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**The Importance of Multimorbidity in
Explaining Utilisation and Costs Across
Health and Social Care Settings: Evidence
from South Somerset's Symphony Project**

CHE Research Paper 96

The importance of multimorbidity in explaining utilisation and costs across health and social care settings: evidence from South Somerset's Symphony Project

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Abstract

Aims

Since the inception of the NHS, an ever-present challenge has been to improve integration of care within the health care system and with social care. Many people have complex and ongoing care needs and require support from multiple agencies and various professionals. But care is often fragmented and uncoordinated, with no one agency taking overall responsibility, so it is often left to individuals and their families to negotiate the system as best they can. South Somerset's Symphony is designed to establish greater collaboration between primary, community, acute and social care, particularly for people with complex conditions.

Methods

We examine patterns of health and social care utilisation and costs for the local population to identify which groups of people would most benefit from better integrated care. We analyse data to identify groups of people according to the frequency of occurrence of underlying conditions; the cost of care; and utilisation of services across diverse settings. The empirical identification strategy is supplemented by local intelligence gained through workshops with health and social care professionals about the appropriateness of existing patterns of provision. We employ two-part regression models to explain variability in individual health and social costs, in total and in each setting.

Data

The Symphony Project has an anonymised individual-level dataset, spanning primary, community, acute, mental health and social care. This includes activity, costs, clinical conditions, age, sex and ward of residence for the entire population of 114,874 people in 2012. Each person's morbidity profile is described using the United Health's Episode Treatment Groups (ETG), which build upon ICD and Read codes.

Results

We identify the frequency of conditions and co-morbidity profile of the entire population and, for the most frequent conditions, we assess utilization and costs of care across health and social care settings. For example, for those with asthma and diabetes, hospital costs account for the largest proportion of costs; in contrast, costs for those with dementia occur mostly in social care, mental health care and community care settings. For the population as a whole, we find that costs of health and social care are driven more by an individual's morbidity profile than by their age.

Data for those with the most frequent conditions were reviewed by local health and social care professionals and managers. It was decided to undertake more detailed analyses for those with diabetes or dementia. 5,676 people are recorded as having diabetes in South Somerset, with hypertension being the most common comorbidity. For those with a sole diagnosis of diabetes, costs are around £1,000 on average but as people are recorded as having more diagnoses, average costs increase progressively. Costs are also higher for older people and women.

People with dementia account for only 0.92% of the South Somerset population, but the average annual cost for the 1,062 people with dementia is around £12,000. A high proportion of these costs are related to the provision of mental health, social and continuing care. Costs are higher the more co-morbidities a person has, and for people from more deprived areas. Age and gender do not explain variation in costs for people with dementia.

Conclusions

This work forms a basis for identifying groups that would most benefit from improved integrated care, which might be facilitated by integrated financial arrangements and better pathway management. The more co-morbidities that a person has, the more likely they are to require care across diverse settings, and the higher their costs. Our analysis identifies those groups of the population which are the highest users of services by activity and cost and provides baseline information to allow budgetary arrangements to be developed for these targeted groups.

1. Introduction

Since the inception of the NHS, an ever-present challenge has been to improve integration of care within the health care system and with social care. Many people have complex and ongoing care needs and require support from multiple agencies and various professionals (Lehnert et al., 2011). But care is often fragmented and uncoordinated, with no one agency taking overall responsibility, so it is often left to individuals and their families to negotiate the system as best they can.

Traditionally, in England, health and social care funds have been channelled to institutions not individuals. Institutionally-based funding fails to recognise that many people, particularly those with combinations of conditions, move across institutions, receiving care in multiple settings. But this creates problems. Patients find it difficult to negotiate their way through the health and care system. Care providers have had little financial incentive and have lacked financial mechanisms to allow funding to follow patients as they move from one setting to another. It has been recognised that financial arrangements need to be revised so as to support rather than inhibit organisations to work collaboratively around the needs of patients (Department of Health, 2012).

South Somerset's Symphony Project is designed to establish greater collaboration between primary, community, mental health, acute and social care, particularly for people with complex conditions. The Project is based on the principle of collaborative care, centred around the needs of individual patients. This means that all of the different organisations involved in delivering services will need to work together to deliver a tailored package of care. Collaborative working is to be incentivised by a shared outcomes framework. There will be joint responsibility for all organisations to deliver the outcomes, and with linked financial structures under an 'alliance contract'.

To support this ambition it is necessary to understand what drives health and social care costs. This will enable stratification into groups in order to inform the appropriate targeting of the programme toward those patient groups which are the highest users of services, who can be identified both by activity and cost (Kadam et al., 2013). Budgetary arrangements can then be developed for these targeted groups.

To support these ends, health and social care data have been collated from multiple sources for the entire population within the South Somerset GP Federation. The Federation covers 17 practices around Yeovil District Hospital NHS Foundation Trust. In this report we analyse these data in order to identify those groups of people for which collaborative care might be most beneficial.

2. The Symphony Dataset

The Symphony Project has built a large dataset which links acute, primary care, community, mental health and social care data for each individual in the South Somerset population. The data are derived from various primary sources all of which cover twelve months from April 2012 to March 2013. The dataset contains anonymised individual-level data about what care has been received and at what cost across all organisations. The dataset has three key features:

1. Anonymised data are available for each individual in the population about their utilisation of health and social care. Utilisation data for each individual are linked across eight broad settings of care:
 - a. PC: primary care episodes and prescribing
 - b. IP: acute inpatient & daycase
 - c. OP: acute outpatient
 - d. AE: acute accident & emergency
 - e. MH: mental health
 - f. CM: community care
 - g. SC: social care.
 - h. CC: continuing care
2. Costs have been calculated for each individual according to the type of care they have received in each setting. These calculations generally reflect the costs to the commissioner of procuring care of a particular type.
3. Demographic characteristics are available for each individual, including age, gender, socio-economic measures, and indicators of morbidity.

Describing multi-morbidity

Each individual's morbidity profile is constructed using United Health's RISC tool. RISC is a patient-centric predictive modelling tool developed by United Health UK to assess the risk of patients having unplanned hospital admissions within a 12 month period. The tool utilises diagnostic information in patient medical records, described using ICD10 and Read codes. This diagnostic information is summarised into 586 Episode Treatment Groups (ETGs) which are grouped under 22 Major Practice Categories. We designated 49 of these 586 ETGs as indicative of chronic conditions, and these 49 conditions form of the basis for describing the morbidity profile of each individual in the population. Individuals can, of course, have multiple chronic conditions.

<http://www.unitedhealthuk.co.uk/OurTechnology/HealthNumericsRISC.aspx>.

3. Analytical approach

The Symphony Project wanted to target collaborative care arrangements initially at a subset of the population that would be expected to benefit most. The analytical objective is to identify which people might comprise this initial group and to assess what size of commissioning budget should be assigned to cover their health and social care requirements.

We have adopted four criteria to identify groups most amenable to an integrated care approach, these being:

1. high frequency of occurrence;
2. utilisation of services across diverse settings;
3. high cost of care;
4. local consensus that changes to the care pathway are feasible.

The rationale for these criteria and the analytical approach are set out in the box below.

Basis	Rationale	Analytical approach
Frequency of occurrence	In developing a budget, there needs to be a reasonably large number of people to form the "risk pool".	Assess how many people have particular chronic conditions (ETG) and combinations of conditions.
Utilisation of services across settings	People who require services across diverse settings are most likely to benefit from collaborative care requirements	Summarise the number and type of settings in which patients receive care by chronic condition/s.
Costs of care	Potential savings are likely to be greater the higher are the costs of care.	Summarise total costs and setting-specific costs by chronic condition/s.
Potential for change	Changes require local ownership and action	Workshops with the local health and social care community

Frequency of occurrence

In developing a budget that covers health and social care requirements, our starting point was that:

1. A reasonably large number of people to form the "risk pool". In the expectation that a large proportion of costs incurred by any particular individual is difficult to predict, there needs to a sufficiently large risk pool so that those with high costs are offset by those with low costs.
2. Moreover, the arrangements should be targeted at people with multiple conditions as these are more likely to require collaborative care arrangements. We employed the 49 chronic conditions (ETG classifications) to describe multi-morbidity and to develop meaningful groups of patients.

Utilisation of services across diverse settings

We believe that people who require services across diverse settings are most likely to benefit from collaborative care requirements. The data allow us to examine the overall pattern of expenditure in South Somerset across settings for people with each chronic condition. We constructed eight types of setting:

- PC: primary care episodes and prescribing
- IP: acute inpatient & daycase
- OP: acute outpatient

- AE: acute accident & emergency
- MH: mental health
- CM: community care
- SC: social care.
- CC: continuing care

Patient 'utilisation' was described in each setting of care as follows:

- In Primary Care, the term 'episodes' refers to a wider measure than merely 'GP consultations'. Through the RISC system we were able to identify each time (episode) a patient interacted with their GP Practice, either through a physical visit (either to a GP or other health professional) or an event that caused a Read code to be recorded against the patient's record 'in absentia'. Primary Care costs (as identified collectively between the South Somerset GP Federation and the Local Area Team of NHS England) were allocated to patients on the basis of a calculated 'unit cost per primary care episode'.
- Prescribing utilisation was calculated with reference to utilisation data from the RISC tool and prescribing budgets managed by Somerset Clinical Commissioning Group.
- Acute and community care utilisation was based on activity and cost information sourced through the NHS Secondary Users Service (SUS) including the number, type and length of hospital episodes.
- Mental health utilisation was based on 'mental health cluster costs', as calculated and supplied by Somerset Partnership NHS Foundation Trust, the local provider of mental health services.
- Social Care utilisation was based on activity and cost information provided directly by Somerset County Council, including utilisation of homecare, residential placements, day care, professional services, direct support and provision of equipment. Note that utilisation of social care is identified if any one of seven types of social care support are utilised by a particular individual.
- Continuing Care was based directly on cost information provided by the local Continuing Healthcare team hosted by South West Commissioning Support and supporting Somerset Clinical Commissioning Group.

Analysing variation in costs

We analyse why costs vary from one person to another by applying multivariate regression models to analyse each person's total costs and costs incurred in each of the eight settings. As is typical in modelling health costs, we use a logarithmic transformation to reduce skewness and make the distribution more symmetric and closer to normality. A high proportion of people in inpatient, outpatient, A&E, mental health, community care, social care, and continuing care incur no costs. To analyse costs in such settings, we employ two-part models (Charlton et al., 2013, Brilleman et al., 2012, Duan et al., 1983) which allow us to account for the large number of zeros found in the data. The two parts are assumed to be independent and can be estimated separately. The first part, estimated by a logistic regression, models the probability of incurring any expenditure and the second part models the amount of expenditure only for those with positive costs. The conditional mean independence assumption is then given by:

$$E(\ln y_i | y_i > 0, X_i) = X_i \beta$$

where y_i are costs for individual i , X_i is a vector of explanatory variables and β indicates the parameter estimates. Primary care costs and total costs exhibit a very small proportion of zeros and are estimated by a simple log-linear regression.

We consider two sets of explanatory variables:

- A *limited* set of variables commonly used in analyses of this kind. These variables are age, gender, social deprivation, the number of chronic conditions, and whether patients died during the year or moved elsewhere.
- The *full* set of variables which, in addition to those listed above, includes co-morbidity variables indicating whether or not a person has a particular condition, namely Dementia, Mental health (excluding dementia), Cancer, Cardio-vascular disease, Stroke, Obesity, Respiratory problems, Gastric problems, Trauma/burns/fractures, Arthritis, or Renal problems.

We assess explanatory power by looking at the R^2 statistic. This summarises the overall ability of the variables included in the model to explain variation in observed costs. The following points are worth bearing in mind:

- Individual health and social care costs are difficult to predict, so we would not expect explanatory power to be particularly high. R^2 statistics of around 15-20% would be deemed satisfactory in most studies of this kind (Nagl et al., 2012).
- The explanatory power of the *limited* model will be lower than the *full* model, simply because fewer variables are included. By comparing the R^2 statistic from both models we can assess whether it is worth including the additional information required to specify the *full* model.
- Explanatory power will vary across settings, because costs vary across settings and the characteristics that explain costs in one setting may be different from those that explain costs in another.

Potential for change

We presented details of multi-morbidity profiles for those with particular conditions at a workshop with local health and social care professionals and managers. Clinical/practitioner and managerial representation was present for all of the major organisations involved (it is anticipated that there will be involvement and impact on many smaller organisations such as local charities, which will not be part of the alliance contract).

There were acknowledged to be conflicting pressures on the choice of group to which the Symphony budgetary arrangements should apply initially. Discussion covered whether specific conditions should be used or multi-morbidity. Multi-morbidity, as measured by number of conditions alone, would potentially benefit a larger group but would represent difficulties when patients presented to an organisation – how would staff recognise the ‘Symphony Patient’. A larger cohort would make it easier for organisations to make coherent changes to their working practices so that staff would not be asked to work in one way with one group of patients and in another way with the remainder. A larger patient group would also result in greater “risk pooling” as described above. However a larger group would represent a bigger proportion of each organisation’s total budget and therefore a greater risk to the organisation if the proposed interventions failed to deliver the expected benefits. A larger group would also make it harder to make a significant difference to the outcomes of the group in a short space of time, and would take longer to mobilise.

The decision was then taken to focus further analytical effort on those with a diagnosis of diabetes and of dementia. This was thought to provide an acceptably large patient group with an expected resource budget that was acceptable to all parties.

4. Descriptive statistics

The Symphony dataset contains information about 114,874 people. Information about each person is available on the following:

- Utilisation and costs of care across settings
- Socio-demographic characteristics
- The chronic conditions of each individual used to describe their multi-morbidity profile.

Utilisation and costs of health and social care

Table 1 summarises utilisation and costs of care according to the type of health and social care utilised for the South Somerset population as a whole. On average, people had 4.79 primary care episodes over the course of the year, received 3.49 unique prescriptions, and had 0.32 inpatient admissions. While some people did not use any service of a particular type, there are some very high users. Some of the utilisation variables are recorded in terms of whether or not people received the care in question. So, for instance, 1.51% of the population received mental health care, 0.69% received homecare and 2.64% received professional support.

Table 1 Summary statistics - utilisation and average costs per person (£)

Variable	Utilisation				Costs		
	Mean	SD	Max	%	Mean	SD	Max
Prescriptions	3.491	5.025	65	66.08	128	185	2388
GP	4.787	6.308	113	78.92	69	90	1618
<i>Acute</i>							
Inpatient	0.320	2.721	163	14.90	380	1561	76120
Outpatient	1.040	2.445	66	30.19	106	242	5863
A&E	0.224	0.694	24	13.77	20	67	2296
<i>Community</i>							
Inpatient	0.004	0.075	3	0.36	34	783	78210
Outpatient	0.006	0.110	6	0.33	1	12	606
A&E	0.014	0.192	25	0.99	1	11	1398
<i>Mental health</i>	0.023	0.339	33	1.51	70	1620	138927
<i>Social care</i>							
Homecare	0.010	0.101	1	0.69	23	451	31931
Placement	0.011	0.159	9	0.77	73	1467	315950
Day care	0.002	0.045	1	0.20	8	249	43680
Direct pay	0.002	0.062	4	0.19	13	445	44842
Equipment	0.009	0.094	1	0.87	2	36	4155
Other services	0.000	0.021	1	0.04	1	55	2684
Prof. support	0.026	0.160	1	2.64	30	183	1140
<i>Continuing care</i>							
CHC Nursing home	0.003	0.058	1	0.34	14	267	11314
Funding	0.004	0.088	5	0.27	53	1908	215152
Total					1026	4112	460103

The average cost of care amounted to £1026 but there is wide variation in costs, with some people incurring high costs – the care for one person amounted to £460,103. The data permit analysis of costs according to the care setting. For example, the average cost of inpatient care amounted to £380, but many people incurred zero inpatient costs while the cost for one person amounted to £76,120. The average cost of social care placements amounted to £73, but reached £315,950 for one individual.

Demographic characteristics

Table 2 summarises the characteristics of the population. The average age of the population is 43 years and 49% are male. During the course of the year, 0.9% of the population died and 2.7% moved out of the area. As in other studies (Charlton et al., 2013, Brilleman et al., 2012, Kadam et al., 2013), we account for socio-economic circumstances by using an Index of Multiple Deprivation, which measures the deprivation of the each person's residential area (electoral ward) (<http://www.ons.gov.uk/ons/index.html>).

Conditions are defined in the data set according to the Episode Treatment Group (ETG) classifications employed by the United Health RISC tool. Taking the population as a whole, the average person has 4.03 conditions (i.e. ETGs), of which 0.94 are chronic conditions.

Table 2 Summary statistics - background variables

Variable	%	Mean	Std Dev	Min	Max
Male	48.93				
Died	0.90				
Moved elsewhere	2.66				
Age		42.648	24.359	0	105
Index of Multiple Deprivation		14.75	8.32	2.31	73.73
Number of conditions		4.027	4.243	0	70
Number of chronic conditions		0.937	1.306	0	13

Morbidity and multi-morbidity

Over and above socio-demographic characteristics, it is most likely that costs will be driven by the conditions that people have (Lehnert et al., 2011). While many people do not have any of the ETGs that we have defined as chronic conditions, some have multiple chronic conditions.

Table 3 presents information on the prevalence of the 49 chronic conditions among the South Somerset population. Almost 16% of the population has a diagnosis of hypertension, 11% have asthma. Many of the conditions are experienced by less than 1% of the population.

We can also examine the prevalence of combinations of chronic conditions. There are 7,605 unique combinations of chronic conditions among the South Somerset population. It is impractical to report each combination, but we can examine the number of conditions that people with particular conditions have. For example, 72% of those with hypertension also have another chronic condition.

In Figure 1 to Figure 3, for each of the chronic condition listed in Table 3, we summarise the percentages of those with that condition who (i) have that condition alone; (ii) have another condition as well; (iii) have two other conditions; and (iv) have three or more other conditions. The conditions are ordered across all three graphs from the most frequent in the population (hypertension) to the least frequent (hepatitis). So we can see, for instance, that almost 50% of those with asthma have no other condition. In contrast, about 10% of those who have suffered a stroke or who have COPD have only this condition, while more than 50% of these people are recorded as having more than three conditions.

Table 3 Prevalence and costs by chronic condition (ETG)

Chronic Condition	Prevalence			Costs			
	N	%	% with >1 conditions	Mean	Std	Min	Max
None	58,362	50.81	NA	293	2,350	9	460,103
Hypertension	17,777	15.48	72.44	2,546	5,950	0	237,924
Asthma	12,769	11.12	51.47	1,337	4,457	0	218,562
Anxiety	7,962	6.93	67.14	2,067	6,283	0	237,924
Cancer	5,932	5.16	81.98	3,195	5,887	0	117,582
Irritable Bowel Syndrome	5,688	4.95	67.33	1,438	3,770	0	124,177
Diabetes	5,676	4.94	85.62	3,036	7,153	0	237,924
Skin infections	5,086	4.43	61.80	2,422	6,739	0	218,562
Coronary Artery Disease	4,695	4.09	85.18	3,911	7,145	0	136,382
Hypothyroidism	4,275	3.72	77.31	2,353	6,474	0	237,924
Skin trauma	3,611	3.14	63.17	2,679	8,228	14	237,924
Stroke	2,665	2.32	90.28	5,231	10,233	0	237,924
Tendinitis	2,578	2.24	71.33	1,970	5,729	14	177,796
Gastroenterology signs & symptoms	2,144	1.87	66.46	2,756	5,328	14	92,328
Chronic Obstructive Pulmonary Disease	1,989	1.73	89.84	3,802	6,503	0	97,235
Breast disorders	1,951	1.70	86.78	2,270	4,115	0	40,040
Fractures	1,546	1.35	67.27	4,663	8,459	14	122,643
Epilepsy	1,470	1.28	64.42	3,511	11,271	0	237,924
Gastritis	1,344	1.17	77.01	2,357	4,618	14	54,558
Hernias	1,336	1.16	79.04	3,293	5,480	14	81,153
Mental health	1,294	1.13	81.30	5,519	12,933	0	237,924
Gynecological infections	1,157	1.01	63.09	2,221	4,715	14	100,826
Hemorrhoids	1,152	1.00	72.40	2,106	4,209	14	57,457
Appendicitis	1,120	0.97	86.43	3,594	5,962	14	97,768
Pneumonias	1,110	0.97	73.24	5,086	11,578	14	218,562
Heart Failure	1,106	0.96	93.49	5,742	7,922	0	77,059
Dementia	1,062	0.92	87.76	12,314	19,654	0	237,924
Cataract	1,023	0.89	91.89	3,761	5,827	14	69,207
Adult Rheumatoid Arthritis	840	0.73	82.50	3,658	5,446	0	43,105
Glaukoma	810	0.71	80.99	2,430	5,628	14	99,128
Open wound	708	0.62	81.36	5,104	8,136	14	78,675
Chronic kidney Disease/Renal failure	640	0.56	96.25	8,694	9,432	0	49,932
Late effects complications	637	0.55	79.43	6,141	8,254	14	77,629
Acute bronchitis	630	0.55	62.22	1,954	4,208	14	41,730
Cirrhosis	518	0.45	81.66	2,334	4,880	0	53,732
Obesity	487	0.42	85.83	4,038	6,947	14	117,582
Environmental trauma	445	0.39	66.52	2,614	7,783	14	109,899

Nutritional Deficiency	366	0.32	87.16	4,766	7,933	51	55,449
Poisonings & effects of drugs	310	0.27	74.19	5,686	12,829	43	124,177
Macular degeneration	305	0.27	95.08	4,414	6,880	80	69,207
Burns	285	0.25	55.44	2,651	16,461	0	237,924
Incontinence	246	0.21	76.83	2,607	5,093	0	61,679
Alcohol dependence	177	0.15	94.35	6,534	10,213	108	73,018
Kidney stones	152	0.13	75.66	3,328	5,121	14	39,890
Eating disorders	126	0.11	59.52	2,838	11,406	0	97,235
Pancreatitis	115	0.10	86.09	4,564	5,318	0	30,652
Ulcer	105	0.09	90.48	7,793	9,823	139	55,449
Diabetic Retinopathy	95	0.08	93.68	5,425	7,304	756	40,851
Occupational Pulmonary disease	45	0.04	95.56	14,142	13,422	51	54,121
Hepatitis	31	0.03	77.42	3,855	5,428	65	19,767

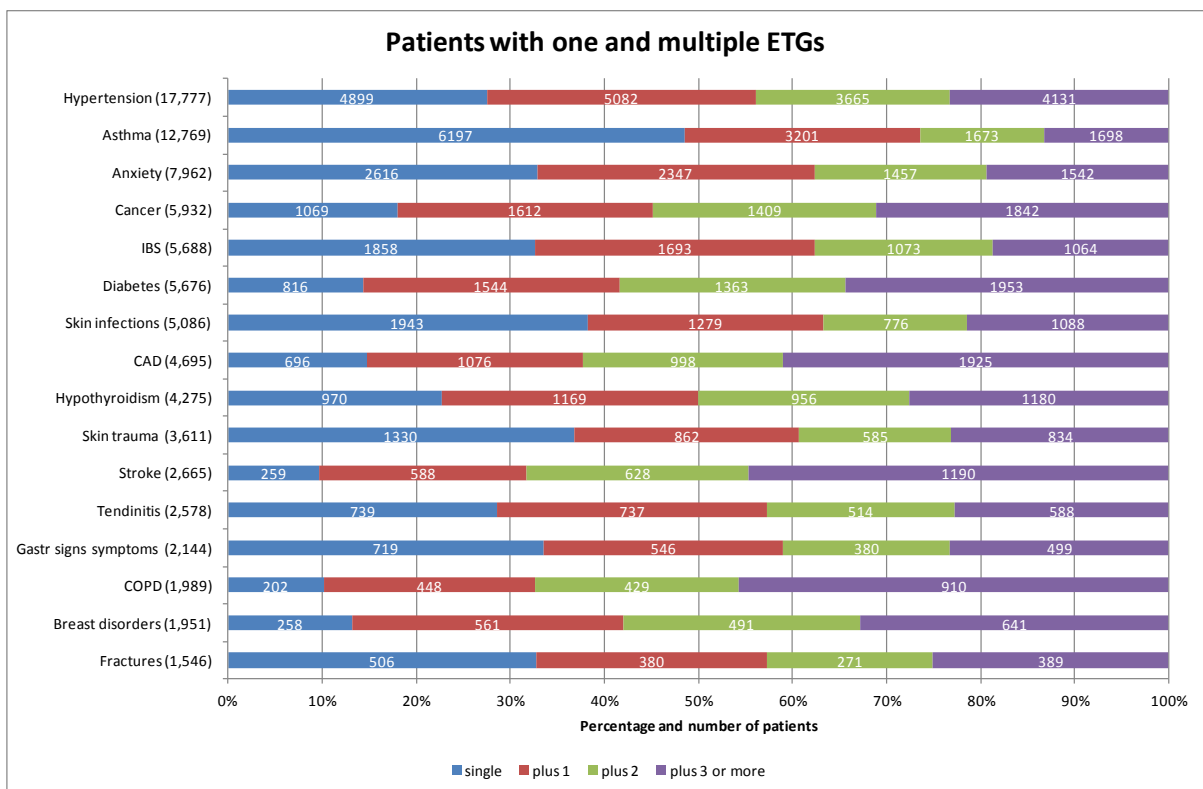


Figure 1 Patients with multiple chronic conditions (ETGs), by condition (1 of 3)

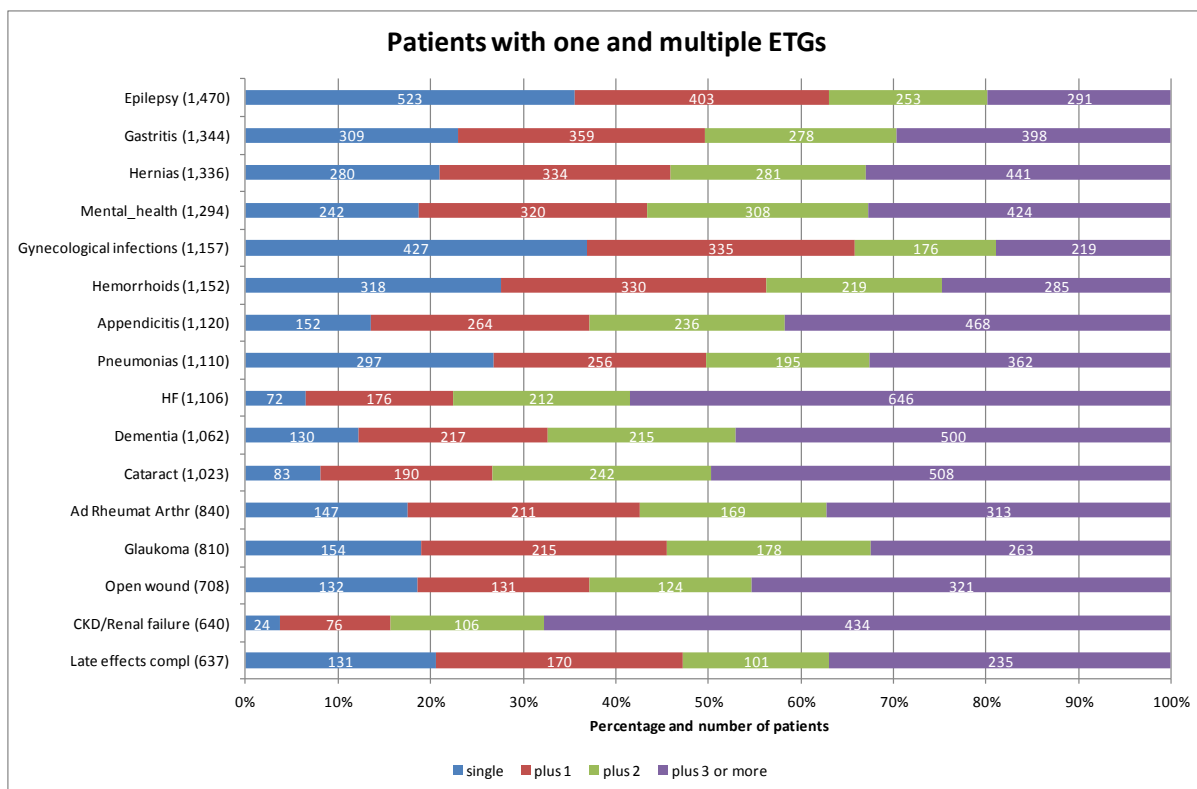


Figure 2 Patients with multiple chronic conditions (ETGs), by condition (2 of 3)

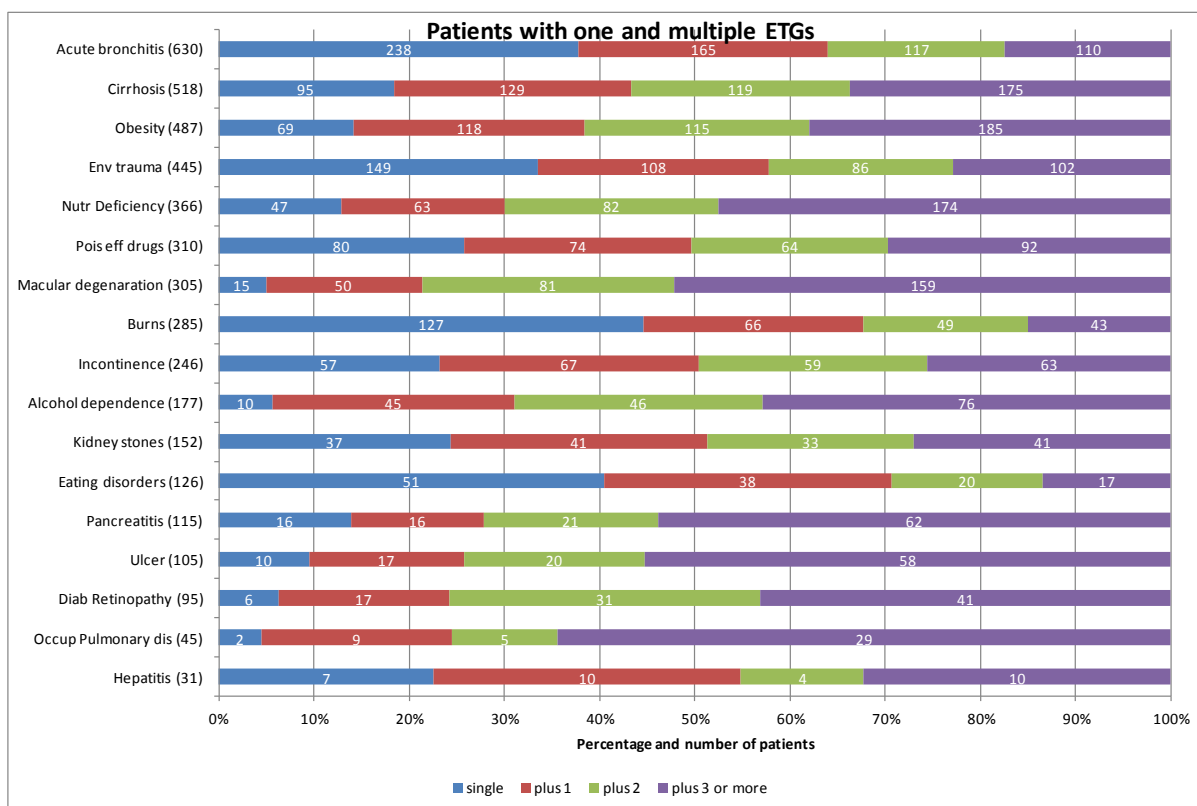


Figure 3 Patients with multiple chronic conditions (ETGs), by condition (3 of 3)

5. The costs of health and social care

For the population as a whole, Figure 4 shows how average costs vary according to the number of chronic conditions that are recorded. The average cost by the number of conditions is reported below each column.

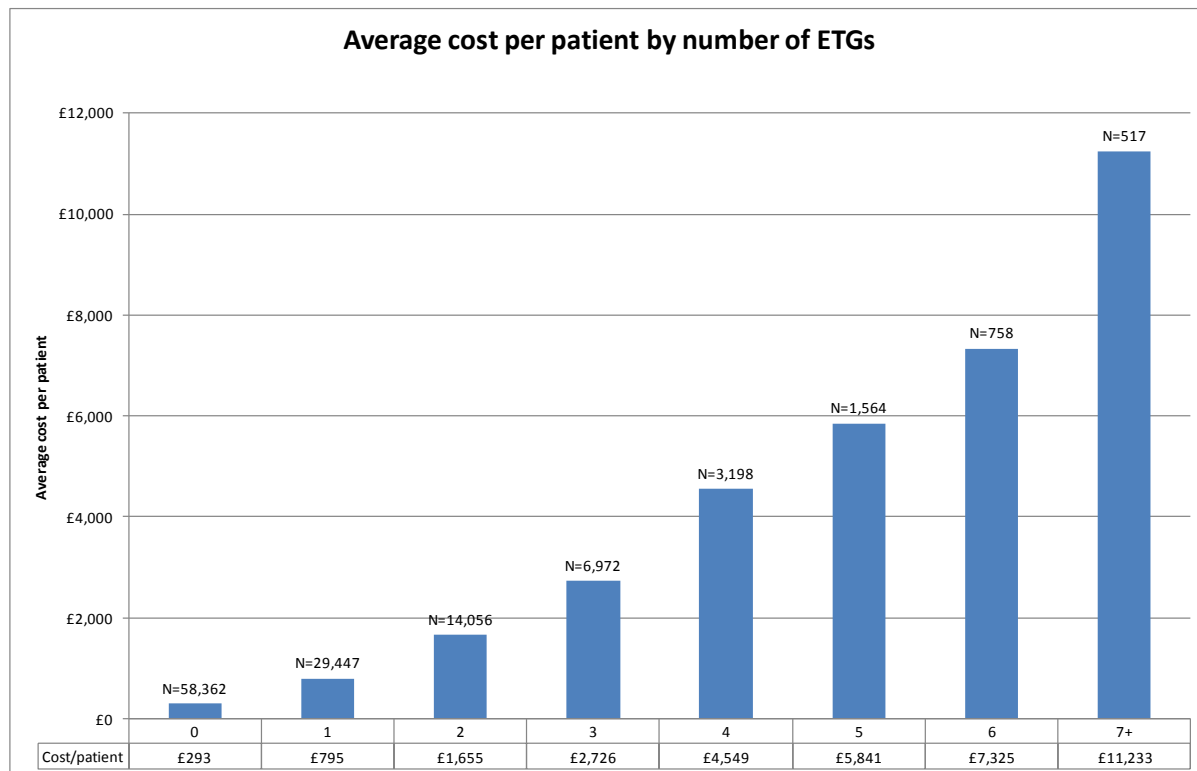


Figure 4 Average cost, full sample

There are a few things of note:

- Some people incur costs even though they have no chronic conditions: the average cost for such people amounts to £293. Some people in this group will have conditions other than the 49 chronic conditions that are the focus of the analysis; many will have incurred no costs at all.
- As might be expected, average costs increase the more conditions that people have. This is indicated by the increase in the height of the columns from left to right.
- More surprising, the *marginal* increase in average costs initially rises the more conditions are recorded. So, for instance, the average cost for the 14,056 people with two conditions is £860 more than the average cost for the 29,447 people with one condition; the difference between those with 3 and those with 2 conditions amounts to £1071; the difference between those with 4 and 3 conditions amounts to around £1,820. Beyond this, marginal cost increases become smaller.

Total costs by condition and setting

Information about costs across settings is summarised in Figure 5 to Figure 7 for each chronic condition (ETG), ordered by total expenditure (note that the scale varies for each graph). This shows that the total costs are highest for those people recorded as having hypertension, with the total cost amounting to almost £45m for the 17,777 people recorded as having this condition. But note that

these costs are for those people recorded as having hypertension – and all the other conditions that these people suffer. The total cost is not for treating hypertension alone.

The graphs also show the breakdown in total costs according to each setting. Acute inpatient and day case costs (labelled “ip”) invariably account for the largest proportion but for many conditions social care costs (labelled “sc”) and primary care (labelled “pc”) account for large proportions also.

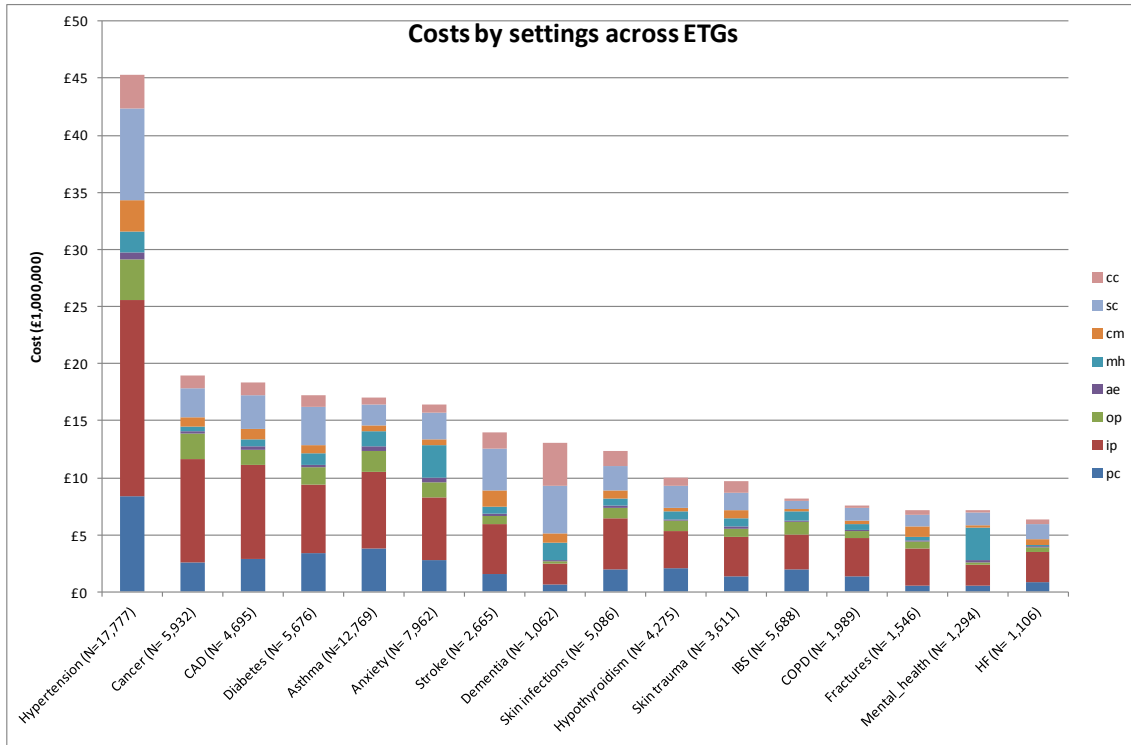


Figure 5 Total cost across settings by chronic condition (1 of 3)

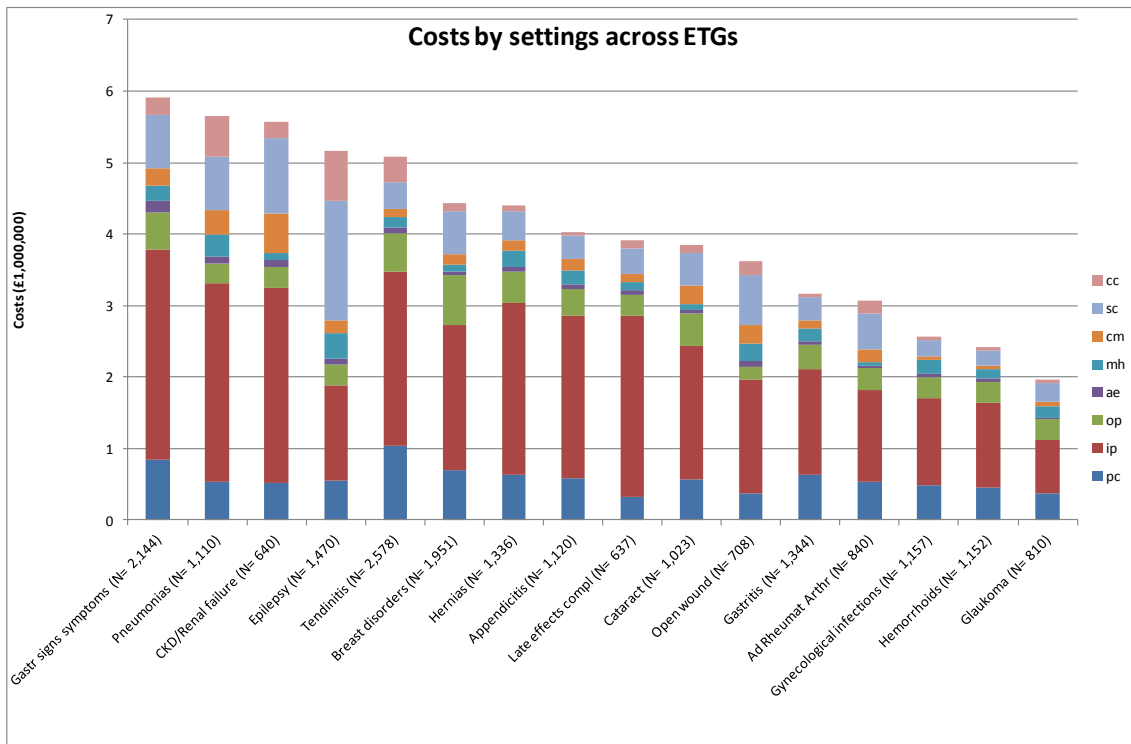


Figure 6 Total cost across settings by chronic condition (2 of 3)

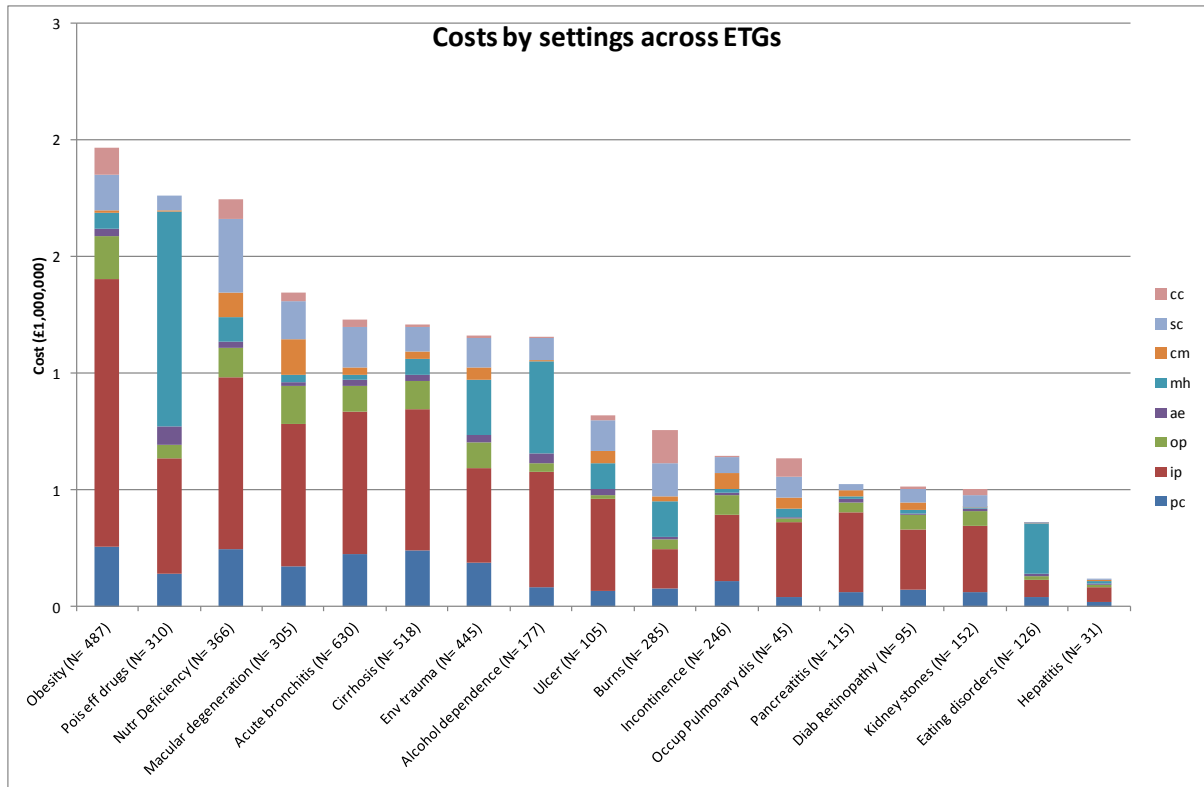


Figure 7 Total cost across settings by chronic condition (3 of 3)

Average costs by condition and setting

In Figure 8 to Figure 10 we provide a breakdown across settings of the *average* cost for people with particular conditions. Note that the scale of each of these three graphs differs.

- The conditions are ordered from the highest average cost - Occupational Pulmonary Disease (£14,142) - in Figure 8 to the lowest – Asthma (£1,337) - in Figure 10.
- For most conditions, inpatient and day case costs account for the largest proportion of average costs, as indicated by the red section of each bar.
- Some conditions stand out as having large proportions of costs incurred in other settings. So, for example, social care costs (light blue section) account for relatively large proportions of the average cost for people with dementia, epilepsy and burns.
- Mental health care costs account for a substantial proportion of the average cost for those with dementia, alcohol dependence, poisonings and effects of drugs, burns, environmental trauma and eating disorders.

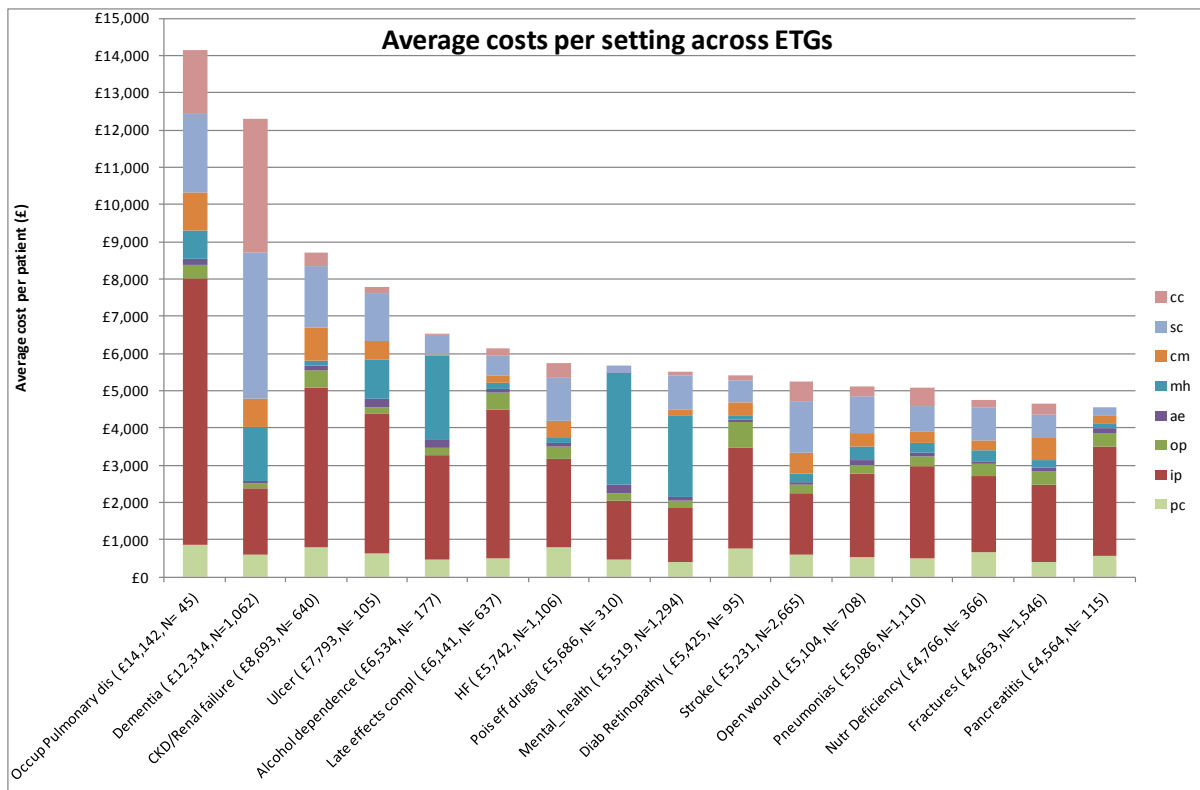


Figure 8 Average costs by setting, across chronic conditions (1 of 3)

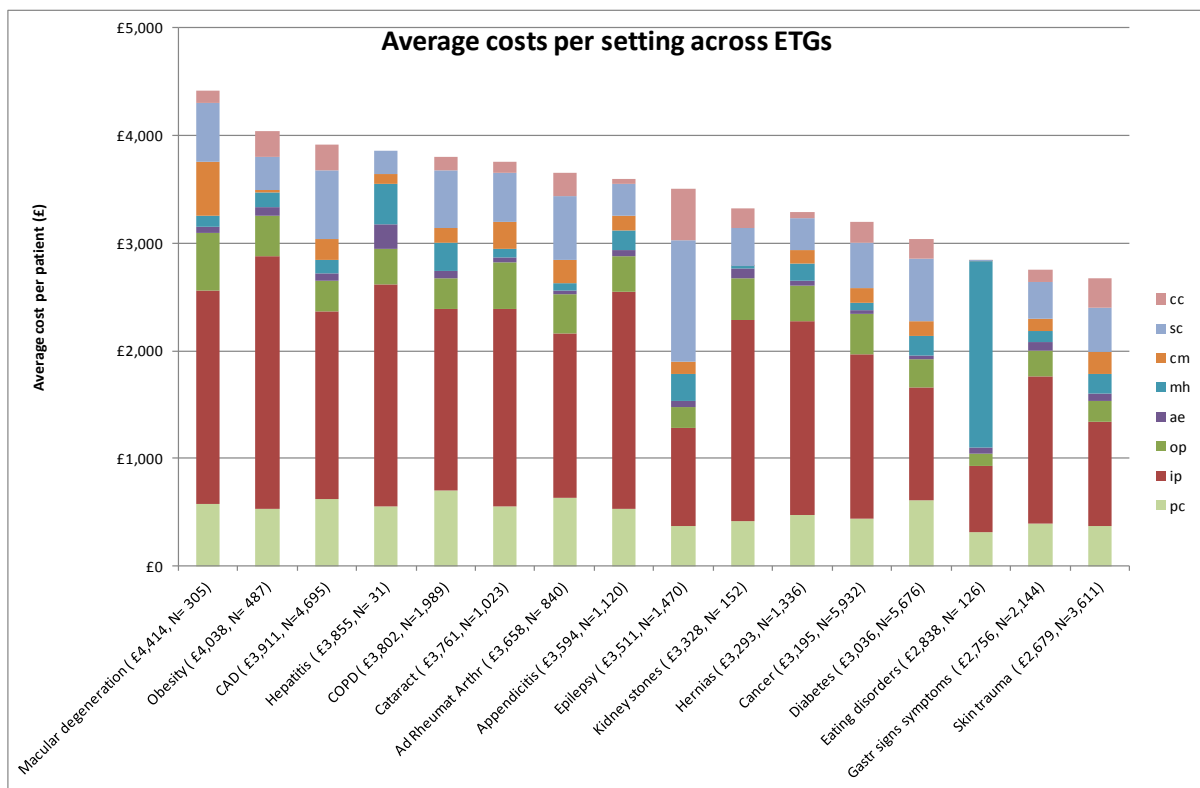


Figure 9 Average costs by setting, across chronic conditions (2 of 3)

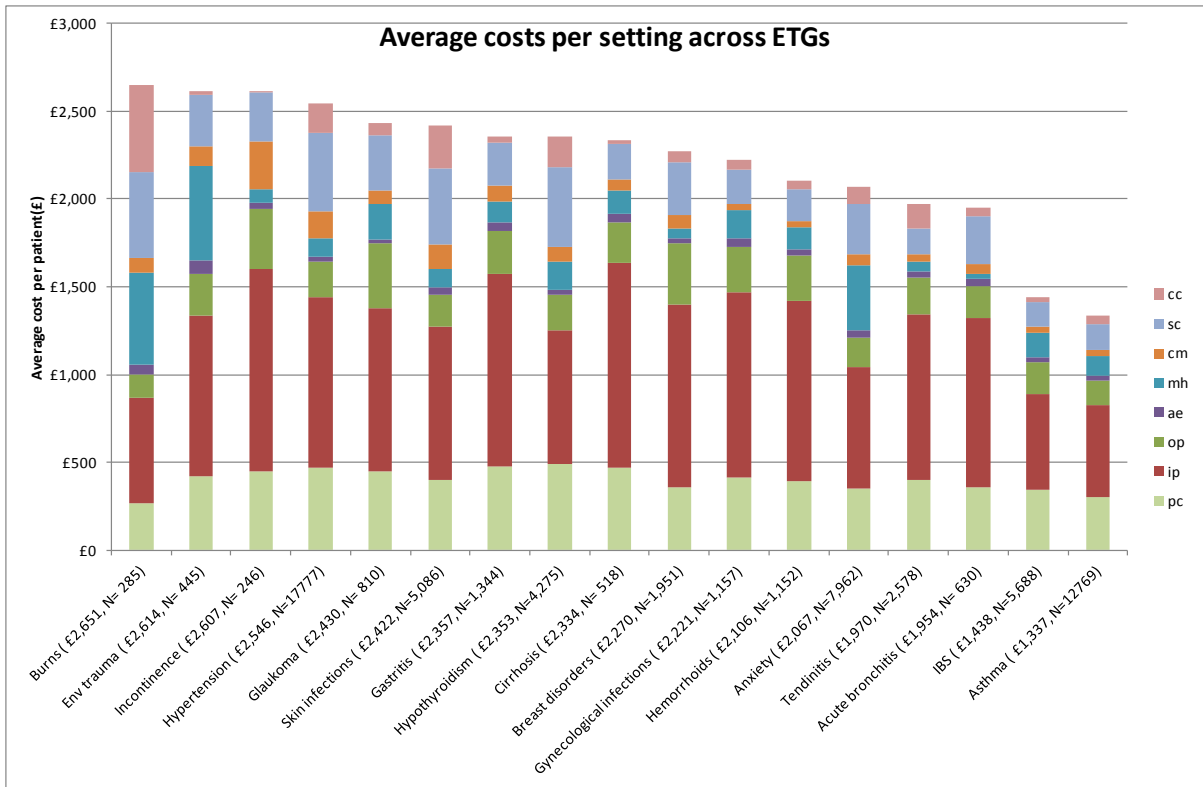


Figure 10 Average costs by setting, across chronic conditions (3 of 3)

6. Explaining variations in cost

Age is often considered an important predictor of costs, and indeed it is important. This is illustrated in Figure 11 which plots average costs by 5-year age bands for the South Somerset population. Average costs of around £650 per year vary little across age bands 20-24 through to 55-59, after which costs increase ever more steeply, reaching almost £5,000 a year for those over 85.

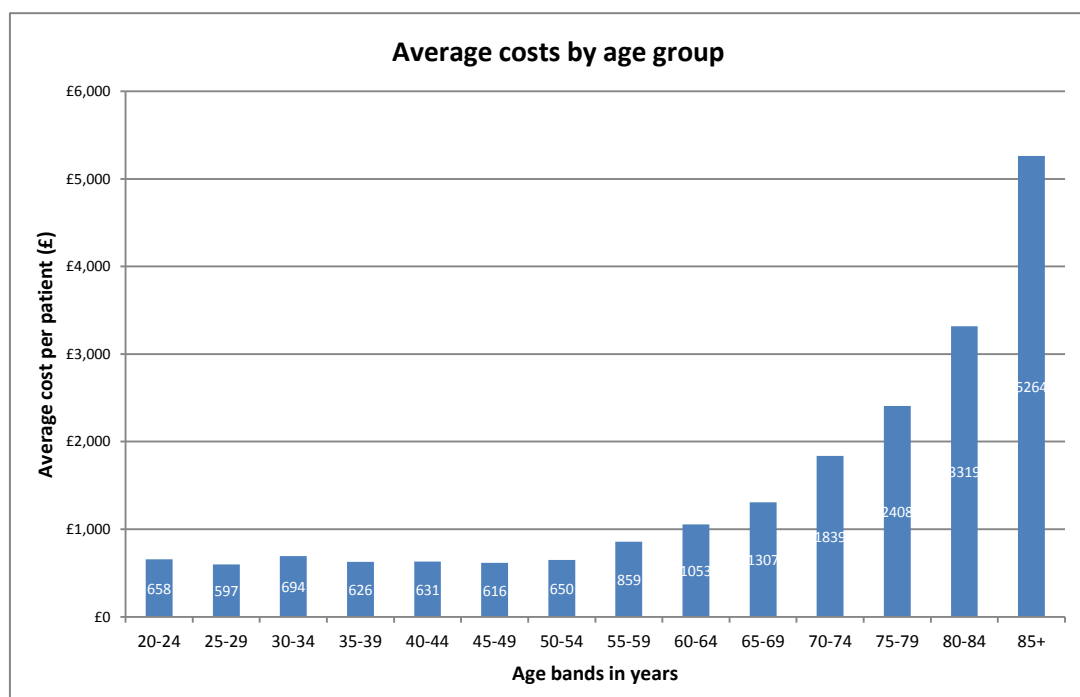


Figure 11 Average costs by age band

But age alone does not explain costs: there are other factors that need to be considered. Risk-adjustment involves determining predictors of cost, some of which may be correlated. An example of correlated cost predictors is age and the number of conditions: the older that people are, the more the conditions they have, and the higher their expected costs. There is a clear age gradient, with older people having more conditions. This is illustrated in Figure 12 which plots the number of chronic conditions by 5-year age bands for the South Somerset population. At the extremes, fewer than 20% of those aged 0-4 have 1 or more conditions while almost 50% of those aged 85+ have three or more chronic conditions.

This raises the question of what drives higher costs – is age or the number of conditions more important? We can use regression analysis to disentangle the relative contributions that age and the number of conditions have on costs, as well as exploring the impact of other potential cost predictors. We have performed a simple examination of the data for the entire population, the results of which are summarised in Table 4:

Table 4 Summary of regression results

Regression variables	Age	Number of conditions	Age, Number of conditions	Number of chronic conditions	Age, Number of chronic conditions
Variation explained	3.36%	19.80%	19.80%	10.48%	10.66%

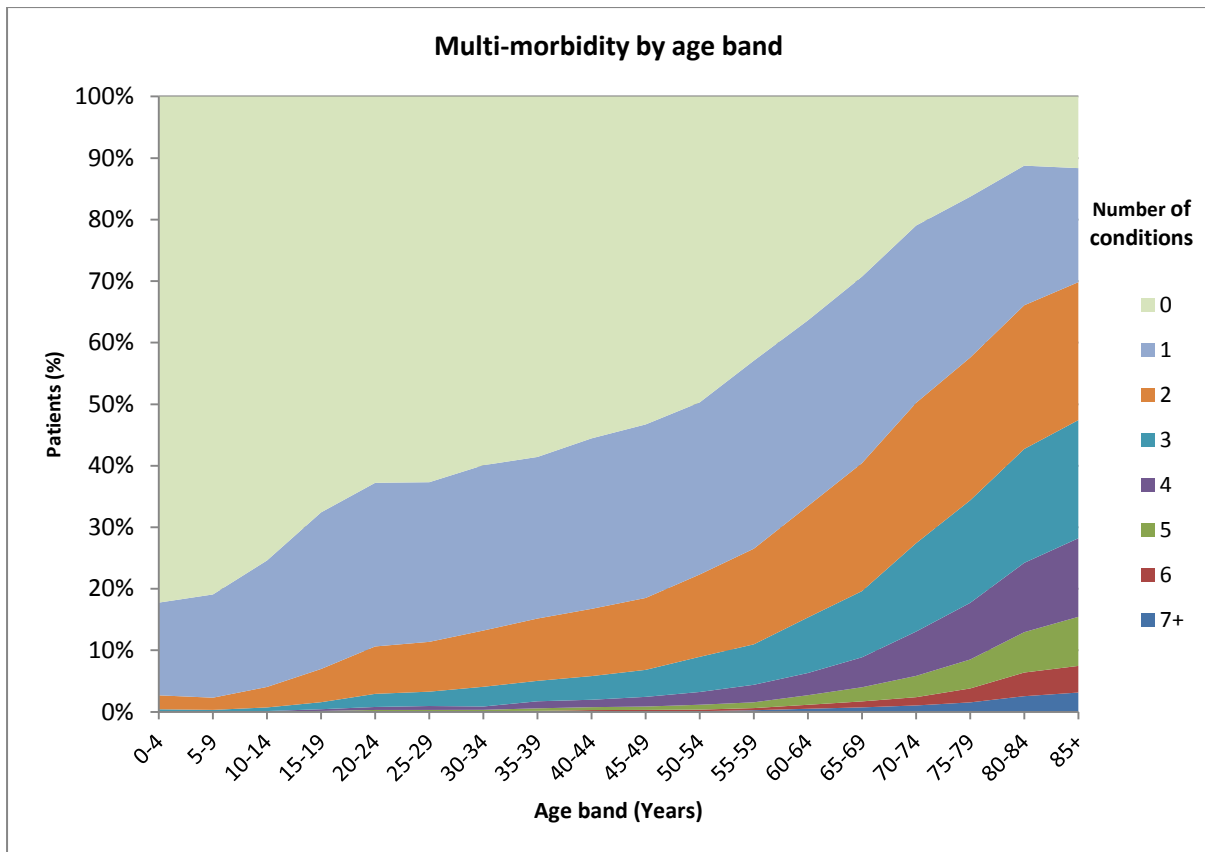


Figure 12 Relationship between age and the number of chronic conditions (ETGs)

- If we consider age by itself, it is able to explain only 3.36% of the variation in cost among the population.
- In contrast, the number of conditions (whether chronic or not) has greater explanatory power. Considering this characteristic alone explains 19.80% of the variation in costs.
- A regression model which considers both age and the number of conditions in combination is able to explain the same amount of the variation in costs (the increase in explanatory power amounts to less than 0.01%). The very small increase in explanatory power suggests that it is the number of conditions, not age, that is most important in explaining variation in costs among the South Somerset population.
- If we consider only the number of chronic conditions, these explain 10.48% of the variation in costs among individuals. Again, adding age as an additional variable adds little explanatory power, R^2 increasing by only 0.18%.

7. Analysis of costs for those with diabetes

Overview

5,625 people over 18 are recorded as having diabetes in South Somerset, their total costs amounting to £17m. A breakdown of these costs by setting is provided in Table 5 and the pie chart in Figure 13. Inpatient care accounts for the largest proportion of costs (35%), followed by social care (19%) and prescribing (14%).

Table 5 Total cost by setting

GP practice (GP)	£1,023,765
Prescribing (Rx)	£2,406,176
Inpatient (IP)	£5,955,165
Outpatient (OP)	£1,429,150
AE	£215,722
Mental health (MH)	£1,036,952
Community care (CM)	£764,655
Social care (SC)	£3,284,967
Continuing care (CC)	£1,040,761
Total cost	£17,157,314

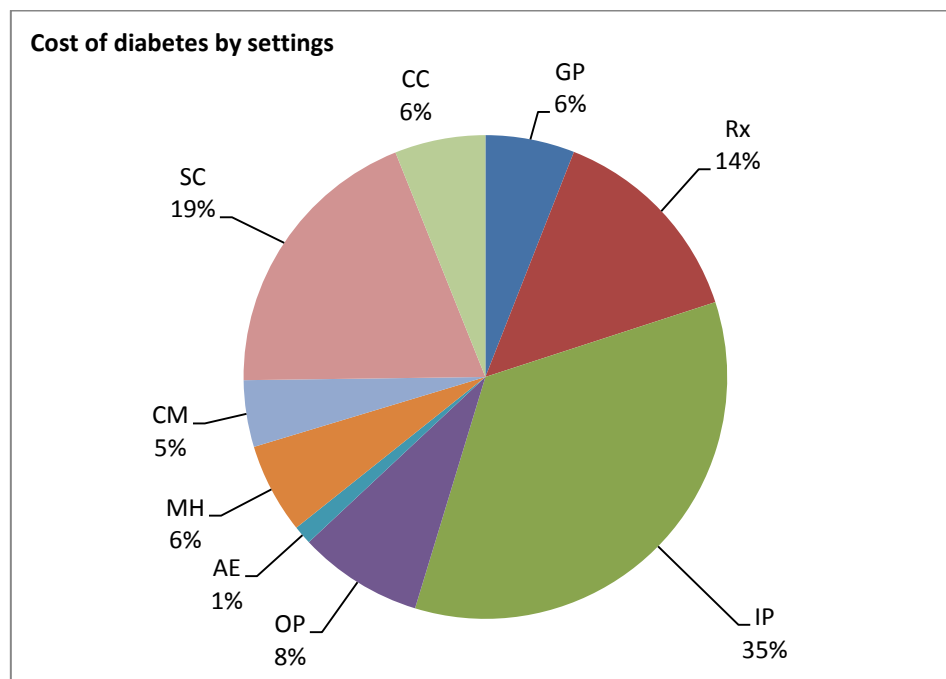


Figure 13 Cost by setting

In Figure 14 we summarise average cost by the number of co-morbidities for those with a diagnosis of diabetes. For those (n=779) with a sole diagnosis of diabetes, costs are around £1,000 on average. As people are recorded as having more diagnoses, average costs increase progressively.

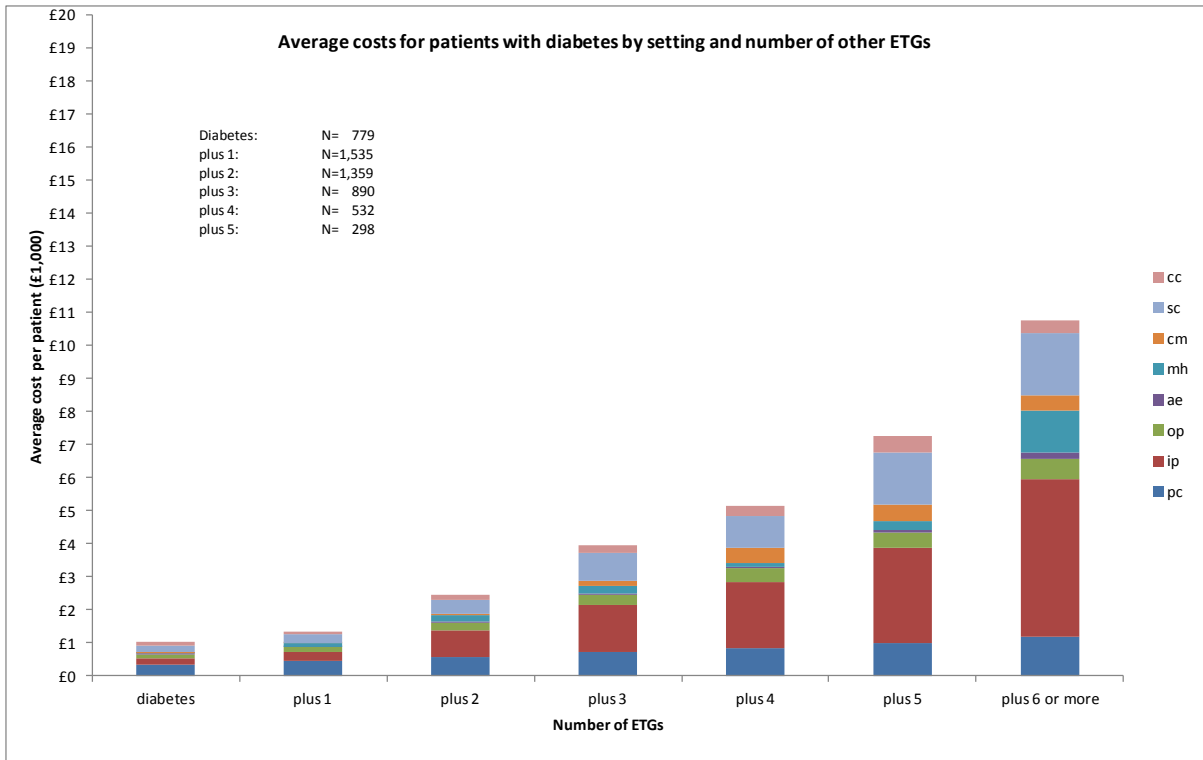


Figure 14 Cost by number of co-morbidities

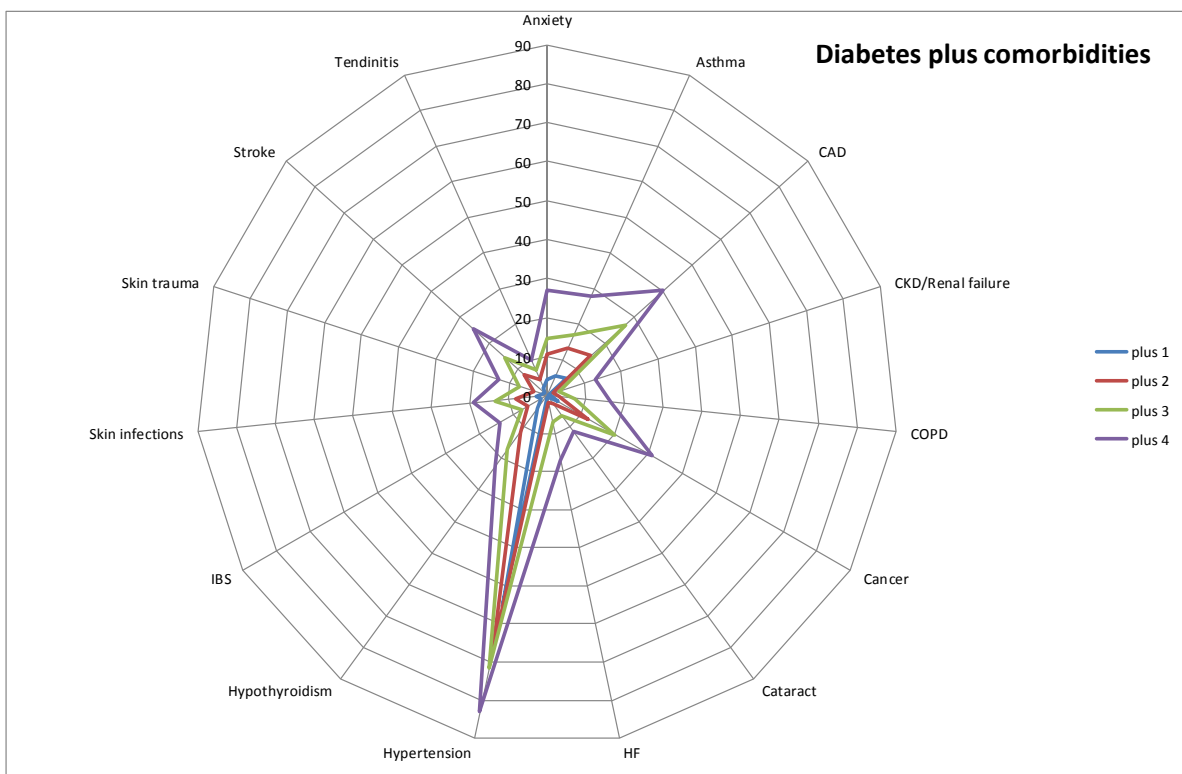


Figure 15 Top 15 most frequent co-morbidities for those with diabetes

Co-morbidity patterns

In Figure 15 we show the most common co-morbidities for those with a diagnosis of diabetes.¹ The following patterns are evident:

- Hypertension is far and away the most common co-morbidity for people with diabetes, a reflection of this being the most common diagnosis in the population as a whole.
- Of the 890 people with diabetes and three other co-morbidities, 27% have a diagnosis of coronary artery disease (CAD). This proportion rises to 40% when considering the 532 people with diabetes and four other co-morbidities.

Costs and co-morbidities

The spider diagrams below (Figure 16 to Figure 19) show average costs for all those with a diagnosis of diabetes and any other condition (red line) and the specific co-morbidity (blue line)

- Consider Figure 16. The average cost for the 1,544 people with diabetes and one other co-morbidity amounts to £1,363.
- The 854 people with diabetes and hypertension have below average costs of £1,091.
- The 51 people with diabetes and cancer have above average costs of £3,589.
- Similarly, those with diabetes and renal failure (n=5) and heart failure (n=7) have above average costs.
- For those with 2+ comorbidities (Figure 17), those with renal failure (n=23) have average costs of around £6,000.
- For those with diabetes and 3 or 4+ conditions (Figure 18, Figure 19), costs appear driven as much by the number of conditions as the type: there is little difference between the red and blue lines.
- The exceptions are renal failure, skin infections, skin trauma and stroke, the costs for people with these combinations being above average.

¹ All spider diagrams are drawn from the whole population, not just those over 18.

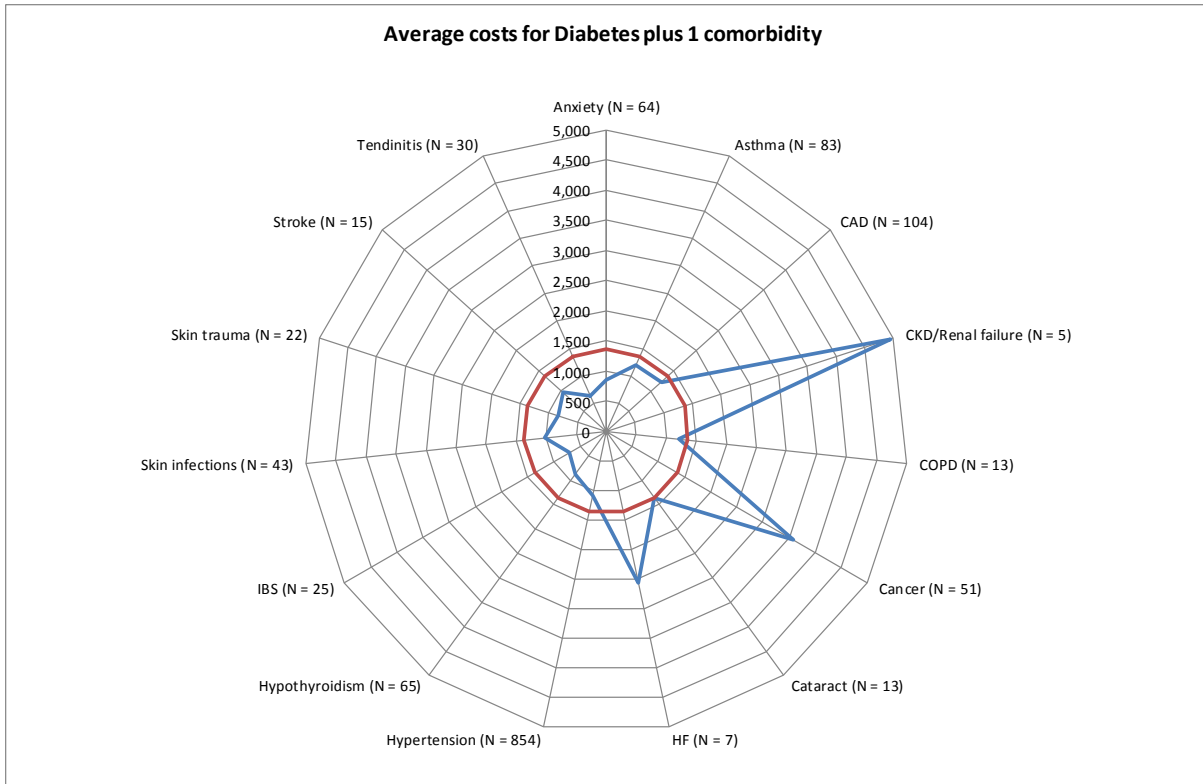


Figure 16 Diabetes plus 1 co-morbidity

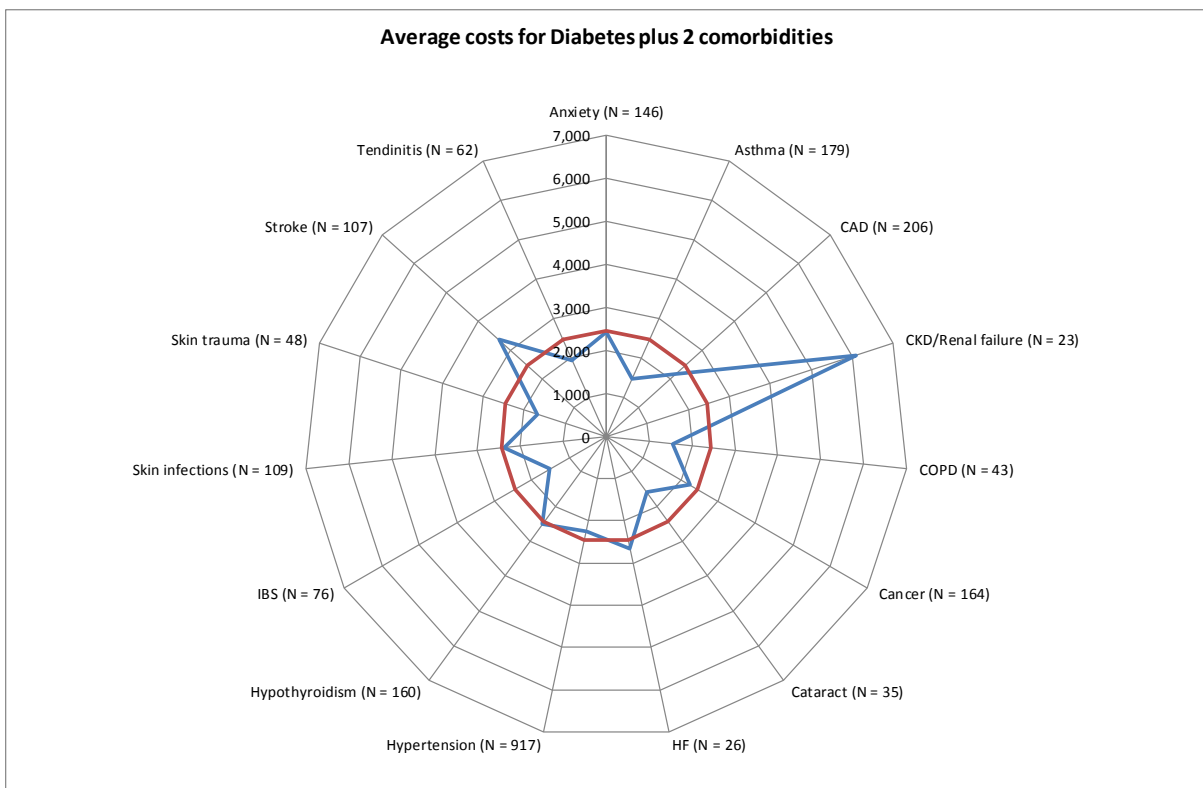


Figure 17 Diabetes plus 2 co-morbidities

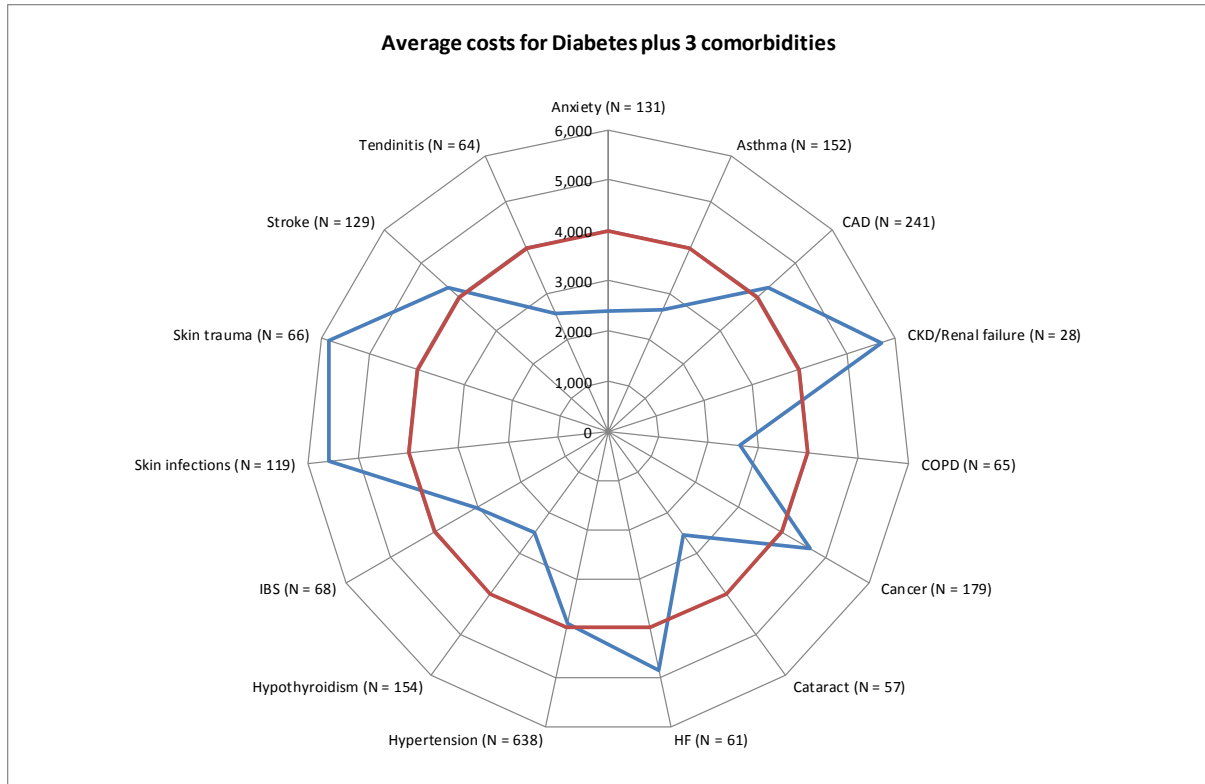


Figure 18 Diabetes plus 3 co-morbidities

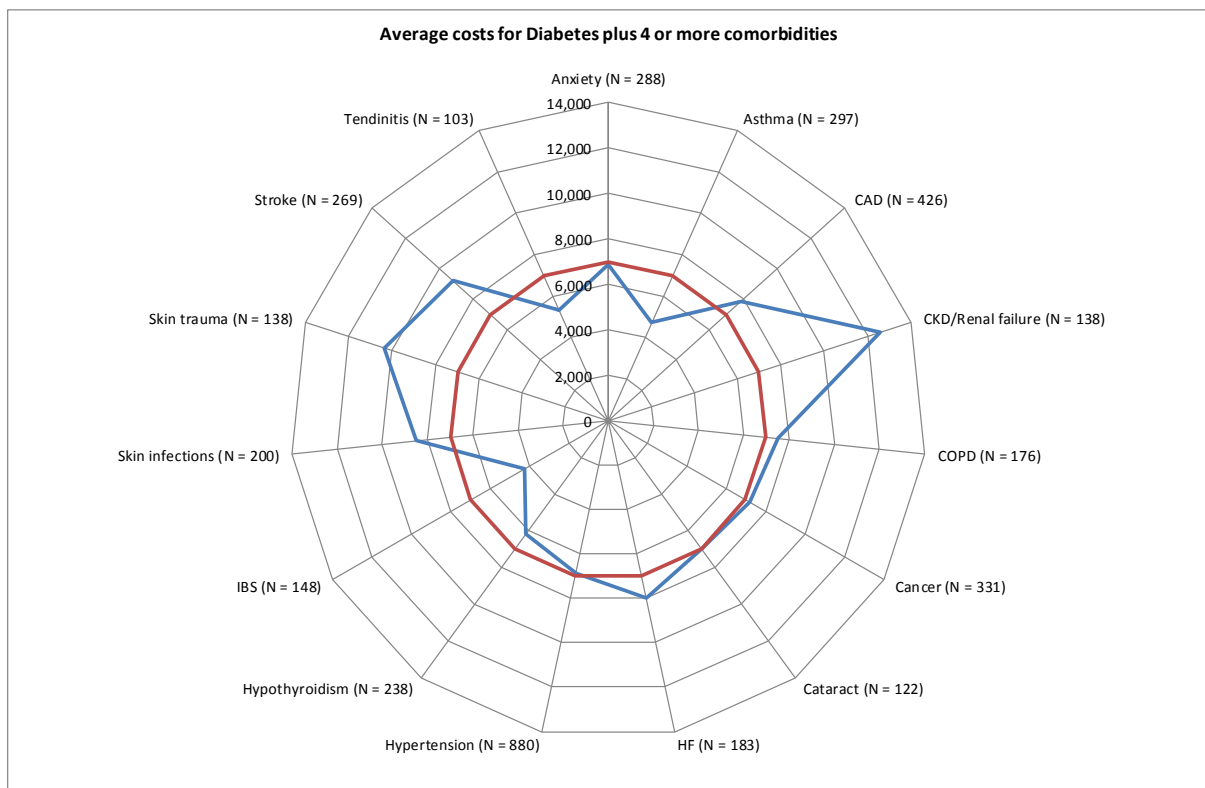


Figure 19 Diabetes plus 4 or more co-morbidities

Regression analyses

In Table 6 we summarise the results of regression analyses of costs incurred in each setting. The following points are of note:

- Virtually no-one with diabetes has zero primary care or prescribing costs.
- In contrast, substantial proportions incur no costs in the other settings. This is particularly evident for mental health, community care, and continuing care costs.
- We are able to explain more than 20% of the variation in primary care and prescribing costs. The inclusion of the variables indicating the broad type of co-morbidity adds little explanatory power.
- 30% of those with diabetes are recorded as having positive inpatient costs but we are able to explain only 15% of the variation in these costs. The co-morbidity variables help improve explanatory power by 3%.
- Very few people with diabetes incur mental health or continuing care costs, but for these people explanatory power is high at 24% and 45% respectively. The inclusion of the co-morbidity variables improves explanatory power considerably.
- The models are poor at explaining variation in social care costs.
- We are able to explain 34% of the variation in total costs by taking account only of age, gender, deprivation, the number of co-morbidities and whether patients died or moved elsewhere. Explanatory power increases to 36% if the set of co-morbidity variables is included.

Table 6 Summary of explanatory power from regression analyses: diabetes

Setting	% with zero costs	Model	Explanatory power	
			Limited	Full
Primary care	0.55	Log	20%	21%
Prescribing	1.01	Log	21%	22%
Inpatient	69.81	Two-part	12%	15%
Outpatient	44.66	Two-part	7%	9%
A&E	78.93	Two-part	19%	21%
Mental health	96.68	Two-part	14%	24%
Community care	97.03	Two-part	39%	45%
Social care	89.64	Two-part	2%	6%
Continuing care	97.85	Two-part	21%	42%
Total	0.18	Log	34%	36%

Table 7 summarises the influence on total costs of the various characteristics of individuals. A positive coefficient indicates that the characteristic in question increases costs and the stars indicate the significance level of the characteristic.

- Deprivation status and the presence of mental health problems or arthritis are not significant influences on the costs of people with diabetes.
- Costs are higher for older people, women, those with more co-morbidities and those who died.
- Costs are higher if people are diagnosed with one of the sets of conditions (with the exceptions of mental health problems or arthritis).

Table 7 Influence of characteristics in explaining total costs for those with diabetes

Variable	Estimate
Age	0.006***
Male	-0.100***
Deprivation	0.003
Number of co-morbidities	0.263***
Died	1.188***
Moved elsewhere	-0.095
Dementia	0.937***
Mental health (exc dementia)	0.069
Cancer	0.176***
Cardio-vascular disease	0.207***
Stroke	0.163***
Obesity	0.562***
Respiratory problems	0.138**
Gastric problems	0.134*
Trauma/burns/fractures	0.382***
Arthritis	-0.030
Renal problems	0.569***

Significance: * $p < 0.1$; ** $p < 0.5$; *** $p < 0.01$

8. Analysis of costs for those with dementia

Overview

Although people with dementia account for only 0.92% of the South Somerset population, the total costs for the 1,062 people recorded as having dementia amounts to £13m (Table 8 and Figure 20)

Table 8 Total cost by setting

GP practice (GP)	£174,461
Prescribing (Rx)	£472,807
Inpatient (IP)	£1,873,156
Outpatient (OP)	£144,990
AE	£81,571
Mental health (MH)	£1,524,991
Community care (CM)	£809,701
Social care (SC)	£4,176,938
Continuing care (CC)	£3,818,728
Total cost	£13,077,343

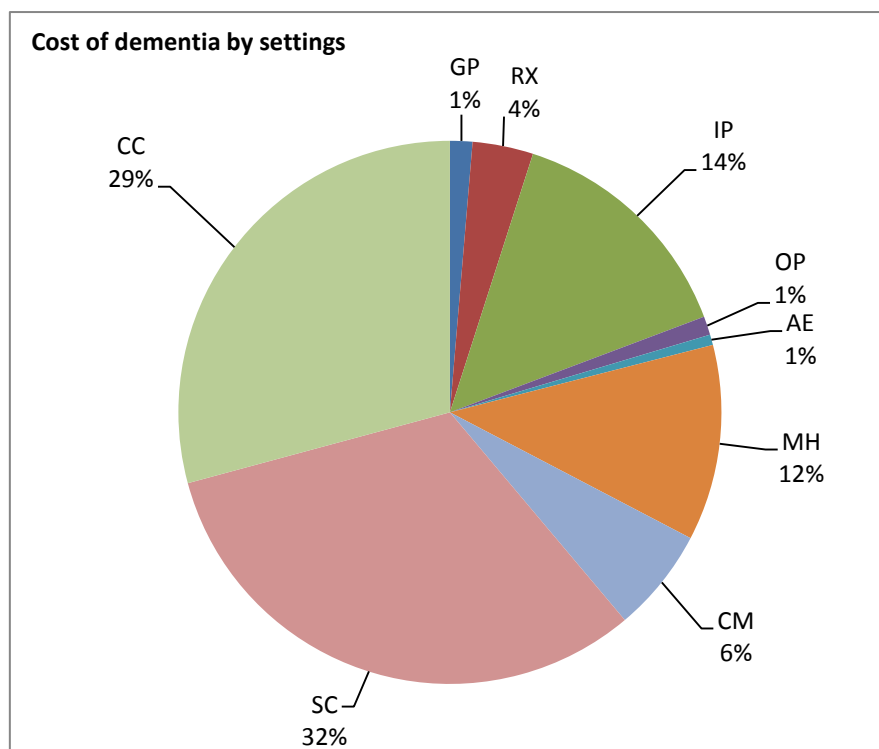


Figure 20 Cost by setting

For people with dementia there is no obvious pattern between the number of conditions and average costs (Figure 21). This is partly because dementia itself is the largest cost driver: the average cost for people with dementia alone is more than £12,000. Additional conditions are likely to be of lower cost. It is also due to the high proportions of total costs accounted for by the costs of continuing care and social care, which do not appear to be driven by multi-morbidity.

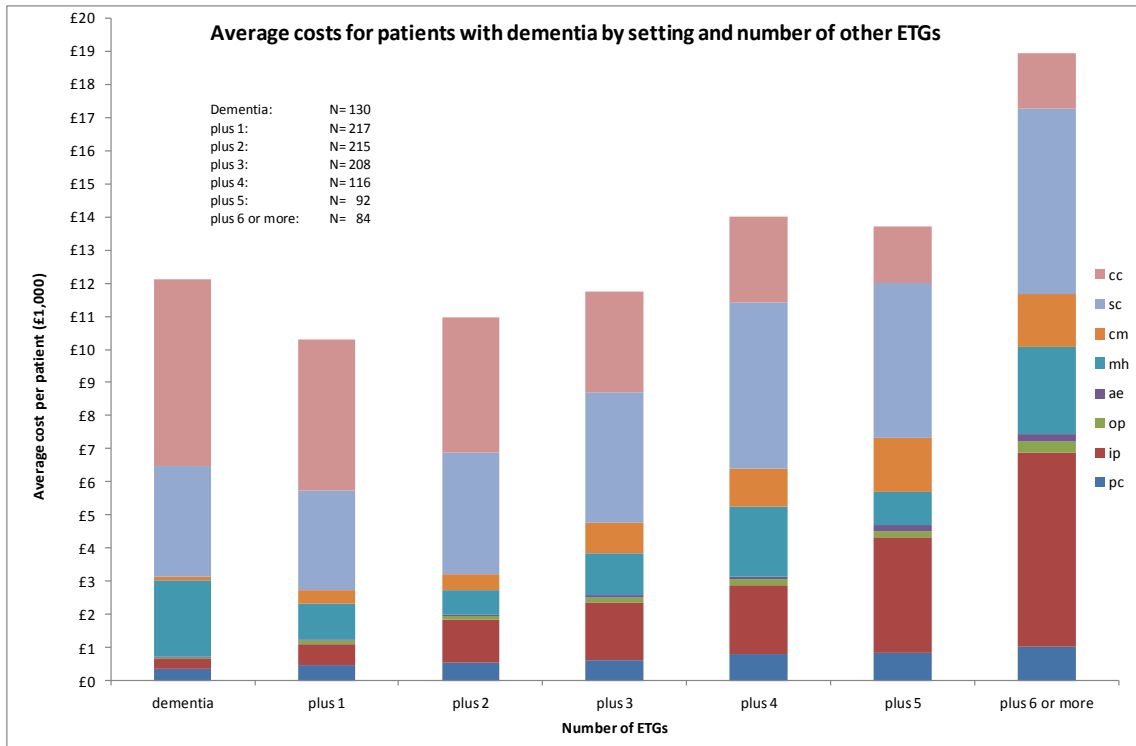


Figure 21 Cost by number of co-morbidities

Co-morbidity patterns

In Figure 22 we show the most common co-morbidities for those with a diagnosis of dementia.

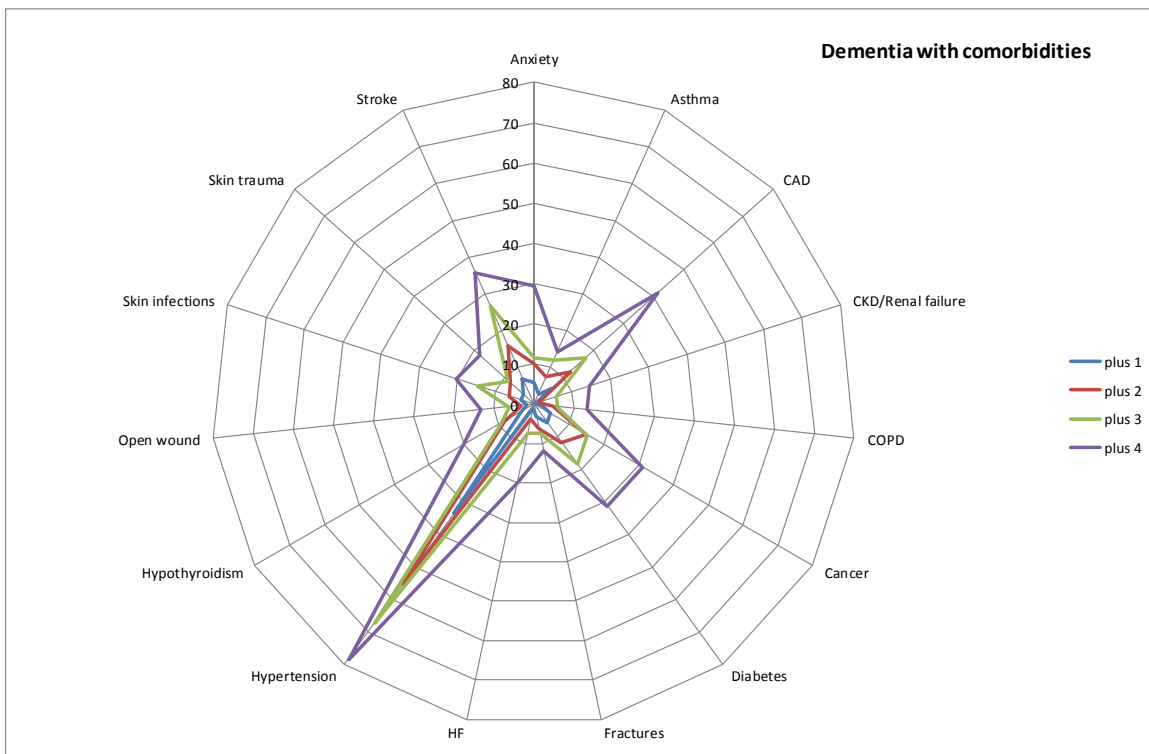


Figure 22 Top 15 most frequent co-morbidities for those with diabetes

- For those with a single additional co-morbidity, this tends to hypertension, which is present for 35% of such people.
- This tendency for hypertension to be present is evident also for those with more co-morbidities. Indeed, for 80% of people with dementia and four or more co-morbidities, hypertension is one of the co-morbidities.
- Among those with four co-morbidities, there is a wide variety of what these other co-morbidities are. 41% have a diagnosis of coronary artery disease, 35% stroke, and 30% have cancer or diabetes.

Costs and co-morbidities

- As Figure 23 shows, the 20 people with dementia who suffered a fracture have costs substantially above the average for those with one or two additional diagnoses.
- Average costs for those with dementia and 4+ conditions (Figure 25) appear driven as much by the number of conditions as the type: there is little difference between the red and blue lines.

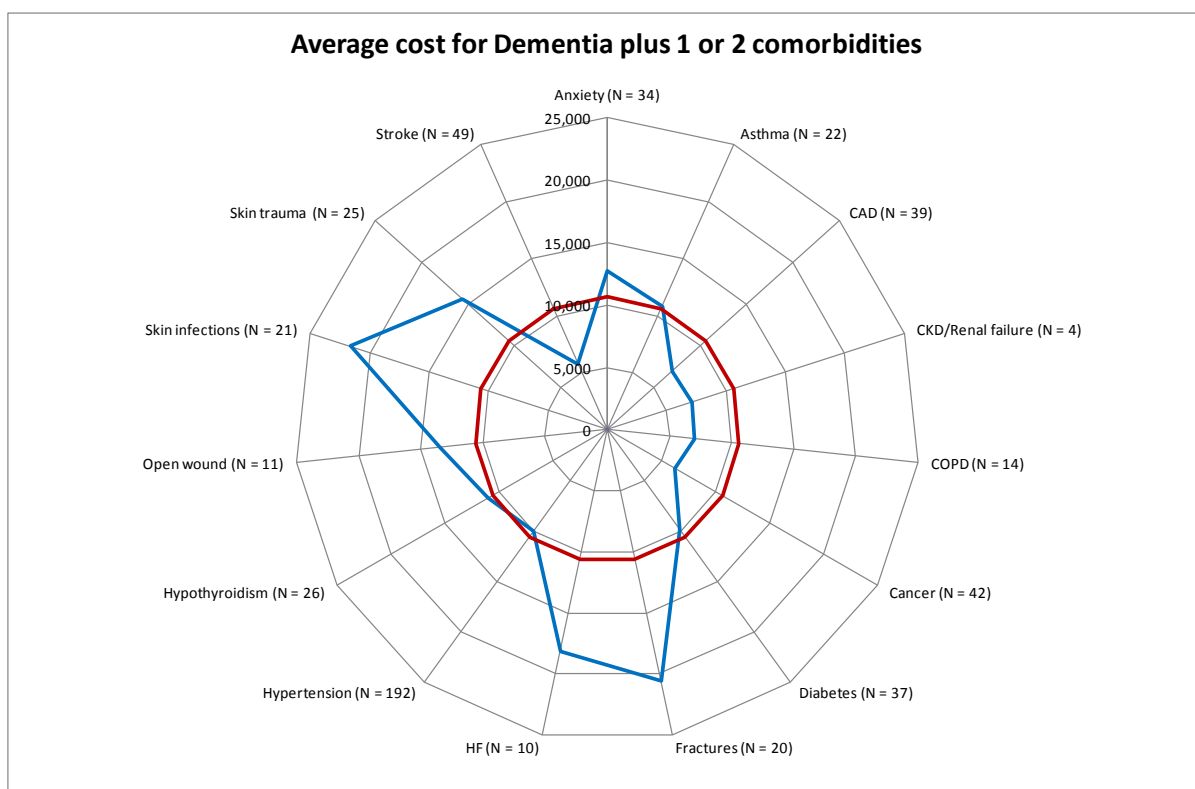


Figure 23 Dementia plus 1 or 2 co-morbidities

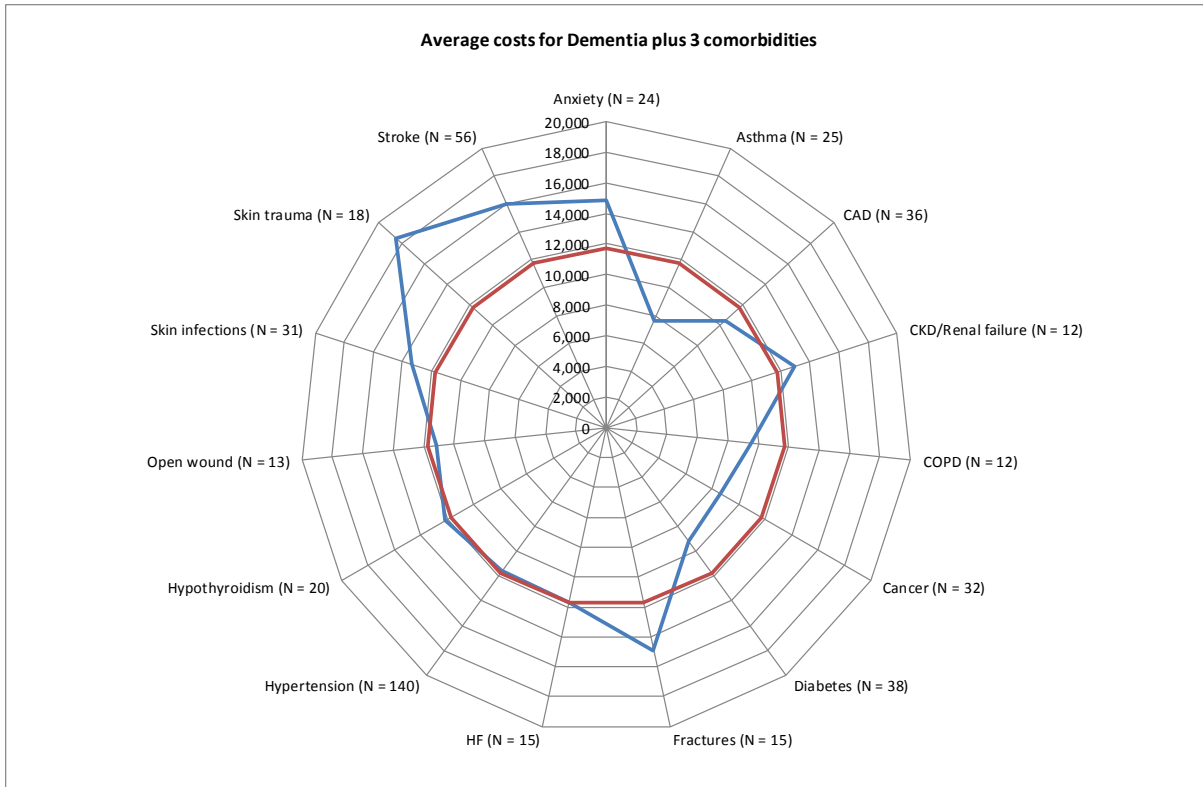


Figure 24 Dementia plus 3 co-morbidities

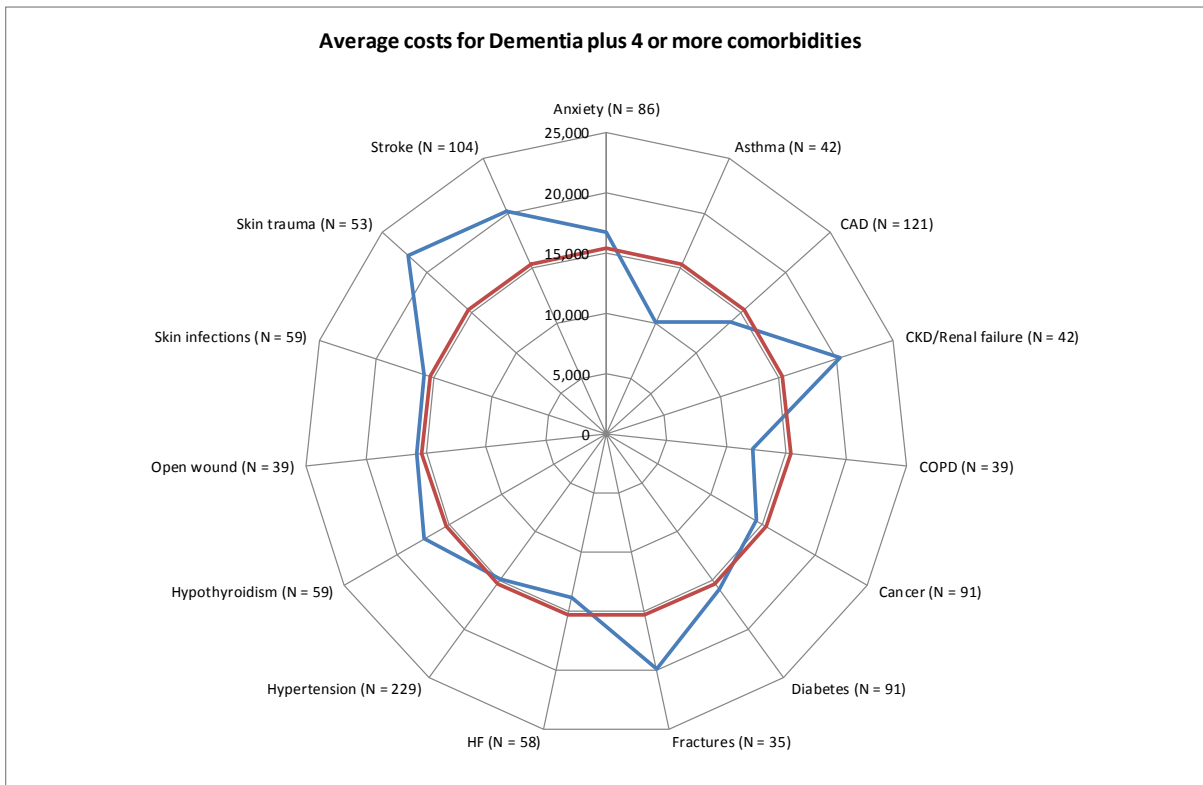


Figure 25 Dementia plus 4 or more co-morbidities

Regression analyses

Table 9 summarises the results of regression analyses of costs for those with dementia by setting and in total. The following points are of note:

- Very few people have zero primary care or prescribing costs and only 0.5% of people with dementia are recorded as having no costs at all.
- Even so, quite large proportions of people (>50%) incur no costs in the other settings.
- We are able to explain 20% of the variation in primary care and 16% of variation in prescribing costs. The inclusion of co-morbidity variables indicating the broad type of co-morbidity adds little explanatory power.
- Around 44% of those with dementia were treated as inpatients. We are able to explain 16% of the variation in inpatient costs. Here the co-morbidity variables help improve explanatory power by 6%.
- 18% of people with dementia had continuing care costs, but for these people explanatory power is reasonably good at 27%. The inclusion of the co-morbidity variables improves explanatory power considerably.
- The models are poor at explaining variation in the costs of mental health care (7%) and social care (4%).
- We are able to explain 11% of the variation in total costs by taking account of age, gender, deprivation, the number of co-morbidities and whether patients died or moved elsewhere. Explanatory power increases to 15% if the set of co-morbidity variables is included.

Table 9 Summary of explanatory power from regression analyses: dementia

Setting	% with zero costs	Model	Explanatory power	
			Limited	Full
Primary care	1.13	Log	18%	20%
Prescribing	2.17	Log	15%	16%
Inpatient	56.31	Two-part	10%	16%
Outpatient	57.34	Two-part	9%	13%
A&E	62.24	Two-part	15%	20%
Mental health	50.38	Two-part	3%	7%
Community care	92.75	Two-part	6%	24%
Social care	51.32	Two-part	3%	4%
Continuing care	82.02	Two-part	18%	27%
Total	0.47	Log	11%	15%

Table 10 summarises the influence on total costs of the various characteristics of individuals.

- Age and gender are not significant influences on the costs of people with dementia.
- Costs are higher for those from more deprived areas, those with more co-morbidities and those who died.
- Costs are higher if people are diagnosed with Trauma/burns/fractures and Renal problems but not for the other variables (with the exceptions of Stroke and Respiratory problems at lower significance levels).

Table 10 Influence of characteristics in explaining total costs for those with dementia

Variable	Estimate
Age	0.01
Male	-0.10
Deprivation	0.02***
Number of co-morbidities	0.14***
Died	0.67***
Moved elsewhere	0.07
Diabetes	0.08
Mental health (exc dementia)	0.23
Cancer	-0.18
Cardio-vascular disease	-0.09
Stroke	0.23*
Obesity	1.37
Respiratory problems	0.30*
Gastric problems	0.00
Trauma/burns/fractures	0.61***
Arthritis	-0.59
Renal problems	0.54**

Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

9. Analysis of costs for those with diabetes and dementia

Overview

6,521 people are recorded as having either diabetes or dementia. There is little overlap between these groups: only 166 (2%) people are identified as having both conditions (Figure 27). The total cost of care for this combined group amounts to £28m (Table 11 and Figure 26).

Table 11 Total cost by setting

GP practice (GP)	£1,163,285
Prescribing (Rx)	£2,778,463
Inpatient (IP)	£7,456,346
Outpatient (OP)	£1,543,905
AE	£281,422
Mental health (MH)	£2,288,199
Community care (CM)	£1,504,421
Social care (SC)	£6,651,990
Continuing care (CC)	£4,401,048
Total cost	£28,069,078

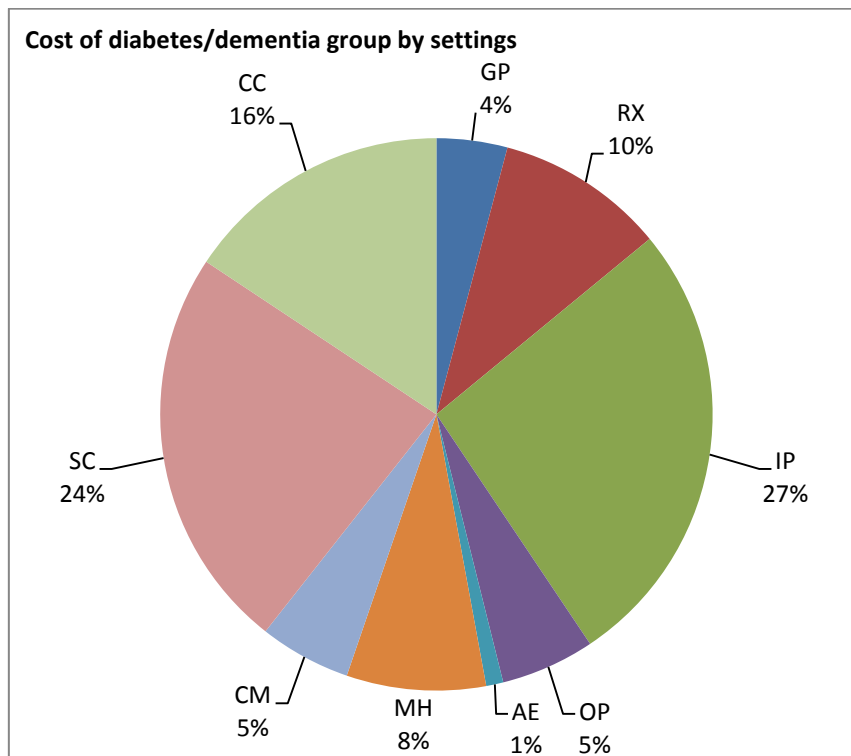


Figure 26 Costs by setting

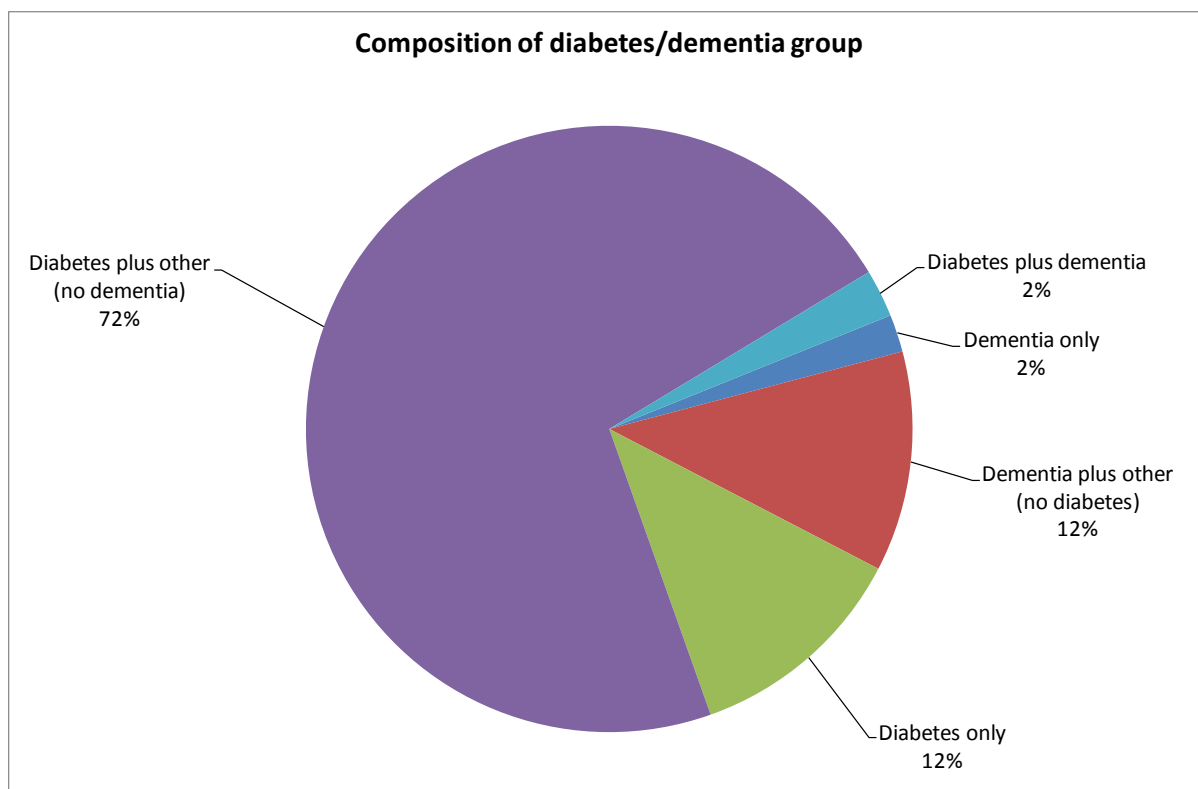


Figure 27 Composition of those with diabetes and dementia

Regression analyses

Table 12 summarises the results of regression analyses of costs incurred in each setting. The following points are of note:

- Very few people have zero primary care or prescribing costs and only 0.2% of people are recorded as having no costs at all.
- Quite large proportions of people incur no costs in the other settings.
- We are able to explain 21% of the variation in primary care and 20% of variation in prescribing costs.
- Around 32% of those with diabetes or dementia were treated as inpatients. We are able to explain 16% of the variation in inpatient costs.
- 4% of people with diabetes or dementia had continuing care costs, but for these people explanatory power is reasonably good at 33%. The inclusion of the co-morbidity variables improves explanatory power by 8%.
- The models are poor at explaining variation in social care costs.
- We are able to explain 36% of the variation in total costs by taking account only of the limited set of variables. Explanatory power increases to 38% if the set of co-morbidity variables is included.

Table 12 Summary of explanatory power from regression analyses: diabetes & dementia

Setting	% with zero costs	Model	Explanatory power	
			Limited	Full
Primary care	0.64	Log	20%	21%
Prescribing	1.21	Log	20%	20%
Inpatient	68.29	Two-part	12%	16%
Outpatient	46.73	Two-part	8%	10%
A&E	78.64	Two-part	18%	21%
Mental health	90.17	Two-part	11%	13%
Community care	96.46	Two-part	41%	46%
Social care	84.62	Two-part	7%	8%
Continuing care	95.72	Two-part	25%	33%
Total	0.23	Log	36%	38%

Table 13 summarises the influence on total costs of the various characteristics of individuals.

- Costs are lower for males.
- Costs are higher for older people, women, those from more deprived areas, those with more co-morbidities, and those who died during the year.
- Costs are higher if people are diagnosed with all groups of conditions except gastric problems and arthritis.

Table 13 Influence of characteristics in explaining total costs for those with diabetes and dementia

Variable	Estimate
Age	0.008***
Male	-0.098***
Deprivation	0.005***
Number of co-morbidities	0.247***
Died	1.051***
Moved elsewhere	-0.045
Dementia, no diabetes	1.050***
Dementia and diabetes	0.959***
Mental health (excluding dementia)	0.085*
Cancer	0.114**
Cardio-vascular disease	0.155***
Stroke	0.140***
Obesity	0.570***
Respiratory problems	0.157***
Gastric problems	0.097
Trauma/burns/fractures	0.425***
Arthritis	-0.121
Renal problems	0.569***

Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

10. Conclusions

South Somerset's Symphony Project is designed to establish greater collaboration between primary, community, mental health, acute and social care, particularly for people with complex conditions. The Project recognises that financial arrangements need to be revised so as to support organisations to work collaboratively around the needs of patients (Department of Health, 2012).

To support this ambition, the Symphony Project has built a large dataset comprising information about each anonymised individual in the South Somerset population. The dataset has three key features: (i) it links acute, primary care, community, mental health and social care data; (ii) costs are assigned to each individual according to the type of care they have received in each setting; and (iii) demographic characteristics are available for each individual, including age, gender, socio-economic measures, and indicators of morbidity.

We define a set of chronic conditions allowing us to examine the multi-morbidity profile of each individual. This allows us to describe the frequency of occurrence of each chronic condition in the population; the combinations of each condition with other co-morbidities; the utilisation of services across different settings; and the costs of care.

As well as looking at the population as a whole, we perform sub-group analyses for people with specific conditions, namely diabetes, dementia, hypertension, asthma, fractures, coronary artery disease, cancer, chronic obstructive pulmonary disease, stroke and mental health (other than dementia).

We analyse why costs vary from one person to another by applying multivariate regression models to analyse each person's total costs and costs incurred in each setting. While costs are positively associated with age, we find that multi-morbidity is much more important in explaining variations in costs across individuals. In fact, age adds little explanatory power once we have accounted for the number of conditions in analysing costs.

This work forms a basis for identifying groups that would most benefit from improved integrated care, which might be facilitated by integrated financial arrangements and better pathway management. The more co-morbidities that a person has, the more likely they are to require care across diverse settings, and the higher their costs. Our analysis identifies those groups of the population which are the highest users of services by activity and cost and provides baseline information to allow budgetary arrangements to be developed for these targeted groups.

Appendix: Analysis of selected conditions

We explore the multi-morbidity profiles and cost data for each condition across settings and according to the number of conditions people have. Figures 28 – 43 provide examples for those people recorded as having hypertension, asthma, fractures, coronary artery disease, cancer, chronic obstructive pulmonary disease, stroke and mental health (other than dementia).

Hypertension

- Hypertension is the most common diagnosis, recorded for 17,777 of the South Somerset population.
- The total cost of care received by these people amounts to £45m, reflecting both the number of people with this diagnosis and the common combination of hypertension with other co-morbidities.
- Hypertension alone is not a big driver of costs, average costs for people with only this diagnosis amounting to £667.
- Diverse diagnoses are recorded alongside hypertension, notably diabetes, cancer, hyperthyroidism, CAD, asthma and stroke.

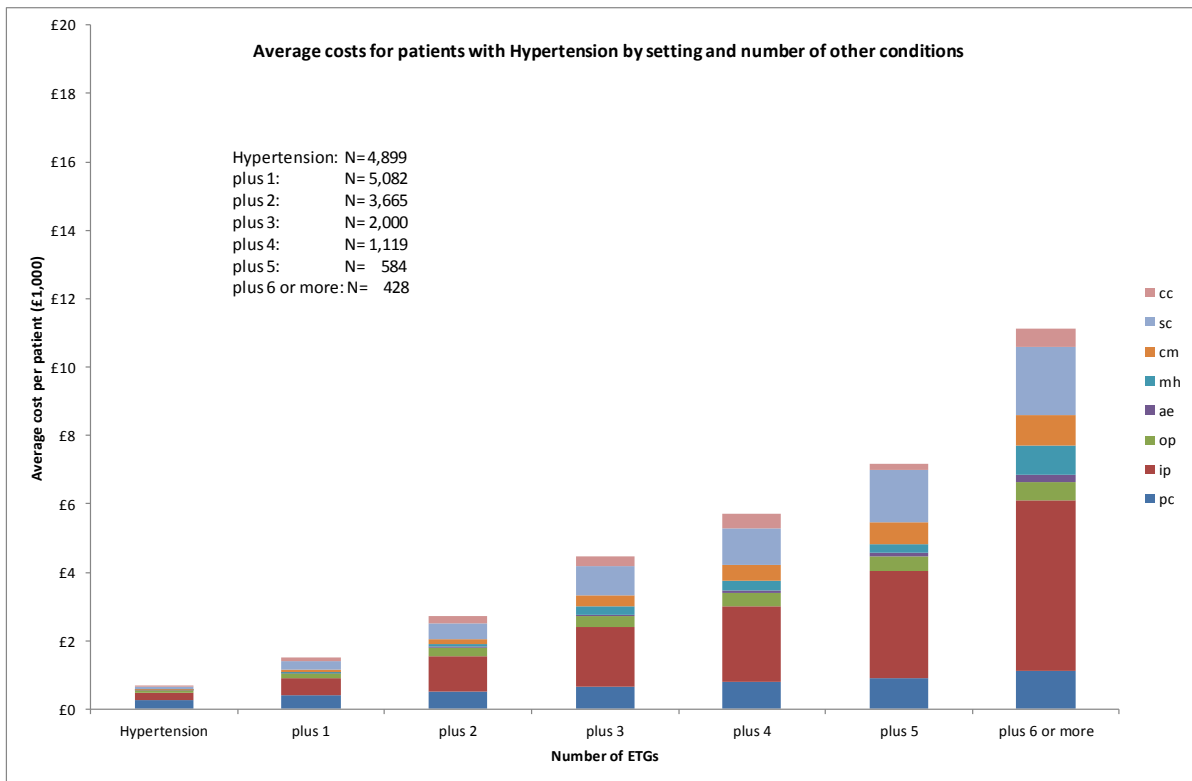


Figure 28 Average costs by setting and number of conditions, hypertension

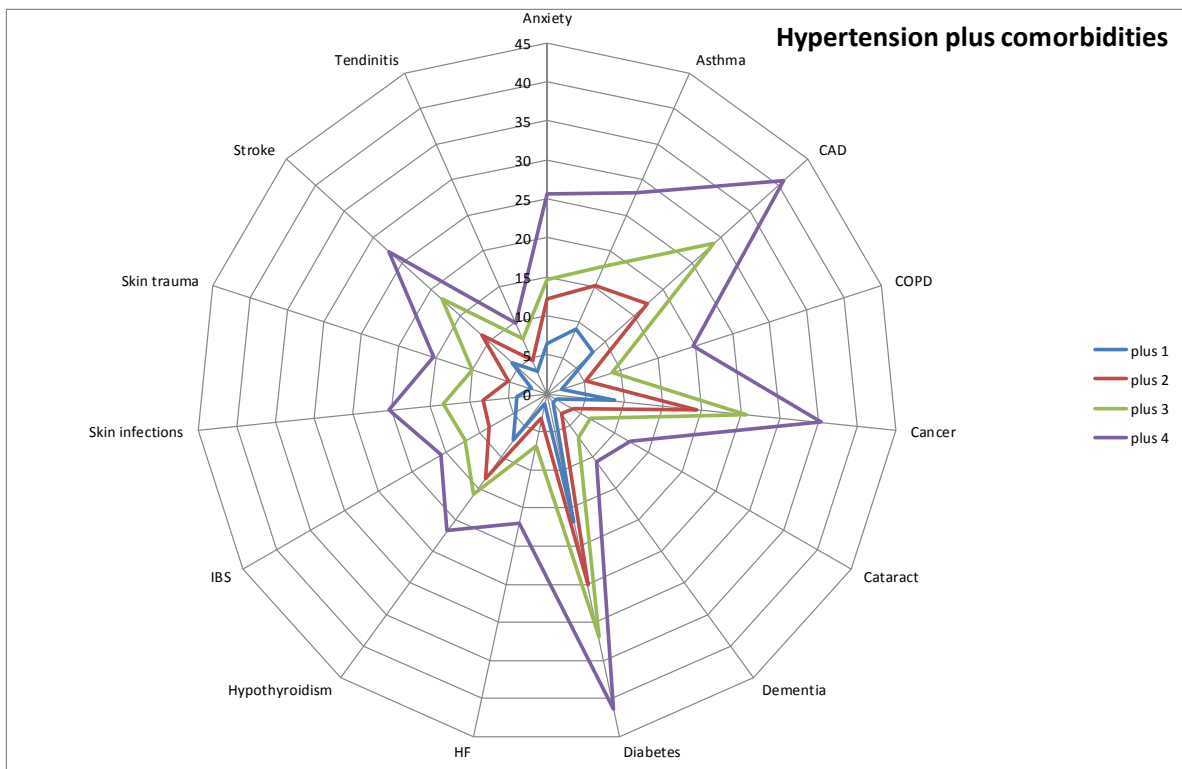


Figure 29 Top 15 most frequent co-morbidities for those with hypertension

Asthma

- Asthma is the second most common diagnosis (after hypertension) in the South Somerset population (n=12,769). The total cost of care for these patients amounts to £17m.
- Alone asthma is not a costly condition to manage, the average cost amounting to around £400.
- As asthma is combined with other (invariably more costly) conditions, the average costs increase for people who are recorded as having asthma. This is due to the management of these other conditions, rather than asthma itself.
- No specific co-morbidity stands out for those with a single additional co-morbidity.
- As more co-morbidities are recorded, the likelihood is that one of these will be hypertension or anxiety (largely reflecting their presence in the population).
- For those with multiple co-morbidities (4+), there is a wide range of combinations of what these might be.

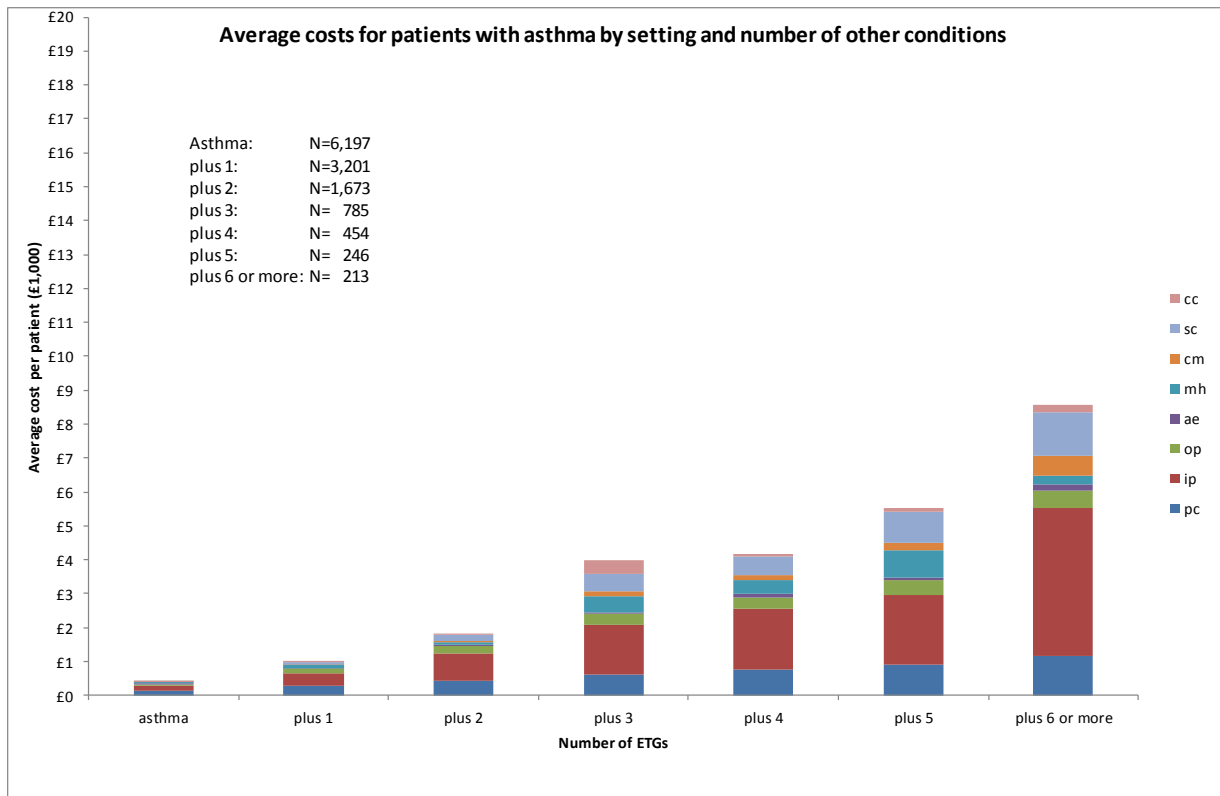


Figure 30 Average costs by setting and number of conditions, Asthma

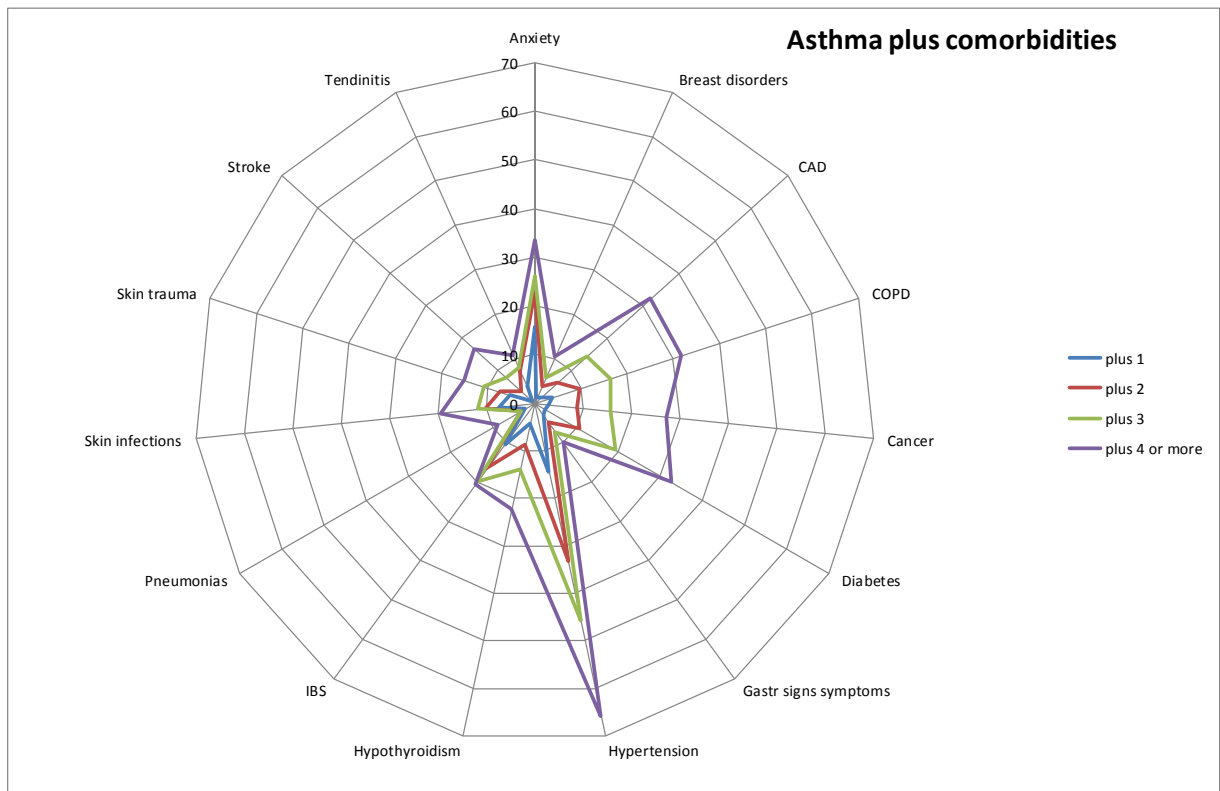


Figure 31 Top 15 most frequent co-morbidities for those with asthma

Fractures

- Fracture is recorded for 1,546 people, the total cost of care for these patients amounting to £7.2m.
- 511 people are recorded as having a fracture only, the average cost amounting to £1,700.
- As more conditions are recorded, average costs increase.
- Most costs are incurred in the inpatient setting.
- For those with a single additional co-morbidity, this tends to be asthma (20%) or hypertension (15%).
- This tendency for asthma or hypertension to be present is evident also for with those with two or three additional co-morbidities.
- For people with four or more co-morbidities, hypertension is invariably present (>70%), but there is a wide variety of other co-morbidities.

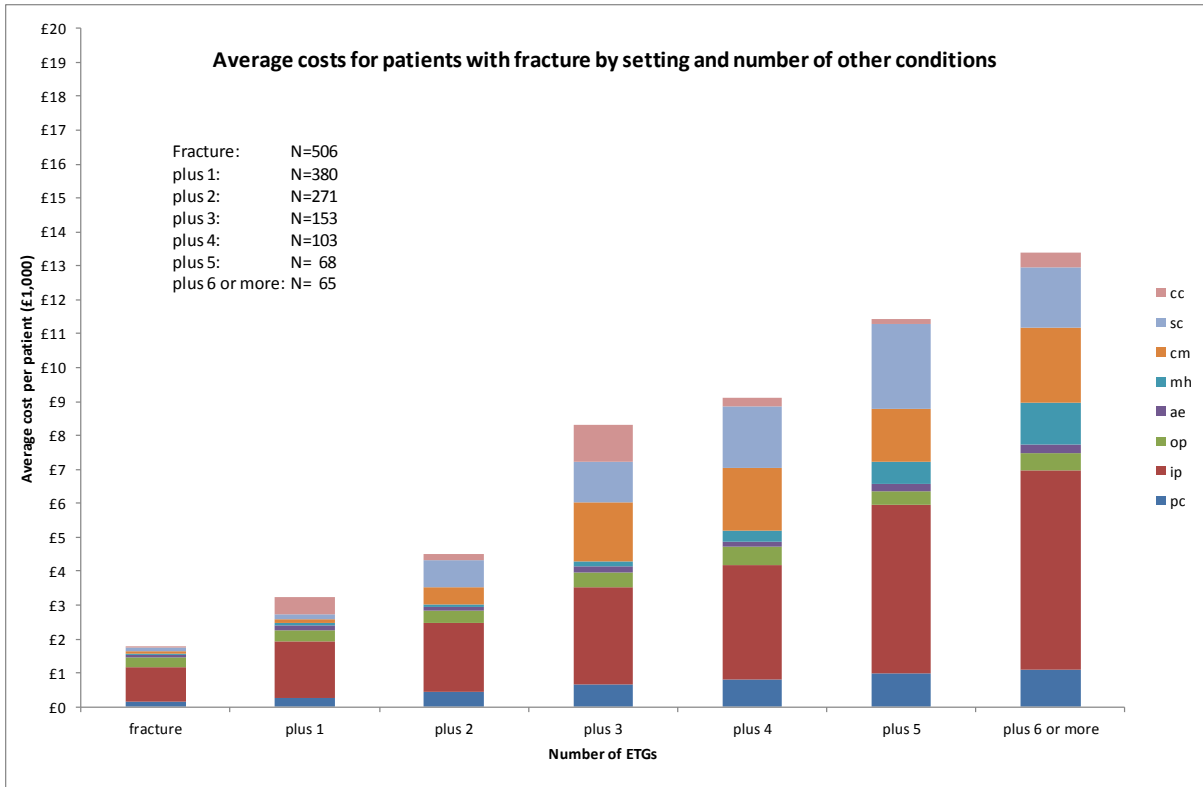


Figure 32 Average costs by setting and number of conditions, fracture

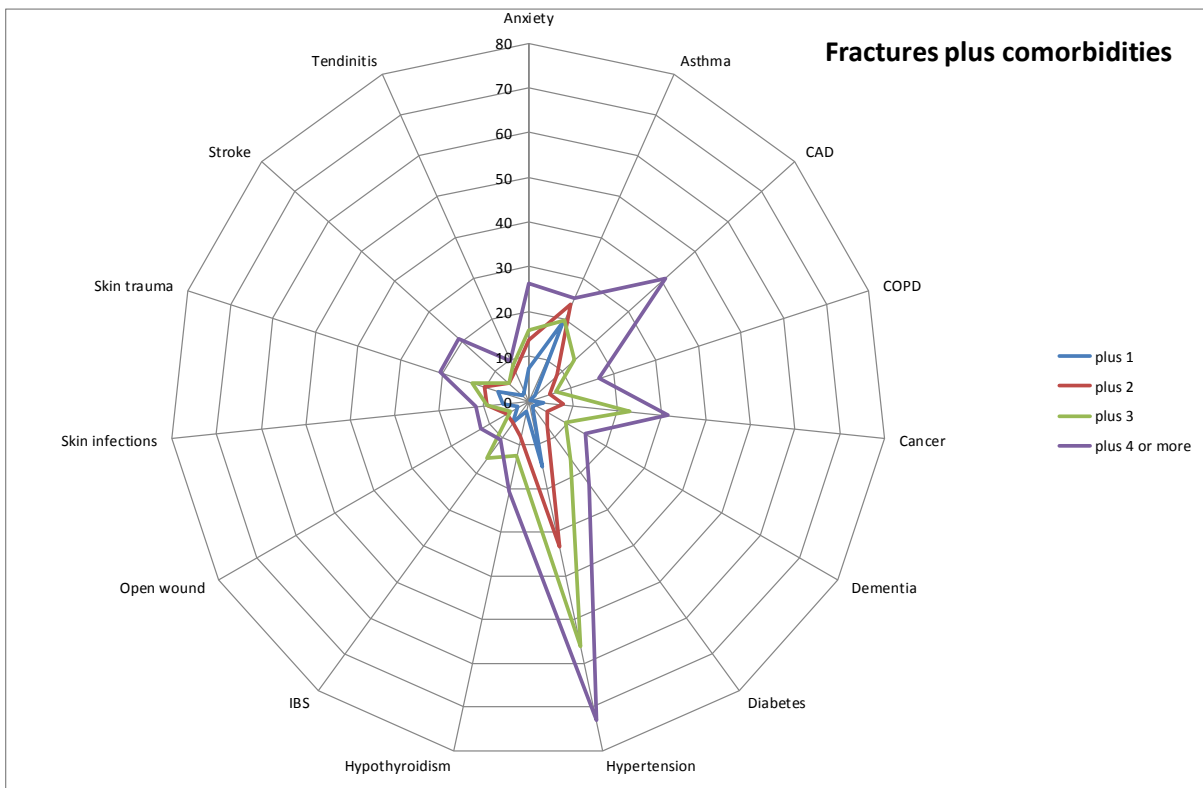


Figure 33 Top 15 most frequent co-morbidities for those with fractures

Coronary Artery Disease

- 4,695 people have coronary artery disease, the total costs of their care amounting to £18.3m.
- 695 people have this sole diagnosis, their costs amounting to around £1,300 on average.
- Inpatient costs account for the highest proportion of costs, with social care costs increasing in importance as more co-morbidities are recorded.
- Hypertension is the most common co-morbidity for people with CAD, followed by diabetes and cancer.

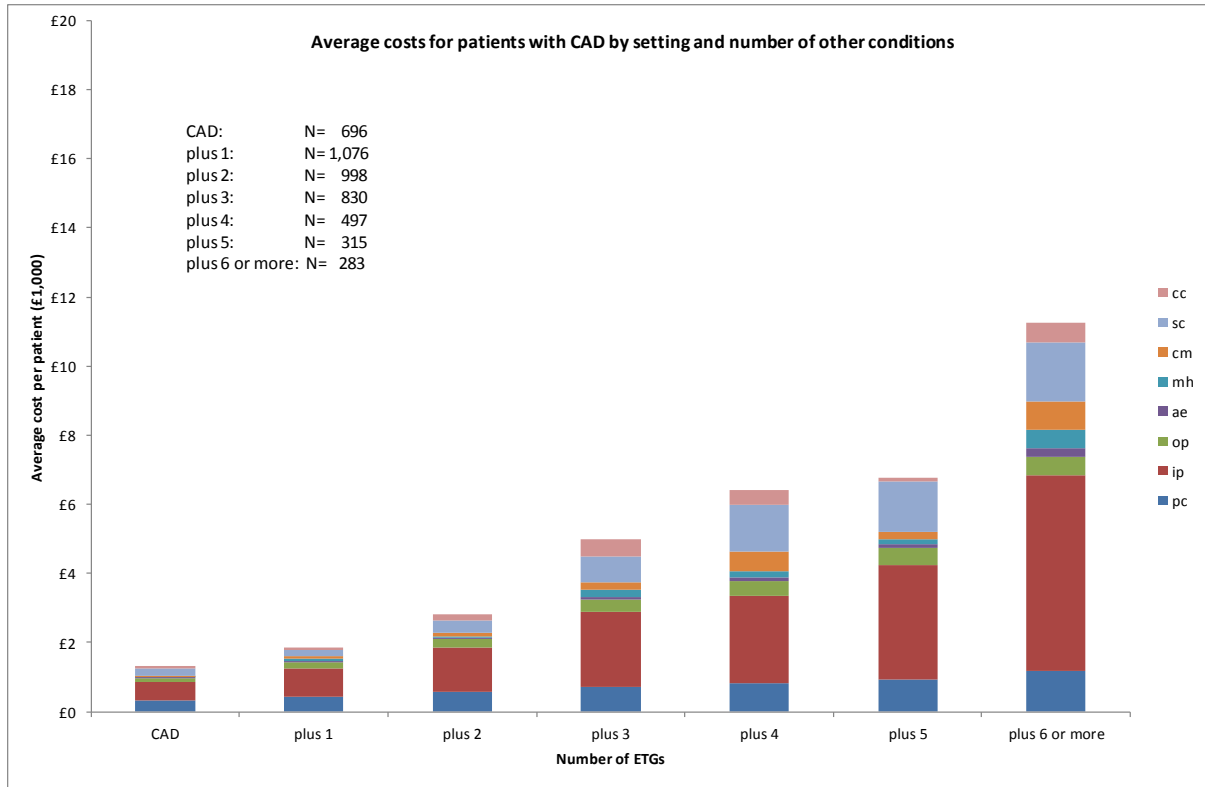


Figure 34 Average costs by setting and number of conditions, coronary artery disease

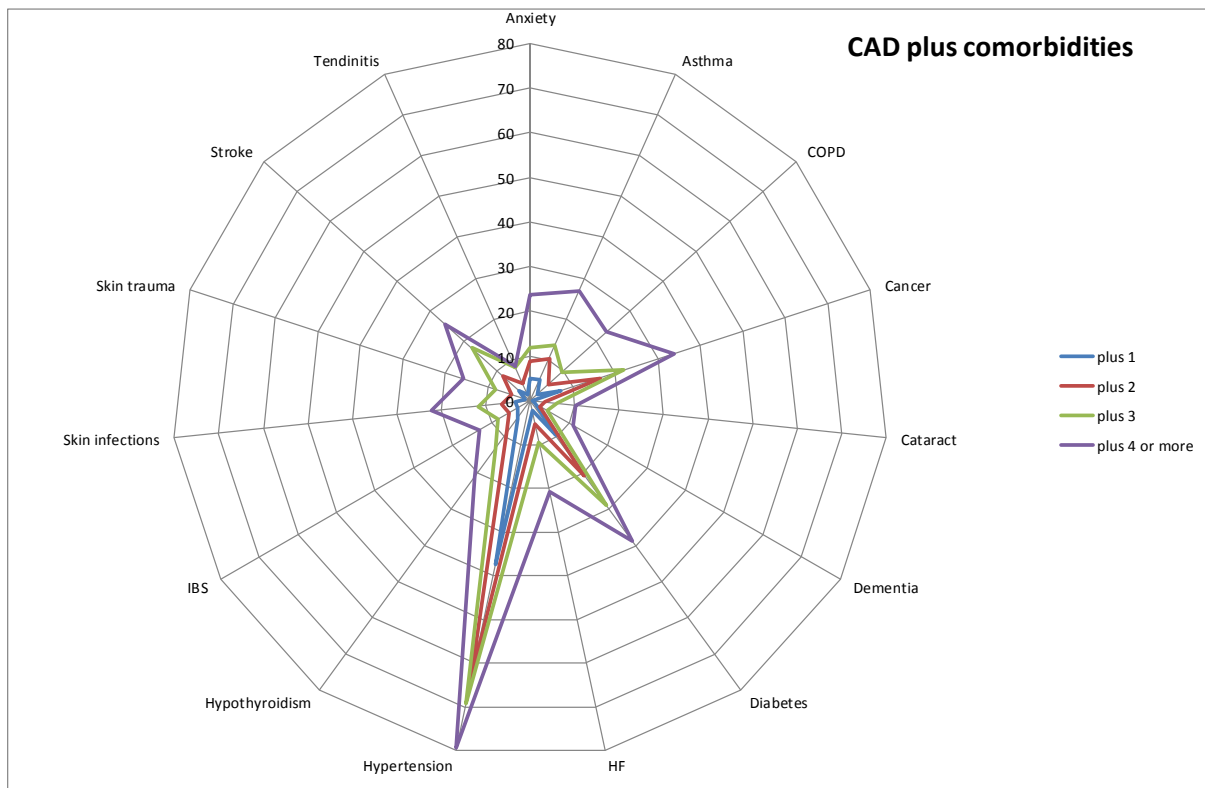


Figure 35 Top 15 most frequent co-morbidities for those with CAD

Cancer

- There are 5,932 people with a cancer diagnosis, the total costs of their care amounting to £19m.
- 1,069 people have this sole diagnosis, their costs amounting to around £1,300 on average.
- Inpatient costs account for the highest proportion of costs, with social, community and primary care costs increasing progressively in importance as more co-morbidities are recorded.
- Breast disorders and hypertension are the most common co-morbidities.

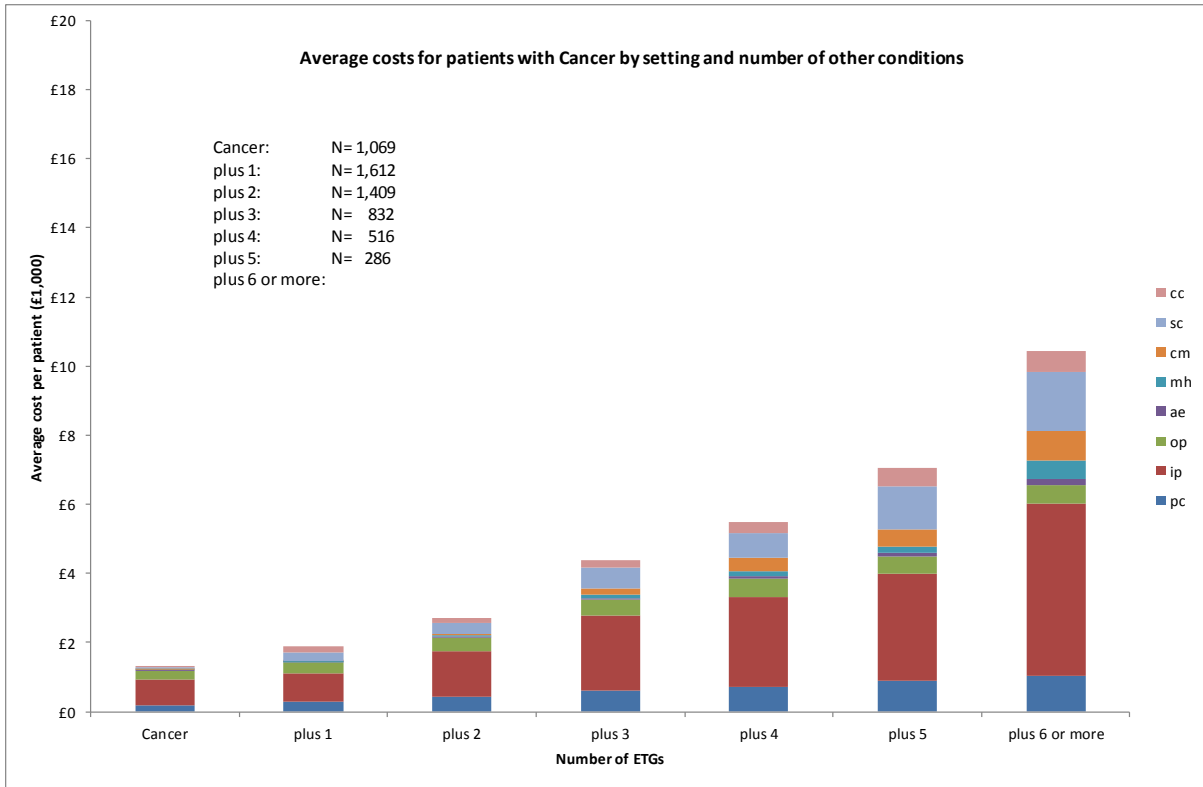


Figure 36 Average costs by setting and number of conditions, cancer

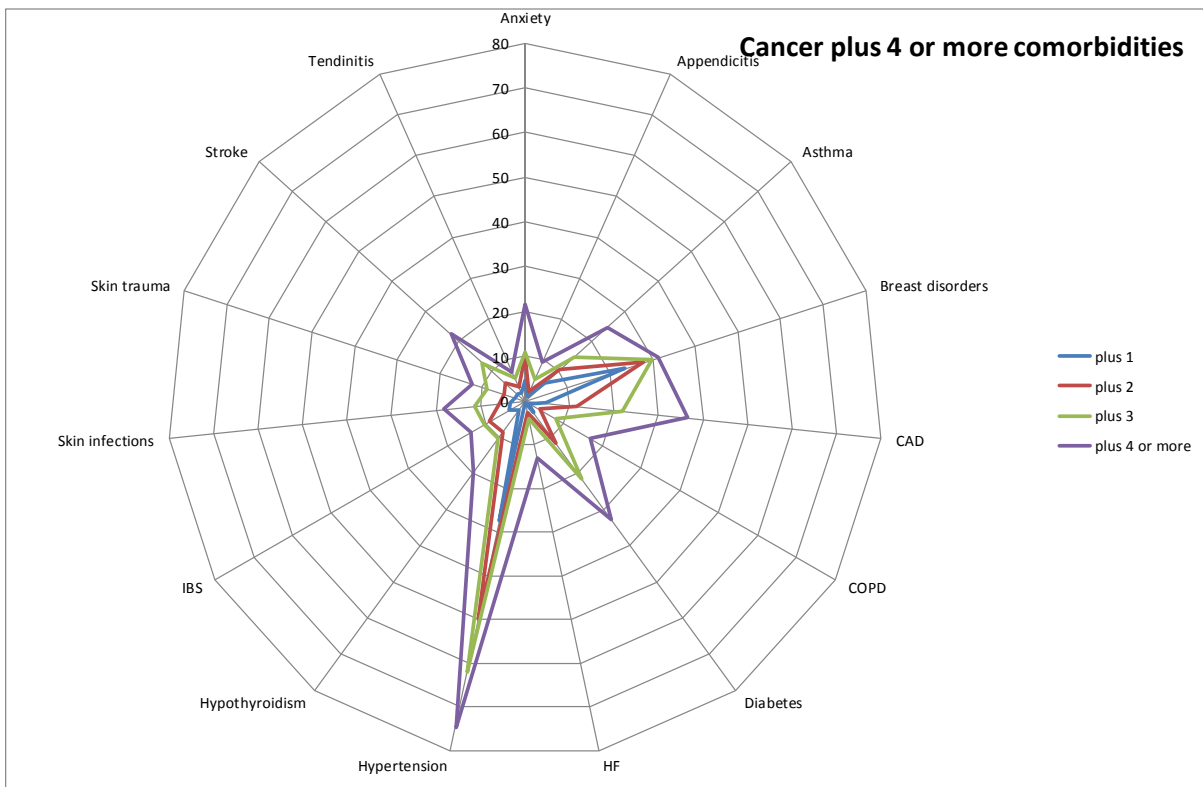


Figure 37 Top 15 most frequent co-morbidities for those with Cancer

Chronic obstructive pulmonary disease

- 1,989 people have a diagnosis of COPD, the total costs of their care amounting to £7.6m.
- Only 202 (10%) have this sole diagnosis, their costs amounting to around £1,000 on average and for whom primary care costs account for the greatest proportion.
- The more diagnoses recorded, the greater the proportion of costs incurred in inpatient and social care settings.
- Asthma and hypertension are the most common co-morbidities.
- There is a wide diversity of co-morbidities for those with 4+ co-morbidities

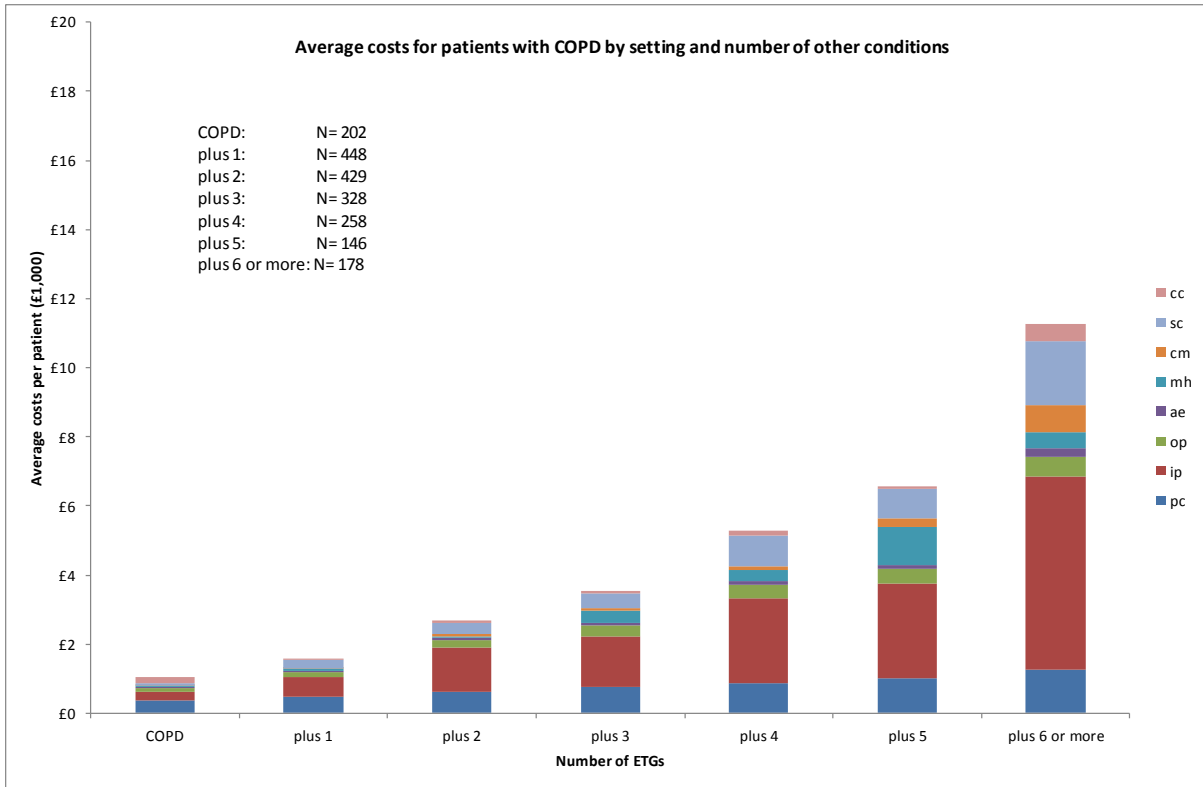


Figure 38 Average costs by setting and number of conditions, COPD

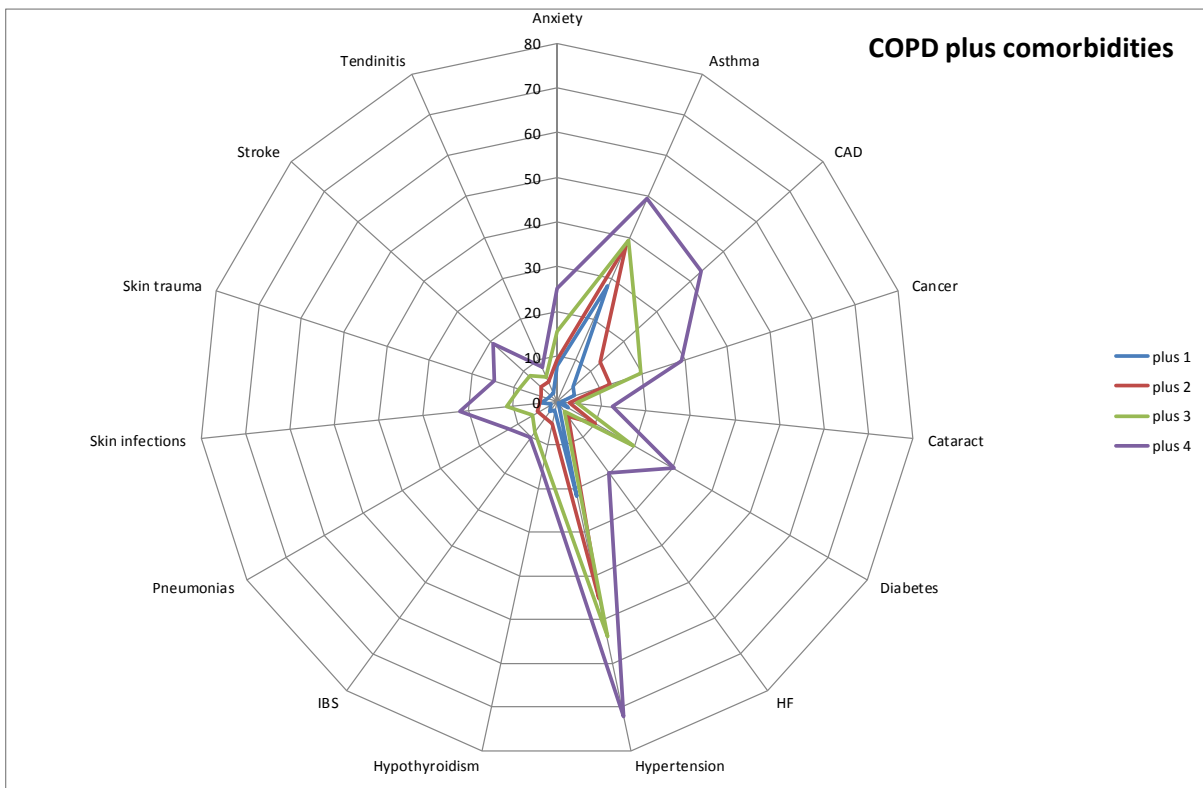


Figure 39 Top 15 most frequent co-morbidities for those with COPD

Stroke

- 2,665 people are recorded as having suffered a stroke, the total cost of their care amounting to £14m.
- Only 10% of these people have stroke as a sole diagnosis, their average costs amounting to £2,100.
- Care is provided across various settings, with social care accounting for a high proportion of costs.
- As more diagnoses are recorded, costs in other settings increase, notably inpatient, community, primary and continuing care.
- Hypertension is by far the most common additional diagnosis, irrespective of how many diagnoses are recorded.

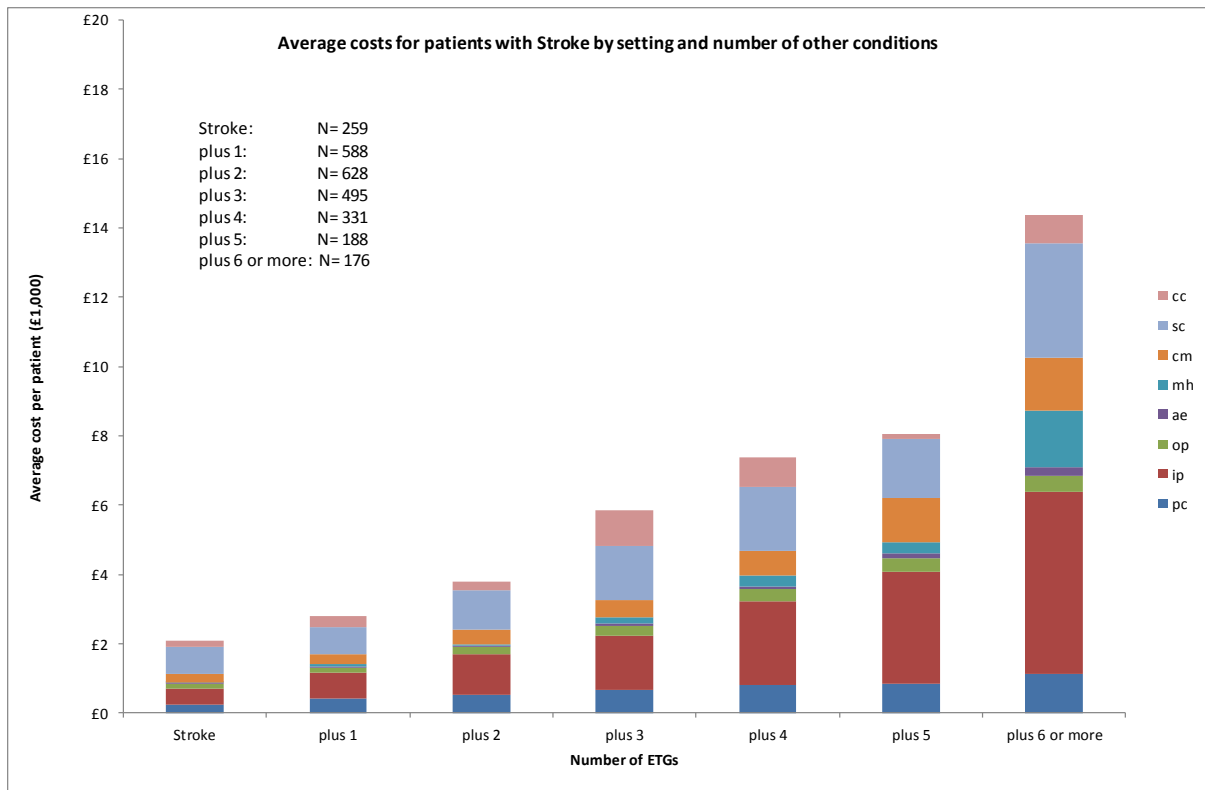


Figure 40 Average costs by setting and number of conditions, Stroke

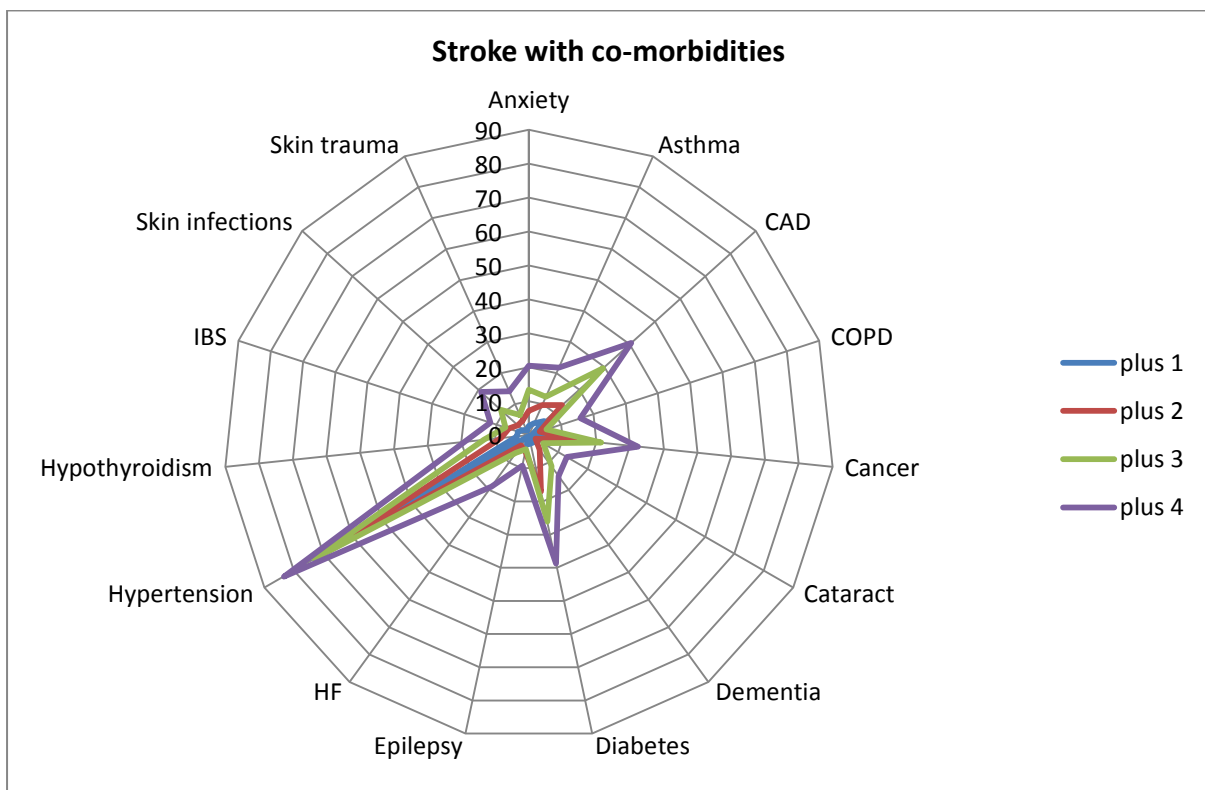


Figure 41 Top 15 most frequent co-morbidities for those with Stroke

Mental health (other than dementia)

- 1,294 people diagnosed with Mental Health problems (other than dementia), their total costs amounting to £7.1m.
- Costs are high, amounting to almost £3,700 for those for whom Mental health is the sole diagnosis.
- Costs are incurred across diverse settings, increasingly so as people have more co-morbidities.
- For those with a single additional co-morbidity, this tends to be anxiety (40%), followed by eating disorders (15%).
- As more co-morbidities are recorded the likelihood of having a diagnosis of anxiety increases markedly but alcohol dependence, asthma and hypertension also become common.

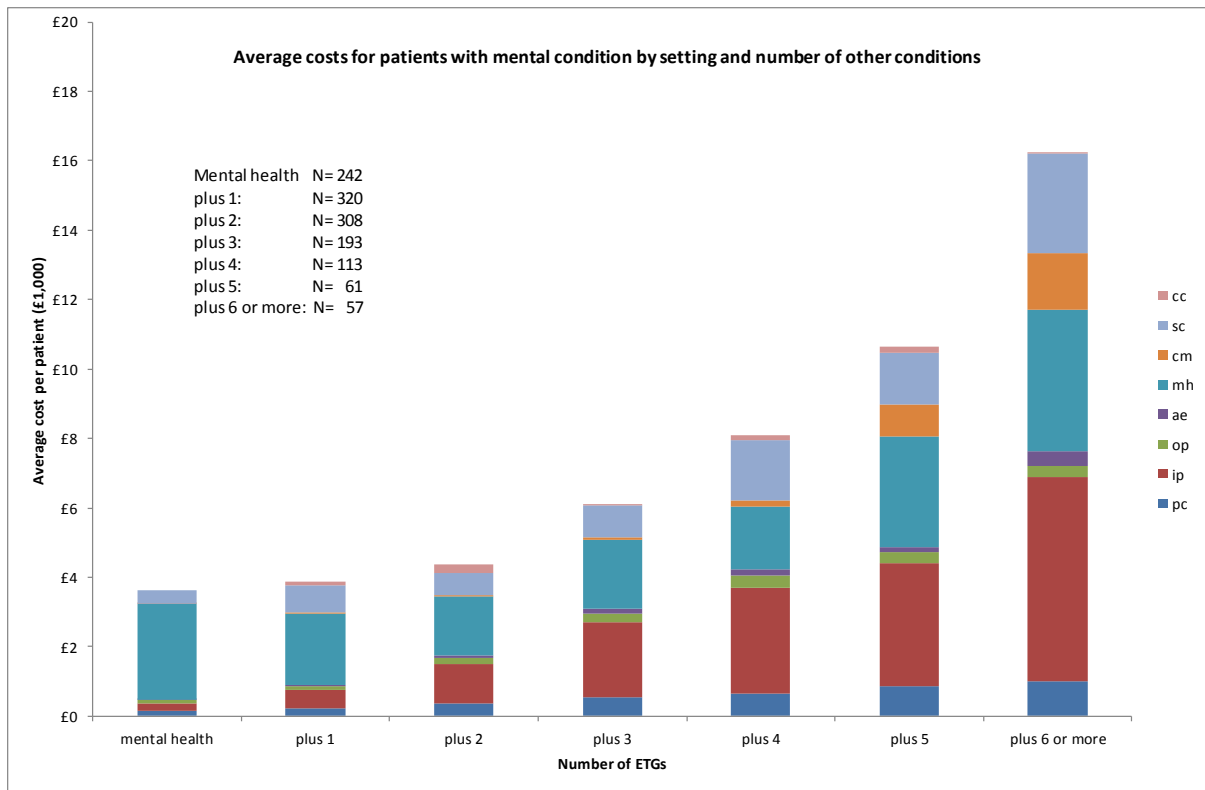


Figure 42 Average costs by setting and number of conditions, mental health

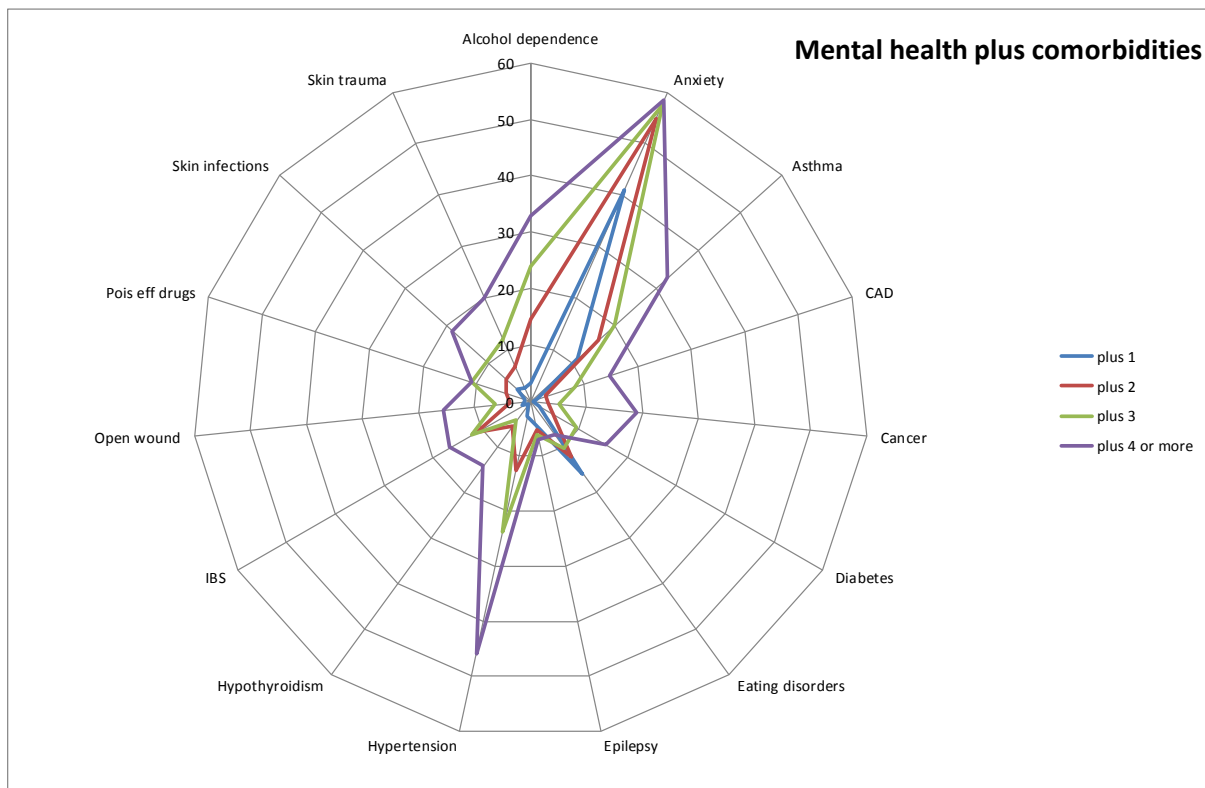


Figure 43 Top 15 most frequent co-morbidities for those with Mental health condition

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