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Chronic respiratory disease and multimorbidity: Prevalence and impact in a general practice setting

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Summary
Background: Multimorbidity is defined as two or more co-existing chronic conditions in an individual and is common in general practice. It is associated with poorer outcomes for patients. This study aimed to establish the prevalence of multimorbidity in patients with chronic respiratory disease in general practice and to describe its impact on health service use.
Methods: Cross-sectional study based in general practice in Dublin. Drug and disease code searches were performed to identify adult patients with a diagnosis of chronic respiratory disease. Medical records were reviewed for chronic respiratory diagnosis, other chronic conditions, demographic characteristics, General Practitioner (GP) and practice nurse utilisation rates, and numbers of medications.
Results: In a general practice population of 16,946 patients 3.9% had chronic respiratory disease and 60% of these had one or more co-existing chronic condition(s). GP and practice nurse utilisation rates, and number of medications were significantly higher among those with multimorbidity compared with those with respiratory disease alone. Multivariate analysis showed that increasing age and low socio-economic status were significantly associated with multimorbidity.
Conclusion: The majority of patients with chronic respiratory disease have multimorbidity. Clinical guidelines based on single disease entities and outcomes are not as easy to implement and may not be as effective in this group.

Introduction

Multimorbidity has been defined as two or more co-existing chronic conditions within an individual.[1–3] It is of particular relevance for patients, their carers and healthcare providers as previous studies have shown an inverse relationship between increasing numbers of co-existing diseases and health-related quality of life.[4–6] Qualitative

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work has established that the main concerns for patients with multimorbidity are loss of function, polypharmacy, a negative effect on their well-being and relationships, and difficulties with co-ordination of their care.[7,8]

Previous studies have demonstrated high levels of co-existing disease among those with chronic respiratory disease, although most have limited the conditions studied to a pre-defined list.[9–13] The presence of co-existing conditions in patients with chronic respiratory disease has been shown to reduce health-related quality of life,[14] reduce the potential benefits of rehabilitation,[15] and contribute to mortality.[16,17]

Managing the health needs of patients with multimorbidity is an integral part of routine general practice. However, there has been relatively little published research on the subject to date.[18] Chronic respiratory disease is among the most prevalent conditions in the literature on multimorbidity.[1,2]

The aim of this study was to establish the prevalence of multimorbidity in adult patients with chronic respiratory disease in general practice, categorise the number and types of additional chronic conditions recorded, and to describe demographic characteristics, GP and practice nurse utilisation rates and numbers of medications in adult patients with chronic respiratory disease with and without multimorbidity.

Methodology

Study design

Cross-sectional descriptive study based on a review of medical records by a clinical (GP) research fellow in three general practice populations.

Setting

The study was based in three general practices in urban areas in Dublin. The structure of Irish general practice is outlined in Fig. 1 and further details are available elsewhere.[19] The practices used in this study were selected from the Trinity College Dublin network of research and teaching practices. The proportion of patients qualifying for free medical care under the General Medical Services (GMS) scheme was similar in the study practices and representative of the general population.

Primary healthcare services are free through the General Medical Services (GMS) scheme to the poorest 30% of the population. Eligibility is means-tested based on the total income in a household. At the time of the study primary care services were also free for those aged 70 years or older (from January 2001 – December 2008). Secondary care is free for all patients.
Registration with a practice is only required if in GMS scheme; there is extensive use of computes in practices though few have disease registers; there are no specific financial incentives for operating recall systems to monitor quality of care
Free prescriptions only available within GMS scheme; others pay full costs of medicines up to monthly limit of €100 per family

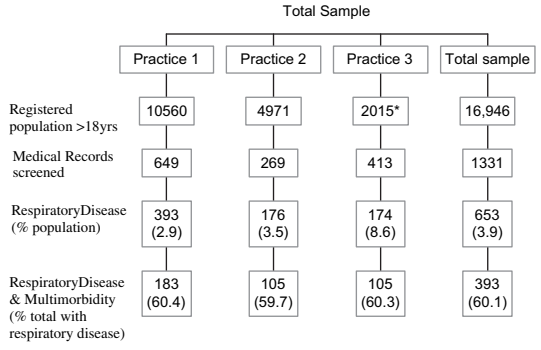
Figure 1 Description of healthcare system in the Republic of Ireland.

Patient identification

Disease code and drug searches were undertaken by the GP researcher within the computerised database in each practice. The disease code search identified patients registered with four codes from the International Classification of Primary Care (ICPC),[20]: chronic bronchitis, chronic obstructive pulmonary disease, asthma and "respiratory disease other". Codes for acute respiratory events and lung cancer were not included. The research group which includes three general practitioners and a consultant respiratory physician devised a list of the most commonly used respiratory-specific drugs. The drug list consisted of the following groups: Beta$_2$-agonists, inhaled steroids, xanthines, sodium cromoglycate, montelukast, anticholinergics, and combination preparations. The database in each practice was used to search for patients who had been prescribed any of the listed drugs at least once and at any time on record. The records of all patients on this database were searched to confirm the presence of chronic respiratory disease and to identify other chronic conditions. In this way, a register of individuals with chronic respiratory disease and a sub-register of those with multimorbidity were created in each practice. Having completed the searches in Practices 1 and 2 and identified a prevalence of chronic respiratory disease of approximately 3%, a power calculation was performed to estimate the sample size of charts to be screened in Practice 3 in order to ensure detection of a similar prevalence with a margin of $\pm$ 1%. This indicated that 1825 charts needed to be screened. As Practice 3 had 4030 potential charts, half were randomly selected by screening every second chart. (See Fig. 2) Where a patient had documented chronic bronchitis, or both asthma and chronic obstructive pulmonary disease (COPD) were documented in the patient record they were classified as having COPD.

Data collection

The GP researcher extracted data from medical records on age, sex, socio-economic status, chronic respiratory diagnosis, any other chronic conditions recorded, number of attendances with a doctor or practice nurse in the previous twelve months and the number of regular medications



* Every second chart was screened in Practice 3, therefore the practice population used was halved.

Figure 2 Prevalence of chronic respiratory disease in participating practices.

recorded in the medical records. This data was collected between October 2008 and April 2009 and anonymised.

Analysis

Univariate analyses were performed with Pearson χ^2 statistics. Multivariate analyses were performed using multiple logistic regression models with goodness of fit measured using the Hosmer–Le Cessie test.[21] Age, gender and socio-economic status were included in the multivariate model irrespective of their statistical significance. All those aged 70 years or more were entitled to free medical care under the GMS scheme and therefore this could not be used as an indicator for low socio-economic status in this age group. Analysis regarding socio-economic status was therefore restricted to patients under 70 years of age. Comparisons of utilisation rates and medications between those with and without multimorbidity were tested for significance using the Wilcoxon test.[22]

Results

The drug code and drug searches resulted in a total of 1331 records for screening. Six hundred and fifty three had chronic respiratory disease and of these, 393 (60%) had multimorbidity. (See Fig. 2)

As expected, the percentage of patients with multimorbidity increased with age. (See Table 1) Among those with chronic respiratory disease aged 18–29 years, 27% (41/150) of patients have multimorbidity compared to 90% (86/96) in those aged over 70. Twenty four percent (159/653) of the total sample with chronic respiratory disease had one additional chronic condition, 20% (130/653) had two additional chronic conditions, and 16% (104/653) had 3 or more additional conditions. There was a higher prevalence of multimorbidity among female patients and those with lower socio-economic status. (See Table 2)

Asthma was the most commonly documented respiratory diagnosis in this study, making up two-thirds of the total sample, and 54% of those with respiratory disease and multimorbidity. The proportion of patients with multimorbidity was higher among those with COPD than those with asthma or other respiratory diagnosis (see Table 3)

Univariate analysis identified significantly higher rates of multimorbidity in females, patients with low socio-economic status, and increasing age. In the multivariate analysis all factors were significantly associated with multimorbdity. (See Fig. 3) A diagnosis of asthma or other chronic respiratory disease was not significantly associated with multimorbidity in the multivariate analysis indicating that the apparent higher rates of multimorbidity in those with COPD compared with asthma can be attributed to the older age of those with COPD. The goodness of fit of the multivariate model was adequate ($p = 0.41$).

The median number of regular medications, and median number of consultations with a GP or practice nurse in the previous 12 months were significantly higher among those with respiratory disease and multimorbidity versus those with respiratory disease alone. Of the total sample, 499 (76.4%) had no consultation with a practice nurse in the previous year, and 606 (92.8%) had consulted fewer than three times Table 4.

Details of the co-existing chronic conditions are outlined in Table 5 with depression, hypertension, cardiovascular disease and musculoskeletal disorders predominating. Depression and anxiety were counted as one condition, even where both were documented in a patient chart as it is generally accepted that there is clinical overlap in signs, symptoms and treatment. Where a patient had two distinct conditions within one category of conditions they were counted separately, for example peripheral vascular disease and heart failure or diverticulitis and gastro-oesophageal reflux disease.

Table 1 Numbers and proportion of patients with and without multimorbidity by age.

	RDA* (%)	RDM* (%)	Total number of patients
18–29 years	109 (73)	41 (27)	150
30–45 years	79 (50)	79 (50)	158
46–69 years	62 (25)	187 (75)	249
70 + years	10 (10)	86 (90)	96

RDA* Respiratory Disease Alone, RDM* Respiratory Disease + Multimorbidity.

Table 2 Socio-economic Status, Gender.

	RDA* (%) $n = 260$	RDM* (%) $n = 393$	Total $n = 653$
Low SES*	130 (50)	313 (79)	443 (68)
Female	148 (57)	259 (66)	407 (62)

RDA* Respiratory Disease Alone, RDM* Respiratory Disease + Multimorbidity Low SES* Low socio-economic status (entitled to GMS card as described in Fig. 1).

Discussion

This study indicated that 60% of patients with chronic respiratory disease identified in a general practice setting have multimorbidity. As far as we can ascertain this is the first paper based in primary care which has used chronic respiratory disease as the index condition and identified the prevalence of multimorbidity in this population. Strength of this approach is that it allows a comparison in patients with chronic respiratory disease between those with and without multimorbidity. Our results are higher than those found by previous studies in patients with chronic respiratory disease where a limited list of co-existing conditions was used.[9–13] Our results are also higher

Table 3 Chronic Respiratory Diagnoses.

Diagnosis	RDA* $n = 260$ (%)	RDM* $n = 393$	Total $n = 653$ (%)
Asthma	219 (84)	213 (54)	432 (66)
COPD	37 (14)	169 (43)	206 (32)
Other	4 (2)	11 (3)	15 (2)

RDA* Respiratory Disease Alone, RDM* Respiratory Disease + Multimorbidity.

		No.	N (%)		OR (95%CI)		p Value	OR (95%CI)		p Value	β
Intercept											-1.69
Sex							0.004			0.046	
	Male	204	96	(47.1)	1.00	(reference)		1.00	(reference)		
	Female	353	211	(59.8)	1.67	(1.18-2.37)		1.49	(1.01-2.22)		0.40
Low SES							<0.0001			<0.0001	
	No	208	78	(37.5)	1.00	(reference)		1.00	(reference)		
	Yes	349	229	(65.6)	3.18	(2.23-4.56)		2.32	(1.57-3.45)		0.84
Age							<0.0001			<0.0001	
	<30	150	41	(27.3)	1.00	(reference)		1.00	(reference)		
	30-39	110	47	(42.7)	1.98	(1.18-3.35)		2.11	(1.24-3.64)		0.75
	40-49	78	49	(62.8)	4.49	(2.53-8.13)		4.12	(2.29-7.57)		1.42
	50-59	116	86	(74.1)	7.62	(4.45-13.37)		6.41	(3.70-11.37)		1.86
	60-69	103	84	(81.6)	11.75	(6.48-22.21)		10.00	(5.44-19.19)		2.30

OR, odds ratio; CI, confidence interval; β, beta coefficient, SES, socio-economic status.

Figure 3 Factors associated with multimorbidity (patients aged < 70 years).

than those found by Van den Akker et al,[23] and lower than those found by Fortin et al,[1] in general practice settings. Fortin et al recruited consecutive consulting patients for the study, and therefore the prevalence of multimorbidity will be higher among this group compared with a population sample of patients registered in general practice.

Co-existing chronic conditions found in previous studies were similar to those found in this study, with cardiovascular disease, diabetes and hypertension among the most prevalent.[9–13] However, the majority of previous studies recording co-existing conditions have limited these to a list of pre-specified diseases such as cardiovascular disease and depression, with some including both acute and chronic conditions.

A limitation of this study is the lack of a control group without a respiratory condition for purposes of comparison of co-existing conditions, attendance rates, and numbers of medications. However, our findings can be compared with other primary care studies conducted in the area of multimorbidity. In the current study, the median number of GP visits among those with multimorbidity was 6 and with respiratory disease alone was 2. This can be compared with data from the Central Statistics Office in Ireland for 2007, which showed that the average number of consultations with a GP per person per year was 2.8 nationally.[24] Another Irish study in a younger, deprived population with at least three chronic conditions,[2] had a mean number of consultations in the previous twelve months of 7.2 in those with single morbidity and 11.6 in those with multimorbidity. A Dutch study compared the consultation rates among a general practice population and found a mean annual consultation rate among patients of 3.2[25] though this varied from 4.2 to 5.7 in patients with one of five selected chronic diseases and from 5.4 to 7.4 in patients with more than one of these diseases.

Table 4 Utilisation rates and medications.

Median (Interquartile range)	RDA*	RDM*	*p* Value
GP Visits in 1 year	2 (0—5)	6 (2—10.25)	$p < 0.0001$
Regular Medications	1 (0—2)	4 (2—8)	$p < 0.0001$

RDA* Respiratory Disease Alone, RDM* Respiratory Disease + Multimorbidity.

The median number of regular medications in the current study was 4 among those with multimorbidity and 1 among those with respiratory disease alone. In comparison, results from the Irish study of a younger more deprived group of patients showed that the mean number of medications was 7.3 in patients with multimorbidity, and was 2.3 among those with a single morbidity.[2]

Factors shown to have significant association with multimorbidity in multivariate analysis in the current study were: low socio-economic status, and increasing age. These findings are similar to the results from previous studies in general practice populations in Canada, the Netherlands, and Scotland.[1,3,26] Female gender has been found to be significant in some studies and not in others. In this study gender was not associated with multimorbidity when controlled for age and socio-economic status.

A limitation of this study is that it was carried out in three general practices in one country and consequently the findings may not be generalisable. There were differences between the practices in documentation, coding and prescribing. The proportion of those documented as having a chronic respiratory disease was significantly higher in Practice 3 when compared with Practices 1 and 2, however the proportion of patients with chronic respiratory disease and multimorbidity was consistent across the three practices. It may be that the prevalence of those documented as having chronic respiratory disease was higher in Practice 3 due to routine, weekly coding entries compared with opportunistic disease coding used in Practices 1 and 2. Under-diagnosis and misdiagnosis of chronic respiratory disease in general practice, particularly for COPD, have been well documented.[27–29] Reasons suggested for this include a nihilistic approach or attitude to COPD by medical practitioners, and under-presentation by patients of symptoms such as chronic cough or sputum production. Studies have also demonstrated under-use of spirometry in diagnosing respiratory disease in general practice.[30] There is also international variation in the incentives provided to GPs to diagnose and manage chronic respiratory disease and such incentivisation generally leads to better diagnosis.[31]

Table 5 Co-existing chronic conditions in patients with chronic respiratory disease and multimorbidity ($n = 393$).

Depression/Anxiety	28%	110
Hypertension	28%	107
Cardiovascular disease (includes cerebrovascular and peripheral vascular disease)	28%	96 patients with 1 condition 11 patients with 2 conditions 1 patient with 3 conditions
Musculoskeletal (includes osteoporosis)	23%	88 patients with 1 condition 1 patient with 2 conditions
Endocrine	20%	76 patients with 1 condition 1 patient with 2 conditions
Gastrointestinal	17%	55 patients with 1 condition 5 patients with 2 conditions 1 patient with 3 conditions
Substance Misuse	14%	54 patients with 1 condition 1 patient with 2 conditions
Hyperlipidaemia, Dermatological, Neurological, Malignancy	< 10%	
Other psychiatric disorder, Ophthalmological, Metabolic, Haematological, Renal disorder	< 4%	
HIV, Dementia, Benign Prostatic Hyperplasia, Connective Tissue Disorder, Obesity, Genetic Disorder, Multisystem Inflammatory Disorder	< 2%	

A second and important limitation is the lack of smoking data. Smoking status is an important potential confounding factor in the analysis of multimorbidity among patients with chronic respiratory disease. However, difficulties obtaining accurate smoking data in primary care settings have been highlighted in a report on the Quality and Outcomes Framework in the UK,[32] and smoking data is therefore not included in some studies on chronic respiratory disease.[33] Several other studies have also demonstrated a poor correlation between GP records and self-report on current smoking internationally.[34–36] None of the participating practices routinely record and update current smoking status at every visit. Therefore, we felt that extracting data from the records would not be accurate and as a result was not done.

When a patient is attending with one condition and has regular reviews with a GP are they more likely to be diagnosed with additional conditions? This is a difference with specialist medicine. The need for clarification and consensus on the definition of multimorbidity and constructs for the assessment of and management of multimorbidity has been highlighted in recently published work by Starfield et al.[37] There are definitional difficulties in distinguishing between co-morbidity and multimorbidity which will inevitably affect prevalence findings. In co-morbidity there are similar pathogenesis or risk factors, for example hypertension and cardiovascular disease. In multimorbidity there may be no common pathogenesis as for example in asthma and arthritis but there is overlap between the areas of co- and multimorbidity.

There is also the question of whether a co-existing condition is classified as a disease or as a risk factor. For example, hyperlipidaemia was included in this study as the diagnosis involves follow-up consultations, blood tests and may involve taking medication and fulfils the definition of a chronic disease as specified by the World Health Organisation (WHO) and is considered a unique condition within the ICPC coding system.[20] Inclusion of hyperlipidaemia did not alter the numbers of people with multimorbidity in this study but it did increase the overall number of conditions.

Deprivation has been shown to be associated with increased morbidity and mortality, greater numbers of psychological problems, shorter consultation times, and poorer access to health services and care.[38] Smoking rates are also higher among those in a lower socio-economic group.[39] which further contributes to increased morbidity and mortality, particularly for respiratory conditions. Due to their association with increased morbidity, smoking and deprivation could be considered as the equivalent of having additional health conditions in future work on multimorbidity.

Our results showed that multimorbidity is common among patients with chronic respiratory disease, and its presence has an impact on workload and numbers of prescribed medications. We need to incorporate the concept of multimorbidity into our chronic disease management programmes.[40] Potential solutions include the adoption of shared or collaborative care, though a Cochrane review of studies on shared care between primary and secondary care did not find evidence for any significant benefits of shared care over usual care other than improved prescribing.[41] An alternative model such as physician guided care has shown promising initial results in a recent US trial with improvements in patient and physician satisfaction with chronic care, a reduction in the number of admissions to hospital and days spent in hospital and a reduction in care giver strain and depression levels.[42–44] Respiratory disease is common in both primary and secondary care and it usually coexists with other illnesses. Effective management represents an important clinical challenge for both primary and secondary care physicians.

Ethical approval

The Research Ethics Committee of the Irish College of General Practitioners approved the study. Data on

individual patients of each participating GP (SOK, SMS and TOD) was collected and anonymised at practice level so no identifiable data left the clinical setting.

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Competing interests

None.

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References

1. Fortin M, Bravo G, Hudon C, Vanasse A, Lapointe L. Prevalence of multimorbidity among adults seen in family practice. *Ann Fam Med* 2005 May-Jun;**3**(3):223—8.
2. Smith SM, Ferede A, O'Dowd T. Multimorbidity in younger deprived patients: an exploratory study of research and service implications in general practice. *BMC Fam Pract* 2008;**9**(1):6.
3. Uijen AA, van de Lisdonk EH. Multimorbidity in primary care: prevalence and trend over the last 20 years. *Eur J Gen Pract* 2008;**14**(Suppl. 1):28—32.
4. Wang HM, Beyer M, Gensichen J, Gerlach FM. Health-related quality of life among general practice patients with differing chronic diseases in Germany: cross sectional survey. *BMC Public Health* 2008;**8**:246.
5. Fortin M, Bravo G, Hudon C, Lapointe L, Almirall J, Dubois MF, et al. Relationship between multimorbidity and health-related quality of life of patients in primary care. *Qual Life Res* 2006 Feb;**15**(1):83—91.
6. Fortin M, Dubois MF, Hudon C, Soubhi H, Almirall J. Multimorbidity and quality of life: a closer look. *Health Qual Life Outcomes* 2007;**5**:52.
7. Noel PH, Frueh BC, Larme AC, Pugh JA. Collaborative care needs and preferences of primary care patients with multimorbidity. *Health Expect* 2005 Mar;**8**(1):54—63.
8. Noel PH, Parchman ML, Williams Jr JW, Cornell JE, Shuko L, Zeber JE, et al. The challenges of multimorbidity from the patient perspective. *J Gen Intern Med* 2007 Dec;**22**(Suppl. 3): 419—24.
9. Ben-Noun L. Characteristics of comorbidity in adult asthma. *Public Health Rev* 2001;**29**(1):49—61.
10. Caughey GE, Vitry AI, Gilbert AL, Roughead EE. Prevalence of comorbidity of chronic diseases in Australia. *BMC Public Health* 2008;**8**:221.
11. Soriano JB, Visick GT, Muellerova H, Payvandi N, Hansell AL. Patterns of comorbidities in newly diagnosed COPD and asthma in primary care. *Chest* 2005 Oct;**128**(4):2099—107.
12. Van Manen JG, Bindels PJ, IJ CJ, van der Zee JS, Bottema BJ, Schade E. Prevalence of comorbidity in patients with a chronic airway obstruction and controls over the age of 40. *J Clin Epidemiol* 2001 Mar;**54**(3):287—93.
13. Barnes PJ, Celli BR. Systemic manifestations and co-morbidities of COPD. *Eur Respir J* 2009;**33**:1165—85.
14. Adams RJ, Wilson DH, Taylor AW, Daly A, Tursan d'Espaignet E, Dal Grande E, et al. Coexistent chronic conditions and asthma quality of life: a population-based study. *Chest* 2006 Feb;**129**(2):285—91.
15. Crisafulli E, Costi S, Luppi F, Cirelli G, Cilione C, Coletti O, et al. Role of comorbidities in a cohort of patients with COPD undergoing pulmonary rehabilitation. *Thorax* 2008 Jun;**63**(6):487—92.
16. Sin DD, Anthonisen NR, Soriano JB, Agusti AG. Mortality in COPD: Role of comorbidities. *Eur Respir J* 2006 Dec;**28**(6): 1245—57.
17. Hansell AL, Walk JA, Soriano JB. What do chronic obstructive pulmonary disease patients die from? A multiple cause coding analysis. *Eur Respir J* 2003 Nov;**22**(5):809—14.
18. Smith SM, O'Dowd T. Chronic diseases: what happens when they come in multiples? *Br J Gen Pract* 2007 Apr;**57**(537): 268—70.
19. O'Dowd T, O'Kelly M, O'Kelly F. *Structure of general practice in Ireland: 1982—2005*. Dublin: Irish College of General Practitioners, Trinity College Dublin; 2006.
20. O'Halloran J, Miller GC, Britt H. Defining chronic conditions for primary care with ICPC-2. *Fam Pract* 2004 Aug;**21**(4):381—6.
21. Hosmer DW, Hosmer T, le Cessie S, Lemeshow S. A comparison of goodness—of—fit tests for the logistic regression model. *Stat Med* 1997;**16**:965—80.
22. Bland M. *An introduction to medical statistics*. 3rd ed. Oxford: Oxford University Press; 2000.
23. Van den Akker M, Buntinx F, Metsemakers JF, Roos S, Knottnerus JA. Multimorbidity in general practice: prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. *J Clin Epidemiol* 1998 May;**51**(5): 367—75.
24. <www.cso.ie>. Central Statistics Office, Republic of Ireland.
25. Schellevis FG, Van de Lisdonk EH, Van der Velden J, Hoogbergen SH, Van Eijk JT, Van Weel C. Consultation rates and incidence of intercurrent morbidity among patients with chronic disease in general practice. *Br J Gen Pract* 1994 Jun;**44** (383):259—62.
26. Mercer SW, Watt GC. The inverse care law: clinical primary care encounters in deprived and affluent areas of Scotland. *Ann Fam Med* 2007 Nov-Dec;**5**(6):503—10.
27. Jeffreys LA, Clark AL, Koperski M. Practice nurses' workload and consultation patterns. *Br J Gen Pract* 1995 Aug;**45**(397): 415—8;
    Takahashi T, Ichinose M, Inoue H, Shirato K, Hattori T, Takishima T. Underdiagnosis and undertreatment of COPD in primary care settings. *Respirology* 2003 Dec;**8**(4):504—8.
28. Bednarek M, Maciejewski J, Wozniak M, Kuca P, Zielinski J. Prevalence, severity and underdiagnosis of COPD in the primary care setting. *Thorax* 2008 May;**63**(5):402—7.
29. Lindberg A, Jonsson AC, Ronmark E, Lundgren R, Larsson LG, Lundback B. Prevalence of chronic obstructive pulmonary disease according to BTS, ERS, GOLD and ATS criteria in relation to doctor's diagnosis, symptoms, age, gender, and smoking habits. *Respiration* 2005 Sep-Oct;**72**(5):471—9.
30. Diaz-Lobato S, Mayoralas S. Underuse of spirometry in primary care. *Chest* 2004 Nov;**126**(5):1712.
31. Roland M. Linking physician pay to quality of care: a major experiment in the UK. *N Engl J Med* 2004;**351**:1448—54.
32. Bingham P. The Limitations of QOF data 2005. Report for the Eastern Regional Public Health Observatory, UK.

33. Ashworth M, Seed P, Armstrong D, Durbaba S, Jones R. The relationship between social deprivation and the quality of primary care: a national survey using indicators from the UK quality and outcomes framework. *Br J Gen Pract* 2007;**57**:441—8.
34. Mant J, Murphy M, Rose P, Vessey M. The accuracy of general practitioner records of smoking and alcohol use: comparison with patient questionnaires. *J Public Health Med* 2000 Jun;**22** (2):198—201.
35. McBride PE, Plane MB, Underbakke G, Brown RL, Solberg LI. Smoking screening and management in primary care practices. *Arch Fam Med* 1997 Mar-Apr;**6**(2):165—72.
36. Selak V, Wells S, Whittaker R, Stewart A. Smoking status recording in GP electronic records: the unrealised potential. *Inform Prim Care* 2006;**14**(4):235—41.
37. Valderas JM, Starfield B, Sibbald B, Salisbury C, Roland M. Defining comorbidity: implications for understanding health and health services. *Ann Fam Med* 2009 Jul-Aug;**7**(4):357—63.
38. Economic and Social Research Institute, Ireland (ESRI). Living in Ireland survey 2002.
39. Fortin M, Soubhi H, Hudon C, Bayliss EA, van den Akker M. Multimorbidity's many challenges. *BMJ* 2007 May 19;**334** (7602):1016—7.
40. Boyd CM, et al. Guided care for multimorbid older adults. *Gerontologist* 2007;**47**(5):697—704.
41. Smith SM, Allwright S, O'Dowd T. Effectiveness of shared care across the interface between primary and specialty care in chronic disease management. Cochrane Database of Systematic Reviews 2007, Issue 3.
42. Leff B, et al. Guided care and the cost of complex health care. *Am J Manag Care* 2009;**15**(8):555—9.
43. Boult C, et al. Early effects of "Guided care" on the quality of health care for Multimorbid older persons: A Cluster-Randomized controlled trial. *J Gerontol Med Sci* 2008;**63A**(3): 321—7.
44. Boyd CM, et al. The effects of guided care on the perceived quality of health care for multi-morbid older persons: 18-month outcomes from a cluster-randomized controlled trial. *J Gen Intern Med* 2010;**25**(3):235—42.