

LOS varied significantly (p<0.001) by when patients were admitted (table 3). Median stay was 3 days if admitted on Tuesday, 5 days if Wednesday or Thursday and 4 days if Friday through Monday. There was no statistically significant difference in in-hospital mortality between days of the week (p=0.28, table 4), but there was a borderline significant difference between weekend and weekday mortality before case-mix adjustment (4.9% vs 4.1%, OR 1.20, 95% CI 1.00 to 1.43, p=0.05), which became less significant after case-mix adjustment (OR 1.10, 95% CI 0.91 to 1.33, p=0.34). If the definition of a weekend was extended to include Friday morning through to and including Monday until midnight (in line with some

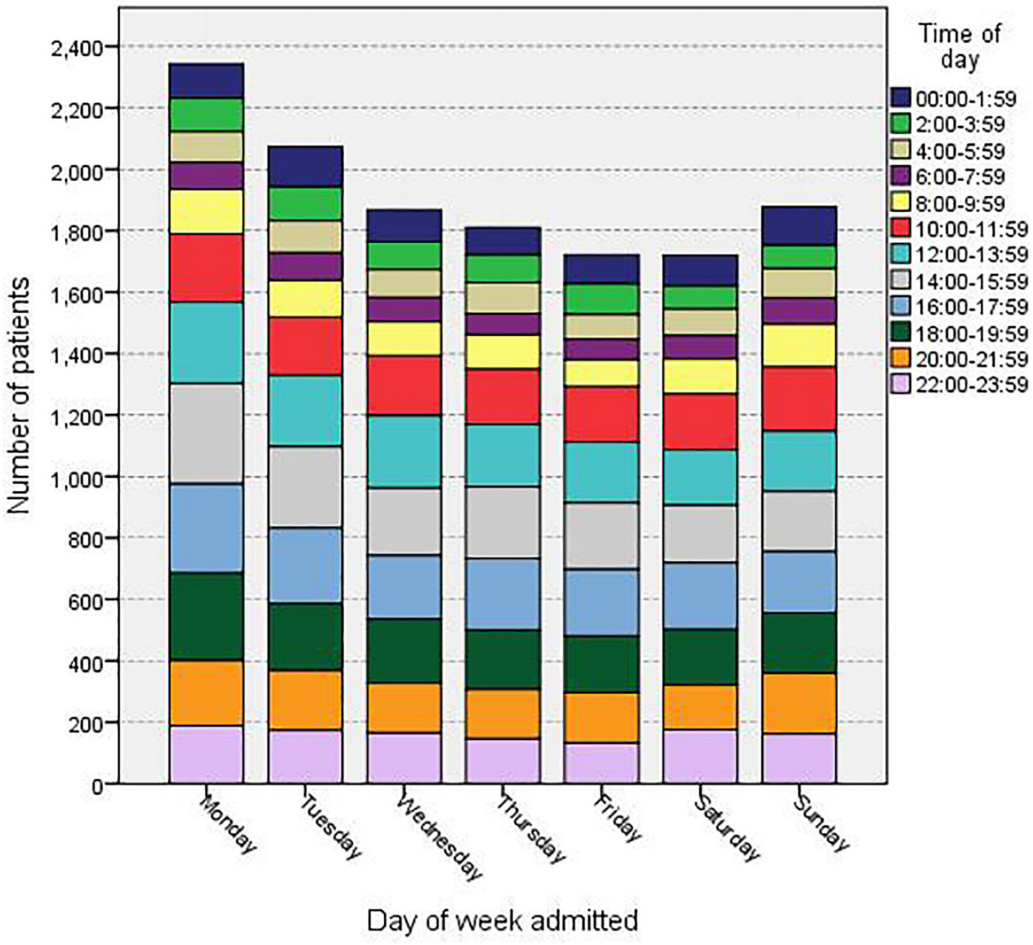

Figure 1 Time of arrival and day of admission to the unit (n=13 414).

previous studies),[14] both unadjusted (4.6% vs 3.8%, OR 1.23, 95% CI 1.03 to 1.46, p=0.02) and case-mix adjusted (OR 1.19, 95% CI 1.00 to 1.43 p=0.05) mortality was higher in patients admitted over this period than for those admitted Tuesday to Thursday. Linked data from the NHS Office for National Statistics demonstrated that the recorded cause of death in these cases was COPD (76%), cardiovascular (8%), pneumonia (1%), other respiratory (4%), and other causes (11%).

In regard to weekend admissions compared with weekdays, disease severity showed more variation in pH and DECAF score: pH <7.26 (7.3%, 6.0% p=0.02), pH <7.35 (23.8%, 21.5% p=0.009), modified DECAF score 3–5 (11.6%, 8.6% p=0.001) than for $PaCO_2$ or MRC grade: $PaCO_2$ >6.0 (44.9%, 43.6%, p=0.23), MRC grades 4 or 5 (69.5%, 70.0%, p=0.68).

DISCUSSION

This is the first clinical study of COPD hospital admissions that measures the quality of care and variation in mortality by time and day of admission.

Mortality and length of stay

Mortality was increased for patients admitted over both the Friday to Sunday weekend as well as the extended 4-day weekend, but case-mix adjusted mortality was not significantly different for the shorter weekend period and of borderline statistical significance for the extended weekend period, the data being consistent with anything from zero up to a 43% increase. While case-mix factors were not available for all cases in this study, documentation of arterial pH on admission, a key determinant of mortality, was comprehensive and suggests that patients admitted Friday to Sunday were more acidotic, and therefore sicker, than those admitted during the normal working week. The highly predictive DECAF score was less well documented but also indicated an increased severity of illness in weekend admissions. It is possible that delayed access to primary care or altered patient behaviours relating to access over this period may be factors that influence severity of admission at the weekend. It is also notable that approximately only one-fifth of deaths occurred within the first 2 days of admission and that the median time to death in those who died was 6 days, suggesting that either weekend patient characteristics and/or care later in the admission may have significant influence on their survival. Such a finding has been recently reported in a study of undifferentiated medical admissions.[19] Some of the patients who died later in the admission may have

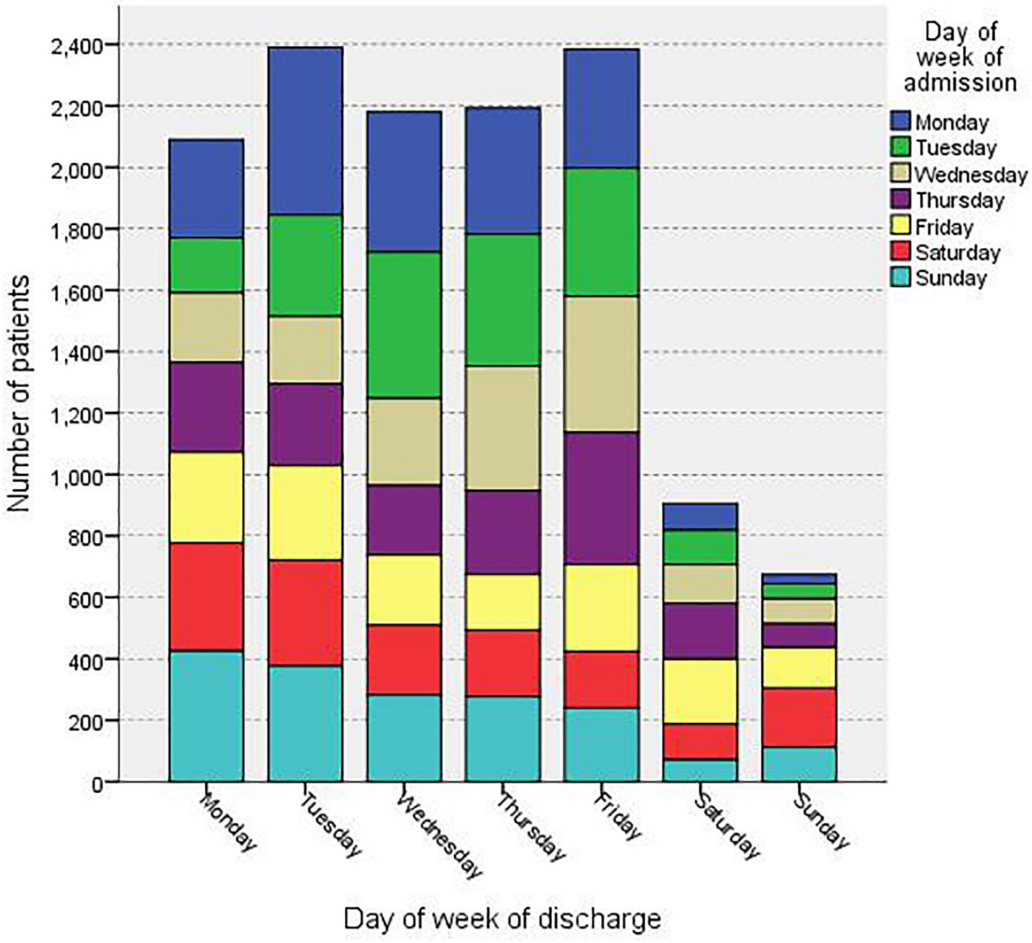

Figure 2 Number of patients discharged, by day of discharge (n=12 838).

been admitted to hospital at end of life, again, possibly because community support services were less available at a weekend.

The observed reduction in the admission to discharge ratio over the weekend extending to Mondays, combined with the increased number of admissions on a Monday is likely to have a negative effect on patient flows and ward placement that might exacerbate system variations. LOS was highest for patients admitted midweek (table 3) who might be expected to be discharged over a weekend period. The significant reductions in discharges over this period is likely to contribute to both an increased workload for clinical staff on a Monday which, combined with high Monday admission rates, may also contribute to poorer bed access for these cases and the documented reduction in clinical guideline compliance. While the data suggest significant efforts are made to clear beds on a Friday with a peak in discharges, there is a failure to maintain the discharge to admission ratio on Saturdays and Sundays. Investment in discharge teams operating at the weekends could provide major benefits for patients waiting to leave hospital and for those waiting for admission over the weekend and provide additional benefits for Monday admissions.

Early care mapped to clinical guidelines

Clinical care within the first 24 hours of attendance at hospital measured against NICE clinical guidance shows a number of statistical variations across the time of admission and days of the week (table 1). Some process measures were less well adhered to on Mondays, notably time to see a middle grade trainee of any specialty was median 6.8 hours versus 5.3 hours on Sunday. This may be explained by the high number of Monday admissions compared with those over the weekend period, but questions whether the workforce resource should be more flexibly deployed to match the variation in demand. Admissions were less likely to undergo arterial blood gas measurement, 76%, compared with a Sunday, 80%, and a chest radiograph taken within 4 hours, 82%, compared with a Saturday admission, 88%. How clinically significant these differences are is difficult to estimate. In contrast, no process measures were less well adhered to on a Friday, Saturday or Sunday than other days of the week. In terms of time of day of admission, guideline adherence was poorer Monday to Friday core working time 08:00–17:00 hours for a number of items, compared with 'out of hours' care at weekends. Notably, ABG measurement: 77% compliance versus 80% at a weekend, chest radiograph taken within 4 hours: 84% versus 87%, ECG not

Table 1 Variation in adherence to clinical guidelines in early care by day of week and time of day of admission

	Day of week of admission											
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Difference in adherence p Value	Monday–Friday 09:00–17:00	Monday–Thursday 00:00–08:59 17:01–23:59	Friday 17:01–23:59 Saturday 00:00–23:59 Sunday 00:00–23:59	Difference in adherence p value
Seen by any specialty trainee/ SpR (ST3+)	62% 1374/2208	62% 1204/1928	60% 1068/1767	63% 1077/1714	62% 1020/1641	64% 1040/1627	62% 1087/1767	0.54	61% 2502/4111	63% 2877/4592	63% 2491/3949	0.09
Median (IQR) hours*	6.8 (2.1–30)	5.1 (1.7–22)	5.6 (1.8–2.6)	5.2 (2.0–25)	5.2 (2.0–31)	5.0 (1.8–27)	5.6 (2.1–25)	0.04	6.3 (2.0–27)	5.1 (1.7–24)	5.2 (2.1–27)	<0.001
If seen, was seen ≤4 hours	38% 431/1146	45% 444/983	42% 381/907	42% 384/914	43% 359/839	45% 388/872	41% 367/905	0.01	40% 836/2094	44% 1047/2396	42% 871/2076	0.04
Arterial blood gas performed	76% 1781/2343	78% 1621/2073	79% 1475/1868	78% 1420/1811	77% 1321/1721	81% 1391/1720	80% 1508/1878	0.002	77% 3372/4385	79% 3816/4849	80% 3329/4180	0.007
Second gas taken if first pH <7.35	84% 308/368	85% 296/350	86% 276/322	84% 255/304	84% 218/260	85% 287/338	88% 303/344	0.70	84% 542/643	84% 743/880	86% 658/763	0.50
No chest X-ray	3.8% 89/2343	3.8% 78/2073	4.1% 76/1868	4.4% 79/1811	3.8% 66/1721	3.8% 66/1720	2.3% 43/1878	0.03	3.9% 172/4385	4.1% 197/4849	3.1% 128/4180	0.03
Chest X-ray within 4 hours of admission	82% 1537/1867	86% 1457/1703	86% 1328/1540	85% 1255/1482	83% 1151/1386	88% 1267/1435	87% 1355/1551	<0.001	84% 2999/3554	85% 3359/3961	87% 2992/3449	0.01
No ECG	7.6% 177/2343	7.2% 149/2073	6.4% 120/1868	6.9% 125/1811	8.1% 140/1721	5.4% 93/1720	6.4% 120/1878	0.04	8.1% 353/4385	6.4% 311/4849	6.2% 260/4180	0.001
Oxygen prescribed on medication chart/ equivalent	56% 1317/2343	56% 1155/2073	54% 1017/1868	55% 999/1811	54% 928/1721	57% 977/1720	55% 1041/1878	0.63	54% 2373/4385	56% 2716/4849	56% 2345/4180	0.11
First dose of antibiotic within 24 hours	86% 2015/2343	86% 1784/2073	85% 1597/1868	86% 1561/1811	86% 1479/1721	86% 1480/1720	86% 1613/1878	0.99	85% 3719/4385	87% 4212/4849	86% 3598/4180	0.02
First dose of oral/ intravenous steroid within 24 hours	89% 2080/2343	87% 1798/2073	88% 1641/1868	88% 1598/1811	88% 1506/1721	88% 1507/1720	89% 1669/1878	0.36	86% 3778/4385	89% 4338/4849	88% 3683/4180	<0.001
Given NIV	11.9% 279/2343	11.7% 242/2073	10.4% 195/1868	13.0% 236/1811	10.8% 186/1721	12.7% 218/1720	13.6% 256/1878	0.03	11.3% 494/4385	12.2% 593/4849	12.6% 525/4180	0.16
Given NIV within 3 hours	40% 81/202	38% 68/177	44% 61/138	40% 70/176	46% 66/142	42% 68/161	47% 91/195	0.58	37% 133/364	45% 195/430	45% 177/397	0.02
Given NIV if first pH <7.35	51% 189/368	52% 181/350	46% 149/322	51% 156/304	48% 125/260	48% 161/338	56% 192/344	0.22	52% 335/643	49% 429/880	51% 389/763	0.41
Given NIV if first and second pH <7.35	73% 161/220	74% 152/205	66% 112/171	72% 123/172	67% 104/155	69% 131/191	74% 153/208	0.39	72% 281/390	71% 340/482	70% 315/450	0.80
Given NIV if first pH ≥7.35	5.9% 81/1365	4.6% 58/1250	3.7% 42/1122	6.6% 72/1094	4.7% 49/1034	4.9% 50/1029	5.3% 60/1135	0.06	5.4% 145/2674	5.1% 146/2854	4.8% 121/2501	0.64

Continued

Table 1 Continued

	Day of week of admission											
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Difference in adherence p Value	Monday–Friday 09:00–17:00	Monday–Thursday 00:00–08:59 17:01–23:59	Friday 17:01–23:59 Saturday 00:00–23:59 Sunday 00:00–23:59	Difference in adherence p value
Given NIV if first and second pH ≥7.35	10.8% 37/344	7.5% 23/305	6.2% 18/290	11.0% 32/290	6.5% 18/277	8.0% 20/251	11.3% 34/302	0.10	9.6% 68/707	7.9% 56/710	9.0% 58/642	0.51
Decision on ceiling of care (including CPR) documented in notes within 24 hours of admission	28% 647/2343	28% 578/2073	28% 516/1868	29% 526/1811	28% 475/1721	29% 498/1720	27% 501/1878	0.71	28% 1222/4385	28% 1367/4849	28% 1152/4180	0.80

*p Values from Kruskal-Wallis test; otherwise χ^2 test.
CPR, cardio pulmonary resuscitation; NIV, non-invasive ventilation; SpR, specialist registrar; ST3+, specialty trainee year 3 or more.

performed: 8.1% versus 6.2% and first dose of systemic steroids given within 24 hours: 86% versus 88%. Again the clinical significance of these differences in clinical standards is difficult to assess, but it is clear that early care mapped to clinical guidelines is not worse at weekends but during core working hours Monday to Friday. The reasons for these differences are not certain, but we may hypothesise that at weekends and out of normal working hours generally, acute teams and clinical support services are freed from other non-emergency duties and are more able to focus on managing emergency admissions. In addition, the number of admissions is highest on a Monday and lowest on Fridays and Saturdays, while the highest proportion of admissions occur during the 08:00–17:00 hours period each day so that workload is higher during the core daytime hours and between Monday and Thursday. These observations raise concerns about the potential unintended consequences on the quality of acute care if full 7 day services such as outpatients and routine ward work were to be introduced without additional resource.

Finally, two key clinical process interventions known to reduce mortality in COPD admissions[20 21] were less well performed throughout the week irrespective of time of admission. Less than 50% of patients receiving NIV received it within 3 hours of admission with an escalation plan documented in only 28% of cases, while oxygen was prescribed, rather than administered unregulated, in just over half the hypoxic patients despite the recent launch of national oxygen guidelines.[22] Disappointingly similar deficiencies in these areas of care were seen in the 2008 national audit.[23]

Specialty care

Time taken for respiratory specialty review was higher for patients admitted on a Friday and a Saturday than for midweek admissions but was actually the lowest of all for Sunday admissions probably because of the lack of specialty care on weekend days but the availability of post-take specialty triage on Monday mornings. Admissions on a Friday and Saturday were also less likely to be seen by a member of the respiratory multidisciplinary team and waited longer to be seen if admitted Friday through to Sunday. They were also less likely to be admitted to a respiratory ward or High Dependency Unit (HDU), which may reflect both the lack of a specialist respiratory triage service on these days and the reduced discharge-to-admission ratio that hinders appropriate placement of patients into specialty and high dependency beds. Just over a half of patients were reviewed at all by a respiratory consultant during their stay in hospital with only slightly more being reviewed by a respiratory nurse or other team member. This is a missed opportunity for patients with COPD to receive specialty advice, which is associated with better access to specialist respiratory services and interventions[24] that may reduce readmission and improve quality of life. Patients admitted on a Friday and a Saturday were less likely to receive smoking cessation advice, be offered

Table 2 Variation in specialist respiratory care by time and day of admission

	Day of week of admission											
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Difference by day of week p Value	Monday–Friday 09:00–17:00	Monday–Thursday 00:00–08:59 17:01–23:59	Friday 17:01–23:59 Saturday 00:00–23:59 Sunday 00:00–23:59	Difference by time of day p Value
Admitted under a respiratory consultant	16% 384/2343	18% 382/2073	17% 314/1868	17% 299/1811	17% 292/1721	19% 327/1720	19% 359/1878	0.08	16% 698/4385	18% 872/4849	19% 787/4180	0.001
Seen by a respiratory consultant	55% 1253/2265	58% 1178/2027	57% 1024/1806	58% 1021/1768	58% 964/1675	58% 959/1666	58% 1054/1823	0.57	57% 2444/4258	57% 2678/4720	58% 2331/4052	0.72
Median (IQR) hours*	22 (13–47)	22 (12–45)	23 (13–44)	22 (12–86)	30 (12–71)	27 (12–51)	19 (10–40)	<0.001	23 (17–66)	18 (11–48)	22 (12–50)	<0.001
If seen, was seen ≤24 hours	57% 544/959	54% 489/901	53% 418/784	58% 442/766	47% 351/752	47% 353/746	59% 484/822	<0.001	55% 1025/1861	53% 1094/2054	53% 962/1815	0.38
Seen by a respiratory nurse/member of the COPD/respiratory team	65% 1457/2228	65% 1283/1983	64% 1140/1786	62% 1067/1711	55% 896/1623	54% 884/1625	65% 1156/1784	<0.001	62% 2591/4157	64% 2976/4629	59% 2316/3954	<0.001
Median (IQR) hours*	23 (16–46)	23 (14–45)	22 (14–45)	22 (15–89)	66 (16–87)	49 (39–72)	26 (17–50)	<0.001	25 (20–68)	18 (12–45)	42 (21–66)	<0.001
If seen, was seen ≤24 hours	52% 594/1138	53% 540/1019	56% 514/912	57% 493/870	33% 227/687	16% 112/690	45% 422/944	<0.001	47% 957/2041	57% 1361/2384	32% 584/1835	<0.001
Seen by a respiratory consultant OR a respiratory nurse/member of the COPD/respiratory team	81% 1841/2286	81% 1641/2026	80% 1464/1821	80% 1410/1771	76% 1277/1676	77% 1273/1661	81% 1481/1834	<0.001	79% 3385/4273	81% 3835/4740	78% 3167/4062	0.003
Median (IQR) hours*	20 (13–40)	19 (11–38)	20 (12–36)	19 (12–33)	27 (11–71)	39 (15–54)	21 (13–38)	<0.001	23 (18–47)	16 (11–37)	25 (14–50)	<0.001
If seen, was seen ≤24 hours	62% 971/1572	62% 877/1412	63% 788/1247	66% 794/1210	47% 505/1075	39% 420/1084	58% 740/1284	<0.001	59% 1690/2869	63% 2093/3308	48% 1312/2707	<0.001
Decision on ceiling of care within 24 hours—respiratory consultant involved	29% 187/647	29% 168/578	31% 162/516	30% 159/526	32% 150/475	30% 147/498	32% 161/501	0.86	30% 369/1222	30% 412/1367	31% 353/1152	0.96
Smoking cessation advice given to current smokers	59% 462/780	57% 393/695	57% 364/634	60% 375/623	53% 313/596	55% 307/558	62% 396/642	0.02	56% 799/1431	59% 1008/1698	57% 803/1399	0.14
Under care of respiratory consultant at discharge/death	50% 1169/2343	53% 1103/2073	51% 951/1868	52% 947/1811	51% 880/1721	50% 853/1720	50% 936/1878	0.19	52% 2259/4385	52% 2502/4849	50% 2078/4180	0.14
NIV patient seen by respiratory team†	95% 261/276	95% 229/241	93% 177/191	93% 219/235	90% 163/182	89% 190/214	93% 235/253	0.10	94% 466/494	93% 540/582	91% 468/516	0.09

Continued

Table 2 Continued

	Day of week of admission							Difference by day of week p Value	Monday–Friday 09:00–17:00	Monday–Thursday 00:00–08:59 17:01–23:59	Friday 17:01–23:59 Saturday 00:00–23:59 Sunday 00:00–23:59	Difference by time of day p Value
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday					
Patient managed at some time on a respiratory ward and/or medical/respiratory HDU	43% 1001/2343	45% 924/2073	45% 838/1868	47% 853/1811	46% 793/1721	42% 729/1720	42% 789/1878	0.009	45% 1969/4385	45% 2180/4849	43% 1778/4180	0.04
Suitable for pulmonary rehabilitation programme at discharge	41% 910/2241	41% 815/1995	41% 740/1790	40% 690/1747	36% 593/1643	37% 611/1634	44% 778/1788	<0.001	39% 1646/4192	41% 1919/4670	40% 1572/3976	0.16
Suitable and accepted for pulmonary rehabilitation programme at discharge	15% 337/2241	15% 294/1995	15% 264/1790	15% 258/1747	13% 215/1643	15% 240/1634	15% 273/1788	0.67	15% 647/4192	14% 654/4670	15% 580/3976	0.16
Discharged to an early/supported discharge scheme (EDS)	42% 950/2241	42% 840/1995	42% 744/1790	41% 724/1747	35% 582/1643	37% 606/1634	41% 733/1788	<0.001	40% 1676/4192	42% 1970/4670	39% 1533/3976	0.002

*p Values from Kruskal-Wallis test; otherwise χ^2 test.
†Respiratory consultant or a respiratory nurse/member of the COPD/respiratory team.
COPD, chronic obstructive pulmonary disease; HDU, high dependency unit; NIV, non-invasive ventilation.

Table 3 Length of stay (LOS) by day and time of admission

	Day of week of admission							Difference between days p Value	Monday–Friday 09:00–17:00	Monday–Thursday 00:00–08:59 17:01–23:59	Friday 17:01–23:59 Saturday 00:00–23:59 Sun 00:00-23:59	Difference between time of day p Value
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday					
LOS 0–3 days	48% 1071/2236	54% 1085/1992	45% 807/1788	35% 602/1744	39% 635/1642	46% 758/1631	48% 854/1783		44% 1855/4183	46% 2132/4665	46% 1825/3968	
LOS 4–7 days	24% 535/2236	20% 405/1992	29% 520/1788	41% 708/1744	39% 642/1642	30% 491/1631	26% 467/1783	<0.001	30% 1250/4183	29% 1350/4665	29% 1168/3968	0.52
LOS >7 days	28% 630/2236	25% 502/1992	26% 461/1788	25% 434/1744	22% 365/1642	23% 382/1631	26% 462/1783		26% 1078/4183	25% 1183/4665	25% 975/3968	
Median (IQR) LOS*	4 (2–8)	3 (2–8)	5 (2–8)	5 (2–7)	4 (3–7)	4 (2–7)	4 (2–8)	<0.001	4 (2–8)	4 (2–8)	4 (2–7)	0.23

*p Values from Kruskal–Wallis test; otherwise χ^2 test.

pulmonary rehabilitation or be admitted to a supported discharge scheme (table 2) all guideline postacute inpatient care processes.

This study appears to be unique, and we have been unable to identify any similar large-scale study of the specific quality of hospital care of COPD admissions related to time or day of admission. There are a number of studies that have reported the relationship of day of admission with mortality. The study of Concha *et al*[7] explored weekend mortality rates across a range of medical conditions and found variable differences with excess deaths in only some disease groups but including respiratory patients. Two other studies have reported mortality findings specific to COPD. A major Canadian report of over 300 000 admissions drawn from insurance databases demonstrated an increase in COPD deaths for patients in hospital at the weekend (HR 1.06) irrespective of the patients' day of admission.[25] A Danish study analysing the national patient registry found increased 30-day COPD mortality for patients admitted on a Saturday and a Sunday.[26] Neither reported quality of care or included details of time to death after admission. The Freemantle study,[18] derived from NHS Hospital Episode Statistics, shows a similar extended weekend effect for both inpatient and 30-day mortality with the greatest risk being for admissions on Saturdays and Sundays, with the day of highest mortality being Wednesday for respiratory deaths, but COPD mortality was not specifically reported. Some variability in reported findings is likely to be due to the different methodological approaches used, while there remains a consistency that there is a 'week-end' effect of some kind for some patient groups found across very different international healthcare systems.

This current study, however, does have significant methodological limitations. It is an observational study and not a controlled trial. Only an estimated 59% of eligible admitted patients were entered into the audit, although this is considerably better than in some other related studies.[27] Data are therefore incomplete and potentially subject to bias. Some data fields were also incomplete. This report is relevant only to patients admitted with COPD, and its applicability outside England and Wales is unclear. The high female proportion of admissions is not seen in most countries but is consistent with the changing demographic profile of COPD admissions observed sequentially in UK COPD Audits and in a third of the other countries that contributed data to the European COPD Audit.[28 29] Notwithstanding this study is drawn from all but one acute hospital in England and Wales and provides the greatest detail of the relationship between quality of care and time and day of admission of any available study. There is consistency of the outcome findings with the existing literature, where comparisons are appropriate and much of the data have face validity.

Table 4 Percentage (%) of admissions who died, by day admitted and by when they died

		Day of week of admission							Monday–Friday 09:00–17:00 (4385)	Monday–Thursday 00:00–08:59 17:01–23:59 (4849)	Friday 17:01–23:59 Saturday 00:00–23:59 Sunday 00:00–23:59 (4180)
		Monday (2343)	Tuesday (2073)	Wednesday (1868)	Thursday (1811)	Friday (1721)	Saturday (1720)	Sunday (1878)			
Day of death (within 0–6 days of being admitted)	Monday	0.17	0.34	0.32	0.11	0.52	0.70	0.27	0.25	0.29	0.48
	Tuesday	0.81	0.10	0.21	0.28	0.41	0.47	0.59	0.36	0.39	0.50
	Wednesday	0.30	0.39	0.11	0.11	0.00	0.47	0.48	0.18	0.23	0.41
	Thursday	0.43	0.19	0.27	0.28	0.29	0.35	0.37	0.30	0.31	0.33
	Friday	0.38	0.39	0.32	0.33	0.17	0.12	0.53	0.32	0.35	0.31
	Saturday	0.13	0.24	0.64	0.17	0.52	0.06	0.27	0.30	0.35	0.19
	Sunday	0.17	0.34	0.32	0.17	0.35	0.17	0.16	0.32	0.21	0.19
Death within 0–6 days		2.39	1.98	2.19	1.44	2.27	2.33	2.66	2.03	2.12	2.42
Death after 7 or more days		1.96	1.64	1.93	2.04	2.27	2.56	2.02	2.30	1.53	2.37
LOS not known		0.00	0.14	0.05	0.06	0.00	0.12	0.11	0.07	0.04	0.10
All deaths*		4.35 102/2343	3.76 78/2073	4.18 78/1868	3.53 64/1811	4.53 78/1721	5.00 86/1720	4.79 90/1878	4.40 193/4385	3.69 179/4849	4.88 204/4180

For example, of 2343 patients admitted on a Monday, 0.17% died that same day, 0.81% next day (Tuesday), 2.39% within the week (Monday–Sunday) and 1.96% after 7 or more days.
*χ^2 test of death rate variation: p=0.28 (between days of week); p=0.02 (between three subgroups).
LOS, length of stay.

CONCLUSIONS

We confirm that weekend admissions with exacerbation carry a higher mortality for patients with COPD, but our data suggest that this is not due to differences in the quality of early clinical care at weekends. Although patients admitted at the weekend are sicker, the majority of deaths occur much later in the admission period. Deficiencies in the provision of specialist respiratory care at weekends does impact on the wider care of patients with COPD through inadequate provision of key interventions such as smoking cessation and pulmonary rehabilitation. Further research is required across the whole admission pathway (including the management of acute crises in primary care) to understand factors that influence in-hospital mortality for patients with exacerbations of COPD.

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