FEV₁ (% predicted) between 18–21 years. While there was some evidence of special cause variation (at 2SD limits) in prior to case-mix adjustment, after adjustment none were outside the 2SD limits. None of the centres were outside the 3SD limits in either analysis.

Conclusion In conclusion the work to-date illustrates that funnel plots can be used to explore potential differences in FEV₁ between specialist centres. Case-mix adjustment models should develop into a useful tool for making centre comparisons which can continue to be used by stakeholders. This is early work, however, and we need to bear in mind that by examining outcomes in small populations risk missing true differences due to low statistical power. Further work is required to assess whether any observed differences are due to chance or are related to the care patients receive.

P221 EVALUATION OF EXACERBATION FREQUENCY AND RE-HOSPITALISATION, AND RISK FOR SUBSEQUENT EXACERBATIONS IN ASTHMA PATIENTS IN A UK PRIMARY CARE SETTING

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Introduction and objective Exacerbations occur in all asthma patients but disproportionately impact those with more severe disease. This study aimed to describe the frequency of exacerbations by asthma severity and the risk for future exacerbation.

Methods In a retrospective cohort of asthma patients in the CPRD (2009–2011), we defined asthma severity based on asthma medication use and exacerbation history; index date was asthma medical code date. Asthma severity was determined by asthma medication use and exacerbation history during the 12 months preceding the index date. Exacerbations were ascertained during the 12-month follow-up period and were defined as an asthma-related accident and emergency (A&E) department visit or hospitalisation, or any oral corticosteroid (OCS) prescription with an asthma medical code recorded within ± 2 weeks. A proportional hazard model was developed to evaluate the risk for subsequent exacerbations associated with the type of exacerbation (OCS vs. ED/hospitalisation).

Results A total of 211,807 patients with asthma were identified in CPRD during the study period. The mean age was 45 years and females made up 58% of the study population. Of these patients, 17,785 (8.4%) and 3,592 (1.7%) experienced ≥ 1 and ≥ 2 exacerbations, respectively during the follow-up period. The proportion of patients experiencing ≥ 1 or ≥ 2 exacerbations increased with severity and prior exacerbation frequency (Table 1). Among 1,900 patients with an asthma-related hospitalisation, 2.3%, 3.3%, and 3.8% experienced asthma-related readmissions within 30-, 60-, and 90-days, respectively. When limited to patients with more severe disease, the readmission rates increased significantly, up to three times in those with a history of ≥ 2 exacerbations. Compared to an OCS defined exacerbation, an A&E visit or hospital admission was associated with a 30% greater risk for any subsequent exacerbation (HR = 1.3, 95% CI 1.15–1.44), after adjusting for gender, disease severity, atopy, and exacerbation history.

Conclusion Asthma exacerbations remain a burden for patients with severe asthma or a history of frequent exacerbations. Additionally, patients should be managed carefully after an asthma exacerbation as they are at higher risk for subsequent exacerbations and readmission. (GSK-funded; WEUSKOP7092).

P222 RATES OF HOSPITALISATION AFTER DIAGNOSIS OF LUNG CANCER: A LINKED AUDIT AND HOSPITAL EPISODE STATISTICS STUDY

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Much of the research in lung cancer is concerning survival or treatment rates and little is known about the rate of hospitalisation (emergency/elective) following the diagnosis of lung cancer.

Newly diagnosed English patients from the National Lung Cancer Audit database (NLCA), 2007–2011, were linked with Hospital Episode Statistics (HES) data to provide details on their subsequent hospital admissions. Hospitalisations for receipt of chemotherapy or cardiothoracic surgery were excluded to ensure only non-treatment related admissions were included. We only included patients included who survived at least 30 days after their first presentation to a physician to exclude more advanced disease. We calculated rates and rate ratios (RR) of elective and emergency admissions per person-year (ppy) by patient features including sex, age, performance status and co-morbidity.

Among 92,482 patients, there were 261,121 non-treatment related hospitalisations with rate of 2.92 admissions ppy (95% CI, 2.91–2.93). Emergency admissions constituted 57% of all admissions at a rate of 1.66 admissions ppy while the elective admission rate was lower at 1.26 admission ppy. Adjusted RRs in Table 1 show that males were approximately 20% more likely than females to be admitted through either route (RR 1.17, 95% CI 1.16 – 1.18 for emergency and 1.20 (1.18–1.21) for elective). Worsening performance status, co-morbidity and advanced stage were all associated with higher emergency admissions while there was no strong association with age. For elective admissions pattern were similar yet associations were weaker and performance status did not show a linear association with admissions. Increasing socioeconomic deprivation was associated with a moderate increase emergency admission rates but a decrease elective admission rates.

The rate of emergency admissions was higher than the rate of elective admissions following diagnosis of lung cancer. Sex, worsening performance status, advanced stage and co-morbidity were all independently associated with admissions with similar patterns for emergency and elective admissions. However, being from a more deprived socioeconomic class was associated with more emergency admissions and fewer elective admissions. Reason for these findings could be related to variation in receiving treatment in these groups or treatment related side effects leading to more emergency admissions.

P223 VALIDITY AND INTERPRETATION OF SPIROMETRY FOR PATIENTS IN PRIMARY CARE

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Background Previous studies have questioned the validity and interpretation of spirometry undertaken in primary care. Knowing that data are accurate is important as many respiratory diseases are diagnosed and managed in primary care. Additionally researchers use data entered into electronic health records both

Abstract P222 Table 1 Rate of emergency and elective admissions following lung cancer diagnosis per person year (n = 261,121 admissions)

	Emergency Admissions		Elective Admissions	
	Rate per person year (95% CI)	Adjusted Rate Ratio (95% CI) [†]	Rate per person year (95% CI)	Adjusted Rate Ratio (95% CI) [†]
Overall	1.66 (1.65–1.67)		1.26 (1.25–1.27)	
Sex				
Female	1.52 (1.51–1.53)	1	1.13 (1.12–1.14)	1
Male	1.78 (1.77–1.79)	1.17 (1.16–1.18)	1.37 (1.36–1.38)	1.20 (1.18–1.21)
Age				
<65	1.66 (1.65–1.68)	1	1.38 (1.37–1.39)	1
65–75	1.61 (1.59–1.62)	0.97 (0.94–0.99)	1.30 (1.29–1.32)	0.93 (0.92–0.95)
>75	1.70 (1.69–1.72)	0.96 (0.93–0.99)	1.08 (1.07–1.09)	0.78 (0.77–0.79)
Performance Status				
0	1.13 (1.11–1.14)	1	1.10 (1.08–1.11)	1
1	1.64 (1.63–1.66)	1.28 (1.26–1.30)	1.34 (1.33–1.36)	1.16 (1.15–1.18)
2	2.44 (2.41–2.47)	1.73 (1.70–1.76)	1.48 (1.46–1.50)	1.26 (1.23–1.28)
3	3.27 (3.22–3.33)	2.26 (2.21–2.30)	1.00 (0.97–1.03)	0.85 (0.82–0.88)
4	3.59 (3.44–3.74)	2.38 (2.28–2.49)	0.80 (0.73–0.87)	0.67 (0.61–0.73)
Missing	1.49 (1.47–1.50)	1.26 (1.24–1.29)	1.27 (1.26–1.29)	1.13 (1.11–1.15)
Stage				
IA-IB	0.73 (0.72–0.74)	1	0.84 (0.83–0.85)	1
IIA-IIIB	1.02 (1.00–1.05)	1.37 (1.33–1.41)	0.99 (0.97–1.01)	1.15 (1.12–1.18)
IIIA	1.56 (1.53–1.58)	2.01 (1.97–2.06)	1.30 (1.28–1.33)	1.49 (1.46–1.52)
IIIB	2.09 (2.06–2.12)	2.68 (2.63–2.74)	1.51 (1.48–1.54)	1.72 (1.69–1.76)
IV	3.14 (3.11–3.17)	3.69 (3.62–3.76)	1.64 (1.62–1.66)	1.78 (1.75–1.82)
SCLC Limited	1.79 (1.75–1.84)	2.37 (2.30–2.44)	1.57 (1.53–1.61)	1.78 (1.72–1.83)
SCLC Extensive	3.64 (3.57–3.72)	4.23 (4.12–4.34)	2.16 (2.10–2.22)	2.25 (2.18–2.32)
SCLC Unknown	1.54 (1.52–1.55)	1.99 (1.95–2.03)	1.27 (1.25–1.28)	1.43 (1.41–1.46)
Comorbidity				
0	1.36 (1.34–1.37)	1	1.12 (1.11–1.14)	1
1	1.52 (1.50–1.54)	1.12 (1.11–1.14)	1.07 (1.05–1.08)	1.00 (0.98–1.01)
2–3	1.61 (1.59–1.63)	1.16 (1.15–1.18)	1.28 (1.27–1.30)	1.22 (1.20–1.24)
4+	2.62 (2.59–2.64)	1.52 (1.50–1.54)	1.79 (1.77–1.81)	1.50 (1.48–1.53)
Townsend quintile of socioeconomic status				
1 (Least deprived)	1.53 (1.51–1.55)	1	1.42 (1.40–1.44)	1
2	1.56 (1.54–1.58)	1.01 (0.99–1.03)	1.23 (1.21–1.25)	0.86 (0.85–0.88)
3	1.65 (1.63–1.67)	1.06 (1.04–1.07)	1.32 (1.31–1.34)	0.93 (0.91–0.94)
4	1.68 (1.66–1.70)	1.08 (1.06–1.10)	1.21 (1.19–1.22)	0.85 (0.83–0.87)
5	1.75 (1.73–1.77)	1.08 (1.07–1.10)	1.14 (1.13–1.16)	0.79 (0.77–0.80)

[†]Rate Ratios adjusted for sex, age, performance status, stage, co-morbidity and socioeconomic quintile.

as single measurements and to track changes in lung function over time. We aimed to determine whether spirometry undertaken in primary care for patients suspected to have COPD was of sufficient quality, and was correctly interpreted.

Methods As part of previous studies to validate the recording of COPD diagnosis and exacerbations of COPD in the clinical practice research datalink (CPRD) we obtained additional information from GPs which included spirometry traces. In this subset, a respiratory physician assessed spirometry traces for: 1) quality and 2) diagnostic interpretation. We used logistic regression to assess predictors of GPs interpretation of spirometric traces with the outcome of COPD diagnosis confirmed by respiratory physician adjudication of spirometry traces as correct and age, sex and previous record for asthma as covariates.

Results We obtained spirometry traces for 306 patients, of which 221 (72.2%) were conducted in primary care. 96.5% of traces were of adequate quality such that a valid interpretation could be made. Of those traces which were of adequate quality and conducted in primary care, and in whom a GP diagnosis of COPD had been made (N = 218), 73.4% showed obstruction, suggestive of COPD (Table 1). There was some evidence that

correct interpretation of spirometry (either as obstructive, restrictive or normal) was influenced by a previous asthma diagnosis (OR 0.49, 95% CI 0.26–0.93). There was no evidence that correct interpretation was modified by age (OR 0.98, 0.96–1.01) or sex (OR 1.28, 0.69–2.38).

Abstract P223 Table 1 Interpretation of spirometry for patients diagnosed with COPD in primary care (N = 218)

Respiratory physician spirometry interpretation	N (%)
Normal	50 (22.9%)
Obstructive	158 (72.5)
Restrictive	8 (3.7)
Mixed obstructive and restrictive	2 (0.9%)

Conclusions Spirometry is performed in primary care to a high standard. Interpretation in patients with suspected COPD in primary care is moderate. Efforts should be made to improve spirometry interpretation for high quality patient care, and for research. As quality of spirometry measurements were high, researchers could use actual recorded values of FEV₁ and FVC,

however should exercise caution with using interpretation of spirometry values documented in primary care records.

P224 THE ASSOCIATION BETWEEN DEGREE OF AIRFLOW LIMITATION AND DEGREE OF CORONARY ARTERY ATHEROMA IS NOT ATTRIBUTABLE TO SMOKING HISTORY

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Introduction Prevalence of coronary artery disease (CAD) in chronic obstructive pulmonary disease (COPD) is 16–53% (Smith and Wrobel. *Int J Chron Obstruct Pulmon Dis*. 2014;9:871–888), with ~25% COPD patients dying from cardiovascular disease. Diverse studies demonstrate ~2-fold increased risk of CAD in COPD after adjustment for known cardiovascular risk factors. By contrast, in asthma increased CAD risk appears to be restricted to smokers (Colak *et al*. *Am J Respir Crit Care Med*. 2015 Apr 27). Our objectives were to investigate the association between airflow limitation and severity of coronary artery atheroma in patients undergoing coronary angiography and to determine the effect of smoking on this relationship.

Methods Patients attending for elective coronary angiography March–July 2015 underwent clinical assessment and spirometry prior to the procedure. Coronary artery disease burden was quantified from angiograms using the Gensini score (Needland *et al*. *Am Heart J* 164:547–552). A single rater (Professor of Interventional Cardiology), blinded to clinical diagnosis, determined number and severity of lesions. Blinded repeats were performed and ratings compared to clinical reports to ensure reliability. A nonlinear score was assigned to each lesion based on the severity of stenosis and a multiplier applied depending on lesion location in the coronary tree. Lesion scores were summed to derive total score, which was log-transformed for analysis.

Results 233 people (age 66 ± 10 years (mean $\pm$ SD), 69% male) had FEV₁ $82 \pm 21\%$ predicted, FVC $89 \pm 21\%$ predicted, FEV₁:FVC ratio $73 \pm 10\%$, Gensini median score 14 (IQR 6–33). On univariate analysis (Table 1), FEV₁ and FEV₁:FVC were significantly and inversely correlated with Gensini score, but Gensini was not significantly associated with smoking status or pack year load. On multivariate analysis, neither airflow limitation nor smoking were significant determinants of Gensini.

Conclusions People with more severe airflow limitation have more coronary atheroma, but smoking does not appear to be a direct determinant of this relationship. Shared comorbid disease (e.g. dyslipidaemia) between COPD and CAD may be more important than smoking in determining the association, supporting the hypothesis that COPD and CAD are part of a multi-morbid disease complex.

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Abstract P224 Table 1 Univariate and multivariate relationships between log Gensini score, lung function and clinical variables

Pearson's correlation	Univariate analysis		Multivariate analysis (ANOVA)	
	R value	P value	Partial eta ²	P value
FEV ₁ % predicted	-0.149	0.036	0.01	0.191
FVC predicted	-0.116	0.105		
FEV ₁ :FVC	-0.157	0.027	0.000	0.964
Age	0.192	0.007	0.003	0.475
Waist to hip ratio	0.129	0.071		
Body mass index	-0.157	0.027	0.006	0.291
Systolic blood pressure	0.052	0.469		
Diastolic blood pressure	-0.056	0.436		
LDL cholesterol	0.145	0.049	0.049	0.003
HbA _{1c}	0.053	0.705		
Creatinine	0.165	0.02	0.002	0.518
hsCRP	-0.022	0.759		
Fibrinogen	0.078	0.285		
Charlson index	0.231	0.001	0.017	0.086
Pack year smoking history	0.080	0.259	0.000	0.795
Number of chest infections in last year	-0.141	0.047	0.012	0.152
ANOVA (categorical variables)	F statistic	P value		
Gender	8.6	0.004	0.035	0.013
Ever smoked	1.4	0.261		
Childhood respiratory illness	0.6	0.432		
Recurrent chest infections	3.0	0.084		

FEV₁, forced expiratory volume in 1 s; FVC, forced vital capacity; LDL, low density lipoprotein; HbA_{1c}, glycated haemoglobin; hsCRP, high sensitivity C reactive protein; ANOVA, analysis of variance.

P225 IDENTIFYING ASTHMA PATIENTS IN WALES USING LATENT CLASS ANALYSIS OF ROUTINE DATA

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Background The Wales Asthma Observatory aims to produce current estimates of asthma prevalence and disease burden using routine data. In the absence of a feasible gold standard to validate case definitions, latent class analysis (LCA) can be employed.

Objectives To estimate the prevalence of treated asthma in Wales using LCA of routine health data.

Methods We performed LCA using observed variables of asthma-related healthcare diagnostics and utilisation in the fiscal year 2011–2012 for a random sample of 98,042 individuals in the Secure Anonymised Information Linkage (SAIL) databank. The observed variables were chosen if they exhibited expected distributions. Diagnostic performance of each of the observed variables was calculated. The model was tested for stability over multiple time windows and small area configurations. Since COPD can be misdiagnosed as asthma, a separate LCA was performed to identify COPD patients and cross-validate the asthma model.