UNIVERSITY of York

This is a repository copy of *The costs of specialised care*.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/135957/

Version: Published Version

Monograph:
Bojke, Chris orcid.org/0000-0003-2601-0314, Grasic, Katja and Street, Andrew David orcid.org/0000-0002-2540-0364 (2014) The costs of specialised care. Working Paper. CHE Research Papers . Centre for Health Economics, University of York

https://www.york.ac.uk/media/che/documents/papers/researchpapers/CHERP103_specialised_care_costs.pdf

Reuse
Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

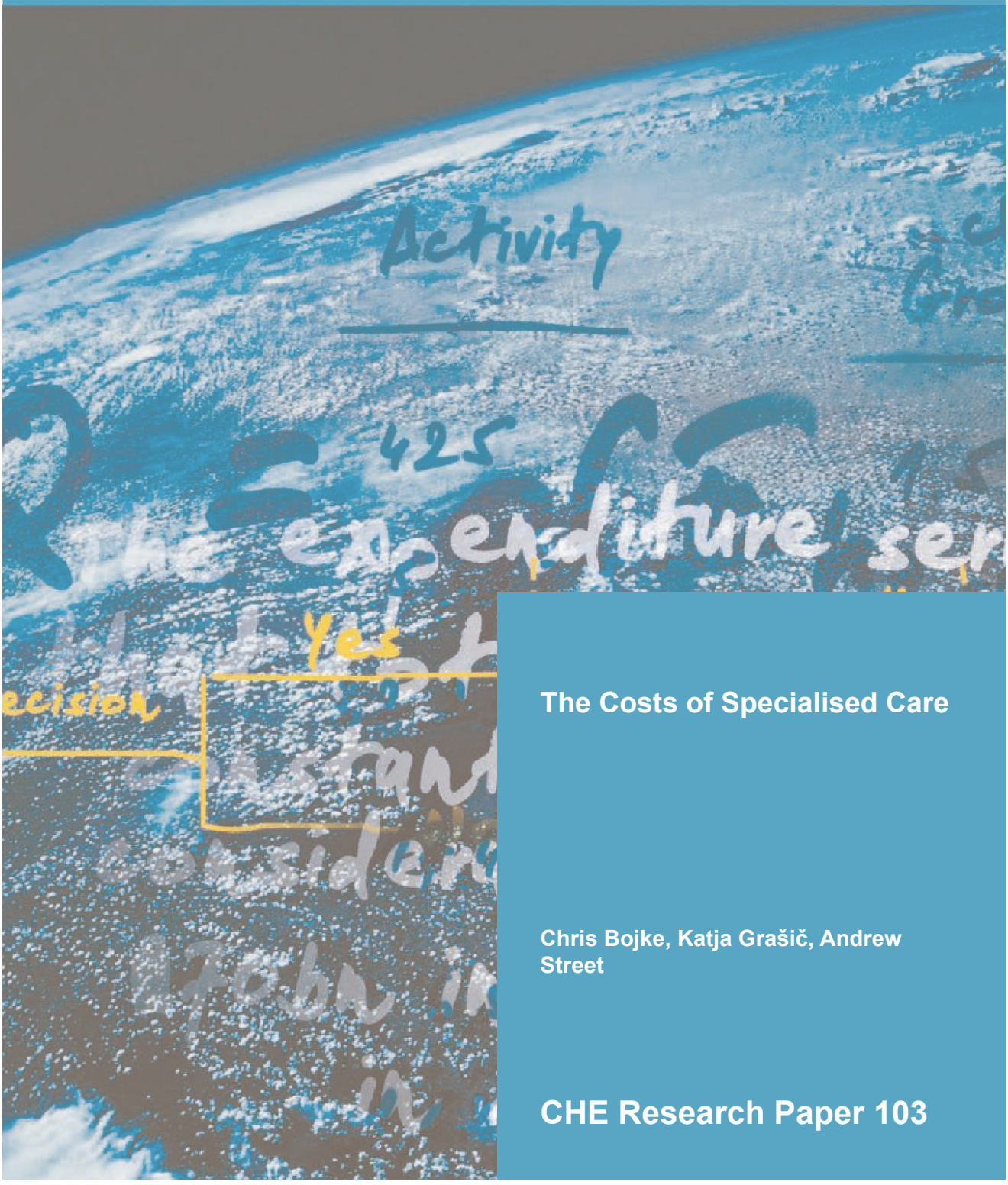
Takedown
If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

White Rose university consortium
Universities of Leeds, Sheffield & York

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

CHE
Centre For Health Economics

THE UNIVERSITY of York



The Costs of Specialised Care

Chris Bojke, Katja Grašič, Andrew Street

CHE Research Paper 103

The costs of specialised care

Chris Bojke
Katja Grašič
Andrew Street

Centre for Health Economics, University of York, UK

September 2014

Background to series

CHE Discussion Papers (DPs) began publication in 1983 as a means of making current research material more widely available to health economists and other potential users. So as to speed up the dissemination process, papers were originally published by CHE and distributed by post to a worldwide readership.

The CHE Research Paper series takes over that function and provides access to current research output via web-based publication, although hard copy will continue to be available (but subject to charge).

Acknowledgements

This project was funded by Monitor. Particular thanks are due to Jason Dean, Sadaf Dhalabhoy, Esther Giles, Jake Gommon, Paul Hughes, Leo Li, Paula Monteith, Bela Prasad, Eileen Robertson, Suzanne Robinson, Ceri Townley, Andrew Wade, and members of the Payment for Specialised and Complex Care Working Group. The views expressed are those of the authors.

Disclaimer

Papers published in the CHE Research Paper (RP) series are intended as a contribution to current research. Work and ideas reported in RPs may not always represent the final position and as such may sometimes need to be treated as work in progress. The material and views expressed in RPs are solely those of the authors and should not be interpreted as representing the collective views of CHE research staff or their research funders.

Further copies

Copies of this paper are freely available to download from the CHE website www.york.ac.uk/che/publications/ Access to downloaded material is provided on the understanding that it is intended for personal use. Copies of downloaded papers may be distributed to third-parties subject to the proviso that the CHE publication source is properly acknowledged and that such distribution is not subject to any payment.

Printed copies are available on request at a charge of £5.00 per copy. Please contact the CHE Publications Office, email che-pub@york.ac.uk, telephone 01904 321405 for further details.

Centre for Health Economics
Alcuin College
University of York
York, UK
www.york.ac.uk/che

© Chris Bojke, Katja Grašič, Andrew Street

Contents

Executive summary ii
1. Introduction 1
2. Data 3
2.1 Cleaning the HES data 4
2.2 Identifying whether a patient received specialised care 4
2.3 Mapping of reference costs to HES records 9
3. Estimation models 13
3.1 Dependent variable 13
3.2 Additional costs of SSNDS defined specialised care 14
3.3 Additional costs of PSS defined specialised care 14
3.4 Sensitivity analyses 15
4. Descriptive statistics 18
5. Results 21
5.1 Introduction 21
5.2 SSNDS analyses 21
5.3 PSS analyses 26
6. Conclusion 40
7. References 42
Appendices 43
A1: Payment for Specialised and Complex Care Working Group 43
A2: Technical Working Party data issue decisions (15/06/14) 44

Executive summary

Overview

Patients requiring specialised care are usually treated by specialist teams with particular expertise and equipment. Concentrating services in this way should be cost-effective but there is concern that national tariffs might fail to fully reflect the true costs associated with treating patients that require specialised care. This is because the Healthcare Resource Groups (HRGs), used to categorise patients and on which national tariffs are based, may not perfectly differentiate between patients that do and do not receive specialised care. In this analysis we identify whether or not a patient received specialised care and evaluate whether and by how much such patients have higher costs than those allocated to the same HRG.

Data and methods

There are two systems for identifying whether or not a patient received specialised care, the Specialised Services National Definition Sets (SSNDS) which have since been superseded by the Prescribed Specialised Services (PSS) system. We employ and compare both systems in our analyses.

Of the 18,754,381 Finished Consultant Episodes (FCEs) in the 2011/12 Hospital Episode Statistics (HES), 2,183,702 (11.6%) are identified as having received specialised care according to the SSNDS, compared to only 1,611,552 (8.6%) under PSS rules. There is little overlap between the SSNDS and PSS: of all those identified as having received specialised care under the two systems, only 537,324 (16.5%) are identified under both.

We match HES records to Reference Costs (RC) reported by each NHS hospital. Our analytical sample comprises 12,286,246 spells (14,184,683 FCEs) of which 10% are designated as having received specialised care according to the SSNDS system and 5.4% according to the PSS system.

We apply regression models to analyse costs for each individual patient to determine whether the receipt of specialised care is associated with higher costs relative to patients allocated to the same HRG who did not receive specialised care. Two broad sets of analyses are conducted, according to whether the SSNDS or PSS is used to identify receipt of specialised care.

We conduct various sensitivity analyses, including the use of FCEs rather than spells as the unit of observation; restriction of the sample to inliers, those who did not stay beyond their HRG-specific length of stay trimpoint; and to those who were not allocated to fully specialised or non-specialised HRGs; and to relaxing the identification requirement for specialised care that patients have to be treated at eligible providers.

Results

We report results as the percentage difference in cost between those that received specialise care and those that did not for each of the SSNDS or PSS specialised care markers.

For the SSNDS markers, we compare previous results for 2009/10 with those for 2011/12. As well as a different population, there will have been changes over time to clinical, coding and costing practice and to the HRG casemix classification. Results for 13 of the 27 of the markers are very similar between the two years. For the remainder, the markers are either now statistically significant (8 of 27) or the cost differentials have changed substantially (6 of 27). With the exception of Neurosciences, for all of these markers changes in volume appear to be the main reason for the change.

Fewer patients are identified as having received specialised care under the PSS system than the SSNDS. Of the 69 PSS markers that apply to hospital care, 11 apply to fewer than 300 patients nationally. By and large, the percentage cost differences tend to be larger for the PSS markers than for the SSNDS markers.

Most of the PSS markers are positive and significant, implying that patients who received specialised care of the type indicated had higher costs than other patients allocated to the same HRG. The cost differential between those that do and do not receive specialised care is more than 10% for 28 PSS markers; for 16 of these the difference is more than 25%; and for 7 it is more than 50%. For some PSS markers the financial implications of the cost differences will be small, partly because only small volumes of patients received the specialised care in question or because the cost differences are small.

Conclusions

Although the PSS system is identifying fewer patients, the fact that the cost differentials are larger suggests that identification of those that receive specialised care is more precise under the PSS than the SSNDS.

We suggest that top-up payments be applied only to those PSS markers for which the financial implications are likely to prove material. Materiality might be based on both the expected volume of patients to whom they are to apply and on the size of the estimated cost differential. We recommend that the calculation of the differential costs between those who did and did not receive specialised care is made using the random effects model that takes account of hospital effects.

1. Introduction

In this paper we assess the costs associated with patients treated in hospital that received specialised services. Specialised services are defined as:

> *those services provided in relatively few hospitals, to catchment populations of more than one million people. The number of patients accessing these services is small, and a critical mass of patients is needed in each treatment centre in order to achieve the best outcomes and maintain the clinical competence of NHS staff. These services tend to be located in specialist hospital Trusts in major towns and cities. Concentrating services in this way ensures that specialist staff can be more easily recruited and their training maintained. It is also more cost-effective and makes the best use of resources such as high tech equipment and staff expertise.* http://www.england.nhs.uk/wp-content/uploads/2012/12/pss-manual.pdf

Someone may require specialised care if their condition is particularly severe, if they suffer serious underlying problems, or to correct complications following a procedure. By virtue of their condition, therefore, patients directed to specialist teams might be more costly to care for than otherwise similar patients who do not require specialised care.

This raises potential problems for hospitals providing specialised care because the reimbursement they receive may be insufficient to cover the costs incurred. English hospitals are funded under a prospective payment system, formerly termed Payment by Results (PbR) but now called the National Tariff Payment System. This links a hospital's income to the number and case mix of patients treated. Payments are defined in terms of the healthcare resource group (HRG) to which each patient is allocated. But HRGs are imperfect measures of casemix: any categorization will inevitably combine patients with below and above average costs. This may be problematic if some patients assigned to the same HRG require more expensive specialised care while others do not.

The current means of dealing with this problem is to make an additional surcharge over and above the base HRG tariff (and excess bedday payment) if there is evidence that the receipt of specialised care does increase costs relative to other patients in the same payment category. The following surcharges (or top-up payments) apply in the payment policy for 2014/15 (Monitor & NHS England, 2013):

- Children's specialised care (high 64%; low 44%)
- Neurosciences (28%)
- Orthopaedics (24%)
- Spinal surgery (32%)

The percentage increases were informed by previous analyses that we conducted for the Department of Health's PbR team (Daidone and Street, 2011a, Daidone and Street, 2011b, Daidone and Street, 2012, Daidone and Street, 2013).

Since that analytical work was conducted, responsibility for price setting has been transferred from the Department of Health to Monitor and NHS England. Moreover, the basis for defining specialised services has been reviewed. Previously, specialised care was defined using Specialised Services National Definition Sets (SSNDS). These definition sets have since been superseded by Prescribed Specialised Services (PSS). It is, therefore, necessarily to update the previous analyses to determine how top-up payments might be constituted under the new definitional arrangements.

To do this, we analyse data from the Admitted Patient Care component of the Hospital Episode Statistics for 2011/12. We describe these data in section 2, detailing how we identify patients who received specialised services, defined using SSNDS and PSS rules, and how we match HES records to Reference Cost (RC) information. In section 3 we outline our empirical strategy to investigate the extent to which variations in cost are explained by whether or not a patient received a specialised service. We conduct various sensitivity analyses and the basis for each of these in also explained. Section 4 provides some summary descriptive statistics. Section 5 focuses on the results, first for the SSNDS markers, then for PSS markers. Conclusions appear in section 6.

2. Data

We analyse data from the Admitted Patient Care component of the Hospital Episode Statistics for 2011/12 matched to Reference Cost data for the same year. There are various issues regarding the data that need to be addressed:

- Cleaning HES data
- How to determine whether or not a patient received specialised care;
- How to assign costs to each patient record, defined as a Finished Consultant Episode (FCE) in the Hospital Episode Statistics;
- How to determine the cost of a provider spell for those patients who have multiple FCEs;

In Table 1 we summarise how the original HES dataset is reduced to our analytical sample, and the number of patients defined as having received some form of specialised care for various sub-samples of the data. The remainder of this section explains the various steps involved.

Table 1 Starting and analytical samples

	FCEs						
	N	%					
Raw HES	18,889,329						
Duration errors	36,821	0.2%					
Duplications	41,591	0.2%					
Drop non-acute trusts	56,536	0.3%					
After cleaning	18,754,381	99.3%					
	FCEs	SSNDS		PSS CHE		PSS Toolkit	
		N	%	N	%	N	%
Cleaned HES	18,754,381	2,183,702	11.6%	1,611,521	8.6%	1,552,209	8.3%
Private Providers (No cost data)	356,960	15,088	4.2%	1,902	0.5%	1,801	0.5%
Zero Cost HRGs	2,091,458	511,664	24.5%	680,168	32.5%	668,660	32.0%
UZ01Z HRGs	214,274	1,906	0.9%	20,604	9.6%	336	0.2%
Potential Analytical Set	16,097,908	1,655,644	10.3%	908,908	5.6%	881,415	5.5%
Best Cost Match	14,184,683	1,374,992	9.7%	714,132	5.0%	683,830	4.8%
Partial Cost Match	1,049,808	128,470	12.2%	67,166	6.4%	71,402	6.8%
Unmatched	863,417	152,182	17.6%	127,610	14.8%	126,183	14.6%
	Spells						
Cleaned HES	16,599,033	2,040,562	12.3%	1,563,641	9.4%		
Best Cost Match	12,286,246	1,226,434	10.0%	662,197	5.4%		

Note: patients that receive multiple types of specialised service are counted only once in the counts of FCEs or spells

Details of the breakdown of SSNDS and PSS specialised services by HRG and by provider are provided in the accompanying spreadsheet to this report www.york.ac.uk/media/che/documents/CHERP103_descriptive_statistics.xlsx. The spreadsheet also provides details of the number of FCEs in HES and those to which Reference Cost data are matched, again by HRG and provider.

2.1 Cleaning the HES data

From an initial sample of 18,889,329 HES episodes, our analytical sample is reduced to 18,754,381 episodes after cleaning.

- Patients with duration errors (with missing or implausible start and end dates) are dropped. There were 36,821 records of this type[a].
- Duplicate records are removed, of which we identified 41,591[b].
- We consider only those patients treated in English NHS acute hospitals. Hence, patients treated in mental health, ambulance and primary care trusts (with the exception of the Isle of Wight) are excluded. 56,536 are dropped for this reason.

2.2 Identifying whether a patient received specialised care

Specialised Services National Definition Sets (SSNDS)

The Specialised Services National Definition Sets (SSNDS) define activity as specialised if it requires a planning population of over 1 million people. Specialised care may also be required if the condition is particularly severe, if the patient suffers other serious underlying problems, or to correct complications following a procedure. The official site for the SSNDS is now archived, but the descriptions and code sheets are available here: http://www.yhscg.nhs.uk/specialised-services/specialised-services-national-definition-set-version-3.htm

For seven definition sets, no definitive codes are provided because additional criteria must be considered in determining whether specialised care is required (for example see (NHS Specialised Services, 2010)), so these definition sets are excluded from the analysis. Thus, we construct 27 dummy variables indicating which type of SSNDS specialised care has been received.

Information in each patient's first diagnostic and all procedural fields is examined to ascertain whether or not specialised care was received. A patient is assigned a specialised care marker if one of the ICD10 in the primary diagnosis field or one of the OPCS codes[c] in any of the procedure fields designated in the SSNDS is present in their HES record. Some codes are designated "maybe specialised" and we do not include these for identification purposes. In contrast, for identification purposes, the patient has to have been treated at provider deemed eligible for top-up payments, because non-eligible providers should not be providing specialised services.

In Table 2 we report the counts of these codes in HES data for 2011/12, the grand total amounting to 2,277,396. Note that this is not a count of the number of individuals that have received specialised care: individuals may have multiple specialised codes. There are 93,694 FCEs for which more than one specialised service is identified. In total, therefore, 2,183,702 FCEs are identified as having received specialised care as defined by the SSNDS (Table 1).

[a] Duration errors include those FCEs with episode start and end dates identified as erroneous within HES via date 'check-flags' plus those FCEs whose end date occurred before the start date.
[b] Duplicates are defined as FCEs having the same patient ID, episode start and end dates, admission start and end dates and having the same CHE-defined transition value (no transfer ; transfer out only ; transfer in and out; transfer in only).
[c] ICD10: International Statistical Classification of Diseases and Related Health Problems 10th Revision; OPCS: Office for Population Censuses and Surveys Classification of Surgical Operations and Procedures

Table 2 Occurrences of SSNDS markers in HES 2011/12

SSNDS Service Number	SSNDS Label	N
TOTAL		**2,277,396**
1	Specialised cancer services (adult)	24,872
2	Specialised services for blood and marrow transplantation (all ages)	580
3	Specialised services for haemophilia and other related bleeding disorders (all ages)	455
4	Specialised services for women's health (adult)	30,536
5	Assessment and provision of equipment for people with complex physical disability (all ages)	-
6	Specialised spinal services (all ages)	14,787
7	Specialised rehabilitation services for brain injury and complex disability (adult)	-
8	Specialised neurosciences services (adult)	38,312
9	Specialised burn care services (all ages)	-
10	Cystic fibrosis services (all ages)	263,439
11	Specialised renal services (adult)	501,863
12	Specialised intestinal failure and home parenteral nutrition services (adult)	2,857
13	Specialised cardiology and cardiac surgery services (adult)	170,948
15	Cleft lip and palate services (all ages)	270,901
16	Specialised immunology services (all ages)	-
17	Specialised allergy services (all ages)	-
18	Specialised services for infectious diseases (all ages)	2,253
19	Specialised services for liver, biliary and pancreatic medicine and surgery (adult)	68,753
20	Medical genetic services (all ages)	-
22	Specialised mental health services (all ages)	-
23	Specialised services for children	320,262
24	Specialised dermatology services (all ages)	10,691
26	Specialised rheumatology services (all ages)	1,478
27	Specialised endocrinology services (adult)	9,599
29	Specialised respiratory services (adult)	298,280
30	Specialised vascular services (adult)	2,852
31	Specialised pain management services (adult)	1,322
32	Specialised ear services (all ages)	2,873
33	Specialised colorectal services (adult)	12,423
34	Specialised orthopaedic services (adult)	5,593
35	Specialised morbid obesity services (all ages)	17,962
36	Specialised services for metabolic disorders (all ages) New for 3rd edition	4,648
37	Specialised ophthalmology services (adult) New for 3rd edition	8,197
38	Specialised haemoglobinopathy services (all ages) New for 3rd edition	190,660

Note: only the above 27 SSNDS chapters are based entirely on ICD and/or OPCS codes

Prescribed Specialised Services (PSS)

The Health and Social Care Act 2012 transferred responsibility for commissioning specialised services from Primary Care Trusts (PCTs) to the newly established NHS Commissioning Board (NHS CB), since renamed NHS England. As part of the transfer of responsibility, the opportunity was taken to review the rules used to determine what constituted specialised care. This led to a new set of definitions being drawn up by which to determine what should constitute Prescribed Specialised Services (PSS), which have now replaced the SSNDS (NHS Commissioning Board, 2012) and has been recommended to Ministers (Department of Health, 2014)

The general definition of specialised services used for SSNDS remained, this being that they "are those services provided in relatively few hospitals, to catchment populations of more than one million people". But four factors were explicitly set out for determining whether services should be directly commissioned by NHS England instead of by the Clinical Commissioning Groups (CCGs) that replaced PCTs:

1. The number of individuals who require the provision of the service or facility;
2. The cost of providing the service or facility;
3. The number of persons able to provide the service or facility; and
4. The financial implications for CCGs if they were required to arrange for the provision of the service or facility

The PSS manual published in 2014 sets out definitions for 143 groups of specialised services, of which 69 relate to services for patients admitted to hospital (NHS England, 2014).

The Health & Social Care Information Centre (HSCIC) has made available an Identification Toolkit as a software package that allows users to apply nationally consistent rules to identify prescribed specialised services in analysing patient-level data. The Prescribed Services 2013-14 Identification Tool (hereafter PSS toolkit), designed to be used alongside the HRG Grouper products for use in the 2013-14 financial year, is available here:
http://www.hscic.gov.uk/casemix/prescribedspecialisedservices

The primary purpose of the PSS Toolkit is to support financial arrangements so, as well as including rules to identify whether or not the requisite ICD and OPCS codes appear in each HES record, the PSS toolkit also includes various checks of the quality of data in other HES fields. If any of these quality checks fail, a record will not be assigned to one of the PSS groups, even if the relevant ICD or OPCS codes appear. These data quality checks are described in the table on page 14 of the manual (Health & Social Care Information Centre, 2013)

In addition, for some PSS service lines the patient has to have been treated at an eligible provider for identification of the care as specialised. The PSS toolkit also embodies a set of hierarchical rules such that, in the case that someone has multiple PSS codes, the record is assigned to just one of the PSS groups.

As the data quality checks are not pertinent for the purposes of the cost analyses that are the subject of this report, we have programmed the PSS coding rules ourselves. This provides the added benefit of allowing us to perform sensitivity analyses to how the rules are applied. Our CHE code is programmed in SAS and implements the rules and ICD and OPCS codes as described in this spreadsheet-http://www.hscic.gov.uk/media/11878/PS-201314-Identification-Code-Sets/xls/PS_2013_14_Prescribed_Services_Identification_Code_Sets_v1.1.xlsx. A number of technical decisions had to be made in order to apply the PSS rules to the 2011/12 data, and these are detailed in appendix A2.

A subset of 69 PSS groups applies to patients that appear in the Hospital Episode Statistics for 2011/12. These are listed in Table 3, together with information about the number of counts of each PSS marker in HES:

1. The column entitled “PSS CHE count” applies our programmed PSS Identification Rules and details the number of times that a specialised service is triggered by the identification rules for patients treated at eligible providers. Our programme identifies 1,771,892 instances of these relevant codes appearing in the data. Note that individual records may trigger multiple specialised codes.
2. The data in column entitled “PSS Toolkit count” is derived from running the HES data through the PSS toolkit. This means that HES records are only identified as specialised if they contain the relevant codes but also satisfy the toolkit’s data quality checks and if the patient was treated at an eligible provider. Unsurprisingly, therefore, fewer records are

identified as specialised than if these quality checks are not applied. The total number of codes identified by the Toolkit amounts to 1,718,306.

3. The final column, headed "Toolkit Dominant Count", applies the Toolkit's PSS hierarchy to assign each record (ie FCE) to a single PSS group. Because each FCE is assigned to only a single PSS group, in essence, this is a count of the number of FCEs in which specialised care was delivered, a total of 1,545,701.

There are two sets of service lines in which the PSS CHE counts and PSS Toolkit counts differ, namely Children's services and Highly Specialised services. In all cases other than Children's Surgery (NCBPS23X – E03), the PSS CHE counts are higher than those of the PSS Toolkit. Discrepancies were reviewed in conjunction with the Technical Working Group for this work, members of which were drawn from the project's Working Group, listed in Appendix 1. The reasons for the discrepancies between the PSS CHE and PSS Toolkit counts are detailed in Appendix 2.

Table 3 Occurrences of PSS markers in HES 2011/12

PSS Code	PSS Description	CHE Count	Toolkit Count	Toolkit Dominant Count
TOTAL		**1,771,892**	**1,718,306**	**1,545,701**
NCBPS01C	B03 - Chemotherapy	667,767	656,002	607,274
NCBPS01P	B02 - PET-CT	757	668	468
NCBPS01R	B01 - Radiotherapy	78,970	76,454	66,123
NCBPS01S	D05 - Stereotactic Radiosurgery	1,401	1,334	1,334
NCBPS01T	B03 - Teenage and Young Adults Cancer	14,600	14,460	10,019
NCBPS01Y	B03 - Rare Cancers (Adult)	67,896	66,921	60,051
NCBPS02Z	B04 - BMT	3,053	2,957	2,950
NCBPS03Z	B05 - Haemophilia	4,591	3,673	3,673
NCBPS04A	E10 - Women - Complex Minimal Access Gynaecology Surgery	1,526	1,080	1,080
NCBPS04C	E12 - Women - Fetal Medicine	182	180	179
NCBPS04D	E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	16	12	12
NCBPS04E	E11 - Women - Maternal Medicine (complications of pregnancy)	45,138	44,021	43,929
NCBPS06Z	D14 - Spinal - Spinal Surgery	8,174	7,118	4,213
NCBPS08O	D04 - Neurosciences - Neurology	127,996	125,407	125,385
NCBPS08P	D04 - Neurosciences - Neurophysiology	175	173	173
NCBPS08R	D04 - Neurosciences - Neuroradiology	32	30	29
NCBPS08S	D03 - Neurosciences - Neurosurgery	76,697	67,796	66,808
NCBPS09Z	D06 - Burns Care	5,923	5,137	5,137
NCBPS10Z	A01 - Cystic fibrosis	12,158	10,989	10,932
NCBPS11C	A06 - Renal Services - Access for dialysis	16,392	11,297	10,855
NCBPS11T	A07 - Renal Services - Renal Transplantation	10,681	9,254	9,253
NCBPS13B	A09 - Cardiac - Cardiac electrophysiology	6,890	6,856	6,854
NCBPS13C	A09 - Cardiac - Inherited heart disorders	7,330	7,262	7,188
NCBPS13E	A10 - Cardiac - Cardiac surgery	45,269	40,589	39,520
NCBPS13F	A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	41,432	36,986	35,034
NCBPS13G	A11 - Cardiac - Pulmonary hypertension	4,443	4,379	3,962
NCBPS13H	A10 - Cardiac - Cardiovascular magnetic resonance	4,560	4,508	2,571
NCBPS13K	A10 - Cardiac - Other	20,440	20,130	18,670
NCBPS13X	A13 - Adult Congenital Heart Disease	7,407	7,331	7,179
NCBPS14Z	B06 - HIV	7,946	8	8
NCBPS15Z	D07 - Cleft Lip Palate	2,844	2,064	2,064
NCBPS16Z	B09 - Immunology	10,985	10,938	10,932
NCBPS17Z	B09 - Allergy	2,538	2,538	2,538
NCBPS18A	B07 - Infectious Diseases Adult	326	308	308
NCBPS18C	B07 - Infectious Diseases Paeds	2,366	303	303
NCBPS19Z	A02 - Hepatology & Pancreatic	4,026	3,901	3,879
NCBPS22Z	C04 - Mental Health - Gender Dysphoria	163	162	161
NCBPS23A	E04 - Childrens services - Cancer	57,279	55,038	38,342
NCBPS23B	E05 - Childrens services - Cardiac	24,025	23,388	15,649
NCBPS23E	E03 - Childrens services - Endocrinology	3,936	3,865	3,729
NCBPS23F	E03 - Childrens services - Gastroenterology	84,100	78,101	69,398
NCBPS23H	E03 - Childrens services - Haematology	2,409	2,383	1,677
NCBPS23M	E09 - Childrens services - Neurosciences	17,407	16,804	12,766
NCBPS23N	E03 - Childrens services - Ophthalmology	8,091	7,764	7,413
NCBPS23S	E03 - Childrens services - Renal	14,685	8,580	6,731
NCBPS23T	E03 - Childrens services - Respiratory	10,163	9,949	7,974
NCBPS23W	E03 - Childrens services - Rheumatology	8,600	7,769	5,872
NCBPS23X	E02 - Childrens services - Surgery	65,472	110,942	90,564
NCBPS23Y	E03 - Childrens services - Paediatric Pain Management	25	23	21
NCBPS28Z	D11 - Hyperbaric Oxygen Treatment	18	14	13
NCBPS29A	A03d - Respiratory - Pulmonary vascular services	275	270	128
NCBPS29B	A12 - Respiratory - Complex thoracic surgery	43,816	42,712	20,261
NCBPS29E	A03d - Respiratory - Management of central airway obstruction	3,147	3,052	2,628
NCBPS29M	A03d - Respiratory - Interstitial lung disease	3,817	3,710	3,605
NCBPS29R	A03d - Respiratory - Other	25,252	23,636	21,904
NCBPS30Z	A04 - Vascular Services	7,438	7,320	6,287
NCBPS32A	D09 - Ears - Cochlear Implants	1,251	1,240	1,238
NCBPS32B	D09 - Ears - Bone anchored hearing aids	1,388	1,376	1,375
NCBPS32D	D09 - Ears - Middle Ear Implants	119	119	116
NCBPS33A	A08 - Colorectal - Complex Surgery for Incontinence	1,692	1,684	1,684
NCBPS33B	A08 - Colorectal - Complex Inflammatory Bowel disease	88	86	80
NCBPS33C	A08 - Colorectal - Transanal Endoscopic Microsurgery	535	533	533
NCBPS34A	D10 - Orthopaedic Surgery	2,007	1,953	1,939
NCBPS34R	D10 - Orthopaedic Surgery - revisions	188	133	133
NCBPS35Z	A05 - Morbid Obesity Surgery	9,170	9,117	9,116
NCBPS37Z	D12 - Ophthalmology	20,850	20,755	20,731
NCBPS38S	B08 - Haemoglobinopathy - Sickle Cell	14,101	13,925	13,907
NCBPS38T	B08 - Haemoglobinopathy - Thalassaemia	8,873	8,839	8,839
NCBPS99Z	Highly Specialised	18,585	-	-

In the analysis that follows we apply our CHE coding rules to identify whether or not a patient received specialised care as defined by the PSS. As well as the data quality checks not being necessary for the analysis, this allows us to relax the conditions regarding provider eligibility and the hierarchy of the PSS markers.

Comparison of SSNDS and PSS

Although it was intended that the PSS would not be a radical departure from SSNDS, it turns out that the definition sets differ considerably in terms of whether or not somebody is identified as having received specialised care during their time in hospital. For the 18,754,381 FCEs in HES in 2011/12, the SSNDS identifies 2,183,702 as involving specialised care while the PSS identifies only 1,611,521 (Table 4).

The (lack of) overlap between the two means of defining specialised services is also shown. Only 16.5% of these HES records are common across the SSNDS and PSS identification systems. By implication, SSNDS and PSS appear to be markedly different systems. Consequently, replacing the SSNDS by the PSS is expected to lead to substantial changes in which particular patients are identified as having received specialised care and, therefore, in estimates of the additional costs associated with receipt of this care.

Table 4 Classification of HES records under SSNDS and PSS definitions

SSNDS only	Overlap	PSS Only
1,646,378	537,324	1,074,197
50.53%	16.49%	32.97%
Total SSNDS:	2,183,702	
Total PSS:	1,611,521	

2.3 Mapping of reference costs to HES records

Some HES records are dropped from the analysis because cost information is unavailable. For the remainder, we map each patient's HES record to Reference Cost data reported by all NHS hospitals. For each HES record (FCE), there are three main elements that require costing:

1. The patient's baseHRG;
2. The cost of excess bed days beyond the patient's HRG specific length of stay trimpoint;
3. Any so-called "unbundled" HRGs to which the patient is assigned.

Private providers, HRG UZ01Z and zero cost HRGs

Private providers do not report cost information, so NHS patients treated at private providers (n=356,960) are dropped from further analysis. For information, Table 1 reports the proportion of NHS patients treated at private providers identified as having received specialised care.

Patients without the requisite information in their HES record to determine HRG allocation are assigned to the unallocated HRG UZ01Z. There are 214,274 (1.1%) HES records of this nature, and these are excluded from further analysis.

There is a significant difference in the number of UZ01Z HRGs assigned to PSS CHE specialised services compared to those identified by the PSS toolkit. The reason for this is that some data items that trigger a UZ01Z HRG are included in the PSS toolkit quality check but not in the PSS CHE version. For example, there is missing provider spell number in almost all HIV cases, which means that the

PSS toolkit only identifies 8 cases whereas the PSS CHE version identifies 7,946 cases. When the grouper is used to assign an HRG to the FCE, the missing provider spell number (and other grouper data quality check) assigns a UZ01Z to all of these FCEs.

Some HRGs have a zero cost attached to them, in accordance with the Reference Cost requirements. Table 5 below lists these HRGs and the number of FCEs associated with them. As these patients attract a zero cost, these are excluded from the analysis. There is a total of 2,091,458 (11.2%) such cases.

Table 5 HRGs attracting a zero Reference Cost

HRG		FCEs
TOTAL		**2,091,458**
DZ13A	Cystic Fibrosis with CC	6,651
DZ13B	Cystic Fibrosis without CC	1,049
LA08E	Chronic Kidney Disease with length of stay 1 day or less, associated with Renal Dialysis	916,952
PA13C	Cystic Fibrosis with length of stay 0 days	2,681
PA13D	Cystic Fibrosis with length of stay between 1 and 7 days	1,577
PA13E	Cystic Fibrosis with length of stay between 8 and 14 days	1,546
PA13F	Cystic Fibrosis with length of stay 15 days or more	500
PB03Z	Healthy Baby	486,728
SB97Z	Same Day Chemotherapy Admission or Attendance	612,416
SC97Z	Same Day External Beam Radiotherapy Admission or Attendance	61,358

The PSS CHE tool identifies approximately 12,000 FCEs which trigger the Cystic Fibrosis (CF) specialised service. Of those cases, approximately 90% are grouped to a zero-cost HRG and thus do not appear in the analytical sample. The remaining 10% of cases have data which trigger different HRGs and are probably not a representative sample of CF specialised services. As such, caution should be attached to any interpretation of the estimated CF parameter.

The cost of the base HRG and excess bed days

We match each hospital's RC data to its patients HES records in order to establish the cost of the base HRG to which they are allocated. For elective and non-elective cases, when the length of stay goes beyond HRG specific trimpoints, we add the hospital's excess *per diem* cost for each additional day. There are 4.1% of FCEs for which length of stay exceeds their HRG trimporint.

For the majority of HES records, a "Best" matching is possible. For others, matching can be achieved by relaxing some of the matching criteria.

1. RC_ID. A "Best" match of RC and HES data is achieved if it is possible to identify the reference cost for the episode through a combination of the Trust code, Department Code (e.g. NEI_L), Service Code (e.g. 300) and HRG code (e.g. EB07H). On this basis, it is possible to match 90% of FCEs to a base HRG cost and 72% to the excess bed day costs.

If an FCE cannot be matched under these criteria, "Partial" matching is achieved by relaxing conditions successively:

2. DC_ID: This identifies the reference cost through a combination of Trust, Department Code and HRG (i.e. does not use Service Code for matching). Dropping the service code allows matching of an additional 4.5% of FCEs to a base HRG cost.

3. SC_ID: This identifies the reference cost through a combination of Trust, Service Code and HRG (i.e. does not use Department Code for matching). Dropping the service code allows matching of an additional 1.7% of FCEs to a base HRG cost.

4. HRG_ID: This identifies the reference cost through a combination of only Trust and HRG. Relaxing this final condition allows an additional 0.3% of FCEs to a base HRG cost.

We define two analytical samples. The first includes only those FCEs in which "perfect" matching of FCEs to RC has been achieved. This forms our "baseline" analytical sample, and comprises a total of 14,184,683 FCEs (Table 6).

The second includes the partial matches defined through steps 2-4. This process assigns costs to an additional 1,049,808 (6.9%) HRGs. This provides a greater analytical sample of 15,234,491 FCEs, which is used as a sensitivity analysis. We do not include partial matches in the baseline analysis because, by supposition, the quality of their cost data is poorer.

Table 6 Matching of HES records to Reference Cost information

		Core HRG		Excess bed day		All FCEs	
RC_ID	"Best" match	14,804,031	93.3%	473,286	78.4%	14,184,683	93.1%
DC_ID + SC_ID + HRG_ID	"Partial" match	1,067,329	6.7%	130,013	21.6%	1,049,808	6.9%
	Total with costs	15,871,360		603,299		15,234,491	

Unbundled HRGs

Around 1.9m FCEs have unbundled activities associated with them. For 73% of these FCEs we can attach a cost to each of the constituent unbundled HRGs. For 690k FCEs there are missing costs for at least one unbundled activity. These cases are excluded from the regression analyses.

Assessing the cost of provider spells

To be able to determine the number of individuals that received specialised care we need to convert the HES data into "provider spells". Each observation in HES comprises a Finished Consultant Episode (FCE), measuring the time the patient spends under the care of a particular consultant. Around 90% of patients remain under the care of a single consultant during their entire hospital stay. The remainder are cared for by more than one consultant, most usually because they are transferred from one specialty to another. We track the consultant episodes pertaining to each individual patient, allowing us to construct a provider spell for each patient, measuring the time from admission to discharge.

Multi-episode spells are likely to be more costly than single-episode spells, but there is no agreed method for determining the additional cost. In our previous work we found that estimation results were not sensitive to whether the cost of multi-episode spells was based on the Sum, Maximum or First of the costs of the constituent FCEs. Consequently, in the analysis that follows, the cost of a provider spell is calculated as the Sum of the cost of each FCE comprising the patient's spell in hospital.

For this analysis we define the patient's base HRG as that which proves most costly among the alternatives to which the patient is assigned across the constituent FCEs. After re-restructuring the HES data so that it comprises observations defined as patient spells, we have an analytical sample of 12,293,231 spells. 10% of these patients received specialised care as defined by the SSNDS, 5.4% as defined by the PSS (Table 1).

We are now in a position to turn to the question of whether the cost of the care for these patients differs to that for other patients assigned to the same HRG.

3. Estimation models

3.1 Dependent variable

In our analyses, all costs reported by hospitals are adjusted by the market forces factor (MFF), this being an index of geographical variation in the prices of land, buildings, and labour, designed to account for unavoidable differences in factor prices incurred by different hospitals.

The dependent variable is defined as the patient's standardised cost $y_{ik} = {}^{c_{ihk}}/_{\hat{c}_h}$ where c_{ihk} is the cost of patient *i* in HRG4 *h* in hospital *k* and $\hat{c}_h$ is the national average cost of all patients allocated to the patient's base HRG4 *h.* The main reason for defining the dependent variable in this way is that, with some mathematical manipulation, we can calculate the percentage difference associated with receipt of specialised care.

Ideally, we would have patient-level costs, constructed using detailed information about all the resources used to provide treatment to each individual patient. If such information were available, the cost distribution for patients in a particular HRG might appear similar to that illustrated in panel [a] of Figure 1.

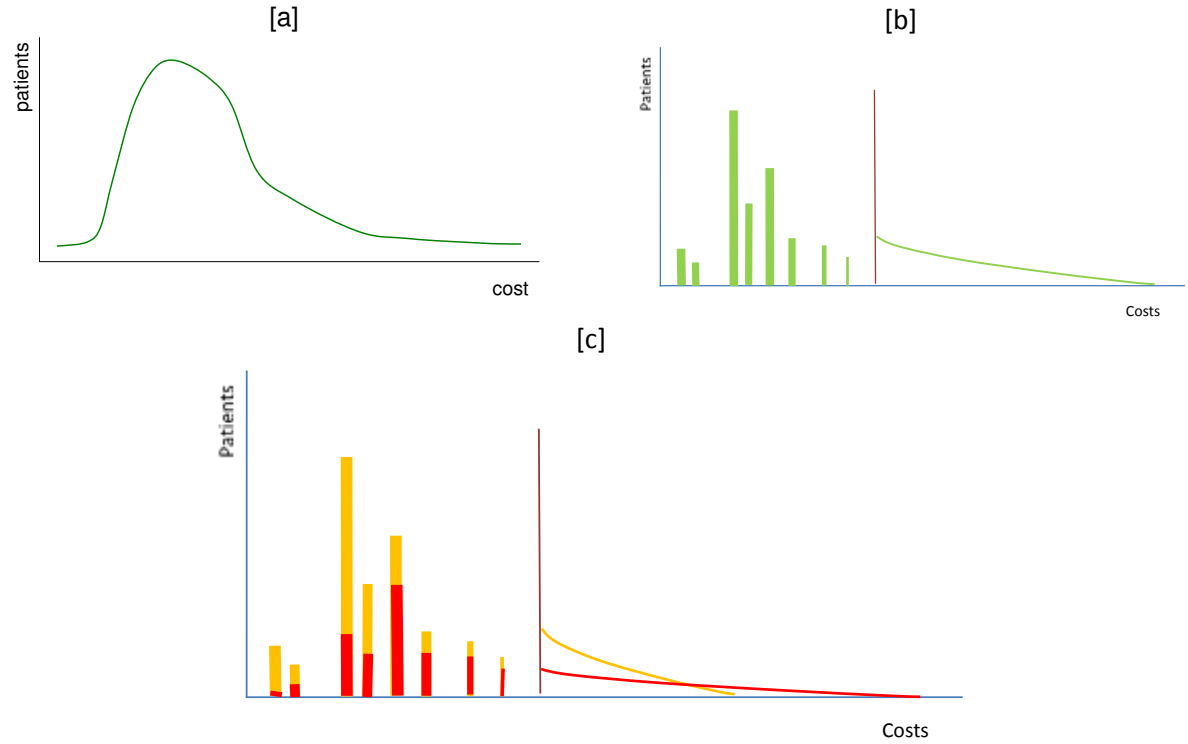


Figure 1 Illustration of the distribution of costs within a HRG

But the Reference Cost data collected in England are not based on precise information about patient resource use. Rather, the "bottom-down" costing processes mean that some patients might be assigned the same costs, namely those treated in the same hospital, with same Department Code (e.g. NEI_L , indicating admission method), the same Service Code (e.g. 300, indicating treatment specialty), and the same HRG code (e.g. EB07H). This will affect those discharged prior to the HRG-specific trimpoint, the associated cost of which is indicated in panel [b] as vertical red line. The cost distribution for patients discharged prior to the trimpoint can be illustrated as a set of bars, in which patients are grouped to the same cost value. For patients discharged beyond the trimpoint, costs reflect excess bed days, so the distribution for these patients will appear as a continuous set of values.

The analytical task is to determine whether patients that received specialised care are more likely to appear toward the higher end of the cost distribution than those who do not. If such patients are more costly, the distribution might be similar to that illustrated in panel [c]. Costs for patients that received specialised services are indicated in red; those that did not are indicated in yellow.

If provision of specialised care is more costly:

- For inlier patients, those that received specialised care will appear closer to trimpoint than other patients allocated to the same HRG.
- For outlier patients, those that received specialised care will be less likely to have costs closer to trimpoint. This possibility is illustrated by the different height and length of the distributions of costs for those that did and did not receive specialised care.

Our analytical models are designed to determine whether an individual's location in the cost distribution is related to whether and what type of specialised care they received.

3.2 Additional costs of SSNDS defined specialised care

If no account is taken of the possibility that costs may be partly related to the hospital in which care is provided, the additional costs associated with receipt of specialised care are estimated by regressing each patient's standardised cost against the set (*n*=1…*N*) of SSNDS specialised care markers (*S*) indicating the type of specialised care received (if any). So, for any individual *i*, $S_{ni} = 1$ if the patient received specialised care of type *n*, and 0 otherwise. The model takes the form:

$$y_i = \propto + \sum_{n=1}^{N} \beta_n S_{ni} + \varepsilon_i \qquad \text{(EQ1)}$$

where β are the parameters to be estimated: if positive and significant, a patient with the specialist care marker has higher costs than do other patients allocated to the same HRG. ε_i captures random error. The model is estimated using ordinary least squares (OLS).

This model fails to recognise that costs may be driven partly by the hospital in which the patient is treated. This can be examined by specifying a hierarchical model of the form:

$$y_{ik} = \propto + \sum_{n=1}^{N} \beta_n S_{nik} + u_k + v_{ik} \qquad \text{(EQ2)}$$

This is a multi-level model that recognises that patients (*i*=1…*I*) are clustered within hospitals (*k*=1…*K*). u_k is the hospital random effect: patients treated in hospitals with higher effects have higher costs than those treated elsewhere, over and above the costs estimated to be due to delivery of specialised services. v_{ik} captures random measurement error. We argue that this is the preferred model on which top-up payments should be made as it identifies the additional costs associated with receipt of specialised care, after controlling for the influence on costs of the hospital where treatment was provided.

In order to derive the percentage increase in costs associated with receipt of specialised care, g_n, we compute the marginal mean for both specialised and non-specialised services:

$$g_n = \frac{E(y_i|S_n=1,\boldsymbol{S}) - E(y_i|S_n=0,\boldsymbol{S})}{E(y_i|S_n=0,\boldsymbol{S})} * 100 \qquad \text{(EQ3)}$$

3.3 Additional costs of PSS defined specialised care

As detailed earlier, a new means of defining specialised services has been developed, the so-called Prescribed Specialised Services (PSS). In order to evaluate the additional costs associated with these

newly defined markers, the estimation models are similar to those specified above, with the exception that the SSNDS specialist markers are replaced by the set of PSS definitions. So EQ1 can be written as:

$$y_i = \propto + \sum_{p=1}^{P} \beta_p P_{pi} + \varepsilon_i \quad \text{(EQ4)}$$

Here the PSS definition sets (p=1…P) comprises the specialised care markers (R) indicating the newly defined type of specialised care received (if any). Similarly, the multi-level model specified in EQ2 becomes:

$$y_{ik} = \propto + \sum_{p=1}^{P} \beta_p R_{pik} + u_k + v_{ik} \quad \text{(EQ5)}$$

3.4 Sensitivity analyses

We consider the sensitivity of estimates derived from applying equation 1 to:

- FCEs: using FCEs rather than spells as the unit of analysis.
- Inliers: restricting analysis to those patients who do not stay beyond their HRG trimpoint.
- Fully specialised: excluding from the analysis those patients in HRGs in which everyone receives specialised care (100% specialised) or in which nobody does (100% non-specialised).
- Eligibility: dropping the requirement that specialised care is defined as being provided in eligible providers only.
- Partial matches: including patients with partially matched Reference Cost data in the analytical sample.

Using FCEs as the unit of analysis

The basic unit of observation in HES is the FCE. We convert FCEs into provider spells and use these as the basic unit of observation for the analysis, the primary reason being that tariffs under PbR are spell-based. Recognising that there may be possible concerns about how we have constructed spells or calculated the cost of spells, we conduct a sensitivity analysis using FCEs as the unit of analysis.

Inlier sample

The base tariff is paid for patients who are discharged from hospital before HRG-specific length of stay trimpoints (so-called inliers). For patients that stay beyond the trimpoint, payment includes the base tariff plus an excess bedday payment for each additional day in hospital above the trimpoint. Top-up payments, where currently applicable, are made to the base HRG tariff and to excess bedday payments.

Given this payment policy, it is important to be reassured that cost differentials are observed for these inlier patients. If cost differentials are observed solely for those that stay beyond the trimpoint, payment policy should be to have differential excess bedday rates, but not differential base tariffs. This sensitivity analysis examines whether cost differentials are observed for inlier patients.

Fully specialised HRGs

The construction of some HRGs means that everyone allocated to them receives specialised care. This is because the HRG itself is defined using the ICD or OPCS codes that are also used as indicators of specialised care. Conversely, some HRGs contain no patients that received specialised care. The HRGs where either situation occurs are listed in Table 7.

Table 7 HRGs in which everyone (100%) or no-one (0%) is classified as having received specialised care under the SSNDS and PSS definitions

100%			0%	
SSNDS		PSS	SSNDS	PSS
AA04B	HC09Z	BZ08B	AA27B	DZ15C
AA11B	LA01A	BZ09B	AB10Z	DZ27C
AA12A	LA01B	CZ25N	DZ34Z	DZ34Z
AA28A	LA02A	CZ25Q	DZ35Z	DZ36Z
AA28B	LA02B	CZ27Z	DZ41Z	DZ41Z
CZ25N	LA03A	CZ28Z	HA39Z	DZ52Z
CZ25Q	LA03B	DZ21D	HA79Z	GA10E
CZ27Z	LA10Z	DZ43Z	HD39C	HA39Z
CZ28Z	LA11Z	DZ46Z	JC13Z	HA59Z
CZ35Y	LA12A	EA01Z	JD02C	HA69Z
DZ01Z	LB46Z	EA24Z	LB28B	HA79Z
DZ18Z	QZ23Z	EA26Z	LB73Z	JA31Z
DZ21D	RC41Z	FZ24F	MC06Z	JC13Z
DZ31Z	RC42Z	FZ42B	MC11Z	JC19D
DZ33Z	SA14Z	FZ83E	MC12Z	KB02C
DZ36Z	SA15Z	FZ85Z	PA55Z	LA12A
DZ43Z	SA16Z	GA01A	QZ21B	LB73Z
DZ46Z	SA19A	GA01B	RC03Z	MA17D
DZ52Z	SA19B	GA10G	WA04U	MA19B
EA01Z	SA20A	GB04E	WA10Z	MA20Z
EA02Z	SA20B	LA01B	WA15K	MB02Z
EA12Z	SA21B	LA02B	WA15L	MC06Z
EA14Z	SA22A	LA03B	WA15M	MC11Z
EA16Z	SA22B	LA11Z	WA15N	MC12Z
EA19Z	SA23A	PA40A	WA15O	QZ21A
EA22Z	SA23B	PA40B	WA15P	QZ21B
EA23Z	SA26A	SA19A	WA15V	RC01Z
EA24Z	SA26B	SA19B	WA23Y	RC03Z
EA26Z	SA27A	SA20A		SA03F
EA43Z	SA27B	SA20B		WA01Y
EA51Z	SA28A	SA21A		WA10Z
EA52Z	SA28B	SA21B		WA15K
EA53Z	WA01W	SA22A		WA15M
EA55Z	WA01Y	SA22B		WA15N
FZ24F		SA23A		WA15P
FZ72Z		SA23B		WA23Y
FZ83E		SA26A		
FZ84Z		SA26B		
FZ85Z		SA27A		
FZ88B		SA27B		
GA01A		SA28A		
GA01B		SA28B		

For the HRGs in question the base tariff will properly account for the costs of specialised (or non-specialised) care so no further top-up adjustment is necessary. Retaining patients allocated to these HRGs in the analysis might be inappropriate for the estimation of the influence of specialised care for patients allocated to other HRGs. This is because there will no cost differential for those in fully specialised HRGs, so including them in the analysis will dilute the difference for those HRGs comprising a mix of patients that do or do not receive specialised care.

Dropping patients in those HRGs in which everyone is identified as having received specialised care and those HRGs in which no-one is identified as having received specialised care reduces the analytical sample by 1.9% (256,861 spells).

Eligible providers

Some hospitals have been designated as eligible for top-up payments for some specialised services, and eligibility arrangements are also embodied in the PSS toolkit. Hospitals that satisfy the eligibility criteria undertake more specialised spells than do other hospitals.

For the PSS service lines listed below, a patient is defined as receiving specialised care if their medical record triggers any of the PSS identification rules *and* they were treated at an eligible provider. We assess the sensitivity of results to relaxation of the condition that specialised services have to be delivered by eligible providers, so that these PSS markers are assigned on the basis of the ICD10 or OPCS codes alone.

- B05 - Haemophilia
- D14 - Spinal - Spinal Surgery
- D03 - Neurosciences - Neurosurgery
- A01 - Cystic fibrosis
- A10 - Cardiac - Cardiac surgery
- A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)
- A11 - Cardiac - Pulmonary hypertension
- D07 - Cleft Lip Palate
- B07 - Infectious Diseases Adult
- A03d - Respiratory - Interstitial lung disease

Partially matched cost data

As described in the previous section, we define two analytical samples. Our baseline analytical sample comprises a total of 14,184,683 FCEs and consists of those for which we secure a Best match between HES and Reference Cost data.

As a sensitivity analysis, we assess the impact of including partially matched data, which increases the sample to 15,234,491 FCEs. We do not conduct this analysis for spell-based data.

4. Descriptive statistics

The numbers of patients identified as having received specialist care as defined by the SSNDS and for which costs are available are reported in Table 8, for both 2009/10 and 2011/12, and the number of spells in the full HES dataset for 2011/12 identified as having received each type of specialised care.

In 2009/10, costs were available for 1,440,351 patients who received specialised care, whereas the corresponding number was 1,285,069 in 2011/12. The reduction is driven by those identified as having specialised renal care, the number falling from 510k in 2009/10 to 35k in 2011/12. This is due to costs for renal patients not being discretely identifiable in the 2011/12 RC submission (some 501,863 patients received specialised renal care in 2011/12, as seen in Table 2). For most other types of specialised care, numbers are fairly similar over time or have increased. The most notable volume increases are for cystic fibrosis (60k), cardiology (26k), children (80k) and respiratory (103k). The main reasons for a change in the volumes over time are:

- Changes in clinical practice
- Changes in coding practice and in the underlying primary classifications used for coding, as identification of specialised care requires accurate coding of ICD10 and OPCS codes
- Changes in costing practice and in our ability to map reported costs to individual patients

Table 8 Number of patients receiving SSNDS specialised services for which "best" cost matches are available and cleaned HES sample

SSNDS chapter	SSNDS label	2009/10 Full sample Spells n	2011/12 Full sample Spells n	2011/12 HES sample Spells n
Specialised cancer services (adult)	Cancer	11,907	11,252	22,487
Specialised services for blood and marrow transplantation (all a	BMT	364	363	580
Specialised services for haemophilia and other related bleedin	Haemophilia	153	420	452
Specialised services for women's health (adult)	Womens	24,389	26,000	30,100
Specialised spinal services (all ages)	Spinal	2,507	11,933	14,753
Specialised neurosciences services (adult)	Neurosciences	26,204	26,034	37,873
Cystic fibrosis services (all ages)	CysticFibrosis	101,770	161,432	252,100
Specialised renal services (adult)	Renal	510,847	35,860	493,968
Specialised intestinal failure and home parenteral nutrition servi	IntestinalFailure	2,246	1,918	2,855
Specialised cardiology and cardiac surgery services (adult)	Cardiology	90,381	116,332	163,125
Cleft lip and palate services (all ages)	CleftLip	238,141	243,449	270,293
Specialised services for infectious diseases (all ages)	InfectiousDiseases	2,039	1,498	1,908
Specialised services for liver, biliary and pancreatic medicine a	Liver	12,244	23,906	57,221
Specialised services for children	Children	131,657	211,774	302,537
Specialised dermatology services (all ages)	Dermatology	12,298	8,952	10,554
Specialised rheumatology services (all ages)	Rheumatology	338	1,040	1,459
Specialised endocrinology services (adult)	Endocrinology	7,306	6,777	9,316
Specialised respiratory services (adult)	Respiratory	68,374	172,142	223,440
Specialised vascular services (adult)	VascularDiseases	1,215	1,798	2,847
Specialised pain management services (adult)	PainManagement	1,266	1,227	1,321
Specialised ear services (all ages)	EarSurgery	1,655	2,715	2,872
Specialised colorectal services (adult)	Colorectal	7,355	8,921	11,065
Specialised orthopaedic services (adult)	Orthopaedic	4,207	5,006	5,589
Specialised morbid obesity services (all ages)	MorbidObesity	11,458	15,018	17,439
Specialised services for metabolic disorders (all ages) New for	MetabolicDisorders	3,236	3,775	4,512
Specialised ophthalmology services (adult) New for 3rd edition	Ophtalmology	7,006	7,792	8,195
Specialised haemoglobinopathy services (all ages) New for 3rd	Haemoglobinopathy	159,788	177,735	190,196
	Specialised sample	**1,440,351**	**1,285,069**	**2,139,057**
	More than 1 SSNDS	35,972	93,694	

The number of patients (spells) receiving specialised care as defined using the PSS definitions is shown in Table 9, for both those with "Best" matched costs and for the full cleaned HES dataset. As can be seen, there is large variation in the numbers of patients in each PSS chapter, with some populated by very few patients nationally (some have fewer than 300 spells). For such poorly populated PSS chapters, the cost estimates are likely to be imprecisely estimated.

Table 9 Number of patients receiving PSS specialised services for which "best" costs are available and cleaned HES sample

PSS chapter	PSS label	Full sample Spells n	HES sample Spells n
B03 - Chemotherapy	NCBPS01C	47,186	667,666
B02 - PET-CT	NCBPS01P	4	754
B01 - Radiotherapy	NCBPS01R	7,363	78,809
D05 - Stereotactic Radiosurgery	NCBPS01S	192	1,397
B03 - Teenage and Young Adults Cancer	NCBPS01T	6,829	14,285
B03 - Rare Cancers (Adult)	NCBPS01Y	29,364	60,504
B04 - BMT	NCBPS02Z	1,846	3,047
B05 - Haemophilia	NCBPS03Z	3,559	4,391
E10 - Women - Complex Minimal Access Gynaecology Surgery	NCBPS04A	1,274	1,526
E12 - Women - Fetal Medicine	NCBPS04C	168	181
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	NCBPS04D	14	16
E11 - Women - Maternal Medicine (complications of pregnancy)	NCBPS04E	39,629	44,238
D14 - Spinal - Spinal Surgery	NCBPS06Z	6,333	8,141
D04 - Neurosciences - Neurology	NCBPS08O	96,650	123,506
D04 - Neurosciences - Neurophysiology	NCBPS08P	87	175
D04 - Neurosciences - Neuroradiology	NCBPS08R	13	32
D03 - Neurosciences - Neurosurgery	NCBPS08S	54,455	71,463
D06 - Burns Care	NCBPS09Z	2,948	5,738
A01 - Cystic fibrosis	NCBPS10Z	646	11,061
A06 - Renal Services - Access for dialysis	NCBPS11C	13,323	15,835
A07 - Renal Services - Renal Transplantation	NCBPS11T	9,296	10,602
A09 - Cardiac - Cardiac electrophysiology	NCBPS13B	5,671	6,863
A09 - Cardiac - Inherited heart disorders	NCBPS13C	3,955	5,957
A10 - Cardiac - Cardiac surgery	NCBPS13E	24,744	41,862
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	NCBPS13F	25,910	41,247
A11 - Cardiac - Pulmonary hypertension	NCBPS13G	3,292	4,367
A10 - Cardiac - Cardiovascular magnetic resonance	NCBPS13H	8	4,549
A10 - Cardiac - Other	NCBPS13K	15,791	20,397
A13 - Adult Congenital Heart Disease	NCBPS13X	4,185	6,992
D07 - Cleft Lip Palate	NCBPS15Z	2,695	2,843
B09 - Immunology	NCBPS16Z	9,760	10,975
B09 - Allergy	NCBPS17Z	1,971	2,538
B07 - Infectious Diseases Adult	NCBPS18A	268	312
B07 - Infectious Diseases Paeds	NCBPS18C	247	2,365
A02 - Hepatology & Pancreatic	NCBPS19Z	2,342	4,073
C04 - Mental Health - Gender Dysphoria	NCBPS22Z	160	163
E04 - Childrens services - Cancer	NCBPS23A	25,405	55,676
E05 - Childrens services - Cardiac	NCBPS23B	8,645	18,326
E03 - Childrens services - Endocrinology	NCBPS23E	3,671	3,933
E03 - Childrens services - Gastroenterology	NCBPS23F	62,385	79,516
E03 - Childrens services - Haematology	NCBPS23H	1,919	2,373
E09 - Childrens services - Neurosciences	NCBPS23M	9,071	16,615
E03 - Childrens services - Ophthalmology	NCBPS23N	6,725	8,055
E03 - Childrens services - Renal	NCBPS23S	9,593	13,947
E03 - Childrens services - Respiratory	NCBPS23T	7,184	9,749
E03 - Childrens services - Rheumatology	NCBPS23W	6,047	8,017
E02 - Childrens services - Surgery	NCBPS23X	44,589	63,719
E03 - Childrens services - Paediatric Pain Management	NCBPS23Y	25	25
D11 - Hyperbaric Oxygen Treatment	NCBPS28Z	12	17
A03d - Respiratory - Pulmonary vascular services	NCBPS29A	178	274
A12 - Respiratory - Complex thoracic surgery	NCBPS29B	27,615	41,886
A03d - Respiratory - Management of central airway obstruction	NCBPS29E	1,901	3,127
A03d - Respiratory - Interstitial lung disease	NCBPS29M	2,534	3,490
A03d - Respiratory - Other	NCBPS29R	13,953	23,733
A04 - Vascular Services	NCBPS30Z	4,839	7,422
D09 - Ears - Cochlear Implants	NCBPS32A	1,150	1,250
D09 - Ears - Bone anchored hearing aids	NCBPS32B	1,370	1,388
D09 - Ears - Middle Ear Implants	NCBPS32D	113	119
A08 - Colorectal - Complex Surgery for Incontinence	NCBPS33A	1,090	1,692
A08 - Colorectal - Complex Inflammatory Bowel disease	NCBPS33B	63	88
A08 - Colorectal - Transanal Endoscopic Microsurgery	NCBPS33C	503	535
D10 - Orthopaedic Surgery	NCBPS34A	1,637	2,006
D10 - Orthopaedic Surgery - revisions	NCBPS34R	176	187
A05 - Morbid Obesity Surgery	NCBPS35Z	8,252	9,169
D12 - Ophthalmology	NCBPS37Z	20,004	20,840
B08 - Haemoglobinopathy - Sickle Cell	NCBPS38S	13,553	13,946
B08 - Haemoglobinopathy - Thalassaemia	NCBPS38T	8,651	8,873
Highly Specialised	NCBPS99Z	11,355	17,382
Specialised sample		**726,386**	**1,716,245**

In Table 10 we summarise the number of observations used in each of the regression analyses, and the number identified as having received specialised services under each definitional type (SSNDS or PSS). Note that patients can have more than one specialised service. The counts below include such patients.

Table 10 Summary of analytical samples

Analysis type	Unit of observation	SSNDS Total sample	Of which specialised	PSS Total sample	Of which specialised
Baseline	Spell	12,286,246	1,285,069	12,286,246	726,386
Inlier sample	Spell	11,927,415	1,232,716	11,927,415	692,779
Full sample	FCE	14,184,683	1,437,072	14,184,683	784,507
Inlier sample	FCE	13,779,336	1,381,977	13,779,336	748,324
PSS toolkit	FCE			14,184,683	750,894
Drop 100% & 0%	Spell	12,228,578	1,234,398	12,244,417	709,903
Eligibility	Spell			12,286,246	747,022
Partail match	FCE			15,234,491	862,407
Random effects	Spell	12,286,246	1,285,069	12,286,246	726,386

Note: counts of the number of specialised FCEs and spells differ from Table 1 because patients can have more than one specialised service

5. Results

5.1 Introduction

We have estimated various equations and explored the sensitivity of estimates to a range of modelling choices. In reporting the results, we focus on the estimates associated with the specialised markers, defined first using SSNDS and then by PSS. Rather than reporting the coefficients, we report the predicted percentage difference in costs for patients who received specialised care compared to those that did not. The specialised markers where estimates are statistically significant appear in bold if p<0.001.

5.2 SSNDS analyses

Baseline analysis

In Table 11 we report the numbers and percentage cost differences for each of the SSNDS markers for 2009/10 and 2011/12. These are derived from estimating equation 1: $y_i = \propto + \sum_{n=1}^{N} \beta_n S_{ni} + \varepsilon_i$

These results form our "baseline" SSNDS analysis and are comparable across the two years, sharing the following core features:

- All observations for which costs are Best matched are included
- Each observation represents a spell (rather than FCE)
- The cost of a spell is calculated as the sum of the cost of the constituent episodes
- Each patient is assigned a specialist marker if one of the SSNDS ICD10 or OPCS codes appears in their record[d]
- The model is estimated using OLS and does not account for clustering within providers.

Changes can be expected in the estimated cost differentials over time. These will be due to a combination of clinical, coding and costing factors that have driven changes over time in the volume of patients identified as having received specialised care and in how their costs have been identified, and in changes to the HRG casemix classification that might have changed the resource homogeneity of the underlying groups to which patients are categorised;

The main messages from these comparisons are the following:

- For 13 of the 27 of the SSNDS markers, estimated cost differences are stable across the two years, even for some of those SSNDS markers where there have been large changes in the number of patients identified as having received specialised care;

- There are 8 of the 27 markers that appear significant in 2011/12 but that were not in 2009/10. For almost all of these, there are substantive differences in the volume of patients identified as having received these particular types of specialised care between the two years.

- For 4 of the 27 markers, the cost differential between those that received specialised care and those that did not is lower in 2011/12 than it was in 2009/10. This is apparent for Neurosciences, where the difference has fallen from 28% to 13%, despite little change in the number identified as having received such care. The cost difference for Children has fallen from 30% to 15%, which may be partly due to the increased volume from 132k to 212k. For

[d] The 2009/10 assignment also conditions upon the patient being treated at provider considered eligible by the Department of Health to provide specialised services

Liver, the number has almost doubled, and the cost difference has fallen from 13% to 3%. For Infectious Diseases, there has been 25% reduction in volume, with the cost differential falling from 41% to 29%. Overall, then, there is no clear relationship between changes in volume and the change in the cost differential. More detailed work would be required to understand the reasons for the volume changes and about the particular characteristics of the patients designated as having received specialised care in each time period.

- For 2 of the 27 markers, the cost differentials have increased. These are Rheumatology and Vascular Diseases, and for both of these there has been an increase in the number identified as having received such specialised services.

Table 11 Comparison of "baseline" results for 2009/10 and 2011/12

SSNDS label	2009/10 Full sample Spells n	Full sample Spells %	2011/12 Full sample Spells n	Full sample Spells % [a]	Increase over time %
Cancer	11,907	**31%**	11,252	**36%**	5%
BMT	364	-4%	363	-6%	-3%
Haemophilia	153	-13%	420	-6%	7%
Womens	24,389	6%	26,000	1%	-6%
Spinal	2,507	14%	11,933	**17%**	3%
Neurosciences	26,204	**28%**	26,034	**13%**	-15%
CysticFibrosis	101,770	**36%**	161,432	**35%**	-1%
Renal	510,847	23%	35,860	**21%**	-2%
IntestinalFailure	2,246	0%	1,918	7%	7%
Cardiology	90,381	**12%**	116,332	**10%**	-2%
CleftLip	238,141	3%	243,449	0%	-4%
InfectiousDiseases	2,039	**41%**	1,498	**29%**	-12%
Liver	12,244	**13%**	23,906	**3%**	-9%
Children	131,657	**30%**	211,774	**15%**	-15%
Dermatology	12,298	0%	8,952	**-22%**	-22%
Rheumatology	338	**33%**	1,040	**46%**	13%
Endocrinology	7,306	6%	6,777	**11%**	5%
Respiratory	68,374	8%	172,142	**1%**	-7%
VascularDiseases	1,215	**34%**	1,798	**41%**	7%
PainManagement	1,266	**225%**	1,227	**243%**	17%
EarSurgery	1,655	8%	2,715	0%	-8%
Colorectal	7,355	**13%**	8,921	**11%**	-2%
Orthopaedic	4,207	**16%**	5,006	**12%**	-5%
MorbidObesity	11,458	-7%	15,018	-1%	6%
MetabolicDisorders	3,236	43%	3,775	**91%**	48%
Ophtalmology	7,006	7%	7,792	**10%**	3%
Haemoglobinopathy	159,788	6%	177,735	**2%**	-4%
Total sample	**12,971,384**		**12,286,246**		

Sensitivity analyses: inliers and FCEs

We assess whether the cost differences for each of the SSNDS markers are sensitive to various analytical choices. In the first two columns of Table 12, we repeat the results of our baseline analysis. This is followed by three sets of two columns reporting volumes and percentage cost differences for the following choices:

- Using spells as the unit of observation, but limiting the analytical sample to inliers, defined as those whose length of stay did not exceed their HRG-specific LoS trimpoint;
- Using FCEs as the unit of observation, but using the full sample;
- Using FCEs as the unit of observation, but again limiting the analytical sample to inliers.

Note that a cost denominator specific to each analytical sample is defined in constructing the standardised cost for each of these analyses. This means that the cost differences refer to different "base" costs in each analysis, so the size of the cost differences are not exactly comparable across models.

Table 12 Analyses for inlier samples and using FCEs

SSNDS label	2011/12 Full sample Spells n	Full sample Spells % [a]	Inlier sample Spells n	Inlier sample Spells % [b]	Full sample FCEs n	Full sample FCEs % [c]	Inlier sample FCEs n	Inlier sample FCEs % [d]
Cancer	11,252	**36%**	10,577	**33%**	13,166	**34%**	12,414	**32%**
BMT	363	-6%	350	-1%	371	-12%	362	-5%
Haemophilia	420	-6%	415	-5%	424	-6%	419	-5%
Womens	26,000	1%	25,361	**4%**	26,963	**2%**	26,316	**6%**
Spinal	11,933	**17%**	10,920	**9%**	12,412	**16%**	11,397	**10%**
Neurosciences	26,034	**13%**	24,371	**7%**	27,416	**12%**	25,732	**7%**
CysticFibrosis	161,432	**35%**	144,702	**14%**	184,383	**32%**	167,223	**9%**
Renal	35,860	**21%**	34,260	**16%**	40,392	**20%**	38,678	**15%**
IntestinalFailure	1,918	7%	1,800	**9%**	2,188	4%	2,064	**7%**
Cardiology	116,332	**10%**	110,328	**9%**	130,680	**7%**	124,263	**7%**
CleftLip	243,449	0%	241,000	**4%**	244,567	1%	242,050	**6%**
InfectiousDiseases	1,498	**29%**	1,409	**16%**	1,789	**26%**	1,693	**14%**
Liver	23,906	**3%**	23,007	**4%**	34,332	**3%**	33,223	**4%**
Children	211,774	**15%**	205,743	**13%**	224,383	**15%**	217,710	**13%**
Dermatology	8,952	**-22%**	8,853	**-23%**	9,074	**-21%**	8,972	**-21%**
Rheumatology	1,040	**46%**	1,003	**47%**	1,058	**43%**	1,020	**45%**
Endocrinology	6,777	**11%**	6,497	**13%**	7,050	**11%**	6,745	**13%**
Respiratory	172,142	**1%**	160,848	**-3%**	249,020	1%	237,002	**-4%**
VascularDiseases	1,798	**41%**	1,684	**35%**	1,931	**38%**	1,817	**34%**
PainManagement	1,227	**243%**	1,155	**266%**	1,229	**238%**	1,155	**265%**
EarSurgery	2,715	0%	2,562	5%	2,726	0%	2,574	**6%**
Colorectal	8,921	**11%**	8,640	**12%**	10,155	**12%**	9,830	**14%**
Orthopaedic	5,006	**12%**	4,595	**6%**	5,064	**13%**	4,657	**8%**
MorbidObesity	15,018	-1%	14,489	2%	15,850	1%	15,308	**4%**
MetabolicDisorders	3,775	**91%**	3,707	**93%**	3,891	**88%**	3,813	**92%**
Ophtalmology	7,792	**10%**	7,529	**11%**	7,803	**12%**	7,539	**13%**
Haemoglobinopathy	177,735	**2%**	176,911	**7%**	178,755	**2%**	178,001	**8%**
Total sample	**12,286,246**		**11,927,415**		**14,184,683**		**13,779,336**	

The main messages from these comparisons are the following:

- The cost differences are robust to whether the unit of observation is based on spells or FCEs. This is evident from comparing columns [a] with [c] (for the full sample) and [b] with [d] (for inliers). The difference between the two sets of estimates never exceeds 5% for either the full or inlier sample.

- The significance (and, often, size) of the cost differences is not particularly sensitive to whether analysis is conducted on the full sample or just inliers. This is evident from comparing columns [a] and [b] for the analyses based on spells (and columns [c] and [d] for the analyses based on FCEs). This is reassuring because it suggests that cost differences are not driven solely by patients with excessive lengths of stay.

- For two SSNDS markers the cost difference is higher for the full sample than for the inlier sample, these being Cystic Fibrosis (21% difference) and Infectious Disease (13%). For five others the difference is more than 5% higher for the full sample (Spinal, Neurosciences, Renal, Vascular Disease and Orthopaedics). This suggests that, for these seven markers,

observed cost differentials between patients who do and do not receive specialised care are more pronounced for those who stay beyond the LoS trimpoint.

- For only one SSNDS marker (Pain Management) is the difference markedly lower for the full sample than for the inlier sample (-23% difference).

Sensitivity analysis: omitting fully and non-specialised HRGs

There are 76 HRGs in which everyone received some form of specialised care as defined by the SSNDS and 28 HRGs in which nobody did. If patients allocated to these HRGs are omitted, 57,668 spells are dropped from the analytical sample. The impact that this has on the results is reported in Table 13. With the exception of that for Pain Management, none of percentage effects change notably for any of the SSNDS markers.

Table 13 Sensitivity analysis to omission of fully or non-specialised HRGs

SSNDS label	2011/12 Full sample Spells n	Full sample Spells % [a]	Drop 100% & 0% Spells n	Drop 100% & 0% Spells % [e]
Cancer	11,252	**36%**	11,240	**36%**
BMT	363	-6%	63	-1%
Haemophilia	420	-6%	419	-6%
Womens	26,000	1%	25,967	1%
Spinal	11,933	**17%**	11,909	**17%**
Neurosciences	26,034	**13%**	24,181	**14%**
CysticFibrosis	161,432	**35%**	156,411	**35%**
Renal	35,860	**21%**	33,820	**23%**
IntestinalFailure	1,918	7%	1,916	7%
Cardiology	116,332	**10%**	95,065	**13%**
CleftLip	243,449	0%	243,370	0%
InfectiousDiseases	1,498	**29%**	1,497	**29%**
Liver	23,906	**3%**	23,900	**3%**
Children	211,774	**15%**	210,163	**15%**
Dermatology	8,952	**-22%**	8,941	**-23%**
Rheumatology	1,040	**46%**	1,039	**46%**
Endocrinology	6,777	**11%**	6,746	**11%**
Respiratory	172,142	**1%**	166,202	**1%**
VascularDiseases	1,798	**41%**	1,670	**45%**
PainManagement	1,227	**243%**	1,134	**262%**
EarSurgery	2,715	0%	279	-8%
Colorectal	8,921	**11%**	8,921	**11%**
Orthopaedic	5,006	**12%**	5,006	**12%**
MorbidObesity	15,018	-1%	7,372	-2%
MetabolicDisorders	3,775	**91%**	3,761	**91%**
Ophtalmology	7,792	**10%**	7,792	**10%**
Haemoglobinopathy	177,735	**2%**	175,614	**2%**
Total sample	**12,286,246**		**12,228,578**	

Accounting for hospital effects

Table 14 compares results from equation 1: $y_i = \propto + \sum_{n=1}^{N} \beta_n S_{ni} + \varepsilon_i$ which is estimated using OLS and where no account is taken of the hospital in which treatment took place with equation 2: $y_{ik} = \propto + \sum_{n=1}^{N} \beta_n S_{nik} + u_k + v_{ik}$ which accounts for hospital clustering using a random effects specification. The table provides estimates of the cost differences associated with the SSNDS markers for each of these specifications.

The cost differences are always larger for the OLS model than the RE model that accounts for clustering. This is because, in the former model, some of the observed cost differences attributed to the receipt of specialised care are actually related to the hospital in which treatment took place. The better specified RE model apportions costs more accurately because it accounts for this clustering.

We recommend that, if required, top-up arrangements should be calculated on the basis of results from the RE model that takes account of hospital effects.

Table 14 Comparison of OLS and RE models

SSNDS label	2011/12 Full sample Spells OLS n	Full sample Spells OLS % [a]	Full sample Spells RE % [f]
Cancer	11,252	**36%**	**29%**
BMT	363	-6%	**-18%**
Haemophilia	420	-6%	**-16%**
Womens	26,000	1%	0%
Spinal	11,933	**17%**	**11%**
Neurosciences	26,034	**13%**	**8%**
CysticFibrosis	161,432	**35%**	**32%**
Renal	35,860	**21%**	**16%**
IntestinalFailure	1,918	7%	**7%**
Cardiology	116,332	**10%**	**5%**
CleftLip	243,449	0%	**-1%**
InfectiousDiseases	1,498	**29%**	**25%**
Liver	23,906	**3%**	0%
Children	211,774	**15%**	**6%**
Dermatology	8,952	**-22%**	**-23%**
Rheumatology	1,040	**46%**	**24%**
Endocrinology	6,777	**11%**	**7%**
Respiratory	172,142	**1%**	**-1%**
VascularDiseases	1,798	**41%**	**34%**
PainManagement	1,227	**243%**	**221%**
EarSurgery	2,715	0%	**-8%**
Colorectal	8,921	**11%**	**8%**
Orthopaedic	5,006	**12%**	4%
MorbidObesity	15,018	-1%	-2%
MetabolicDisorders	3,775	**91%**	**67%**
Ophtalmology	7,792	**10%**	**9%**
Haemoglobinopathy	177,735	**2%**	**2%**
Total sample	**12,286,246**		

5.3 PSS analyses

Baseline analysis

In Table 15 we report the numbers and cost differences for each of the PSS markers for 2011/12. These estimates are based on data with the following features:

- All observations for which "Best" matched Reference Costs are available are included.
- Each observation represents a spell (rather than FCE).
- The cost of a spell is calculated as the sum of the cost of the constituent episodes
- Each patient is assigned a specialist marker if one of the PSS ICD10 or OPCS codes appears in their record and they were treated at an eligible provider.
- The model is estimated using OLS and does not account for clustering within providers.

Two sets of estimates are provided

- The first uses the full sample – column [a]
- The second limits the analytical sample to inliers (ie those whose length of stay did not exceed their HRG defined LoS trimpoint) – column [b]

The main messages are as follows:

- Most of the PSS markers are positive and significant, implying that patients who received specialised care of the type indicated had higher costs than other patients allocated to the same HRG;

- For the majority of PSS markers the above is true whether we look at the full sample or just the inlier sample. This suggests that it is reasonable to apply a top-up adjustment, if merited, to the base tariff;

- For some PSS markers the financial implications of the cost differences will be small, partly because only small volumes of patients received the specialised care in question (eg B02-PET-CT) or because the cost differences are small;

- For a handful of PSS markers the cost differences are negative, suggesting such patients have lower costs than comparable patients that did not receive specialised care. This might be contrary to expectations, so these PSS markers repay further scrutiny to see whether the negative effects are sensitive to specification choices. In particular, the cost differences reported here do not account for the cost implications associated with clustering of patients within hospitals. These provider-level effects may be important at explaining cost differences among patients over and above the provision of specialised care.

- For those markers with more than 300 patients in the analysis and that are statistically significant, the cost differential between those that do and do not receive specialised care is more than 10% for 33 PSS markers; for 21 of these the difference is more than 25%; and for 11 it is more than 50%.

Table 15 Baseline and inlier analyses based on spells

PSS chapter	Full sample Spells n	Full sample Spells % [a]	Inlier sample Spells n	Inlier sample Spells % [b]
B03 - Chemotherapy	47,186	**50%**	47,007	**53%**
B02 - PET-CT	4	**483%**	2	**249%**
B01 - Radiotherapy	7,363	**129%**	6,760	**117%**
D05 - Stereotactic Radiosurgery	192	**-182%**	189	**-168%**
B03 - Teenage and Young Adults Cancer	6,829	**31%**	6,682	**28%**
B03 - Rare Cancers (Adult)	29,364	**22%**	27,734	**20%**
B04 - BMT	1,846	-5%	1,790	-4%
B05 - Haemophilia	3,559	**80%**	3,503	**79%**
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,274	**-8%**	1,263	**-6%**
E12 - Women - Fetal Medicine	168	0%	163	-14%
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	**83%**	14	**89%**
E11 - Women - Maternal Medicine (complications of pregnancy)	39,629	**11%**	37,695	**7%**
D14 - Spinal - Spinal Surgery	6,333	-1%	5,692	**-4%**
D04 - Neurosciences - Neurology	96,650	**43%**	91,723	**34%**
D04 - Neurosciences - Neurophysiology	87	**-34%**	85	**-42%**
D04 - Neurosciences - Neuroradiology	13	-43%	13	-41%
D03 - Neurosciences - Neurosurgery	54,455	**41%**	50,758	**37%**
D06 - Burns Care	2,948	**71%**	2,755	**47%**
A01 - Cystic fibrosis	646	**25%**	638	**29%**
A06 - Renal Services - Access for dialysis	13,323	**59%**	11,968	**32%**
A07 - Renal Services - Renal Transplantation	9,296	-1%	8,846	**-3%**
A09 - Cardiac - Cardiac electrophysiology	5,671	1%	5,266	1%
A09 - Cardiac - Inherited heart disorders	3,955	**53%**	3,489	**26%**
A10 - Cardiac - Cardiac surgery	24,744	**24%**	23,029	**22%**
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	25,910	**25%**	24,392	**27%**
A11 - Cardiac - Pulmonary hypertension	3,292	**29%**	3,107	**13%**
A10 - Cardiac - Cardiovascular magnetic resonance	8	52%	3	27%
A10 - Cardiac - Other	15,791	**5%**	15,252	**5%**
A13 - Adult Congenital Heart Disease	4,185	**6%**	4,073	**6%**
D07 - Cleft Lip Palate	2,695	**10%**	2,615	**11%**
B09 - Immunology	9,760	**12%**	9,737	**14%**
B09 - Allergy	1,971	**-13%**	1,971	**-8%**
B07 - Infectious Diseases Adult	268	**-38%**	258	**-43%**
B07 - Infectious Diseases Paeds	247	**33%**	239	-2%
A02 - Hepatology & Pancreatic	2,342	**8%**	2,214	**10%**
C04 - Mental Health - Gender Dysphoria	160	**30%**	159	**35%**
E04 - Childrens services - Cancer	25,405	**12%**	25,056	**13%**
E05 - Childrens services - Cardiac	8,645	**44%**	8,054	**36%**
E03 - Childrens services - Endocrinology	3,671	**8%**	3,657	**14%**
E03 - Childrens services - Gastroenterology	62,385	**16%**	60,427	**10%**
E03 - Childrens services - Haematology	1,919	**32%**	1,879	**32%**
E09 - Childrens services - Neurosciences	9,071	**73%**	8,564	**54%**
E03 - Childrens services - Ophthalmology	6,725	**4%**	6,637	**5%**
E03 - Childrens services - Renal	9,593	**31%**	9,407	**26%**
E03 - Childrens services - Respiratory	7,184	**73%**	6,825	**67%**
E03 - Childrens services - Rheumatology	6,047	**11%**	5,784	**9%**
E02 - Childrens services - Surgery	44,589	**13%**	42,754	**14%**
E03 - Childrens services - Paediatric Pain Management	25	**150%**	25	**162%**
D11 - Hyperbaric Oxygen Treatment	12	**139%**	9	43%
A03d - Respiratory - Pulmonary vascular services	178	**-32%**	164	**-30%**
A12 - Respiratory - Complex thoracic surgery	27,615	**43%**	25,967	**45%**
A03d - Respiratory - Management of central airway obstruction	1,901	**68%**	1,760	**62%**
A03d - Respiratory - Interstitial lung disease	2,534	**-10%**	2,499	**-7%**
A03d - Respiratory - Other	13,953	**22%**	12,107	**9%**
A04 - Vascular Services	4,839	**17%**	4,499	**13%**
D09 - Ears - Cochlear Implants	1,150	-6%	1,040	-2%
D09 - Ears - Bone anchored hearing aids	1,370	0%	1,342	2%
D09 - Ears - Middle Ear Implants	113	-12%	108	-10%
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	1,087	**-41%**
A08 - Colorectal - Complex Inflammatory Bowel disease	63	5%	60	8%
A08 - Colorectal - Transanal Endoscopic Microsurgery	503	**54%**	502	**60%**
D10 - Orthopaedic Surgery	1,637	**22%**	1,462	**13%**
D10 - Orthopaedic Surgery - revisions	176	**53%**	142	**36%**
A05 - Morbid Obesity Surgery	8,252	1%	7,908	2%
D12 - Ophthalmology	20,004	2%	19,558	1%
B08 - Haemoglobinopathy - Sickle Cell	13,553	**7%**	13,064	**5%**
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	8,646	**3%**
Highly Specialised	11,355	**74%**	10,702	**67%**
Total sample	**12,286,246**		**11,927,415**	

Sensitivity analysis: FCEs rather than spells as unit of observation

Table 16 provides details of the estimates when the unit of observation is based on FCEs rather than spells. Comparison with the estimates presented in Table 15 shows that the cost differences are not sensitive to this choice:

- There is little difference in the cost differences for the full sample – column [a] in Table 15 and column [c] in Table 16. For only 6 PSS markers with more than 300 patients is the difference more than 10%.

- The same is true for the cost differences for the inlier sample – column [b] in Table 15 and column [d] in Table 16. For only 7 PSS markers with more than 300 patients is the difference more than 10%.

- Unsurprisingly, therefore, conclusions drawn Table 16 are the same as those for Table 15.

Table 16 Analyses using FCEs as the unit of observation

PSS chapter	Full sample FCEs n	Full sample FCEs % [c]	Inlier sample FCEs n	Inlier sample FCEs % [d]
B03 - Chemotherapy	47,306	**51%**	47,115	**54%**
B02 - PET-CT	4	**486%**	2	**223%**
B01 - Radiotherapy	7,719	**140%**	7,057	**126%**
D05 - Stereotactic Radiosurgery	199	**-194%**	195	**-180%**
B03 - Teenage and Young Adults Cancer	7,102	**32%**	6,946	**29%**
B03 - Rare Cancers (Adult)	35,623	**20%**	33,791	**18%**
B04 - BMT	1,893	-6%	1,846	-3%
B05 - Haemophilia	3,689	**76%**	3,630	**75%**
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,281	-8%	1,270	-5%
E12 - Women - Fetal Medicine	176	**68%**	170	**25%**
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	-1%	14	3%
E11 - Women - Maternal Medicine (complications of pregnancy)	40,810	**10%**	38,817	**6%**
D14 - Spinal - Spinal Surgery	6,706	**-6%**	6,069	**-7%**
D04 - Neurosciences - Neurology	103,517	**58%**	98,041	**47%**
D04 - Neurosciences - Neurophysiology	88	**-46%**	88	**-40%**
D04 - Neurosciences - Neuroradiology	13	-43%	13	-41%
D03 - Neurosciences - Neurosurgery	60,753	**43%**	56,787	**39%**
D06 - Burns Care	3,115	**73%**	2,915	**49%**
A01 - Cystic fibrosis	741	**25%**	732	**30%**
A06 - Renal Services - Access for dialysis	14,744	**60%**	13,300	**30%**
A07 - Renal Services - Renal Transplantation	9,760	**-4%**	9,272	**-5%**
A09 - Cardiac - Cardiac electrophysiology	5,850	0%	5,432	1%
A09 - Cardiac - Inherited heart disorders	5,292	**55%**	4,668	**25%**
A10 - Cardiac - Cardiac surgery	29,654	**33%**	27,596	**30%**
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	28,470	**10%**	26,953	**10%**
A11 - Cardiac - Pulmonary hypertension	3,382	**43%**	3,180	**23%**
A10 - Cardiac - Cardiovascular magnetic resonance	8	65%	3	48%
A10 - Cardiac - Other	16,214	**8%**	15,673	**9%**
A13 - Adult Congenital Heart Disease	4,596	**4%**	4,474	**5%**
D07 - Cleft Lip Palate	2,712	**17%**	2,631	**16%**
B09 - Immunology	9,775	**13%**	9,750	**16%**
B09 - Allergy	1,971	**-8%**	1,971	-3%
B07 - Infectious Diseases Adult	289	**-23%**	278	**-30%**
B07 - Infectious Diseases Paeds	259	**40%**	248	4%
A02 - Hepatology & Pancreatic	2,839	5%	2,702	5%
C04 - Mental Health - Gender Dysphoria	161	**31%**	160	**37%**
E04 - Childrens services - Cancer	26,651	**12%**	26,234	**13%**
E05 - Childrens services - Cardiac	11,940	**42%**	11,212	**32%**
E03 - Childrens services - Endocrinology	3,678	**8%**	3,665	**15%**
E03 - Childrens services - Gastroenterology	66,605	**16%**	64,426	**10%**
E03 - Childrens services - Haematology	1,961	**31%**	1,915	**30%**
E09 - Childrens services - Neurosciences	10,032	**77%**	9,397	**56%**
E03 - Childrens services - Ophthalmology	6,809	**4%**	6,716	**5%**
E03 - Childrens services - Renal	10,246	**32%**	10,031	**27%**
E03 - Childrens services - Respiratory	7,670	**68%**	7,282	**61%**
E03 - Childrens services - Rheumatology	6,503	**17%**	6,152	**13%**
E02 - Childrens services - Surgery	48,114	**7%**	46,318	**9%**
E03 - Childrens services - Paediatric Pain Management	25	**149%**	25	**163%**
D11 - Hyperbaric Oxygen Treatment	13	**151%**	9	54%
A03d - Respiratory - Pulmonary vascular services	184	**-45%**	168	**-40%**
A12 - Respiratory - Complex thoracic surgery	31,004	**50%**	29,183	**52%**
A03d - Respiratory - Management of central airway obstruction	2,044	**88%**	1,889	**75%**
A03d - Respiratory - Interstitial lung disease	2,837	2%	2,803	**7%**
A03d - Respiratory - Other	16,843	**17%**	15,193	2%
A04 - Vascular Services	5,500	**10%**	5,181	**7%**
D09 - Ears - Cochlear Implants	1,153	-3%	1,043	0%
D09 - Ears - Bone anchored hearing aids	1,371	1%	1,342	3%
D09 - Ears - Middle Ear Implants	113	-11%	108	-9%
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	1,087	**-40%**
A08 - Colorectal - Complex Inflammatory Bowel disease	64	8%	61	11%
A08 - Colorectal - Transanal Endoscopic Microsurgery	505	**58%**	504	**65%**
D10 - Orthopaedic Surgery	1,664	**22%**	1,487	**15%**
D10 - Orthopaedic Surgery - revisions	179	**51%**	145	**34%**
A05 - Morbid Obesity Surgery	8,330	1%	7,982	2%
D12 - Ophthalmology	20,049	1%	19,599	1%
B08 - Haemoglobinopathy - Sickle Cell	13,788	**12%**	13,280	**10%**
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	8,646	3%
Highly Specialised	12,166	**90%**	11,452	**79%**
Total sample	**14,184,683**		**13,779,336**	

Sensitivity analysis: Using the PSS toolkit to identify specialised services

As discussed, because it incorporates various data quality checks, the PSS toolkit identifies fewer patients as having received specialised care than we do when we programme the PSS Identification Rules based on the designated ICD and OPCS codes. In Table 17 we report details of analyses based on our identification of patients who received PPS care and that subset of patients identified using the PSS toolkit. The main points are:

- For the majority of PSS markers, the volume of patients identified by both methods is very similar (our approach always identifies more). Unsurprisingly, therefore, the cost differences are virtually identical in most instances;

- For only six of the PSS markers the cost differences differ by more than 0.1 (ie 10%). For four of these, the markers apply to fewer than 200 patients. For the other two (D06-Burns Care and E03-Childrens services-Renal), we are identifying substantially more patients than the toolkit does.

Table 17 Analyses in which PSS specialised is identified using the PSS toolkit

PSS chapter	Full sample FCEs n	Full sample FCEs % [c]	Full sample FCEs toolkit n	Full sample FCEs toolkit % [e]
B03 - Chemotherapy	47,306	**51%**	47,003	**49%**
B02 - PET-CT	4	**486%**	-	N/A
B01 - Radiotherapy	7,719	**140%**	6,963	**140%**
D05 - Stereotactic Radiosurgery	199	**-194%**	196	**-146%**
B03 - Teenage and Young Adults Cancer	7,102	**32%**	7,017	**32%**
B03 - Rare Cancers (Adult)	35,623	**20%**	35,097	**23%**
B04 - BMT	1,893	-6%	1,845	**-14%**
B05 - Haemophilia	3,689	**76%**	3,003	**83%**
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,281	-8%	977	**-11%**
E12 - Women - Fetal Medicine	176	**68%**	175	69%
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	-1%	10	**2%**
E11 - Women - Maternal Medicine (complications of pregnancy)	40,810	**10%**	40,266	11%
D14 - Spinal - Spinal Surgery	6,706	**-6%**	5,772	**-8%**
D04 - Neurosciences - Neurology	103,517	**58%**	102,386	**50%**
D04 - Neurosciences - Neurophysiology	88	**-46%**	88	**-47%**
D04 - Neurosciences - Neuroradiology	13	-43%	12	**-39%**
D03 - Neurosciences - Neurosurgery	60,753	**43%**	53,301	41%
D06 - Burns Care	3,115	**73%**	2,397	**25%**
A01 - Cystic fibrosis	741	**25%**	699	**30%**
A06 - Renal Services - Access for dialysis	14,744	**60%**	10,171	**60%**
A07 - Renal Services - Renal Transplantation	9,760	**-4%**	8,558	**-3%**
A09 - Cardiac - Cardiac electrophysiology	5,850	0%	5,828	**1%**
A09 - Cardiac - Inherited heart disorders	5,292	**55%**	5,258	55%
A10 - Cardiac - Cardiac surgery	29,654	**33%**	27,549	**32%**
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	28,470	**10%**	25,523	**11%**
A11 - Cardiac - Pulmonary hypertension	3,382	**43%**	3,336	**41%**
A10 - Cardiac - Cardiovascular magnetic resonance	8	65%	-	N/A
A10 - Cardiac - Other	16,214	**8%**	16,023	**7%**
A13 - Adult Congenital Heart Disease	4,596	**4%**	4,559	5%
D07 - Cleft Lip Palate	2,712	**17%**	1,949	**-7%**
B09 - Immunology	9,775	**13%**	9,747	**12%**
B09 - Allergy	1,971	**-8%**	1,971	**-12%**
B07 - Infectious Diseases Adult	289	**-23%**	273	**-24%**
B07 - Infectious Diseases Paeds	259	**40%**	252	**33%**
A02 - Hepatology & Pancreatic	2,839	5%	2,727	**7%**
C04 - Mental Health - Gender Dysphoria	161	**31%**	161	33%
E04 - Childrens services - Cancer	26,651	**12%**	26,403	**13%**
E05 - Childrens services - Cardiac	11,940	**42%**	11,885	**28%**
E03 - Childrens services - Endocrinology	3,678	**8%**	3,610	**8%**
E03 - Childrens services - Gastroenterology	66,605	**16%**	65,782	**14%**
E03 - Childrens services - Haematology	1,961	**31%**	1,941	**31%**
E09 - Childrens services - Neurosciences	10,032	**77%**	9,726	**69%**
E03 - Childrens services - Ophthalmology	6,809	**4%**	6,779	**3%**
E03 - Childrens services - Renal	10,246	**32%**	6,512	**35%**
E03 - Childrens services - Respiratory	7,670	**68%**	7,522	**68%**
E03 - Childrens services - Rheumatology	6,503	**17%**	5,929	**12%**
E02 - Childrens services - Surgery	48,114	**7%**	60,410	**29%**
E03 - Childrens services - Paediatric Pain Management	25	**149%**	23	**135%**
D11 - Hyperbaric Oxygen Treatment	13	**151%**	12	**152%**
A03d - Respiratory - Pulmonary vascular services	184	**-45%**	183	**1%**
A12 - Respiratory - Complex thoracic surgery	31,004	**50%**	30,404	52%
A03d - Respiratory - Management of central airway obstruction	2,044	**88%**	1,990	**88%**
A03d - Respiratory - Interstitial lung disease	2,837	2%	2,755	**4%**
A03d - Respiratory - Other	16,843	**17%**	15,923	**16%**
A04 - Vascular Services	5,500	**10%**	5,434	**12%**
D09 - Ears - Cochlear Implants	1,153	-3%	1,145	-14%
D09 - Ears - Bone anchored hearing aids	1,371	1%	1,363	**-1%**
D09 - Ears - Middle Ear Implants	113	-11%	113	-11%
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	1,083	-43%
A08 - Colorectal - Complex Inflammatory Bowel disease	64	8%	64	12%
A08 - Colorectal - Transanal Endoscopic Microsurgery	505	**58%**	503	**60%**
D10 - Orthopaedic Surgery	1,664	**22%**	1,632	33%
D10 - Orthopaedic Surgery - revisions	179	**51%**	127	**39%**
A05 - Morbid Obesity Surgery	8,330	1%	8,303	**2%**
D12 - Ophthalmology	20,049	1%	19,968	**3%**
B08 - Haemoglobinopathy - Sickle Cell	13,788	**12%**	13,639	**11%**
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	8,639	**0%**
Highly Specialised	12,166	**90%**	-	N/A
Total sample	**14,184,683**		**14,184,683**	

Sensitivity analysis: Dropping HRGs in which everyone or no-one received specialised services

There are 42 HRGs in which everybody is identified as having received specialised care as defined by the PSS. At the other extreme, there are 36 HRGs in which nobody received specialised care. For these HRGs, there is no need to pay a top-up for specialised care, either because the costs will be embodied in the base HRG payment or because specialised care is irrelevant.

If patients allocated to these HRGs are omitted, 41,829 spells are dropped from the analytical sample. The impact that this has on the results is reported in Table 18. None of the PSS markers are sensitive to omitting these patients from the analysis.

Table 18 Sensitivity analysis to omission of fully or non-specialised HRGs

PSS chapter	Full sample Spells n	Full sample Spells % [a]	Drop 100% & 0% Spells n	Drop 100% & 0% Spells % [f]
B03 - Chemotherapy	47,186	**50%**	47,033	**50%**
B02 - PET-CT	4	**483%**	4	**484%**
B01 - Radiotherapy	7,363	**129%**	7,306	**130%**
D05 - Stereotactic Radiosurgery	192	**-182%**	191	**-183%**
B03 - Teenage and Young Adults Cancer	6,829	**31%**	6,790	**31%**
B03 - Rare Cancers (Adult)	29,364	**22%**	29,357	**22%**
B04 - BMT	1,846	-5%	2	**430%**
B05 - Haemophilia	3,559	**80%**	3,558	**80%**
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,274	**-8%**	1,274	-8%
E12 - Women - Fetal Medicine	168	0%	168	0%
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	**83%**	14	83%
E11 - Women - Maternal Medicine (complications of pregnancy)	39,629	**11%**	39,628	**11%**
D14 - Spinal - Spinal Surgery	6,333	-1%	6,332	-1%
D04 - Neurosciences - Neurology	96,650	**43%**	96,649	**43%**
D04 - Neurosciences - Neurophysiology	87	**-34%**	87	-34%
D04 - Neurosciences - Neuroradiology	13	-43%	13	-43%
D03 - Neurosciences - Neurosurgery	54,455	**41%**	54,453	**41%**
D06 - Burns Care	2,948	**71%**	2,948	**71%**
A01 - Cystic fibrosis	646	**25%**	642	**26%**
A06 - Renal Services - Access for dialysis	13,323	**59%**	13,323	**59%**
A07 - Renal Services - Renal Transplantation	9,296	-1%	9,295	-1%
A09 - Cardiac - Cardiac electrophysiology	5,671	1%	5,671	1%
A09 - Cardiac - Inherited heart disorders	3,955	**53%**	3,955	**53%**
A10 - Cardiac - Cardiac surgery	24,744	**24%**	24,599	**24%**
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	25,910	**25%**	25,907	**25%**
A11 - Cardiac - Pulmonary hypertension	3,292	**29%**	3,292	**29%**
A10 - Cardiac - Cardiovascular magnetic resonance	8	52%	7	71%
A10 - Cardiac - Other	15,791	**5%**	15,790	**5%**
A13 - Adult Congenital Heart Disease	4,185	**6%**	3,988	**10%**
D07 - Cleft Lip Palate	2,695	**10%**	2,694	**9%**
B09 - Immunology	9,760	**12%**	9,757	**12%**
B09 - Allergy	1,971	**-13%**	1,971	**-13%**
B07 - Infectious Diseases Adult	268	**-38%**	268	**-38%**
B07 - Infectious Diseases Paeds	247	**33%**	244	**33%**
A02 - Hepatology & Pancreatic	2,342	**8%**	2,342	8%
C04 - Mental Health - Gender Dysphoria	160	**30%**	160	30%
E04 - Childrens services - Cancer	25,405	**12%**	24,205	**14%**
E05 - Childrens services - Cardiac	8,645	**44%**	8,109	**46%**
E03 - Childrens services - Endocrinology	3,671	**8%**	3,671	**8%**
E03 - Childrens services - Gastroenterology	62,385	**16%**	60,889	**17%**
E03 - Childrens services - Haematology	1,919	**32%**	1,907	**32%**
E09 - Childrens services - Neurosciences	9,071	**73%**	9,060	**72%**
E03 - Childrens services - Ophthalmology	6,725	**4%**	5,942	**6%**
E03 - Childrens services - Renal	9,593	**31%**	9,548	**31%**
E03 - Childrens services - Respiratory	7,184	**73%**	7,182	**73%**
E03 - Childrens services - Rheumatology	6,047	**11%**	6,041	**10%**
E02 - Childrens services - Surgery	44,589	**13%**	41,547	**14%**
E03 - Childrens services - Paediatric Pain Management	25	**150%**	25	**150%**
D11 - Hyperbaric Oxygen Treatment	12	**139%**	12	**139%**
A03d - Respiratory - Pulmonary vascular services	178	**-32%**	178	**-35%**
A12 - Respiratory - Complex thoracic surgery	27,615	**43%**	27,546	**43%**
A03d - Respiratory - Management of central airway obstruction	1,901	**68%**	1,899	**68%**
A03d - Respiratory - Interstitial lung disease	2,534	**-10%**	2,534	**-10%**
A03d - Respiratory - Other	13,953	**22%**	13,941	**22%**
A04 - Vascular Services	4,839	**17%**	4,835	**17%**
D09 - Ears - Cochlear Implants	1,150	-6%	61	-14%
D09 - Ears - Bone anchored hearing aids	1,370	0%	30	1%
D09 - Ears - Middle Ear Implants	113	-12%	112	-12%
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	1,090	**-42%**
A08 - Colorectal - Complex Inflammatory Bowel disease	63	5%	63	5%
A08 - Colorectal - Transanal Endoscopic Microsurgery	503	**54%**	503	**54%**
D10 - Orthopaedic Surgery	1,637	**22%**	1,637	**21%**
D10 - Orthopaedic Surgery - revisions	176	**53%**	176	**53%**
A05 - Morbid Obesity Surgery	8,252	1%	4,112	0%
D12 - Ophthalmology	20,004	2%	20,003	2%
B08 - Haemoglobinopathy - Sickle Cell	13,553	**7%**	13,551	**6%**
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	8,651	0%
Highly Specialised	11,355	**74%**	11,131	**76%**
Total sample	**12,286,246**		**12,244,417**	

Sensitivity analysis: dropping eligibility requirements

In this sensitivity analysis we relax the condition that the patient had to be treated at an eligible provider in order to be identified as having received some form of specialised care. With the relaxation of this condition, identification is conditional only on the presence of the relevant identification rules in the patient's HES record.

Relaxation of the eligibility requirement increases the number of patients identified as having received specialised care, but only for the following PSS markers and for some of these, there is only a small increase in numbers identified:

- B05 - Haemophilia
- D14 - Spinal - Spinal Surgery
- D03 - Neurosciences - Neurosurgery
- A01 - Cystic fibrosis
- A10 - Cardiac - Cardiac surgery
- A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)
- A11 - Cardiac - Pulmonary hypertension
- D07 - Cleft Lip Palate
- B07 - Infectious Diseases Adult
- A03d - Respiratory - Interstitial lung disease

We might expect, then, that results for these PSS markers are sensitive to relaxation of the eligibility condition, while those for other markers are unchanged. As Table 19 shows, there is indeed no change for the markers unaffected by relaxing of the eligibility requirement. For the above markers in which changes might be expected, there is no uniformity in the size or direction of change.

Following relaxation of the eligibility condition, the percentage effect increases for the following PSS markers:

- A10 - Cardiac - Cardiac surgery from 24% to 28%
- A11 - Cardiac - Pulmonary hypertension from 29% to 36%
- B07 - Infectious Diseases Adult (though the effect on this marker is negative)

In contrast, the percentage effect falls for B05 - Haemophilia and there is no change for the other PSS markers.

Table 19 Sensitivity to dropping eligibility requirements in identifying specialised care

PSS chapter	Full sample Spells n	Full sample Spells % [a]	Eligibility Spells n	Eligibility Spells % [g]	Increase in n
B03 - Chemotherapy	47,186	**50%**	47,186	**50%**	-
B02 - PET-CT	4	**483%**	4	**484%**	-
B01 - Radiotherapy	7,363	**129%**	7,363	**129%**	-
D05 - Stereotactic Radiosurgery	192	**-182%**	192	**-183%**	-
B03 - Teenage and Young Adults Cancer	6,829	**31%**	6,829	**31%**	-
B03 - Rare Cancers (Adult)	29,364	**22%**	29,364	**22%**	-
B04 - BMT	1,846	-5%	1,846	-5%	-
B05 - Haemophilia	3,559	**80%**	5,264	**48%**	1,705
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,274	**-8%**	1,274	-8%	-
E12 - Women - Fetal Medicine	168	0%	168	1%	-
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	**83%**	14	83%	-
E11 - Women - Maternal Medicine (complications of pregnancy)	39,629	**11%**	39,629	**11%**	-
D14 - Spinal - Spinal Surgery	6,333	-1%	9,221	**-5%**	2,888
D04 - Neurosciences - Neurology	96,650	**43%**	96,650	**43%**	-
D04 - Neurosciences - Neurophysiology	87	**-34%**	87	-34%	-
D04 - Neurosciences - Neuroradiology	13	-43%	13	-43%	-
D03 - Neurosciences - Neurosurgery	54,455	**41%**	56,095	**42%**	1,640
D06 - Burns Care	2,948	**71%**	2,948	**71%**	-
A01 - Cystic fibrosis	646	**25%**	747	**24%**	101
A06 - Renal Services - Access for dialysis	13,323	**59%**	13,323	**59%**	-
A07 - Renal Services - Renal Transplantation	9,296	-1%	9,296	-1%	-
A09 - Cardiac - Cardiac electrophysiology	5,671	1%	5,671	1%	-
A09 - Cardiac - Inherited heart disorders	3,955	**53%**	3,955	**53%**	-
A10 - Cardiac - Cardiac surgery	24,744	**24%**	27,418	**28%**	2,674
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	25,910	**25%**	30,563	**25%**	4,653
A11 - Cardiac - Pulmonary hypertension	3,292	**29%**	4,389	**36%**	1,097
A10 - Cardiac - Cardiovascular magnetic resonance	8	52%	8	52%	-
A10 - Cardiac - Other	15,791	**5%**	15,791	**4%**	-
A13 - Adult Congenital Heart Disease	4,185	**6%**	4,185	**6%**	-
D07 - Cleft Lip Palate	2,695	**10%**	2,811	**11%**	116
B09 - Immunology	9,760	**12%**	9,760	**12%**	-
B09 - Allergy	1,971	**-13%**	1,971	**-13%**	-
B07 - Infectious Diseases Adult	268	**-38%**	279	**-26%**	11
B07 - Infectious Diseases Paeds	247	**33%**	247	**33%**	-
A02 - Hepatology & Pancreatic	2,342	**8%**	2,342	**8%**	-
C04 - Mental Health - Gender Dysphoria	160	**30%**	160	**30%**	-
E04 - Childrens services - Cancer	25,405	**12%**	25,405	**13%**	-
E05 - Childrens services - Cardiac	8,645	**44%**	8,645	**44%**	-
E03 - Childrens services - Endocrinology	3,671	**8%**	3,671	**8%**	-
E03 - Childrens services - Gastroenterology	62,385	**16%**	62,385	**16%**	-
E03 - Childrens services - Haematology	1,919	**32%**	1,919	**32%**	-
E09 - Childrens services - Neurosciences	9,071	**73%**	9,071	**73%**	-
E03 - Childrens services - Ophthalmology	6,725	**4%**	6,725	3%	-
E03 - Childrens services - Renal	9,593	**31%**	9,593	**31%**	-
E03 - Childrens services - Respiratory	7,184	**73%**	7,184	**73%**	-
E03 - Childrens services - Rheumatology	6,047	**11%**	6,047	**11%**	-
E02 - Childrens services - Surgery	44,589	**13%**	44,589	**13%**	-
E03 - Childrens services - Paediatric Pain Management	25	**150%**	25	**150%**	-
D11 - Hyperbaric Oxygen Treatment	12	**139%**	12	**139%**	-
A03d - Respiratory - Pulmonary vascular services	178	**-32%**	178	**-35%**	-
A12 - Respiratory - Complex thoracic surgery	27,615	**43%**	27,615	**39%**	-
A03d - Respiratory - Management of central airway obstruction	1,901	**68%**	1,901	**69%**	-
A03d - Respiratory - Interstitial lung disease	2,534	**-10%**	8,285	1%	5,751
A03d - Respiratory - Other	13,953	**22%**	13,953	**22%**	-
A04 - Vascular Services	4,839	**17%**	4,839	**17%**	-
D09 - Ears - Cochlear Implants	1,150	-6%	1,150	-6%	-
D09 - Ears - Bone anchored hearing aids	1,370	0%	1,370	0%	-
D09 - Ears - Middle Ear Implants	113	-12%	113	-12%	-
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	1,090	**-42%**	-
A08 - Colorectal - Complex Inflammatory Bowel disease	63	5%	63	5%	-
A08 - Colorectal - Transanal Endoscopic Microsurgery	503	**54%**	503	**54%**	-
D10 - Orthopaedic Surgery	1,637	**22%**	1,637	**22%**	-
D10 - Orthopaedic Surgery - revisions	176	**53%**	176	**53%**	-
A05 - Morbid Obesity Surgery	8,252	1%	8,252	1%	-
D12 - Ophthalmology	20,004	2%	20,004	2%	-
B08 - Haemoglobinopathy - Sickle Cell	13,553	**7%**	13,553	**7%**	-
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	8,651	0%	-
Highly Specialised	11,355	**74%**	11,355	**74%**	-
Total sample	**12,286,246**		**12,286,246**		

Sensitivity analysis: including those with partially matched costs

In Table 20 we expand the analytical sample to include those with partially matched Reference Costs. This increases the number of FCEs in the analysis from 14,184,683 to 15,234,491. This changes some of the percentage effects, but rarely by more than 3%. Where changes are larger than this, these occur for those PSS markers with relatively small numbers of patients.

Table 20 Inclusion of patients with partially matched costs

PSS chapter	Full sample Spells n	Full sample Spells % [a]	Imperfect match FCEs n	Imperfect match FCEs % [h]
B03 - Chemotherapy	47,186	**50%**	50,772	**49%**
B02 - PET-CT	4	**483%**	5	**392%**
B01 - Radiotherapy	7,363	**129%**	8,244	**134%**
D05 - Stereotactic Radiosurgery	192	**-182%**	233	**-183%**
B03 - Teenage and Young Adults Cancer	6,829	**31%**	7,771	**29%**
B03 - Rare Cancers (Adult)	29,364	**22%**	40,941	**20%**
B04 - BMT	1,846	-5%	2,313	-5%
B05 - Haemophilia	3,559	**80%**	4,041	**70%**
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,274	**-8%**	1,282	-8%
E12 - Women - Fetal Medicine	168	0%	179	**65%**
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	**83%**	15	2%
E11 - Women - Maternal Medicine (complications of pregnancy)	39,629	**11%**	44,057	**10%**
D14 - Spinal - Spinal Surgery	6,333	-1%	7,260	-5%
D04 - Neurosciences - Neurology	96,650	**43%**	109,244	**52%**
D04 - Neurosciences - Neurophysiology	87	**-34%**	148	9%
D04 - Neurosciences - Neuroradiology	13	-43%	31	-22%
D03 - Neurosciences - Neurosurgery	54,455	**41%**	63,160	**40%**
D06 - Burns Care	2,948	**71%**	5,756	**51%**
A01 - Cystic fibrosis	646	**25%**	1,058	**21%**
A06 - Renal Services - Access for dialysis	13,323	**59%**	15,648	**58%**
A07 - Renal Services - Renal Transplantation	9,296	-1%	10,335	-3%
A09 - Cardiac - Cardiac electrophysiology	5,671	1%	5,914	0%
A09 - Cardiac - Inherited heart disorders	3,955	**53%**	5,605	**57%**
A10 - Cardiac - Cardiac surgery	24,744	**24%**	35,514	**31%**
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	25,910	**25%**	28,990	**10%**
A11 - Cardiac - Pulmonary hypertension	3,292	**29%**	3,401	**40%**
A10 - Cardiac - Cardiovascular magnetic resonance	8	52%	8	66%
A10 - Cardiac - Other	15,791	**5%**	17,539	**6%**
A13 - Adult Congenital Heart Disease	4,185	**6%**	4,950	4%
D07 - Cleft Lip Palate	2,695	**10%**	2,836	**17%**
B09 - Immunology	9,760	**12%**	10,658	**13%**
B09 - Allergy	1,971	**-13%**	2,538	5%
B07 - Infectious Diseases Adult	268	**-38%**	301	-21%
B07 - Infectious Diseases Paeds	247	**33%**	274	**40%**
A02 - Hepatology & Pancreatic	2,342	**8%**	3,519	5%
C04 - Mental Health - Gender Dysphoria	160	**30%**	162	31%
E04 - Childrens services - Cancer	25,405	**12%**	28,587	**11%**
E05 - Childrens services - Cardiac	8,645	**44%**	14,509	**41%**
E03 - Childrens services - Endocrinology	3,671	**8%**	3,780	6%
E03 - Childrens services - Gastroenterology	62,385	**16%**	72,978	**17%**
E03 - Childrens services - Haematology	1,919	**32%**	2,171	**27%**
E09 - Childrens services - Neurosciences	9,071	**73%**	11,154	**73%**
E03 - Childrens services - Ophthalmology	6,725	**4%**	7,141	**7%**
E03 - Childrens services - Renal	9,593	**31%**	12,261	**30%**
E03 - Childrens services - Respiratory	7,184	**73%**	8,531	**68%**
E03 - Childrens services - Rheumatology	6,047	**11%**	7,871	**18%**
E02 - Childrens services - Surgery	44,589	**13%**	54,878	**7%**
E03 - Childrens services - Paediatric Pain Management	25	**150%**	25	**145%**
D11 - Hyperbaric Oxygen Treatment	12	**139%**	16	**120%**
A03d - Respiratory - Pulmonary vascular services	178	**-32%**	197	**-38%**
A12 - Respiratory - Complex thoracic surgery	27,615	**43%**	38,667	**43%**
A03d - Respiratory - Management of central airway obstruction	1,901	**68%**	2,667	**74%**
A03d - Respiratory - Interstitial lung disease	2,534	**-10%**	3,039	2%
A03d - Respiratory - Other	13,953	**22%**	21,007	**16%**
A04 - Vascular Services	4,839	**17%**	6,346	**9%**
D09 - Ears - Cochlear Implants	1,150	-6%	1,231	-3%
D09 - Ears - Bone anchored hearing aids	1,370	0%	1,380	1%
D09 - Ears - Middle Ear Implants	113	-12%	115	-11%
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	1,691	**-50%**
A08 - Colorectal - Complex Inflammatory Bowel disease	63	5%	84	11%
A08 - Colorectal - Transanal Endoscopic Microsurgery	503	**54%**	529	**55%**
D10 - Orthopaedic Surgery	1,637	**22%**	1,724	**22%**
D10 - Orthopaedic Surgery - revisions	176	**53%**	184	**49%**
A05 - Morbid Obesity Surgery	8,252	1%	8,431	0%
D12 - Ophthalmology	20,004	2%	20,233	1%
B08 - Haemoglobinopathy - Sickle Cell	13,553	**7%**	13,902	**15%**
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	8,848	1%
Highly Specialised	11,355	**74%**	13,528	**92%**
Total sample	**12,286,246**		**15,234,491**	

Accounting for hospital effects

Table 21 compares equation 1, estimated using OLS, with equation 2, which accounts for hospital clustering using a random effects specification. The table provides estimates of the cost differences between these specifications.

As we found for the SSNDS markers, the cost differences are invariably larger for the OLS model than the RE model that accounts for clustering, for the same reasons as previously.

For 28 PSS markers, the cost differential between those that do and do not receive specialised care is more than 10% for 28 PSS markers; for 16 of these the difference is more than 25%; and for 7 it is more than 50%.

Table 21 Comparison of OLS and RE models

PSS chapter	Full sample Spells n	Full sample Spells % [a]	Full sample Spells RE % [i]
B03 - Chemotherapy	47,186	**50%**	**49%**
B02 - PET-CT	4	**483%**	**451%**
B01 - Radiotherapy	7,363	**129%**	**113%**
D05 - Stereotactic Radiosurgery	192	**-182%**	**-172%**
B03 - Teenage and Young Adults Cancer	6,829	**31%**	**25%**
B03 - Rare Cancers (Adult)	29,364	**22%**	**19%**
B04 - BMT	1,846	-5%	**-10%**
B05 - Haemophilia	3,559	**80%**	**65%**
E10 - Women - Complex Minimal Access Gynaecology Surgery	1,274	**-8%**	-7%
E12 - Women - Fetal Medicine	168	0%	-5%
E10 - Women - Complex Urinary and Faecal Incontinence & Genital Prolapse	14	**83%**	77%
E11 - Women - Maternal Medicine (complications of pregnancy)	39,629	**11%**	**10%**
D14 - Spinal - Spinal Surgery	6,333	-1%	-3%
D04 - Neurosciences - Neurology	96,650	**43%**	**39%**
D04 - Neurosciences - Neurophysiology	87	**-34%**	-33%
D04 - Neurosciences - Neuroradiology	13	-43%	-53%
D03 - Neurosciences - Neurosurgery	54,455	**41%**	**36%**
D06 - Burns Care	2,948	**71%**	**62%**
A01 - Cystic fibrosis	646	**25%**	9%
A06 - Renal Services - Access for dialysis	13,323	**59%**	**52%**
A07 - Renal Services - Renal Transplantation	9,296	-1%	**-5%**
A09 - Cardiac - Cardiac electrophysiology	5,671	1%	**-7%**
A09 - Cardiac - Inherited heart disorders	3,955	**53%**	**48%**
A10 - Cardiac - Cardiac surgery	24,744	**24%**	**21%**
A09 - Cardiac - PPCI and Structural Heart Disease (Complex Invasive Cardiology)	25,910	**25%**	**22%**
A11 - Cardiac - Pulmonary hypertension	3,292	**29%**	**18%**
A10 - Cardiac - Cardiovascular magnetic resonance	8	52%	53%
A10 - Cardiac - Other	15,791	**5%**	2%
A13 - Adult Congenital Heart Disease	4,185	**6%**	1%
D07 - Cleft Lip Palate	2,695	**10%**	0%
B09 - Immunology	9,760	**12%**	**8%**
B09 - Allergy	1,971	**-13%**	**-11%**
B07 - Infectious Diseases Adult	268	**-38%**	**-36%**
B07 - Infectious Diseases Paeds	247	**33%**	**27%**
A02 - Hepatology & Pancreatic	2,342	**8%**	2%
C04 - Mental Health - Gender Dysphoria	160	**30%**	**37%**
E04 - Childrens services - Cancer	25,405	**12%**	**7%**
E05 - Childrens services - Cardiac	8,645	**44%**	**29%**
E03 - Childrens services - Endocrinology	3,671	**8%**	**-11%**
E03 - Childrens services - Gastroenterology	62,385	**16%**	**10%**
E03 - Childrens services - Haematology	1,919	**32%**	**19%**
E09 - Childrens services - Neurosciences	9,071	**73%**	**52%**
E03 - Childrens services - Ophthalmology	6,725	**4%**	-1%
E03 - Childrens services - Renal	9,593	**31%**	**12%**
E03 - Childrens services - Respiratory	7,184	**73%**	**50%**
E03 - Childrens services - Rheumatology	6,047	**11%**	2%
E02 - Childrens services - Surgery	44,589	**13%**	**4%**
E03 - Childrens services - Paediatric Pain Management	25	**150%**	**145%**
D11 - Hyperbaric Oxygen Treatment	12	**139%**	**140%**
A03d - Respiratory - Pulmonary vascular services	178	**-32%**	-22%
A12 - Respiratory - Complex thoracic surgery	27,615	**43%**	**37%**
A03d - Respiratory - Management of central airway obstruction	1,901	**68%**	**59%**
A03d - Respiratory - Interstitial lung disease	2,534	**-10%**	**-39%**
A03d - Respiratory - Other	13,953	**22%**	**19%**
A04 - Vascular Services	4,839	**17%**	**15%**
D09 - Ears - Cochlear Implants	1,150	-6%	-9%
D09 - Ears - Bone anchored hearing aids	1,370	0%	-5%
D09 - Ears - Middle Ear Implants	113	-12%	-17%
A08 - Colorectal - Complex Surgery for Incontinence	1,090	**-42%**	**-45%**
A08 - Colorectal - Complex Inflammatory Bowel disease	63	5%	4%
A08 - Colorectal - Transanal Endoscopic Microsurgery	503	**54%**	**49%**
D10 - Orthopaedic Surgery	1,637	**22%**	**15%**
D10 - Orthopaedic Surgery - revisions	176	**53%**	**45%**
A05 - Morbid Obesity Surgery	8,252	1%	1%
D12 - Ophthalmology	20,004	2%	2%
B08 - Haemoglobinopathy - Sickle Cell	13,553	**7%**	0%
B08 - Haemoglobinopathy - Thalassaemia	8,651	0%	**-8%**
Highly Specialised	11,355	**74%**	**57%**
Total sample	**12,286,246**		

6. Conclusion

This report updates our previous analyses estimating the costs associated with specialised care. In the intervening period the rules used to identify whether or not a patient has received specialised care have been overhauled. Although fundamental principles remain the same, the new Prescribed Specialised Services (PSS) system represents a radical departure from the superseded Specialised Services National Definition Sets (SSNDS).

We have applied both sets of rules to the 18,754,381 FCEs in the 2011/12 Hospital Episode Statistics (HES). Of these, 2,183,702 (11.6%) are identified as having received specialised care according to the SSNDS, compared to only 1,611,552 (8.6%) under PSS rules. There is little overlap between the SSNDS and PSS: of all those identified as having received specialised care under the two systems, only 537,324 (16.5%) are identified under both. Of the 69 PSS markers that apply to hospital care, 11 apply to fewer than 300 patients nationally.

We analyse costs for each individual patient to determine whether the receipt of specialised care is associated with higher costs relative to patients allocated to the same HRG who did not receive specialised care. To do this, we have matched HES records to Reference Costs (RC) reported by each NHS hospital. Our analytical sample comprises 12,286,246 spells (14,184,683 FCEs) of which 10% are designated as having received specialised care according to the SSNDS system and 5.4% according to the PSS system.

Two broad sets of analyses are conducted, according to whether the SSNDS or PSS is used to identify receipt of specialised care. We conduct various sensitivity analyses, including the use of FCEs rather than spells as the unit of observation; restriction of the sample to inliers, those who did not stay beyond their HRG-specific length of stay trimpoint; and to those who were not allocated to fully specialised or non-specialised HRGs; and to relaxing the identification requirement for specialised care that patients have to be treated at eligible providers.

For the SSNDS markers, we compare previous results for 2009/10 with those for 2011/12. As well as a different population, there will have been changes over time to clinical, coding and costing practice and to the HRG casemix classification. Results for 13 of the 27 of the markers are very similar between the two years. For the remainder, the markers are either now statistically significant (8 of 27) or the cost differentials have changed substantially (6 of 27). With the exception of Neurosciences, there have also been marked changes in volume of patients receiving these types of specialised care.

Most of the PSS markers are positive and significant, implying that patients who received specialised care of the type indicated had higher costs than other patients allocated to the same HRG. For some PSS markers the financial implications of the cost differences will be small, partly because only small volumes of patients received the specialised care in question or because the cost differences are small. The cost differential between those that do and do not receive specialised care is more than 10% for 28 PSS markers; for 16 of these the difference is more than 25%; and for 7 it is more than 50%.

The estimated cost differentials are robust to the various sensitivity analyses that we conduct for both the PSS and SSNDS markers. Fewer patients are identified as having received specialised care under the PSS system than the SSNDS. But the percentage cost differences tend to be larger for the PSS markers than for the SSNDS markers. The implication is that, although the PSS system is identifying fewer patients, because the cost differentials are larger, identification of those that receive specialised care appears more precise under the PSS than the SSNDS.

We recommend that, if top-up arrangements are to be made, the following should be considered:

- The top-up differential should be based on results from the RE model that takes account of hospital effects in calculating differential costs between those who did and did not receive specialised care;

- Top-up payments should be applied only to those PSS markers for which the financial implications are likely to prove material. Materiality should be based on both the expected volume of patients to whom they are to apply and on the size of the estimated cost differential.

7. References

DAIDONE, S. & STREET, A. 2011a. *Estimating the costs of specialised care. CHE Research Paper 61,* York, Centre for Health Economics, University of York.

DAIDONE, S. & STREET, A. 2011b. *Estimating the costs of specialised care: updated analysis using data for 2009/10. CHE Research Paper 71,* York, Centre for Health Economics, University of York.

DAIDONE, S. & STREET, A. D. 2012. *Specialisation hierarchy within the Children's Specialised Services National Definition Set. Report to Department of Health,* University of York, York, Economics of Social and Health Care Research Unit.

DAIDONE, S. & STREET, A. D. 2013. How much should be paid for specialised treatment? . *Social Science and Medicine,* 84**,** 110-8.

DEPARTMENT OF HEALTH 2014. *Prescribed Specialised Services Advisory Group Recommendations to Ministers https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/308068/PSSAG_recommendations_to_ministers.pdf,* London, Department of Health.

HEALTH & SOCIAL CARE INFORMATION CENTRE 2013. *Prescribed Specialised Services Identification Tool 2013/14 http://www.hscic.gov.uk/media/11672/PS-201314-User-Manual/pdf/PS1314_reference_manual_v1.0.pdf,* Leeds, NHS England.

MONITOR & NHS ENGLAND 2013. *2014/15 National Tariff Payment System https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/300547/2014-15_National_Tariff_Payment_System_-Revised_26_Feb_14.pdf,* London, NHS England Publications Gateway Reference 00883.

NHS COMMISSIONING BOARD 2012. Manual for prescribed specialised services http://www.england.nhs.uk/wp-content/uploads/2012/12/pss-manual.pdf.

NHS ENGLAND 2014. *Manual for Prescribed Specialised Services 2013/14 http://www.england.nhs.uk/wp-content/uploads/2014/01/pss-manual.pdf,* London, NHS England.

NHS SPECIALISED SERVICES 2010. *Specialised Burn Care Services (all ages) - Definition No. 9 http://www.specialisedservices.nhs.uk/library/26/Specialised_Burn_Care_Services_all_ages.pdf,* London, Department of Health.

Appendices

A1: Payment for Specialised and Complex Care Working Group

First name	Surname	Role & Organisation
Sivakumar	Anandaciva	Head of Analysis, Foundation Trust Network
Anita	Charlesworth [Chair]	Chief Economist, Health Foundation
Andrew	Copley	Director of Finance, Airedale NHS Foundation Trust
Jacqueline	Cornish	National Clinical Director (Children), Bristol Royal Hospital for Children
Andrew	Davies	Market Access Director, Association of British Healthcare Industries
Ken	Dunn	Consultant (Burn and Plastic Surgery), University Hospital of South Manchester
Rupert	Egginton	Director of Finance, Nottingham University Hospitals
Janice	Fawell	Project Lead (Project Diamond), University College London Hospitals
Tom	Fellows	Contract Compliance Manager, Nuffield Health
Joanne	Fitzpatrick	Executive Director of Finance & Business Development, The Christie NHS Foundation Trust
Chris	Ford	NHS England, Hertfordshire and South Midlands Area Team
Tabitha	Gardner	NHS England, Cheshire Warrington and Wirral Area Team
Helen	Maguire	Head of Commercial Commissioning, Royal Brompton & Harefield NHS Foundation Trust
Mark	Mansfield	Director of Finance and Procurement, Oxford University Hospitals
David	Melbourne	Deputy Chief Executive and Chief Financial Officer, Birmingham Children's Hospital [Paul Hughes, Head of Contracting, will also attend meetings]
Nicky	Mowatt	Senior Business Consultant, NHS Trust Development Authority
Angela	Pedder	Chief Executive Officer, Royal Devon and Exeter NHS Foundation Trust
Adrian	Roberts	Director of Finance, Central Manchester University Hospitals Foundation Trust
Lee	Rowlands	Director of Contracting and Income, Central Manchester University Hospitals Foundation Trust
Anthony	Rudd	Professor of Stroke Medicine, Kings College London
Petra	Scantlebury	Head of Income and Costing, Royal Free London
Justine	Stalker-Booth	NHS England, East Anglia Area Team
Jonathan	Stephens	Deputy Chief Executive/Director of Finance, Alder Hey Children's NHS Foundation Trust
Tony	Whitfield	Director of Finance, St James's University Hospitals

A2: Technical Working Party data issue decisions (15/06/14)

1. The majority of 43 APC PSS definitions that use OPCS codes in the identification rules, do so via a triggering OPCS code in any operation field in the HES data. There are, however, 3 definitions that use the OPCS code in DGVP (Dominant Grouping Variable-Procedure) only. They are:

PSS			ToolKit FCEs	CHE FCEs
NCBPS23X	E02 - Paeds Surgery	Childrens services - Surgery	110,942	64,466
NCBPS34A	D10 - Orthopaedics	Orthopaedic Surgery	1,953	2,007
NCBPS34R	D10 - Orthopaedics	Orthopaedic Surgery - revisions	133	188

The DGVP does not come directly from HES but is instead an output of the HRG grouper which via a set of rules identifies the dominant OPCS code from a potential list of several in terms of which is most influential in determining the HRG.

The supporting information given in the identification rules worksheet for each of the above specialised services is sometimes a little ambiguous in definition. For example, for NCBPS23X, the supporting information discusses 'primary procedure position' rather than DGVP *per se*. NCBPS34A and NCBPS34R state 'dominant procedure position'. The interpretation of these rules was to check the DGVP provided by the 11/12 grouper for any of the triggering OPCS codes. However as indicated in the table above this leads to a situation where there are far fewer PSS CHE identified FCEs for 'Children's Services – Surgery' than identified by the PSS toolkit. For the two orthopaedic codes the problem is less pronounced: the PSS CHE tool using the DGVP field identifies a greater number of FCEs than the PSS toolkit. However for Orthopaedic Surgery there are 112 cases where the PSS toolkit identifies the FCE as specialised whereas the PSS CHE version does not.

A potential solution explored was to change the identifying rule to check the first operation field in HES rather than the grouper provided DGVP. This provides a closer match between PSS CHE and PSS toolkit. For example, with Children's surgery, this version of the rule identifies 129,993 FCEs as having that specialisation. This 17% increase above that identified by the PSS toolkit is more in keeping with general increased number of PSS CHE identified specialised services.

In discussion with the project technical working party, it was felt that the most likely candidate for the discrepancy between the original PSS CHE and the PSS toolkit was due to differences in the manner in which the 2012/13 grouper implementation (inherent in the toolkit) and the 2011/12 grouper identifies the DGVP. Nevertheless, the technical working party favoured the PSS CHE interpretation of the Identification Rules, which uses the DGVP, producing a lower count of services for Children's surgery.

2. The PSS CHE version of the IR workbook rules has consistently identified more FCEs with PSS Toolkit and more PSS services (allowing for more than 1 PSS to be identified per FCE) than the PSS toolkit. Excluding Children's Surgery (for reasons outlined above), the PSS CHE version identifies approximately 99,000 (or 6%) more PSS services over the full data set than the PSS toolkit.

Further investigation shows that approximately 18,500 of these cases are due to the Highly Specialised service identified by purchaser code which does not seem to be implemented in the PSS toolkit.

The remaining 'excess' services appear to be a function of the data quality checks inherent in the PSS toolkit some of which are potentially not applicable to 2011/12 data mainly due to an ICD10 update in codes between 2011/12 and 2012/13.

For example, the CHE version identifies nearly 8,000 HIV services and the toolkit only 7. Further inspection shows that the HES provider spell number, a field used for quality checking but not service identification, is missing in all but 7 of these cases. Thus the PSS toolkit identifies these 7 cases. In contrast, PSS CHE version, which does not implement any of these quality checks, identifies nearly 8,000. The missing provider spell number does trigger the allocation of a UZ01Z HRG in the grouping stage so we are unable to allocate a cost to these episodes. Consequently, the frequency of PSS HIV services in the analytical dataset is nil irrespective of whether the PSS CHE or PSS Toolkit is used.

To further determine the extent to which the inherent PSS toolkit quality checks are responsible for the remaining 'excess' difference between PSS CHE and the PSS toolkit, we took those FCEs for which the PSS CHE identified a PSS and the PSS toolkit version did not. For those records we changed the data items that are used for quality checking but not used in the identification of a service into values that would not trip the quality alarm. These fields are: diagnosis codes following the primary diagnosis, provider spell number and purchaser code number. This accounts for approximately 85% of the additional PSS CHE identified codes.

Given that the same issue may affect the primary diagnosis code which is a field checked for identification of services, the technical group agreed that the PSS CHE version mirrored the PSS toolkit sufficiently and that observed differences were attributed to quality check factors or to to the ICD update that was not applicable for 2011/12 data. The conclusion was that the PSS CHE version was to be adopted as the means of identifying PSS services for the analysis.

3. HIV specialisation. As discussed the CHE version identifies approximately 8,000 FCEs which qualify for the HIV 14Z service. The toolkit identifies 7 such cases. This is almost exclusively due to missing spell provider numbers in the HES record which the PSS toolkit uses as a quality check. This data field plays no part in identification rules per se.

Missing provider spell numbers also seem to be disproportionately high in these FCEs (i.e. they account for 10% of all missing provider spell numbers in the entire HES dataset). In terms of the analysis dataset we find that the missing provider spell number always generates a UZ01Z HRG and so we have no HIV cases in our analytical dataset.

As with PSS toolkit identification, the provider spell number does not have a crucial HRG identification role especially when dealing with FCEs. As a missing provider spell number seems to be an artefact associated with HIV, possibly due to sensitivity/privacy issues, we could therefore impute 'correct' provider spell numbers to generate non-UZ01Z HRGs for the HIV cases and re-introduce them into our dataset. The technical working party decided against this option.

4. The ICD10 update has caused a potential mismatch between the diagnosis codes contained in the Identification Rules and those in the 2011/12 HES dataset. Fortunately the impact appears rather limited. The following table shows the updates of ICD codes that appear in the rule sets and involves mostly 1:1 mappings.

code_description	code (4th edition)	map (to old code)	N in diag_1
Tuberculosis of ear	A186	A186D	2
Chagas' disease (chronic) with heart involvement	B572	(B572D + I412A) or (B572D + I981A)	(1+0 [1 case in diag_2]) or (1+0)
Echinococcus granulosus infection, unspecified	B674	B674 or B711	0 or 0
Angiostrongyliasis due to Parastrongylus cantonensis	B832	B832 or B838	0 or 1
Idiopathic acute pancreatitis	K850	K85X	30,242
Biliary acute pancreatitis	K851	K85X	
Alcohol-induced acute pancreatitis	K852	K85X	
Drug-induced acute pancreatitis	K853	K85X	
Other acute pancreatitis	K858	K85X	
Acute pancreatitis, unspecified	K859	K85X	
Necrotizing fasciitis	M726	M725	166
Severe acute respiratory syndrome [SARS], unspecified	U049	J128 + B972	159 + 0 (34 cases in diag2)

The fourth column of this table lists the number of times these old ICD codes were found in diag_1 (and in the case of the combination codes, diag_2 also). As can be seen there seems little scope for much to change with the exception of the pancreatitis codes (K85X) and Necro fasciitis (M725).

Fortunately the K85- changes all appear in one rule: NCBPS19Z A02 - Hepatology and Pancreatic. This makes for a relatively simple adaptation to accommodate the ICD changes: we simply add K85X as one of the triggering codes in the list of codes that that rule checks for. Similarly for M726 it only appears in NCBPS18C Infectious Diseases Paeds B07 - Infectious Diseases and an analogous solution has been implemented.

The technical working party agreed that this simple solution should be implemented for the analysis. As these ICD codes are checked in combination with other qualifying variables it has meant that a further 72 PSS services in NCBPS19Z and 2059 services in NCBPS18C have been identified.