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Primary Care Consultations after Hospitalisation for Pneumonia: A Large Population-based Cohort Study

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ABSTRACT

Background: Up to 70% of patients report ongoing symptoms four weeks after hospitalisation for pneumonia, and the impact on primary care is poorly understood.

Aim: To investigate the frequency of primary care consultations after hospitalisation for pneumonia, and the reasons for consultation.

Design: Population-based cohort study

Setting: UK primary care database of anonymised medical records (Clinical Practice Research Datalink, CPRD) linked to Hospital Episode Statistics (HES), England

Methods: Adults with the first ICD-10 code for pneumonia (J12-J18) recorded in HES between July 2002-June 2017 were included. Primary care consultation within 30 days of discharge was identified as the recording of any medical Read code (excluding administration-related codes) in CPRD. Competing-risks regression analyses were conducted to determine the predictors of consultation and antibiotic use at consultation; death and readmission were competing events. Reasons for consultation were examined.

Results: Of 56,396 adults, 55.9% (n=31,542) consulted primary care within 30 days of discharge. The rate of consultation was highest within 7 days (4.7 per 100 person-days). The strongest predictor for consultation was a higher number of primary care consultations in the year prior to index admission (adjusted sHR 8.98, 95% CI 6.42-12.55). The commonest reason for consultation was for a respiratory disorder (40.7%, n=12,840), 12% for pneumonia specifically. At consultation, 31.1% (n=9,823) received further antibiotics. Penicillins (41.6%, n=5,753) and macrolides (21.9%, n=3,029) were the commonest antibiotics prescribed.

Conclusion: Following hospitalisation for pneumonia, a significant proportion of patients consulted primary care within 30 days, highlighting the morbidity experienced by patients during recovery from pneumonia.

HOW THIS FITS IN?

What is known?

Readmissions after hospitalisation for pneumonia occur in 10% to 14% of adults and is increasing in the UK. Up to 70% of patients report ongoing symptoms four weeks post-discharge.

What this study adds?

Approximately 56% of adults consult primary care within 30 days after hospitalisation for pneumonia; of those who consult, 40% consult for a respiratory disorder and 30% receive one or more courses of antibiotics. This is the first study to describe the previously unrecognised, but substantial morbidity experienced by patients during recovery from pneumonia.

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INTRODUCTION

Community acquired pneumonia (CAP) accounts for 5-12% of lower respiratory tract infections presenting to primary care in the UK.(1,2) Little is known about the morbidity related to recovery from pneumonia. A systematic literature review of patient reported outcomes in CAP found limited research suggesting that up to 70% of patients report at least one symptom four weeks post-discharge; the commonest symptom being fatigue, followed by cough and dyspnoea.

Readmission to hospital is common. A meta-analysis estimated the pooled 30-day readmission rate to be 10% with 31% of readmissions due to pneumonia-related reasons.(3) In the UK, 30-day readmission following CAP has increased from 10.5% in 2009 to 14.6% in 2019.(4) In contrast, the impact on primary care is much less understood. In a small study (n=108) of working age adults (<65 years old) discharged from hospital following admission for CAP, 59% consulted primary care within 28 days of discharge.(5)

The aim of this study was to address the gap in knowledge about the impact on primary care following hospitalisation for pneumonia with specific objectives of determining (1) the rate and predictors of consultation, (2) reasons for primary care consultations and hospital readmissions, and (3) antibiotic use at consultation.

METHODS

Data sources

The Clinical Practice Research Datalink (CPRD) is a UK Government research service that provides anonymised electronic health records from general practices, with established linkages to non-primary care data such as hospitalisation data from Hospital Episode Statistics (HES) and death registration data from Office for National Statistics (ONS). Hospital Episode Statistics Admitted Patient Care data contained details of all admissions to NHS hospitals in England from 01/04/97–30/11/18 with diagnostic data coded using International Classification of Diseases, Tenth Revision (ICD-10). The ONS Death Registration Data included all deaths registered during the coverage period of between 02/01/98–14/01/19.

Study population and follow-up

Adults aged ≥ 18 years with the first episode of hospitalisation for pneumonia recorded in HES between 1 July 2002 and 30 June 2017 were included. The 'epidemiological year' definition of July-June was used as the unit of time to avoid the winter peak of pneumonia traversing two calendar years. Pneumonia was defined as ICD-10 codes J12-J18 recorded as the primary code for the first episode of hospitalisation. Patients were excluded if they a) did not have data that met the minimum quality criteria for use in research b) had less than a year of time registered to practice before admission or c) were admitted for at least a day in the 10 days preceding the index admission. Patients were followed up from day one after the date of discharge from hospital to either the first primary care consultation, end of data collection (30 days), date of transfer out of practice, date of last data collection for the practice or date of death, whichever came first.

Definitions

Primary care consultation was considered to have occurred if medical Read codes were recorded after the date of discharge from hospital; administration-related codes were excluded to capture face-to-face consultations.(6,7) If multiple Read codes were recorded in a day per patient, this was counted as a single consultation. Validated codelists were used for pneumonia, smoking status, alcohol consumption, Charlson Comorbidity Index (CCI) and specific co-morbidities of interest.(8–10) In addition to the common reasons for consultations, namely respiratory, digestive, genitourinary and cardiac disorders, constitutional symptoms and cognitive disorder were categorised according to Read codes. Read codes for antibiotics were categorised according to the British National Formulary (BNF) listing in Section 5.1 (Antibacterial drugs), excluding anti-tuberculosis and anti-leprotic drugs.

Statistical analysis

Age was fitted as a categorical variable following likelihood ratio test (age categories: 18-49, 50-64, 65-74, 75-84, ≥ 85). The 2015 English Index of Multiple Deprivation (IMD) was used as composite measure of material deprivation at the patient level.(11) 'Time to consultation' was measured from day one after discharge from hospital to the first consultation at primary care. Based on the first episode of consultation per patient, rates of consultation per 100 person-days for ≤ 7 days and ≤ 30 days were determined. Characteristics of adults who consulted were compared to those who did not consult. Predictors of consultation were determined from published literature on consultations for acute lower respiratory tract infection (LRTI) based on a postulated similarity between pneumonia and non-pneumonic acute LRTI in this regard.(12) There were missing data in smoking status (2.9%),

alcohol consumption (15.1%) and IMD score (0.1%). Multiple imputation using chained equations was performed with 10 imputed datasets for smoking status and alcohol consumption respectively. Univariate and multivariate competing-risks regression analyses were used with death and readmission as competing events. Univariate analyses were conducted to investigate the association between primary care consultation and each variable (age, gender, smoking status (never smoked, ex-smokers, current smokers), alcohol consumption (non-drinker, former, occasional, moderate (≤ 14 units/week), heavy drinker (>14 units/week)), length of hospital stay (≤ 3 , 4-7, >7 days), previous primary care consultations in the year prior to admission for pneumonia (<5 , 5-15, >15 consultations), IMD quintile (score of 1 (least deprived) -5 (most deprived), unknown), practice region (West Midlands was selected as the reference region as it was a region representative of England by population size, age and gender(13)), presence of comorbidities. Variables that were considered associated in the univariate analyses ($p < 0.05$) were included in a multivariable backward logistic regression model with imputed data; age and sex were *a priori* variables. The CCI and specific comorbidities of interest were included in separate multivariate models.

The proportions for reasons of consultations were calculated for all patients who consulted, with sub-analyses for those who consulted before readmission or death. The top 20 reasons for hospital readmission were determined. The number of antibiotic prescriptions, frequency of antibiotic courses (multiple antibiotics prescribed at a single consultation were counted as a single 'course') and the type of antibiotics prescribed at primary care consultation were examined. Univariate and multivariate logistic regression analyses were performed to investigate predictors of antibiotic prescription at consultation. Statistical analyses were performed using Stata 15.

RESULTS

Over the 15-year study period, there were 215,828 patients admitted to hospital with ICD-10 codes for pneumonia (**Figure 1**), and after exclusions, the study cohort comprised 56,396 patients. **Table 1** shows the characteristics of the study population. Median age of the study cohort was 75 years (interquartile range (IQR): 61-84 years) and 49.7% were male. During the 30-day follow-up, 16% ($n=9,051$) were readmitted to hospital and 6.1% ($n=3,446$) died after discharge from hospital.

Primary care consultation occurred in 27.7% ($n=15,626$ patients) and in 55.9% ($n=31,542$ patients) within 7 days and 30 days of discharge respectively. The rate of first consultation was highest within 7 days of hospital discharge at 4.7 per 100 person-days and declined to 3.3 per 100 person-days

within 30 days of hospital discharge. Of those who consulted within 30 days, 47.7% (n=15,506) consulted two or more times.

Factors associated with consultation

The strongest predictor of consultation was previous consultation behaviour; specifically, having consulted >15 times in the year prior to the index admission for pneumonia (adjusted OR 8.98, 95% CI 6.42-12.55) (**Table 2**). Other factors independently associated with a higher probability of consultation included current and ex-smoking status compared to never smokers, length of hospital stay of between 4-7 days compared to ≤ 3 days, CCI score ≥ 3 , and co-existing chronic heart and lung conditions as well as diabetes mellitus (**Table 2**). Age ≥ 85 years was associated with a lower probability of consultation, whereas age 50–74 years was associated with a higher probability of consultation, compared to age 18–49 years. Increasing social deprivation was associated with lower probabilities of consultation. Geographical variation was observed with the lowest probability of consultation in the South East Coast compared to West Midlands. Gender and alcohol consumption were not independently associated with consultation.

Reasons for consultations and readmissions

The commonest reason for primary care consultation was for a respiratory disorder (40.7%) with 11.8% consulting for pneumonia specifically (**Table 3**). A small proportion of patients consulted for constitutional symptoms, such as fever, fatigue, loss of appetite or general malaise. Reasons for consultation within 7 days were similar.

Of patients readmitted within 30 days of discharge, 38.2% (n=3,459 of 9,051) consulted primary care before readmission. These patients had similar reasons for consulting when compared to all patients. The commonest reason for readmission was pneumonia; 34.6% (n=1,255 of 3,625) and 26.9% (n=2,431 of 9,051) within 7 and 30 days respectively (**Table S1**). A large proportion of patients who died within 30 days of discharge consulted primary care before death (60.3%, n=2,077). Of these, 413 of 2077 (19.9%) were for reasons of palliative care or terminal illness (n=230), or cancers (n=183).

Antibiotic prescription at consultation

Antibiotics were prescribed in 17.3% of those who consulted within 7 days of discharge compared to 30% of those who consulted within 30 days (**Table 4**). At consultations within 7 and 30 days of discharge, antibiotics were prescribed at the same time as respiratory Read coding in 56.4% and

48.9% respectively. Of those who received antibiotics at consultation, 22.8% received two or more courses of antibiotics within 30 days of discharge. Penicillins and macrolides were the commonest antibiotics prescribed.

Factors independently associated with a higher odds of antibiotic prescription in the first week after discharge were; year of pneumonia hospitalisation and pre-existing COPD or asthma. Factors independently associated with a lower odds of antibiotic prescription were; age ≥ 65 years, hospital stay ≥ 4 days, and practice region (East of England and London) (**Table S2**).

DISCUSSION

Summary

We found that 56% of patients consulted primary care within 30 days of hospital discharge, the highest rate of consultation occurring within 7 days. Nearly 40% of consultations were for a respiratory disorder, with 12% consulting for pneumonia specifically and 30% of patients consulting received further antibiotics. Previous consultation behaviour at primary care was the strongest predictor of post-discharge consultation.

Strengths and limitations

A major strength of this study is the large, nationally representative study cohort of over 56,000 patients obtained through linkage between the CPRD and HES, two large validated medical record databases.⁽¹⁴⁾ This study dataset reflects the real-world practice of pneumonia in England covering a span of 15 years. To avoid measuring non-medically relevant consultation, administration-related Read codes were judiciously excluded.

A weakness of this study is that the study data are only from England (HES is only available for England) and therefore study results may not be generalisable to the rest of the UK. Secondly, a large number of patients ($n=87,564$) were excluded because their data did not meet the minimum research quality checks or their first practice registration date to date of admission was less than a year. These patients were younger than those included (median 71 vs 75 years, $p<0.0001$) and there was a higher proportion of females (51.5% vs 50.4%). Those discharged to a care facility outside the catchment area of their previous primary care practice would also have been excluded from the analysis. Excluded patients may have different patterns of consultation behaviour compared to the

study cohort. Thirdly, we relied on ICD-10 coding for the identification of patients with pneumonia. Roughly a third of ICD-10 coded cases of pneumonia within HES lack radiographic evidence of pneumonia and would strictly be considered cases of non-pneumonic LRTI.(4) The vast majority of these patients are nevertheless treated clinically as having pneumonia and inclusion of these patients in the analysis reflects routine practice. Fourthly, although considerable efforts were made to ensure data quality, we cannot fully exclude the possibility of information bias from miscategorisation of the study exposure, confounders and outcomes.

Comparison with existing literature

Very few studies have examined the impact on primary care following hospital discharge after pneumonia. A Dutch study using electronic health records observed that only 8% of adults consulted primary care within 30 days after discharge.(15) Their study comprised patients who were younger (mean age range per year from 2002- 2009; 57 years (SD 27.9) to 61 years (SD 24.8)) and with lower severity; combined mortality (in-hospital and within 30 days of discharge) of 7%, compared to 26.2% in our study.(16) Two Spanish studies (a prospective cohort study at a tertiary hospital (n=934) and a multicentre clinical trial (n=207)) observed consultation proportions of 18-20%.(17,18) A 3-centre UK study by Daniel *et al.* (n=108) of adults aged <65 years found primary care consultation occurred in 59%.(5)

We found a lower proportion of consultation due to respiratory symptoms compared to Daniel *et al.* and Adamuz *et al.* (69% and 75% respectively). Direct comparison between these studies is not possible due to the use of different methodologies for measuring and categorising reasons for consultation.(5,18) Antibiotic use at consultation in our study (30.8%) was similar to that reported by Daniel *et al.* (34.4%).(5)

Other studies have investigated the burden of reconsultations after primary care management of patients with lower respiratory tract infections (LRTIs) or acute bronchitis.(12,19–21) The patient cohorts in these studies mostly involve adults with self-limiting LRTIs in whom the challenge is the avoidance of overuse of antibiotics and managing patient expectation. In these patient groups, reconsultations were observed in 20-33%. Similar to other research in LRTI consultations not requiring hospital admission, we found that a prior history of consultation was a strong predictor of post-discharge consultation.(12,22) The provision of patient information leaflets or delayed prescriptions in the management of LRTIs has been shown to reduce reconsultation.(22–24) Such strategies may be relevant in managing patients on discharge from hospital as well. In addition, existing integrated post-discharge care pathways between primary and secondary care may provide

applicable approaches to improving the quality of care and patients' experiences following pneumonia.(25,26)

Implications for clinicians and policymakers

After discharge from hospital, patients often continue to report persistence of symptoms, including fatigue, cough and dyspnoea, associated with functional impairment for several weeks.(27) Primary care consultation following hospitalisation for pneumonia may serve as a means of safety-netting, providing an opportunity for clinicians to identify deteriorating patients who need further medical intervention or sometimes readmission. On the other hand, qualitative studies reveal that at the time of hospital discharge, patients often lack a clear understanding about the short and long-term consequences of CAP, or the natural course of their symptoms.(28,29) Many patients describe a sense of isolation when their experiences of relatively slow recovery do not match the expectations of relatives, carers and even physicians.(28,29) Ongoing unaddressed patient needs may contribute towards the high level of primary care consultation observed as patients seek reassurance of adequate recovery. Such consultations may be avoidable.

At a strategic level, lack of recognition by the public, clinicians and policy makers of the morbidity experienced by patients during recovery from pneumonia has thus far meant that evidence-based interventions to meet patients' needs have not been adequately developed. The health economic costs of primary care consultations are considerable. Annually, over 100,000 patients are admitted to hospital in England with CAP.(30) Assuming a cost of £30 for each primary care consultation, we estimate post-pneumonia consultations alone to cost the NHS approximately £2 million a year.(31) These figures do not take into account any additional NHS and ecological costs from antibiotic prescribing nor the impacts from 'long-COVID' consequent on SARS-CoV2 infection specifically.(32–35)

The observation that previous consultation behaviour is strongly associated with post-pneumonia discharge consultation raises the question of whether the index pneumonia admission is a precipitating event leading to further health consequences, or whether it is only a marker of on-going health needs. It is likely that both these explanations play some part. Further studies are required to better understand the relative contributions of these factors and to inform where to direct health improvement efforts.

Table 1: Characteristics of the overall study population

		Overall study population n (%)	
Number of patients		56,396	
Age			
	18-49	8208	(14.6)
	50-64	8830	(15.7)
	65-74	10499	(18.6)
	75-84	15317	(27.2)
	≥85	13542	(24.0)
Gender			
	Male	28002	(49.7)
	Female	28394	(50.4)
IMD (patient-level)			
	1 (least deprived)	10596	(18.8)
	2	11407	(20.2)
	3	11909	(21.1)
	4	11263	(20.0)
	5 (most deprived)	11171	(19.8)
	Unknown	50	(0.1)
Practice region			
	West Midlands	6990	(12.4)
	North West	9855	(17.5)
	Yorkshire & The Humber	1926	(3.4)
	East Midlands	1294	(2.3)
	North East	1454	(2.6)
	East of England	5589	(9.9)
	South West	7541	(13.4)
	South Central	7031	(12.5)
	London	7114	(12.6)
	South East Coast	7602	(13.5)
Charlson Index			
	0	13636	(24.2)
	1	12290	(21.8)
	2	9912	(17.6)
	3	7777	(13.8)
	4	5096	(9.0)
	≥5	7685	(13.6)

Table 2: Univariate and multivariate competing-risks regression analyses investigating the predictors of primary care consultation after hospitalisation for pneumonia in the first 30 days after discharge.

	Did not consult n (%)	Consulted n (%)	Univariate CRR sHR (95% CI)	Multivariate CRR sHR (95% CI)	p value
Number of patients	24854	31542			
Age					
18-49	4017 (48.9)	4191 (51.1)	1.00 Reference	1.00 Reference	
50-64	3755 (42.5)	5075 (57.5)	1.18 (1.13-1.23)	1.08 (1.04-1.13)	*<0.001
65-74	4277 (40.7)	6222 (59.3)	1.24 (1.19-1.28)	1.08 (1.03-1.12)	*<0.001
75-84	6459 (42.2)	8858 (57.8)	1.21 (1.16-1.25)	1.03 (0.99-1.07)	0.161
≥85	6346 (46.9)	7196 (53.1)	1.10 (1.06-1.14)	0.95 (0.91-0.99)	*0.018
Gender					
Male	12277 (43.8)	15725 (56.2)	1.00 Reference	1.00 Reference	
Female	12577 (44.3)	15817 (55.7)	0.99 (0.96-1.01)	0.99 (0.97-1.01)	0.32
Smoking status					
Never	8036 (45.5)	9634 (54.5)	1.00 Reference	1.00 Reference	
Ex	5970 (42.3)	8149 (57.7)	1.08 (1.05-1.11)	1.03 (1.00-1.06)	*0.03
Current	9897 (43.1)	13061 (56.9)	1.06 (1.03-1.09)	1.03 (1.00-1.06)	*0.027
Unknown	951 (57.7)	698 (42.3)	-		
Alcohol status					
Non-drinker	5559 (44.2)	7016 (55.8)	1.00 Reference		
Former drinker	1164 (41.1)	1667 (58.9)	1.08 (1.03-1.14)		
Occasional drinker	3276 (42.4)	4454 (57.6)	1.04 (1.00-1.08)		
Moderate drinker	7717 (42.4)	10499 (57.6)	1.03 (1.00-1.06)		
Heavy drinker	2896 (44.2)	3663 (55.8)	0.98 (0.94-1.02)		
Unknown	4242 (50.0)	4243 (50.0)	-		
CAP admission year					
2002/03-2004/05	3296 (44.6)	4094 (55.4)	1.00 Reference	1.00 Reference	
2005/06-2006/07	2650 (41.3)	3764 (58.7)	1.09 (1.05-1.14)	1.03 (0.99-1.08)	0.144
2007/08-2008/09	3387 (42.5)	4576 (57.5)	1.05 (1.01-1.09)	0.98 (0.94-1.02)	0.256
2009/10-2010/11	4157 (43.7)	5357 (56.3)	1.03 (0.98-1.07)	0.95 (0.91-0.99)	*0.008
2011/12-2012/13	4416 (43.6)	5717 (56.4)	1.04 (1.00-1.08)	0.95 (0.91-0.99)	*0.014
2013/14-2014/15	3984 (44.1)	5042 (55.9)	1.04 (1.00-1.08)	0.95 (0.91-0.99)	*0.015
2015/16-2016/17	2964 (49.8)	2992 (50.2)	0.88 (0.84-0.93)	0.82 (0.79-0.87)	*<0.001
Length of stay					
≤3	7694 (44.9)	9455 (55.1)	1.00 Reference	1.00 Reference	
4-7	6351 (42.1)	8743 (57.9)	1.07 (1.04-1.10)	1.04 (1.01-1.07)	*0.019
>7	10809 (44.8)	13344 (55.2)	1.03 (1.01-1.06)	1.00 (0.97-1.02)	0.852
Primary care consultations in the previous year					
0	358 (91.1)	35 (8.9)	1.00 Reference	1.00 Reference	
<5	1108 (61.3)	700 (38.7)	5.31 (3.77-7.48)	5.11 (3.63-7.21)	*<0.001
5-15	4039 (50.7)	3931 (49.3)	7.27 (5.20-10.16)	7.05 (5.04-9.87)	*<0.001
>15	19349 (41.9)	26876 (58.1)	9.30 (6.66-12.99)	8.98 (6.42-12.55)	*<0.001

IMD (patient level)							
1 (least deprived)	4617 (43.6)	5979 (56.4)	1.00	Reference	1.00	Reference	
2	5038 (44.2)	6369 (55.8)	0.98	(0.94-1.01)	0.96	(0.93-0.99)	*0.019
3	5116 (43.0)	6793 (57.0)	1.01	(0.98-1.04)	0.99	(0.96-1.03)	0.585
4	5053 (44.9)	6210 (55.1)	0.95	(0.92-0.99)	0.93	(0.90-0.96)	*<0.001
5 (most deprived)	5002 (44.8)	6169 (55.2)	0.96	(0.93-0.99)	0.91	(0.88-0.94)	*<0.001
Unknown	28 (56.0)	22 (44.0)	0.73	(0.48-1.10)	0.78	(0.51-1.18)	0.237
Practice region							
West Midlands	2878 (41.2)	4112 (58.8)	1.00	Reference	1.00	Reference	
North West	4160 (42.2)	5695 (57.8)	0.97	(0.93-1.01)	0.98	(0.94-1.02)	0.245
Yorkshire & The Humber	857 (44.5)	1069 (55.5)	0.89	(0.84-0.95)	0.89	(0.83-0.95)	*<0.001
East Midlands	533 (41.2)	761 (58.8)	1.00	(0.92-1.07)	1.01	(0.93-1.09)	0.846
North East	568 (39.1)	886 (60.9)	1.05	(0.98-1.12)	1.05	(0.98-1.13)	0.154
East of England	2246 (40.2)	3343 (59.8)	1.03	(0.99-1.08)	1.04	(0.99-1.08)	0.12
South West	3268 (43.3)	4273 (56.7)	0.93	(0.89-0.97)	0.92	(0.89-0.96)	*<0.001
South Central	3116 (44.3)	3915 (55.7)	0.91	(0.87-0.95)	0.90	(0.86-0.94)	*<0.001
London	3492 (49.1)	3622 (50.9)	0.80	(0.77-0.84)	0.83	(0.79-0.86)	*<0.001
South East Coast	3736 (49.1)	3866 (50.9)	0.80	(0.77-0.84)	0.81	(0.77-0.85)	*<0.001
§ Charlson Comorbidity Index							
0	6590 (48.3)	7046 (51.7)	1.00	Reference	1.00	Reference	
1	5488 (44.7)	6802 (55.3)	1.10	(1.06-1.13)	0.99	(0.96-1.02)	0.562
2	4387 (44.3)	5525 (55.7)	1.11	(1.07-1.15)	0.98	(0.95-1.02)	0.42
3	3279 (42.2)	4498 (57.8)	1.18	(1.14-1.23)	1.04	(1.00-1.08)	*0.047
4	2078 (40.8)	3018 (59.2)	1.23	(1.18-1.28)	1.08	(1.03-1.13)	*0.001
≥5	3032 (39.5)	4653 (60.5)	1.28	(1.24-1.33)	1.14	(1.09-1.18)	*<0.001
Co-morbidities							
COPD	4666 (39.5)	7132 (60.5)	1.14	(1.12-1.17)	1.05	(1.01-1.08)	*0.003
Asthma	5351 (40.1)	7996 (59.9)	1.12	(1.09-1.15)	1.06	(1.03-1.08)	*<0.001
‡Chronic lung disease	391 (43.6)	505 (56.4)	1.00	(0.92-1.09)			
Congestive cardiac failure	2251 (39.8)	3397 (60.2)	1.15	(1.11-1.19)	1.14	(1.10-1.18)	*<0.001
Myocardial infarction	2125 (40.3)	3143 (59.7)	1.12	(1.08-1.17)	1.10	(1.06-1.15)	*<0.001
#Other cardiac diseases	9755 (41.8)	13571 (58.2)	1.11	(1.08-1.13)	1.11	(1.09-1.14)	*<0.001
Malignancy	5231 (42.2)	7166 (57.8)	1.07	(1.04-1.10)			
Chronic renal disease	4624 (42.1)	6350 (57.9)	1.08	(1.06-1.11)			
Cerebrovascular disease	3806 (40.5)	5584 (59.5)	1.12	(1.09-1.15)			
Diabetes mellitus	2701 (42.4)	3676 (57.6)	1.07	(1.03-1.11)	1.04	(1.01-1.07)	*0.009
Cognitive impairment	2725 (46.7)	3109 (53.3)	0.97	(0.94-1.01)			
Liver disease	213 (40.1)	318 (59.9)	1.09	(0.98-1.21)			

* signify a p value of <0.05

‡Chronic lung disease excluding COPD and asthma

Other cardiac diseases excluding CCF and MI (e.g. hypertension, arrhythmias, valvular heart disease, conduction disorder of the heart, pericarditis, myocarditis)

§ Charlson Comorbidity Index was added to a separate multivariate model with all the listed variables except specific co-morbidities

Table 3: Reasons for GP consultation after hospital discharge

Reason for consultation*	All patients who consulted		Patients who consulted before readmission ^a		Patients who consulted before death ^b	
	≤ 7 days N= 15,626 n (%)	≤30 days N= 31,542 n (%)	≤ 7 days N=648 n (%)	≤30 days N=3,459 n (%)	≤ 7 days N=633 n (%)	≤30 days N=2,077 n (%)
Respiratory (all)	6155 (39.4)	12840 (40.7)	253 (39.0)	1350 (39.0)	158 (25.0)	741 (35.7)
specifically pneumonia	2470 (15.8)	3730 (11.8)	71 (11.0)	293 (8.5)	87 (13.7)	312 (15.0)
Digestive	1196 (7.7)	3316 (10.5)	60 (9.3)	439 (12.7)	27 (4.3)	183 (8.8)
Cardiac	1139 (7.3)	2732 (8.7)	50 (7.7)	274 (7.9)	58 (9.2)	209 (10.1)
Genitourinary	466 (3.0)	1629 (5.2)	26 (4.0)	179 (5.2)	16 (2.5)	76 (3.7)
Cognitive	191 (1.2)	558 (1.8)	12 (1.9)	53 (1.5)	16 (2.5)	78 (3.8)
Constitutional symptoms	379 (2.4)	1240 (3.9)	16 (2.5)	162 (4.7)	15 (2.4)	84 (4.0)

* only Read codes referring to acute symptoms and disorders were included, such as acute cough, acute atrial fibrillation or worsening cognitive impairment; excluding routine reviews for chronic conditions, or routine post-discharge consultations

^a Readmission within 30 days of discharge

^b Death within 30 days of discharge

Note: The same patient could fall into multiple categories for 'Reason for consultation'

Table 4: Antibiotic prescription at consultation

	≤ 7 days n (%)	≤ 30 days n (%)
Frequency of antibiotic courses		
None	12919 (82.7)	21719 (68.9)
One course	2582 (16.5)	7587 (24.0)
Two or more courses	125 (0.8)	2236 (7.1)
Total #	15626 (100.0)	31542 (100.0)
Type of antibiotics		
Penicillin	1352 (41.9)	5753 (41.6)
Macrolide	830 (25.7)	3029 (21.9)
Tetracycline	352 (10.9)	1467 (10.6)
Quinolones	220 (6.8)	875 (6.3)
Others	474 (14.7)	2705 (19.6)
Total*	3228 (100.0)	13829 (100.0)

counted by number of people

* counted by number of antibiotic courses

The total for 'Type of antibiotics' do not match one or more courses of antibiotics prescribed due to difference in the way the count was done as listed above.

Competing interests

Professor Lim reports grants from National Institute for Health Research (NIHR), grants from Pfizer, outside the submitted work.

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Statement of Contributorship

All included authors fulfil the criteria of authorship; VB, RH, TM and WSL had substantial contributions to the study conception and design. VB, FP, TM and WSL had substantial contributions to the data acquisition, analysis, and interpretation for the study. VB, TM and WSL wrote the original draft. All authors revised the manuscript critically for important intellectual content, provided the final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Ethical approval

Access to CPRD GOLD and linked datasets were provided after approval by MHRA Independent Scientific Advisory Committee (ISAC) (study protocol number: 18_178A).

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