Public Health England

Protecting and improving the nation's health

The health and social care costs of a selection of health conditions and multi-morbidities

Technical appendix

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Public Health England
Wellington House
133-155 Waterloo Road
London SE1 8UG
Tel: 020 7654 8000
www.gov.uk/phe
Twitter: @PHE_uk
Facebook: www.facebook.com/PublicHealthEngland

For queries relating to this document, please contact: healtheconomics@phe.gov.uk

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Chapter 1. Costs of diseases and multi-morbidities literature review

This chapter provides more detail about the literature review carried out for part 1 of the project.

Literature review methods

We carried out a literature review using the following databases: Cochrane library (including HTA database), NHS economic evaluation database (NHS EES) and health economic evaluations database, Pubmed, and NICE evidence services. Further, a strategy referred to as “Reference hopping” was undertaken. This process identifies key documents relevant to the search (in this case the Public Health England call for applicants document and the UK Health Forum bid document). Each article is searched for on Pubmed and the ‘Similar articles’ section is reviewed to discover further relevant papers. This process identified an additional 46 articles.

Search terms: key words such as multi-morbidity, co-morbidity, multiple chronic health conditions AND cost, health expenditure, cost-of-illness (COI). The full set of search terms are displayed in Table 2.

Inclusion criteria: English language papers only, and published since 1998, cost-of-illness studies (COI).

Exclusion criteria: Studies focusing on single diseases
Publication dates: 1998 - current
Languages: English only
Humans only
Some indexes and weights were excluded:

Some weights such as Charlson’s comorbidity index (CCI) define multimorbidity (MM) but are based on disease severity rather than morbidity. Consequently, a high Charlson index may reflect only one fatal disease rather than the combination of several well-managed diseases. For example, a patient with a moderate to severe liver disease may have the same CCI score as a patient with Chronic Obstructive Pulmonary Disease (COPD), dementia, and myocardial infarction depending on their age and disease severity. Therefore, the papers reviewed in this study were only included if the focus was on MM rather than index scores of diseases or the use of weights. Table 1 provides a list of different indexes and weights that were excluded.

Table 1. List of the different indexes and weights used and associated reference

Indexes and weights
comorbidity index (1),
body system (2),
number of diseases (3)
cumulative illness rating scale (4)
clinical risk groups model (5)
Rx-defined morbidity groups (Rx-MG) (6), super-additivity (7),
compound co-morbidities" (CCMs) (8) comorbidity index (9) Hopkins,
comorbitiy index (10), (9)
adjusted clinical groups (ACGs) (11)
Adjusted Clinical Groups (11),
Adult Comorbidity Evaluation 27 (ACE 27), (12): deyo index: (13),
Comorbidity using the Romano adaptation of the Charlson comorbidity (14),
Elixhauser index (15)

Search strategy

Search terms were agreed by the review team and working group. Five databases were searched for articles: Pubmed, Cochrane Library, HTA database, NICE Evidence search and NHS Economic Evaluation database. Table 2 summarises the search strategy applied in each database. Searches were performed between 2 March 2018 and 8 April 2018.

The search strategy took into account variations in terms and spelling, searching for both co-morbidity/comorbidity and multi-morbidity/multimorbidity.

Table 2. Search strategies by database

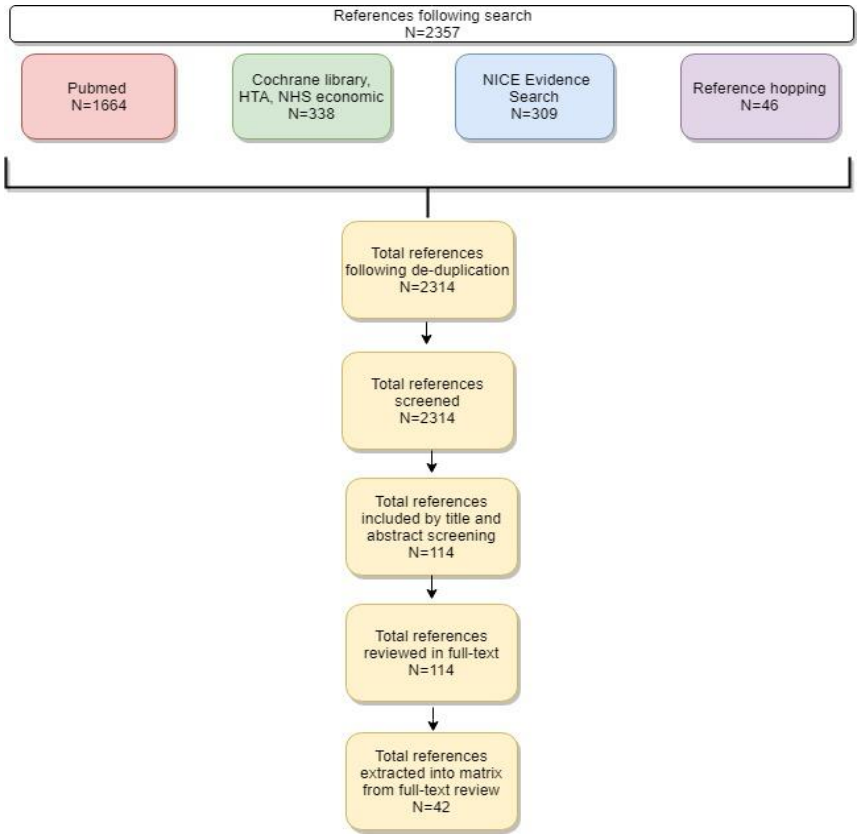
Database	Search Strategy	Results
Pubmed (without MeSH terms)	((((((("cost analysis"[Title/Abstract]) OR spend[Title/Abstract]) OR "cost of illness"[Title/Abstract]) OR "health expenditure"[Title/Abstract]) OR cost[Title/Abstract])) AND (((((("multiple chronic"[Title/Abstract]) OR comorbidity[Title/Abstract]) OR co-morbidity[Title/Abstract]) OR multimorbidity[Title/Abstract]) OR multi-morbidity[Title/Abstract])	1664
Cocharane Library, HTA database, NHS Economic Evaluations database	1 (multimorbidity) OR (multi-morbidity) FROM 1998 TO 2018 2 (comorbidity) OR (co-morbidity) FROM 1998 TO 2018 3 (multiple chronic health conditions) OR (long term disease) FROM 1998 TO 2018 4 (health expenditure) OR (cost) OR (cost analysis) FROM 1998 TO 2018 5 #1 OR #2 OR #3 6 #4 AND #5	10 693 34 20192 733

	Total references:	338 **338**
NICE Evidence Search	(multimorbidity OR comorbidity) AND "health costs" (multimorbidity OR comorbidity) AND "cost analysis" Total brought to Endnote Removed duplicates **Total references**	131 198 329 -40 **309**

Literature review results

A total of 2357 results were retrieved from the combined searches and exported into Endnote. Removal of duplicates left 2314 articles. The remaining 2314 articles were reviewed by title and abstract identifying 42 eligible papers (Figure 1). The majority of results were disregarded due to them focussing on one disease or calculating prevalence rather than cost.

Figure 1. Flow diagram of articles review at each stage



Summary of key studies

Results were summarised by methods used to calculate costs of multimorbidity. We summarise some key studies below.

Doos et al.(16) showed that MM for COPD and congestive heart failure (CHF) could be cost limiting or cost increasing depending on age, with all ages being cost limiting with the exception of age 50-59 years where a small increased cost was observed. Duarte et al. (17) carried out a cost-effectiveness analysis looking at an intervention that combines care for both cancer and depression. The authors did not distinguish between the different morbidities and only assessed the incremental cost of having an additional morbidity. It is not possible to investigate the limiting or increasing impact of MM in this study, but the mean total costs included 'primary care consultations', 'hospital outpatient visits', 'hospital admissions' and 'total healthcare cost' in the previous 12 months and was estimated at £2,924.92 per patient.

Glynn, et al. (18) showed that costs of MM increased with the number of MMs (Table 3). Costs associated with hospital admission were the most expensive of all the costs investigated in the paper followed by primary care and hospital outpatient costs.

Table 3. Glynn et al (18): Unadjusted mean cost per patient in previous 12 months of their study

Type of care	Number of conditions			
	0	**1**	**2**	**3**
Primary care (£)	161	262	355	469
Hospital outpatient (£)	98	183	220	283
Hospital admission (£)	314	422	733	893

Hazra et al. (19) estimated that disease cost followed a bell-shaped curve in relation to age (Table 4).

Table 4. Hazra et al. (19) results: mean cost per patient by number of morbidity

Number of conditions	**Age group**				
	80-84	**85-89**	**90-94**	**95-99**	**100**
0 morbidity (£)	589	807	758	535	103
1-3 morbidity/ies (£)	1,796	2,107	2,209	2,277	1,728

Kadam et al. (20) estimated the following disease costs of interests (£): the distribution of costs among increasing age categories follow a Gaussian pattern for all the disease combinations studied with a peak at the ages 60-79 years old.

Table 5. Kadam et al. (20) results

Age group	Disease combinations			
	Hypertension and Diabetes	**Diabetes + CHD**	**CHD + COPD**	**CHF + COPD**
40-49	866	152	22	4
50-59	2,043	533	179	179
60-69	2,866	1,067	499	140
70-79	2,686	1,219	710	298
80-89	1,152	552	409	236
90+	122	51	36	34

Chapter 2. Summary of prescription cost analysis

Introduction

This chapter describes the prescription cost analysis that was carried out in order to estimate the costs of drugs that are given to patients with specific diseases. These costs were then used in the calculation of annual average cost of a condition (or group of conditions). The data from the CPRD was used to extract prescriptions and these were matched with net ingredient costs (NIC) to calculate the annual prescription cost per condition.

Datasets used

Clinical Practice Research Datalink (CPRD)
Only products in CPRD prescribed between 1st January 2015 to 31st December 2015 inclusively were assigned costs because this was the year of interest. Overall, 17,629 drugs and applicances were dispensed within this time period. Of this, 15,069 were successfully matched to their costs and the unmatched products were assigned imputed costs of £9.85 based on the literature (21). This represents an average cost of £9.85 per item where it was not possible to match CPRD and prescription data.

NHS drug Tariff (February 2016)
This is produced on a monthly basis by the NHS Prescription Services on behalf of the Department of Health and Social Care (22). The Drug Tariff has various components but for the purpose of our matching and costing, we used drugs and appliances, from parts VIIIA, VIIIB and IX.

NHS prescription cost (PCA) (2015)
If drugs were not present in the NHS drug Tariff then PCA was used for matching. Prescription Cost Analysis (PCA) data gives detailed information on the number of items and the net ingredient costs (NIC) of all prescriptions dispensed in the community in England (23). The drugs dispensed are listed by British National Formulary (BNF) therapeutic class. The 2015 PCA spans the date range of 1st January 2015 to 31st December 2015.

Applying costs from PCA and NHS Drug Tariff to products in CPRD

For the NHS Drug tariff, the basic price of products were divided by the packsize for products from part VIII, and by quantity for products from part IX to get price per packsize or price per quantity. Note that the “packsize” variable for products from part

VIII of the drug tariff and the “quantity” variable for products from part IX, all correspond to the “quantity” variable in CPRD. In essence, price per quantity was calculated by dividing basic price by either packsize or quantity.

For the PCA, net ingredient costs (NIC) for products were divided by quantity for tablets, capsules, gel, discharge solidifying agents, adhesives, foams, eye products, and all chemical and liquid formulations; and by the number of items dispensed for other product forms to get the cost per quantity or cost per item. Note that both the “quantity” variable for the former and the “number of items dispensed” variable for the latter all correspond to the “quantity” variable in CPRD. In summary, NIC per quantity (same as price per quantity) was estimated by dividing NIC by either quantity or number of items dispensed.

Each product from CPRD was cleaned by removing underscores, forward slashes, plus sign, words in brackets, trailing “s” and converted to lower case. The cleaning procedure for CPRD was repeated on The Drug Tariff except that bracket signs were removed instead of removing words in brackets. Words in brackets for CPRD were removed because they were mainly the manufacturers name.

We designed two algorithms: The first matching algorithm uses a partial matching (pmatch) function in R and performs a look up of the drug name in CPRD in either the NHS drug tariff 2016 or PCA 2015 to assign costs to the drugs in CPRD. If more than one item is returned the algorithm goes through the items and selects the cheapest one. For example, if the drug name in CPRD is ‘paracetamol’, the algorithm would identify both ‘paracetamol’ and ‘paracetamol250mg’ from the drug tariff, then would and pick the one with the cheapest price.

However, if the drug name in CPRD is ‘paracetamol250mg’ and the one in Drug Tariff or PCA is ‘paracetamol’, the algorithm would not match and assign cost. This is when a second algorithm would then be used. Matching algorithm 2 uses the same principle as matching algorithm 1, except that it takes drug names from both NHS Drug Tariff 2016 and NHS PCA 2015 and performs look up on drug names in CPRD to assign cost to the drugs in CPRD – a ‘reverse matching’ of the method in algorithm 1.

Assigning cost per quantity to drugs not matched by the matching algorithms

The remaining drugs were assigned costs with PCA by hand. This was done in several steps to make the identification easier:

- for CPRD we created a table with product code and product name
- for PCA we created a table with product name and price per quantity
- these two tables were merged together by the first 15 characters of the product names and screened manually by hand to assign costs to the merged products – the

procedure was repeated by merging products from CPRD and PCA using a reduced number of characters until merging on the first 5 characters, thus 12, 10, 8, 6 and 5

Calculating the prescription cost per patient

The total cost for each prescribed product to patients in CPRD was calculated by multiplying the assigned price per quantity from either PCA or Drug Tariff by the total quantity of the product assigned to the patient. For CPRD products that were not matched to their price per quantity using the above procedures, a cost of 9.85 GBP was assigned to them as suggested by Carey et al (21), who used 'a default average cost of £9.85 per item where it was not possible to easily merge CPRD and prescription cost analysis data'. The total prescription cost per patient was then calculated by aggregating the costs of all prescriptions corresponding to the patient. Finally, some adjustments had to be made in order to take account of irregular data entry by practitioners submitting data into CPRD (see Table 6).

Table 6. Correction of the 'qty' variable in CPRD

Conditions	Rules
packtype=2164 & qty>=4 digits	divide by 1000
packytype= 46 qty>= 3 digits	divide by 120
packtype= 926 & prodcode = 35091	divide by 80
(packtype= 57 or packtype = 2615) & & qty>= 3 digits	divide 120
packtype= 926 & prodcode = 51190 or 156	divide 100
pactype= 926 or 3 & prodcode = 734 & qty >= 2 digits	divide by 15
packtype= 926 & prodcode = 50493 or 51090	divide by 80
Packtype = 926 and prodcode = 50493 or 51090, qty >= 4 digits	divide by 300
packtype=120 dose nasal or 2615 and digit 3	divide by 120
prodcode = 49228 and qty>=60	divide by60
prodcode = 3666 and qty>=60	divide by 60
prodcode =49228 and qty>=30	divide by 30
prodcode = 49218	divide by 200
prodcode = 52345	divide by 300
prodcode = 37251	divide by 5
prodcode = 49379	divide by 1200
prodcode = 45979	divide by 100
prodcode = 36869 and qty >= 60	divide by 60
prodcode = 62112	divide by 100
prodcode = 62129	divide by 200
prodcode = 59327	divide by 30
prodcode = 23449 and qty >= 40	divide by 40
prodcode = 48655	divide by 10
prodcode = 42327 and qty >= 350	divide by 350
prodcode = 6780 and packtype = 2615 and qty >= 60	divide by 60

Prodcode 20361 & qty >= 4 digits & packtype = 6	Divide by 2200

Chapter 3. Hospital utilisation in England: Costing method and data treatment using Hospital Episode Statistics (HES)

Overview

Healthcare data

Following the CPRD analysis of primary care in 2015, the analysis of the annual cost of individual's hospital service and utilisation is based on the Hospital Episode Statistics dataset (HES) for the calendar year 2015. As the hospital tariffs are only available by fiscal year, and the hospital admissions can only be processed by the grouper on a fiscal year basis, we matched hospital care utilisation to the 2015/16 reference costs. The final dataset after cleaning and treatment by the Healthcare Reference Group (HRG) grouper tool contains 462,105 patients.

The utilisation of the four main hospital facilities were treated separately for the preparation of the individual costs, and ultimately grouped for the analysis of individuals' healthcare costs. These were:

- Admitted Patient Care (APC)
- Adult Critical Care (ACC)
- Non-Admitted Patient Care (NAC)
- Emergency Medicine (EM)

Inclusion criteria

All finished consultant episodes (FCE) for spells discharged between 1 January 2015 and 31 December 2015 were included in the analysis.

Literature
The chosen methodology is based on articles by Canavan et al. (2016) (24), Danese et al. (2017) (25), Leal et al. (2018) (26) and Thorn (2016) (27).

- Canavan et al. (2016) proposes a general method for estimating costs of health services using Clinical Practice Research Datalink (CPRD) and linked Hospital Episode Statistics (HES) data at an individual level. They demonstrate that CPRD-HES allows multiple stratification reflecting patient heterogeneity. The paper details

all steps to be taken for data treatment and processing costing, and offers a guide to HRG grouper software application.
- Danese et al. (2017) also shows how to implement methods for estimating the cost of hospitalizations, prescriptions, general practitioner and specialist visits. It refers to Canavan et al. (2016), bringing more specific details on costing process.
- Leal et al. (2018) offers a comparison of various costing methods highlighting the implications of selecting a particular approach.
- Thorn et al. (2016) evaluates the accuracy of routine HES data for costing inpatient resource use in a large clinical trial and investigates costing methodologies. It assesses the suitability of HES inpatient data set for costing purposes in an economic evaluation.

National tariffs

The 2015/16 spell national tariffs, which are estimated by Monitor (now NHS improvement) and the NHS, were applied to the HES data at the spell level in order to compute annual individual hospital costs (28).

Limitations
The Market Force Factors (MFF) could not be taken into account as CPRD does not provide information allowing the identification of single hospitals. The MFF is an index with a minimum value of 1 and a maximum value of 1.3 (29), therefore we are underestimating the true cost of about 15% on average.

Outpatient first visits are normally more expensive than the follow-up visits, however our costing approach does not distinguish between the two as this information was not available in our HES extract, and we apply the same tariff for both.

Data: assembling HES datasets

For each of the HES components a database was created, and composed of various subsets of data allowing collection of all necessary information for the purpose of HRGs computation at spell level and subsequent costing, as displayed below.

Admitted patient care (APC)

APC displays both inpatient and day case episodes of hospitalisation. The final dataset after cleaning and treatment contains 177,468 patients.

Adult critical care (ACC)

ACC displays periods that patient spent in critical care within a spell. The final set after cleaning and treatment contains 4,701 patients. One data file was used:

- hes.ccare_17_280R3

Non-admitted patient care (NAC)

NAC contains outpatient and specialist visits. The final set after cleaning and treatment contains 347,544 patients. NAC is composed of two sets of data:

- hesop_appointment_17_280R3
- hesop_clinical_17_280R3

Emergency medicine (EM)

EM reports on accident and emergency activity. The final set after cleaning and treatment contains 214,785 patients. Three sets of data have been treated:

- hesae_attendance_17_280R3
- hesae_investigation_17_280R3
- hesae_treatment_17_280R3

Computation of HRGs at spell level: NHS grouper for Casemix Classification

Overview

Hierarchization of episodes within a spell
Inpatient hospital stays are reported at the Finished Consultant Episodes (FCE) level in HES, which is the time a patient spends under the continuous care of one consultant. Although most of the hospital stays are single episodes, patients can be looked after simultaneously and/or sequentially by more than one consultant. These episodes can be grouped into spells, which correspond to the time the patients spend under the care of one hospital provider, and is the basis for hospitals' reimbursement of patients' stays. We construct the spells using the NHS grouper, a tool provided by the NHS.[1] Each of

[1] https://digital.nhs.uk/services/national-casemix-office/downloads-groupers-and-tools/grouper-and-tools-archive/costing-hrg4-2016-17-reference-costs-grouper

previously created datasets was read into the NHS grouper tool. The grouper software reads patient-level data at the episode level to produce one HRG code at spell level (28).The grouper hierarchized the episodes. Each procedure is assigned a hierarchical value associated with its expected resource use. This is then used to estimate a dominant HRG, defined as the one with the highest expected resource use. This HRG can then be used to assign a tariff to the spell. This method is referred to as the Casemix Costing method (30).

Unbundled HRGs
Furthermore, if additional high-cost elements related to the hospital episode and spell were recorded then additional HRGs were reported. These are called unbundled HRGs and this methodology ensures that all aspects of the spell can be fully captured.

Severity and complexity levels are also incorporated by the grouper tool within the design of HRGs, for cases when a particular diagnosis may be a major complication for some procedures.

Grouper output summary

All data has been formatted to fit the required data format to input into the NHS grouper tool. A summary of grouper outputs for each of hospitalisation facility is given below.

Admitted patient care

Total for data analysis = 359,502 records

- 429,841 total FCE recorded
- 363,369 total spells recorded
- 3,307 FCE records containing errors leading to 3,867 spells ungrouped
- 99% of the original spells grouped under the grouper

Adult critical care

Total for data analysis = 6,010 records

- 6,131 total periods recorded
- 121 records containing coding errors on critical care unit function
- 98% of the original data grouped under the grouper

Non-admitted adult care

Total for data analysis = 1,951,621 records

- 2,003,536 attendances recorded
- 51,915 records with missing treatment function
- 97.4% of the original records grouped under the grouper

Emergency medicine

Total for data analysis = 331,392 records

- 339,140 events recorded
- 7,748 containing coding errors on treatment or investigation
- 97.8% of the original records grouped under the grouper

All data rejected by the grouper because of HES coding errors were not included in the final analysis.

Costing from the grouper output

For each output dataset, HRGs computed by the grouper were linked with the appropriate NHS national tariff as described below.

Admitted patient care
Costing was differentiated for day case and inpatient spells as well as for elective and non-elective hospital admissions.

Method of admission: elective and non-elective tariff

Tariffs are different depending on whether the spell results from an elective admission or whether the patient entered hospital after an emergency episode.

The HES dataset provides a variable named “ADMIMETH” coding for the method of admission and classifying hospital stays into two groups: “elective admission” and “emergency admission”. This classification is in line with NHS costing methodology. The HES dictionary provides the following nomenclatures and definitions (31):

a. **Elective Admission**- when the decision to admit could be separated in time from the actual admission:
   - 11 = Waiting list. A patient admitted electively from a waiting list having been given no date of admission at a time a decision was made to admit.

- 12 = Booked. A patient admitted having been given a date at the time the decision to admit was made, determined mainly on the grounds of resource availability.
- 13 = Planned. A patient admitted, having been given a date or approximate date at the time that the decision to admit was made. This is usually part of a planned sequence of clinical care determined mainly on social or clinical criteria (e.g. check cystoscopy). Note that this code does not include a transfer from another Hospital Provider (see 81 below).

b. **Emergency Admission:** when the admission is unpredictable and at short notice because of clinical need:
   - 21 = Accident and emergency or dental casualty department of the Health Care Provider.
   - 22 = General Practitioner: after a request for immediate admission has been made direct to a Hospital Provider, i.e. not through a Bed bureau, but by a General Practitioner or deputy.
   - 23 = Bed bureau
   - 24 = Consultant Clinic, of this or another Health Care Provider.
   - 25 = Admission via Mental Health Crisis Resolution Team
   - 2A = Accident and Emergency Department of another provider where the patient had not been admitted
   - 2B = Transfer of an admitted patient from another Hospital Provider in an emergency
   - 2C = Baby born at home as intended
   - 2D = Other emergency admission
   - 28 = Other means, examples are: Admitted from the Accident and Emergency Department of another provider where they had not been admitted; Transfer of an admitted patient from another Hospital Provider in an emergency
   - 31 = Admitted ante-partum
   - 32 = Admitted post-partum
   - 81 = Transfer of any admitted patient from other Hospital Provider other than in an emergency
   - 82 = The birth of a baby in this Health Care Provider
   - 83 = Baby born outside the Health Care Provider except when born at home as intended.
   - 98 = Not applicable
   - 99 = Not known: a validation error

Excess length of stay

For inpatient spells, costing is adjusted for excess bed days according to the spell 2015/2016 Trimpoint computed using the grouper and based on FCE durations and subsequent spell duration (32).

If the number of bed days is higher than Trimpoint then each additional bed day is costed with the appropriate tariff.

Unbundled HRGs
Tariffs were differentiated for the case of unbundled HRGs. The unbundled HRG cost was then added to the spell cost (33-35).

Adult critical care

Critical care periods were added to the APC cost as unbundled HRG components (28).

Non-admitted patient care
Each outpatient attendance was attributed a cost according to the HRG computed by the grouper. The main limitation encountered is the inability to distinguish between first and subsequent visits because of a lack of information in the NAC file (variable FIRSTATT is not in our extract) (24). As a result, the reference cost applied is an average value. This is a limitation as we expect patients with a multi-morbidity to have more subsequent visits than healthier patients.

Emergency medicine
The national tariff for non-elective short-stay attendance was applied to all accident and emergency episodes (35).

Data treatment summary results

Summary statistics for the final dataset are displayed below:

Table 7 Admitted Patient Care (APC)

Admitted Patient Care type	Number of individuals
Day Case - Elective	97,235
Day Case - Non Elective	7,113
Inpatient - Elective	95,998
Inpatient - Non elective	132,643

Table 8: Admitted Patient Care (APC) dataset summary statistics at spell level

Inpatient Summary	Min.	1st Quartile	Median	Mean	3rd Quartile	Max
Excess Bed Days	0	2	2	3.662	2	194
Trimpoint in bed day	0	12	59	52.81	78	134
Number of episodes per spell	0	2	2	3.056	2	22
Spell duration in days (excluding day case)						
Inpatient Elective	0	0	0	1.416	1	1720
Inpatient Non elective	0	0	2	5.766	6	2045

Table 9: Individual Cost distribution and number of patients for each care facility (GBP, 2015 price level)

	Min.	1st Quartile	Median	Mean	3rd Quartile	Max	Number of individuals
Admitted Patient Care	53.70	924.90	1,375.00	2,940.00	2,367.00	352,700.00	177,468
Non-Admitted Patient Care	66.55	265.10	759.50	1,412.00	1,657.00	96,960.00	347,544
Emergency Medicine	564.00	564.00	564.00	910.90	1,128.00	90,240.00	214,785

Table 10 Total Costs Distribution (GBP, 2015 price level)

Total Individual cost	Min.	1st Quartile	Median	Mean	3rd Quartile	Max
Day Case - Elective	41.91	351.00	1,058.00	711.30	1,058.00	4,202.00
Day Case - Non Elective	187.70	461.00	461.00	460.20	461.00	461.00
Inpatient - Elective	478.80	841.10	1,429.00	1,699.00	1,699.00	66,300.00
Inpatient - Non elective	635.40	916.00	960.40	1,860.00	960.40	65,610.00

References

1. Yoon SJ, Kim EJ, Seo HJ, Oh IH. The Association between Charlson Comorbidity Index and the Medical Care Cost of Cancer: A Retrospective Study. Biomed Res Int. 2015;2015:259341.

2. Zulman DM, Pal Chee C, Wagner TH, Yoon J, Cohen DM, Holmes TH, et al. Multimorbidity and healthcare utilisation among high-cost patients in the US Veterans Affairs Health Care System. BMJ Open. 2015;5(4):e007771.

3. Yoon J, Zulman D, Scott JY, Maciejewski ML. Costs associated with multimorbidity among VA patients. Med Care. 2014;52 Suppl 3:S31-6.

4. Nagl A, Witte J, Hodek JM, Greiner W. Relationship between multimorbidity and direct healthcare costs in an advanced elderly population. Results of the PRISCUS trial. Z Gerontol Geriatr. 2012;45(2):146-54.

5. Carreras M, Ibern P, Coderch J, Sanchez I, Inoriza JM. Estimating lifetime healthcare costs with morbidity data. BMC Health Serv Res. 2013;13:440.

6. Kuo RN, Lai MS. The influence of socio-economic status and multimorbidity patterns on healthcare costs: a six-year follow-up under a universal healthcare system. Int J Equity Health. 2013;12:69.

7. Cortaredona S, Ventelou B. The extra cost of comorbidity: multiple illnesses and the economic burden of non-communicable diseases. BMC Med. 2017;15(1):216.

8. Sarkar IN, Chen ES. Determining compound comorbidities for heart failure from hospital discharge data. AMIA Annu Symp Proc. 2012;2012:809-18.

9. Selim AJ, Fincke G, Ren XS, Lee A, Rogers WH, Miller DR, et al. Comorbidity assessments based on patient report: results from the Veterans Health Study. J Ambul Care Manage. 2004;27(3):281-95.

10. Sicras-Mainar A, Navarro-Artieda R, Blanca-Tamayo M, Velasco-Velasco S, Escribano-Herranz E, Llopart-Lopez JR, et al. The relationship between effectiveness and costs measured by a risk-adjusted case-mix system: multicentre study of Catalonian population data bases. BMC Public Health. 2009;9:202.

11. Sicras-Mainar A, Navarro-Artieda R, Ibanez-Nolla J. Clinical and economic characteristics associated with type 2 diabetes. Rev Clin Esp (Barc). 2014;214(3):121-30.

12. Paleri V, Wight RG, Silver CE, Haigentz M, Jr., Takes RP, Bradley PJ, et al. Comorbidity in head and neck cancer: a critical appraisal and recommendations for practice. Oral Oncol. 2010;46(10):712-9.

13. Stundner O, Kirksey M, Chiu YL, Mazumdar M, Poultsides L, Gerner P, et al. Demographics and perioperative outcome in patients with depression and anxiety undergoing total joint arthroplasty: a population-based study. Psychosomatics. 2013;54(2):149-57.

14. Genther DJ, Gourin CG. Effect of comorbidity on short-term outcomes and cost of care after head and neck cancer surgery in the elderly. Head Neck. 2015;37(5):685-93.

15. Zingmond DS, Arfer KB, Gildner JL, Leibowitz AA. The cost of comorbidities in treatment for HIV/AIDS in California. PLoS One. 2017;12(12):e0189392.

16. Doos L, Uttley J, Onyia I, Iqbal Z, Jones PW, Kadam UT. Mosaic segmentation, COPD and CHF multimorbidity and hospital admission costs: a clinical linkage study. J Public Health (Oxf). 2014;36(2):317-24.

17. Duarte A, Walker J, Walker S, Richardson G, Holm Hansen C, Martin P, et al. Cost-effectiveness of integrated collaborative care for comorbid major depression in patients with cancer. J Psychosom Res. 2015;79(6):465-70.

18. Glynn LG, Valderas JM, Healy P, Burke E, Newell J, Gillespie P, et al. The prevalence of multimorbidity in primary care and its effect on health care utilization and cost. Fam Pract. 2011;28(5):516-23.

19. Hazra NC, Rudisill C, Gulliford MC. Determinants of health care costs in the senior elderly: age, comorbidity, impairment, or proximity to death? Eur J Health Econ. 2017.

20. Kadam UT, Uttley J, Jones PW, Iqbal Z. Chronic disease multimorbidity transitions across healthcare interfaces and associated costs: a clinical-linkage database study. BMJ Open. 2013;3(7).

21. Carey I, Hosking F, Harris T, DeWilde S, Breighton C, Cook D. An evaluation of the effectiveness of annual health checks and quality of health care for adults with intellectual disability: an observational study using a primary care database. 2017;5(25).

22. Services NP. Drug Tariff.

23. Digital N. Prescription Cost Analysis- England, 2015. 2016 [17/09/2018]. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/prescription-cost-analysis/prescription-cost-analysis-england-2015.

24. Canavan, C., West, J., & Card, T. (2016). “Calculating total health service utilisation and costs from routinely collected electronic health records using the example of patients with irritable bowel syndrome before and after their first gastroenterology appointment”. *Pharmacoeconomics*, *34*(2), 181-194.

25. Danese, M. D., Gleeson, M., Griffiths, R. I., Catterick, D., & Kutikova, L. (2017). “Methods for estimating costs in patients with hyperlipidemia experiencing their first cardiovascular event in the United Kingdom”. Journal of medical economics, 20(9), 931-937.

26. Leal, J., Manetti, S., & Buchanan, J. (2018). “The impact of hospital costing methods on cost-effectiveness analysis: a case study”. PharmacoEconomics, 1-10.

27. Thorn, J. C., Turner, E. L., Hounsome, L., Walsh, E., Down, L., Verne, J., & Noble, S. M. (2016). “Validating the use of Hospital Episode Statistics data and comparison of costing methodologies for economic evaluation: an end-of-life case study from the Cluster randomised triAl of PSA testing for Prostate cancer (CAP)”. BMJ open, 6(4), e011063.

28. The National Casemix Office Health and Social Care Information Centre (2016). “HRG4+ 2015/16 Reference Costs Grouper User Manual v1.0”.

29. Monitor – NHS England (2013), A guide the Market Forces Factor https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/300859/A_guide_to_the_Market_Forces_Factor.pdf

29. The National Casemix Office Health and Social Care Information Centre (2016). Casemix Companion v1.0.

30. HES Data Dictionary - Admitted Patient Care (2018) https://digital.nhs.uk/binaries/content/assets/legacy/pdf/1/c/hes_data_dictionary_-_admitted_patient_care.pdf

31. Trimpoint. https://digital.nhs.uk/binaries/content/assets/legacy/pdf/o/7/hrg4__201718_reference_costs_grouper_trimpoint_methodologyv1.0.pdf

32. Monitor - NHS England (2016). 2015/16 National Tariff Payment System: A consultation notice.

33. Monitor - NHS England (2016). The national tariff information workbook. NHS England Publications Gateway Reference 03237. 2015/16 Enhanced Tariff Option spreadsheet.

34. NHS Improvement (2018). “National Cost Collection Guidance 2018”.