

This is a repository copy of *Trends in and drivers of Healthcare Expenditure in the English NHS : a retrospective analysis*.

White Rose Research Online URL for this paper:  
<https://eprints.whiterose.ac.uk/162456/>

Version: Accepted Version

---

**Article:**

Rodriguez Santana, Idaira [orcid.org/0000-0003-2022-3239](https://orcid.org/0000-0003-2022-3239), Aragon Aragon, Maria Jose Monserratt [orcid.org/0000-0002-3787-6220](https://orcid.org/0000-0002-3787-6220), Rice, Nigel [orcid.org/0000-0003-0312-823X](https://orcid.org/0000-0003-0312-823X) et al. (1 more author) (2020) Trends in and drivers of Healthcare Expenditure in the English NHS : a retrospective analysis. *Health Economics Review*. 20. ISSN 2191-1991

<https://doi.org/10.1186/s13561-020-00278-9>

---

**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](mailto:eprints@whiterose.ac.uk) including the URL of the record and the reason for the withdrawal request.

# Health Economics Review

## Trends in and drivers of Healthcare Expenditure in the English NHS: a retrospective analysis --Manuscript Draft--

|  |  |                 |
|--|--|-----------------|
| <b>Manuscript Number:</b>                            | HECR-D-20-00062R1  |                 |
| <b>Full Title:</b>                                   | Trends in and drivers of Healthcare Expenditure in the English NHS: a retrospective analysis   |                 |
| <b>Article Type:</b>                                 | Research   |                 |
| <b>Funding Information:</b>                          | National Institute for Health Research (103/0001)  | Mrs. Anne Mason |
| <b>Abstract:</b>                                     | <p>Background: In England, rises in healthcare expenditure consistently outpace growth in both GDP and total public expenditure. To ensure the National Health Service (NHS) remains financially sustainable, relevant data on healthcare expenditure are needed to inform decisions about which services should be delivered, by whom and in which settings.</p> <p>Methods: We analyse routine data on NHS expenditure in England over 9 years (2008/09 to 2016/17). To quantify the relative contribution of the different care settings to overall healthcare expenditure, we analyse trends in 14 healthcare settings under three broad categories: Hospital Based Care (HBC), Diagnostics and Therapeutics (D&amp;T) and Community Care (CC). We exclude primary care and community mental health services settings due to a lack of consistent data. We employ a set of indices to aggregate diverse outputs and to disentangle growth in healthcare expenditure that is driven by activity from that due to cost pressures. We identify potential drivers of the observed trends from published studies.</p> <p>Results: Over the 9-year study period, combined NHS expenditure on HBC, D&amp;T and CC rose by 50.2%. Expenditure on HBC rose by 54.1%, corresponding to increases in both activity (29.2%) and cost (15.7%). Rises in expenditure in inpatient (38.5%), outpatient (57.2%), and A&amp;E (59.5%) settings were driven predominately by higher activity. Emergency admissions rose for both short-stay (45.6%) and long-stay cases (26.2%). There was a switch away from inpatient elective care (which fell by 5.1%) and towards day case care (34.8% rise), likely reflecting financial incentives for same-day discharges. Growth in expenditure on D&amp;T (155.2%) was driven by rises in the volume of high cost drugs (270.5%) and chemotherapy (110.2%). Community prescribing grew by 45.2%, with costs falling by 24.4%. Evidence on the relationship between new technologies and healthcare expenditure is mixed, but the fall in drug costs could reflect low generic prices, and the use of health technology assessment or commercial arrangements to inform pricing of new medicines.</p> <p>Conclusions: Aggregate trends in HCE mask enormous variation across healthcare settings. Understanding variation in activity and cost across settings is an important initial step towards ensuring the long-term sustainability of the NHS.</p> |                 |
| <b>Corresponding Author:</b>                         | Anne Mason, BA, MA<br>University of York<br>YORK, UNITED KINGDOM   |                 |
| <b>Corresponding Author E-Mail:</b>                  | anne.mason@york.ac.uk  |                 |
| <b>Corresponding Author Secondary Information:</b>   |  |                 |
| <b>Corresponding Author's Institution:</b>           | University of York   |                 |
| <b>Corresponding Author's Secondary Institution:</b> |  |                 |
| <b>First Author:</b>                                 | Idaira Rodriguez Santana   |                 |
| <b>First Author Secondary Information:</b>           |  |                 |
| <b>Order of Authors:</b>                             | Idaira Rodriguez Santana<br>María José Aragón  |                 |

|  |   |
|--|---|
|  | Nigel Rice  |
|  | Anne Mason, BA  |
| <b>Order of Authors Secondary Information:</b> |   |
| <b>Response to Reviewers:</b>                  | <p>NOTE TO THE EDITOR</p> <p>Dear Professor Braun,<br/> Thank you for the positive reviews and constructive comments from two referees and for the opportunity to resubmit a revised manuscript.<br/> We have taken the comments on board, uploaded a point-by-point response within the 'Response to Reviewers' box in the submission system and highlighted all changes made within the revised manuscript. We have also edited the text for clarity, as advised by the reviewers.<br/> Thank you for considering this manuscript for Health Economics Review. We look forward to hearing from you.</p> <p>*****</p> <p>RESPONSE TO REVIEWER COMMENTS</p> <p>REVIEWER #1:</p> <p>It is an interesting article about the expenditures of the NHS. There are important findings useful for policy making. My comments about this text are the following:</p> <p>1.the paper does not mention how new technology and utilization of resources influence the total expenditure. At this point, no reference to seminal Joseph Newhouse’s paper is found. I think that the discussion should mention something about this author’s findings and how they related to the current text.</p> <p>RESPONSE</p> <p>We agree that new technologies are an important driver of healthcare expenditure. The paper covers pharmaceuticals in the section on Diagnostics and Therapeutics, in which we note the large rise in the volume of high cost drugs and chemotherapy. However, technologies are broader than pharmaceuticals, and we have expanded the discussion section to address the referee’s point, as follows.</p> <p>“In the majority of the individual settings, with the exception of renal dialysis and rehabilitation, growth in expenditure was driven primarily by growth in activity. Indeed, year to year cost growth rates were negative for both D&amp;T and community prescribing. This finding accords with Newhouse’s argument that technological change - “the march of science” – increases the capacity of healthcare systems to supply healthcare [45] and is a major factor driving rising healthcare expenditure. However, whilst there is evidence of a strong, positive relationship between new technologies and aggregate HCE [5, 9], the relationship at the individual level is complex and dynamic, and varies depending on the context and particular type of technology [46].”</p> <p>2.the methods describe several price indexes, named equations; however, their connection to the results is not clear.</p> <p>RESPONSE</p> <p>We agree that the methods section needs to explain the connection between the indices and results more clearly. We have revised the methods section to address this, adding further explanation and subheadings to make the text easier to follow.</p> <p>3.authors classify the results as expenditure, volume and costs, however, it is not clear the data source used to disentangle these 3 categories. Furthermore, it is not clear how data, for instance, of medication and devices related to costs (i.e. prices) are obtained to calculate these figures. Mostly when confidential discounts are a common practise for many drugs in England.</p> |

## RESPONSE

We thank the reviewer for drawing our attention to these issues. We have added subheadings and substantially revised the text. We have also explained our data sources more clearly, particularly in regard to the cost of medication and devices.

4. table 1, high drug costs seem to decrease, do you have any explanation for this aside from confidential discounts? This phenomenon is not observed in other jurisdictions.

## RESPONSE

The reviewer asks a good question. HCDs are expensive drugs that are reimbursed separately from other services if their costs are disproportionately borne a small number of providers. At the time of our study, a steering group within NHS England updated the list each year, with new treatments nominated by health sector organisations.

One reason why costs may have been kept low is that many of the drugs were appraised by NICE, and their value for money may have informed price negotiations. The Pharmaceutical Price Regulation Scheme is another plausible factor, as this limits the growth of prices of branded drugs. We agree with the reviewer that commercial agreements (discounts) are another possible explanation, and have amended the text as follows:

Abstract: "Evidence on the relationship between new technologies and healthcare expenditure is mixed, but the fall in drug costs could reflect low generic prices, and the use of health technology assessment or commercial arrangements to inform pricing of new medicines."

Results: In the subsection 'Diagnostics and Therapeutics', we have amended the text as follows:

"NICE assesses the value of many HCDs, a category that captures drugs whose cost is disproportionately high and that are used to treat a limited number of patients. Although NICE assessments inform value-based pricing, NICE does not negotiate the price of new drugs. Over our study period, prices of branded medicines were regulated by a voluntary scheme known as the Pharmaceutical Price Regulation Scheme (PPRS). The aims of the scheme were to keep expenditure on branded medicines within 'affordable limits', whilst improving access to new medicines and encouraging innovation [36]. The scheme limited the growth of NHS spend on new drugs, included pricing flexibilities such as Patient Access Schemes, and allowed manufacturers to offer local discounts to hospitals. Therefore, the PPRS is a potential explanation for the observed trends in HCD activity and costs."

## REVIEWER #2:

1. This analysis of health care expenditure (HCE) disaggregates growth into the separate parts of volume and cost and additionally categories HCE into health care settings. It is a neat and simple approach to the disaggregation to identify trends over time in volume (or volume of activity, or in some instances just activity - note to authors to review the consistency in their terminology) and cost.

## RESPONSE

We have checked and edited the text for consistency, as advised by the reviewer.

2. It would be useful to understand what share of total cost these 14 settings have of total HCE, in say 2008/09 and 2016/17. This is currently mentioned in the results but a graphical presentation would be useful. For the latter pie chart it would be useful to understand the share of primary care and community mental health services, so to understand how much weight to put on these results given the absence of these settings from the analysis.

RESPONSE

We agree and have added a bar chart showing how the shares of total cost vary over time by setting (new Figure 1).

3.I believe the results describing the table and graphs are good and complete. I do however feel like the discussion of the cost drivers is misplaced in the results section (e.g. line 163-181). I wonder if this shouldn't be a separate section, also without knowing the literature well perhaps the focus should be on UK studies if they exist or there should be a greater discussion drawn on how these papers were identified from the CHE working paper?

RESPONSE

We thank the referee for affirming our presentation of the empirical results. We acknowledge that the literature review could be reported separately and we've considered this. On balance, we feel that to separate the analysis of trends from the evidence would obstruct the flow of the text – for example, if a reader wanted to look at high-cost drugs, they would need to flip forward to find the relevant subsection rather than having both elements together on the same page. Therefore, we've decided to leave the structure in its original format.

It is not possible to focus on UK studies because there are so few of them, and because reviews we cite cover the international evidence. However, we agree that more explanation of the way studies were selected would be helpful for readers, and have added this to the Methods as follows:

“To identify potential drivers for the observed trends we drew on a previous systematic review [3] that reported published studies by healthcare setting. We selected studies from this review if they directly or indirectly provided evidence on potential drivers of trends from the empirical analyses. We drew on UK studies where possible, and included international evidence where UK evidence was lacking. We also considered the role of relevant regulatory schemes operating within the UK during our study period.”

4.I note that the discussion of technologies refers to the role of NICE but key is also the PPRS which NICE aside has always control the expenditure on pharmaceuticals. This should be discussed.

RESPONSE

We agree that the PPRS is an important factor influencing helping to curb expenditure on pharmaceuticals. The PPRS was in operation during our study period but has now been superseded by the 2019 voluntary scheme for branding medicines pricing and access.

In the subsection 'Diagnostics and Therapeutics', we have amended the text as follows:

“NICE assesses the value of many HCDs, a category that captures drugs whose cost is disproportionately high and that are used to treat a limited number of patients. Although NICE assessments inform value-based pricing, NICE does not negotiate the price of new drugs. Over our study period, prices of branded medicines were regulated by a voluntary scheme known as the Pharmaceutical Price Regulation Scheme (PPRS). The aims of the scheme were to keep expenditure on branded medicines within 'affordable limits', whilst improving access to new medicines and encouraging innovation [36]. The scheme limited the growth of NHS spend on new drugs, included pricing flexibilities such as Patient Access Schemes, and allowed manufacturers to offer local discounts to hospitals. Therefore, the PPRS is a potential explanation for the observed trends in HCD activity and costs.”

Additional Information:

Question

Response

**Is this study a clinical trial?**

*A clinical trial is defined by the World Health Organisation as 'any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes'.*

No

1 Trends in and drivers of Healthcare Expenditure in the  
2 English NHS: a retrospective analysis

3

4 Idaira Rodriguez Santana<sup>1</sup>, María José Aragón<sup>2</sup>, Nigel Rice<sup>2</sup>, Anne Mason<sup>2\*</sup>

5

6 <sup>1</sup> HCD Economics

7 The Innovation Centre

8 Keckwick Ln

9 Daresbury

10 Warrington WA4 4FS

11 United Kingdom.

12

13 <sup>2</sup> Centre for Health Economics

14 Alcuin A Block

15 University of York

16 York

17 YO10 5DD

18 United Kingdom

19

20

21 \* Corresponding author: Anne Mason [anne.mason@york.ac.uk](mailto:anne.mason@york.ac.uk)

22 **Declarations**

23 **Ethics approval and consent to participate**

24 **Not applicable**

25 [Consent for publication](#)

26 Not applicable

27 [Availability of data and materials](#)

28 The datasets analysed in the current study are freely available to download from the following  
29 websites:

30 **National Schedule of Reference Costs (2008/09 to 2016/17)**

31 2008/09: [https://data.gov.uk/dataset/f9b1a80c-187e-4e92-9fe1-25370291f5c0/nhs-reference-](https://data.gov.uk/dataset/f9b1a80c-187e-4e92-9fe1-25370291f5c0/nhs-reference-costs-2008-09)  
32 [costs-2008-09](https://data.gov.uk/dataset/f9b1a80c-187e-4e92-9fe1-25370291f5c0/nhs-reference-costs-2008-09)

33 2009/10 - 2015/16: <https://www.gov.uk/government/collections/nhs-reference-costs>

34 2016/17: <https://improvement.nhs.uk/resources/reference-costs/#archive>

35 **Prescription Cost Analysis (PCA)**

36 <https://digital.nhs.uk/data-and-information/publications/statistical/prescription-cost-analysis>

37 **NHS Dental Statistics**

38 <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-dental-statistics>

39 **General Ophthalmic Services: activity statistics**

40 [https://digital.nhs.uk/data-and-information/publications/statistical/general-ophthalmic-services-](https://digital.nhs.uk/data-and-information/publications/statistical/general-ophthalmic-services-activity-statistics)  
41 [activity-statistics](https://digital.nhs.uk/data-and-information/publications/statistical/general-ophthalmic-services-activity-statistics)

42 [Competing interests](#)

43 The authors declare that they have no competing interests.

44 [Funding](#)

45 This study is funded by the National Institute for Health Research (NIHR) Policy Research  
46 Programme, conducted through the NIHR Policy Research Unit in Economics of Social and Health  
47 Care (reference 103/0001). The views expressed are those of the authors and not necessarily those  
48 of the NIHR or the Department of Health and Social Care.



49 [Authors' contributions](#)

50 AM designed the study. IRS compiled and analysed the data. MJA, IRS and AM reviewed the  
51 literature. IRS produced the first draft of the paper; AM, MJA and NR critically revised the  
52 manuscript. All authors read and approved the final manuscript.

53 [Acknowledgements](#)

54 We are grateful for constructive comments on an earlier draft of this study from the Department of  
55 Health and Social Care (England, UK).

56

57

[Click here to view linked References](#)

## 1 Abstract

2 **Background:** In England, rises in healthcare expenditure consistently outpace growth in both GDP  
3 and total public expenditure. To ensure the National Health Service (NHS) remains financially  
4 sustainable, relevant data on healthcare expenditure are needed to inform decisions about which  
5 services should be delivered, by whom and in which settings.

6 **Methods:** We analyse routine data on NHS expenditure in England over 9 years (2008/09 to  
7 2016/17). To quantify the relative contribution of the different care settings to overall healthcare  
8 expenditure, we analyse trends in 14 healthcare settings under three broad categories: Hospital  
9 Based Care (HBC), Diagnostics and Therapeutics (D&T) and Community Care (CC). We exclude  
10 primary care and community mental health services settings due to a lack of consistent data. We  
11 employ a set of indices to aggregate diverse outputs and to disentangle growth in healthcare  
12 expenditure that is driven by activity from that due to cost pressures. We identify potential drivers  
13 of the observed trends from published studies.

14 **Results:** Over the 9-year study period, combined NHS expenditure on HBC, D&T and CC rose by  
15 50.2%. Expenditure on HBC rose by 54.1%, corresponding to increases in both activity (29.2%) and  
16 cost (15.7%). Rises in expenditure in inpatient (38.5%), outpatient (57.2%), and A&E (59.5%) settings  
17 were driven predominately by higher activity. Emergency admissions rose for both short-stay  
18 (45.6%) and long-stay cases (26.2%). There was a switch away from inpatient elective care (which  
19 fell by 5.1%) and towards day case care (34.8% rise), likely reflecting financial incentives for same-  
20 day discharges. Growth in expenditure on D&T (155.2%) was driven by rises in the volume of high  
21 cost drugs (270.5%) and chemotherapy (110.2%). Community prescribing grew by 45.2%, with costs  
22 falling by 24.4%. Evidence on the relationship between new technologies and healthcare  
23 expenditure is mixed, but the fall in drug costs could reflect low generic prices, and the use of health  
24 technology assessment or commercial arrangements to inform pricing of new medicines.

25 **Conclusions:** Aggregate trends in HCE mask enormous variation across healthcare settings.

26 Understanding variation in activity and cost across settings is an important initial step towards  
27 ensuring the long-term sustainability of the NHS.

29 Keywords: Healthcare expenditure, activity, cost, drivers, demographic pressures, technology

## 30 Background

31 Since the NHS was established in 1948, healthcare expenditure (HCE) has risen faster than both GDP  
32 and total public expenditure [1], a trend that is echoed in most OECD countries [2]. Between 2008  
33 and 2018, government expenditure on healthcare in England rose 25% in real terms, substantially  
34 more than the 13% real terms growth of the economy (GDP), and faster than every other category of  
35 government expenditure [3]. Rises in HCE are expected to continue in the medium to long-term even  
36 in the most conservative cost containment scenarios [2].

37 Tackling the drivers of HCE is an enduring policy concern. Known drivers of overall growth in HCE  
38 include behaviours and lifestyle factors such as smoking, diet or physical activity [4], wealth and  
39 income effects [5] and prices [6]. There is evidence that demographic factors such as population  
40 ageing [7] are associated with rises in HCE. Increases in the prevalence of multimorbidity is another  
41 well-known predictor and studies suggest that comorbidities may be ‘super-additive’ meaning that  
42 the total cost of treating comorbid conditions is greater than the sum of the independent treatment  
43 costs of the underlying disease conditions [8]. More recently, macro-level studies of US expenditure  
44 have identified strong positive relationships between HCE and technological progress [5, 9], although  
45 the impact of new technology appears to vary across the distribution of expenditure [10].

46 Year-on-year real term rises in HCE, such as those observed within the English NHS, are considered  
47 to be one of the greatest challenges to its long-term fiscal sustainability [11]. To ensure the NHS  
48 remains financially viable, there is a need to understand how HCE may change in the future. This  
49 requires an oversight of historical trends in activity and cost across the whole system, and an

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66

appreciation of how these vary by healthcare setting and why. For example, a disaggregated analysis may reveal settings where costs are rising but activity is static, and this may be due to inefficiencies and/or waste. According to the OECD, one-fifth of health spending is wasteful; examples include missed appointments, avoidable admissions, duplication of services, delayed discharges and unnecessary expenditure on pharmaceuticals or procedures of limited clinical value [12].

A simple comparison of trends across healthcare settings can identify “pressure points” and help to guide an exploration of potential drivers leading to improved performance. In addition, understanding how trends in expenditure, activity and cost vary across settings can inform spending reallocations within existing budgets, and improve workforce and budget planning.

However, few studies of drivers of HCE have investigated how factors vary by care setting [3, 10, 13]. In addition, analyses of HCE trends are commonplace, but rarely disaggregate HCE growth into its constituent parts: activity and costs. The purpose of this study is to address those gaps in the evidence base. Our analyses provide an overview of the trends in expenditure and their breakdown in terms of cost and activity growth in three broad categories of care in the English NHS between 2008/09 and 2016/17. These categories together account for over 80% of total NHS spend. For each of the three categories, we also analyse trends in healthcare settings, and identify potential drivers for the observed trends drawing on evidence from the published literature.

## 67 Methods

68 To quantify the relative contribution of different settings to overall HCE, we analyse trends in  
69 expenditure, activity and costs for 14 healthcare settings of the English NHS. The settings are  
70 grouped into three broad categories: Hospital Based Care (HBC), Diagnostics and Therapeutics (D&T)  
71 and Community Care (CC). The study period covers the financial years 2008/09 to 2016/17. Potential  
72 drivers for the observed trends are identified from evidence in the published literature.

73 Table 1 shows which settings are included in each of the three categories, and the type of activity  
74 captured by each setting.

75

76 Table 1 Rates of growth in English NHS expenditure, activity and cost by healthcare setting

| Category                                   | Setting                            | Type of Activity                              | Total Growth<br>2008/09 - 2016/17 |          |        | Mean year on year<br>growth<br>2008/09 - 2016/17 |          |       |
|--|------------------------------------|---|-----------------------------------|----------|--------|--|----------|-------|
|  |                                    |   | Expendi-<br>ture                  | Activity | Cost   | Expendi-<br>ture                                 | Activity | Cost  |
| Hospital<br>Based Care<br>(HBC)            | Inpatient Care                     | FCE and Excess<br>bed days                    | 38.6%                             | 19.5%    | 16.0%  | 4.2%   | 2.3%     | 1.9%  |
|  | Outpatient                         | Attendances and<br>procedures                 | 57.2%                             | 43.7%    | 9.4%   | 5.8%   | 4.7%     | 1.1%  |
|  | Accident &<br>Emergency            | Attendances,<br>investigations,<br>treatments | 59.5%                             | 30.2%    | 22.5%  | 6.0%   | 3.4%     | 2.6%  |
|  | Specialist Services                | Activity                                      | 34.8%                             | 21.7%    | 10.8%  | 3.8%   | 2.5%     | 1.3%  |
|  | <i>HBC weighted average growth</i> |   |                                   | 54.1%    | 29.2%  | 15.7%  | 5.6%     | 3.3%  |
| Diagnostics<br>and<br>Therapeutic<br>(D&T) | Chemotherapy                       | Treatment,<br>procurement                     | 113.1%                            | 110.2%   | 1.4%   | 10.0%  | 9.9%     | 0.4%  |
|  | Radiotherapy                       | Treatment,<br>preparation                     | 42.9%                             | 72.1%    | -17.0% | 4.6%   | 7.3%     | -2.2% |
|  | High Cost Drugs                    | Drug types                                    | 230.7%                            | 270.5%   | -10.7% | 16.7%  | 18.0%    | -1.2% |
|  | Radiology                          | Examinations                                  | 34.1%                             | 39.8%    | -4.1%  | 3.8%   | 4.3%     | -0.5% |
|  | Diagnostic Tests                   | Tests   | 47.3%                             | 59.0%    | -7.4%  | 5.1%   | 6.2%     | -0.8% |
|  | Renal Dialysis                     | Sessions                                      | 16.1%                             | -1.0%    | 17.3%  | 1.9%   | -0.1%    | 2.0%  |
| <i>D&amp;T weighted average growth</i>     |                                    |   | 155.2%                            | 191.1%   | -7.0%  | 12.5%  | 14.4%    | -0.9% |
| Community<br>Care (CC)                     | Community<br>Prescribing           | Prescriptions                                 | 9.8%                              | 45.2%    | -24.4% | 1.2%   | 4.8%     | -3.4% |
|  | Community<br>Services              | Activity                                      | 35.0%                             | 18.7%    | 13.8%  | 4.0%   | 2.4%     | 1.6%  |
|  | Optometry &<br>Dentistry           | No. eye tests<br>and dental<br>procedures     | 23.7%                             | 7.2%     | 15.3%  | 2.7%   | 0.9%     | 1.8%  |
|  | Rehabilitation                     | Activity                                      | 10.4%                             | -2.3%    | 13.1%  | 1.5%   | -0.1%    | 1.6%  |
|  | <i>CC weighted average growth</i>  |   |                                   | 19.2%    | 34.7%  | -7.1%  | 2.3%     | 3.8%  |
| Total: all settings                        |                                    |   | 50.2%                             | 40.3%    | 7.1%   | 5.2%   | 4.3%     | 0.9%  |

FCE: Finished Consultant Episode

77

78 Two important settings, primary care and community mental healthcare, have been excluded from  
79 the analysis. This is due to a lack of historical official estimates of activity and cost for primary care  
80 and a lack of data for community mental health before 2011/12.

## 81 Data

82 For 12 of the 14 settings, activity and cost data come from the National Schedule of Reference Costs  
83 [14]. NHS providers are required to report these administrative data every year in accordance with  
84 national costing guidance. The cost of High Cost Drugs is included in the National Schedule of  
85 Reference Costs. Data on community prescribing comes from the Prescription Cost Analysis (PCA)  
86 dataset [15],<sup>1</sup> which provides details of the number of items and the net ingredient cost of  
87 prescriptions dispensed in the community. Data on activities and costs of dentistry [16] and  
88 optometry [17] are provided by NHS Digital.

## 89 Measuring Trends in Activity and Cost

90 In order to disentangle the extent to which changes in HCE are driven by changes in activity and/or  
91 changes in unit cost we employ a set of indices. These are measures of change that allow the  
92 aggregation of diverse output items (such as Finished Consultant Episodes (FCEs), attendances, tests,  
93 prescriptions, etc.) in a single index and are useful for facilitating comparisons across categories and  
94 settings of healthcare. These indices are routinely used in healthcare productivity analyses to  
95 measure the rate of growth of output [18, 19].

96 The Laspeyres Activity index is shown in Equation 1. Cost is held constant to quantify the change in  
97 activity: the denominator is the product of each type of activity at time 0 and its associated cost at  
98 time 0; the numerator is the product of activity at time t and its cost at time 0. The Paasche Price  
99 index (Equation 2), works in a similar way, but activity is held constant to quantify the change in cost.  
100 The index for Total Expenditure incorporates both cost and activity changes (Equation 3).

101

102 *Equation 1 (i) Laspeyres Activity Index*

$$103 X_{(0,t)}^L = \frac{\sum_{j=1}^J x_{jt} c_{j0}}{\sum_{j=1}^J x_{j0} c_{j0}} \quad (1)$$

---

<sup>1</sup> PCA data are supplied by the Prescription Pricing Authority via the NHS Digital Prescription Drugs Team.

104

105 *Equation 2 (ii) Paasche Cost Index*

$$C_{(0,t)}^P = \frac{\sum_{j=1}^J x_{jt} c_{jt}}{\sum_{j=1}^J x_{jt} c_{j0}} \quad (2)$$

107

108 *Equation 3 (iii) Total Expenditure Growth*

$$E_{(0,t)} = C_{(0,t)}^P * X_{(0,t)}^L = \frac{\sum_{j=1}^J x_{jt} c_{jt}}{\sum_{j=1}^J x_{j0} c_{j0}} \quad (3)$$

110

111 In all three equations,  $x_j$  is the number of units of activity, i.e. FCEs, attendances, or treatments of  
 112 type  $j$ , where  $j = 1, \dots, J$ ;  $c_j$  is the unit cost of output  $j$ ; and  $t$  is time with  $t = 0$  indicating the first  
 113 period of the time series. The formulae are shown for a two-period index. To measure growth over a  
 114 longer period of time, we use a chain index. In a chain index, the computation of the growth rates is  
 115 performed over successive periods, then the product of these growth rates produces a chain series  
 116 that uses the first period as reference (i.e. base year). Equation (4) shows the chain for the Laysperes  
 117 activity index.

118

119 *Equation 4: Chain index for Laspeyres Activity*

$$X_{(0,T)}^L = X_{(0,t)}^L \times X_{(t,t+1)}^L \times \dots \times X_{(T-1,T)}^L \quad (4)$$

121

122 We calculate these three indices for each of the three broad categories of care HBC, D&T and CC,  
 123 and also for the 14 subcategories (settings). We then plot growth rates using 2008/09 as the base  
 124 year (i.e. 2008/09 indices are set equal to 100). Next, we identify relevant setting-specific evidence,  
 125 drawn primarily from a previous review [3], to identify potential drivers of the observed trends. All  
 126 analyses were conducted using SAS Enterprise Guide 7.1.

## Identifying Drivers of Trends in Activity and Cost

To identify potential drivers for the observed trends we drew on a previous systematic review [3]

that reported published studies by healthcare setting. We selected studies from this review if they

directly or indirectly provided evidence on potential drivers of trends from the empirical analyses.

We drew on UK studies where possible, and included international evidence where UK evidence was

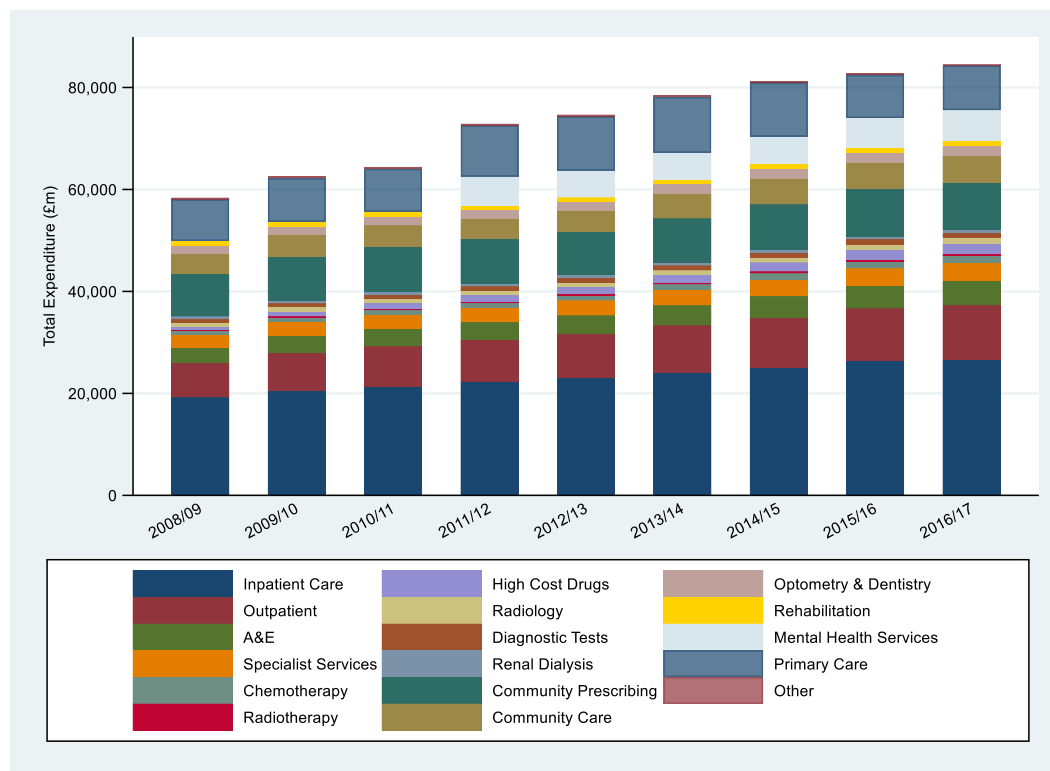
lacking. We also considered the role of relevant regulatory schemes operating within the

UK during our study period.

## Results

Between 2008/09 and 2016/17, total current expenditure in the English NHS rose from £58.9 billion to £84.6 billion (Figure 1). NHS expenditure on the three care categories, HBC, D&T and CC, rose by 50.2% and together account for over 82% of NHS expenditure.

Figure 1 Total expenditure by care setting, £ million

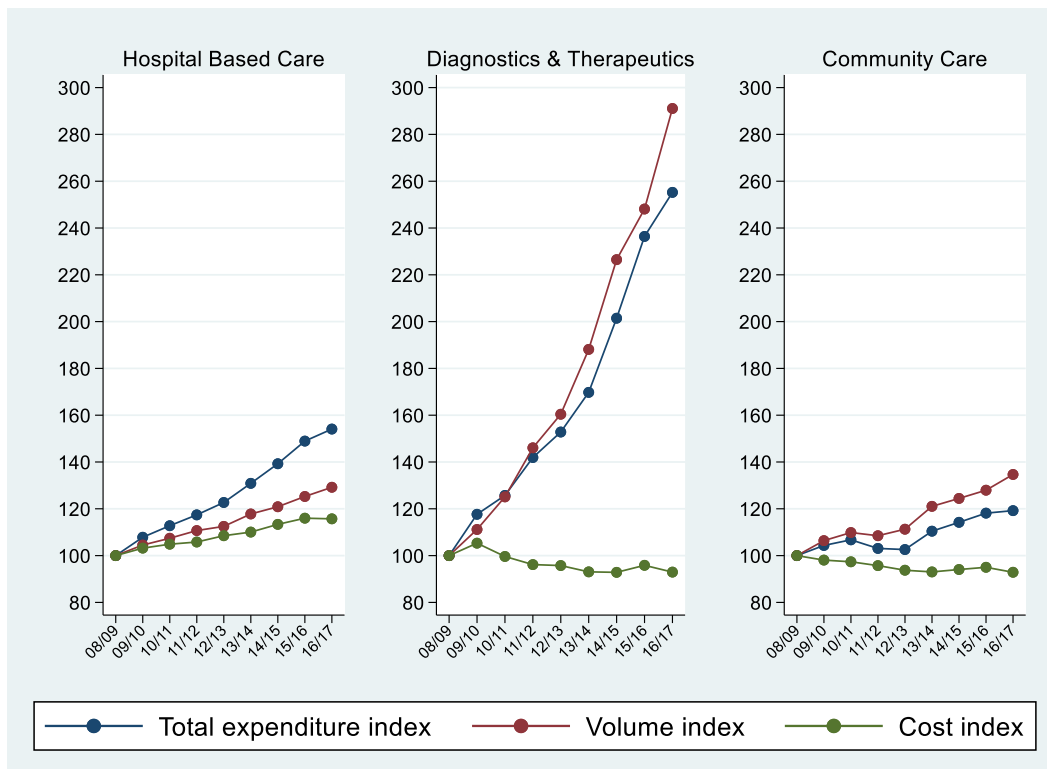


For the period 2008/09 – 2016/17, Table 1 shows the growth in total expenditure, activity and cost and mean year-on-year growth, calculated using Equations (3), (1) and (2) respectively. The



142 information is provided at setting level as well as weighted averages for the three main groups.  
 143 Average growth rates are weighted with respect to group size, measured by the relative share of  
 144 total expenditure for each group. The table also shows the type of activity captured by each of the  
 145 settings (e.g. FCEs, attendances, items, prescriptions, etc.).

146 **Figure 2** Trends in Expenditure, Activity and Costs growth: main activity groups



147  
 148 **Figure 2** shows the weighted average growth trends for total expenditure, activity and costs for the  
 149 three broad categories of care HBC, D&T and CC. From 2008/09 to 2016/17, healthcare expenditure  
 150 and activity rose every year in each of the three groups, with D&T exhibiting the greatest rate of  
 151 increase. However, the D&T category accounts for approximately 7% of overall NHS spend and so its  
 152 relative impact is less than that of HBC (which accounts for around 53% of total spend) and also  
 153 below that of CC (22% of total spend). In terms of cost, there was a positive and increasing trend in  
 154 HBC for the whole period, whereas the cost trends for D&T and CC were negative. These averages,  
 155 however, conceal large variations across the different settings, which we consider below.

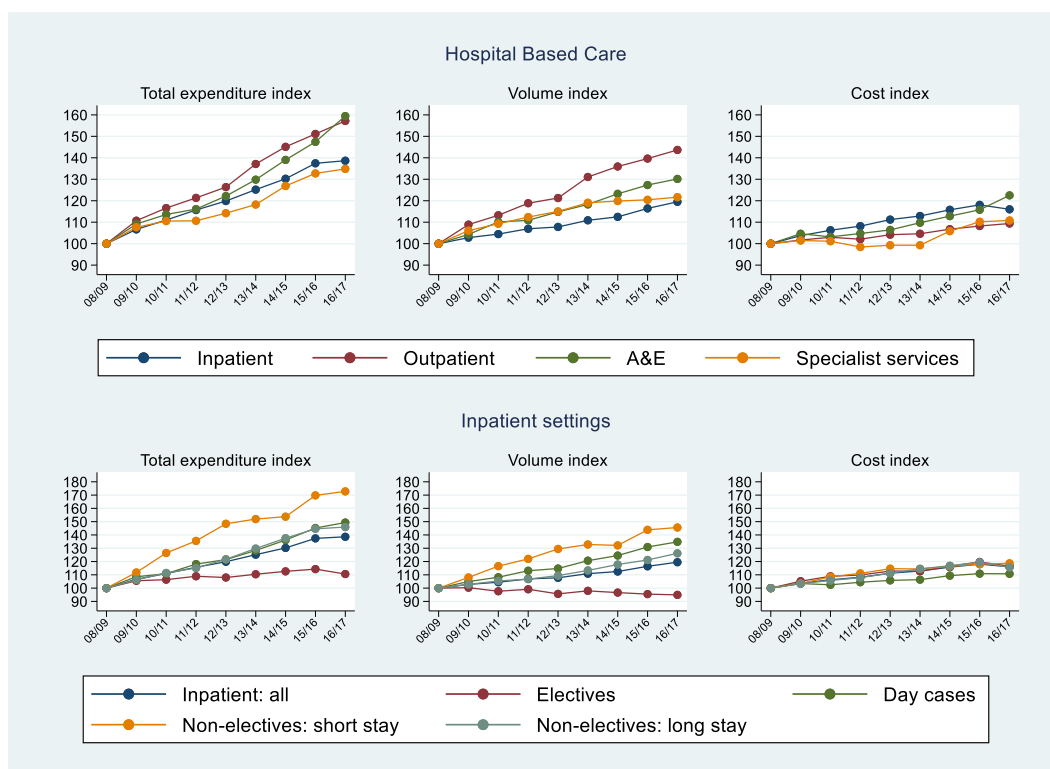
156 Hospital Based Care (HBC)

157 Hospital based care (HBC) is the largest expenditure category and includes inpatient, outpatient,  
 158 A&E and specialist services, accounting for over 50% of total English NHS expenditure. Overall, total  
 159 expenditure grew by 54.1% from 2008/09 to 2016/17, which corresponds to a 29.2% growth in  
 160 activity and a 15.7% growth in costs. In other words, around two-thirds of the rise in expenditure  
 161 was due to increased activity and one-third to rises in cost.

162 Inpatient care

163 **Figure 3** shows trends for each of the four HBC settings and a further breakdown for inpatient care  
 164 which is the largest setting in terms of total value, accounting for over one-third of total NHS  
 165 expenditure. Across the HBC settings, rises in expenditure ranged from 30% to 60% over the nine-  
 166 year study period.

167 **Figure 3** Trends in Expenditure, Activity and Costs for Hospital Based Care and Inpatient care



168  
 169 On average, total inpatient expenditure rose by 4.2% annually. This translates into an increase from  
 170 2008/09 to 2016/17 of 38.6% due to rises in both activity (19.5%) and cost (16.0%). There were

171 marked differences in growth rates for elective and non-elective care (Figure 2). Non-elective  
172 inpatient activity grew rapidly (45.6% for short stays and 26.2% for long-stays). In contrast, elective  
173 inpatient care fell by 5.1% over the period, whilst day cases rose by 34.8%.

174 Cost trends for all the inpatient care sub-settings were similar with the rise in total cost ranging from  
175 15% to 19%. The exception was day cases where costs grew just over 10%.

176 A plausible reason for the switch away from inpatient elective care to day cases is the Best Practice  
177 Tariff (BPT). Introduced in 2010, BPTs are national prices designed to incentivise high quality and  
178 cost-effective care ('best practice') and aim to reduce unexplained variation in clinical quality. The  
179 price differential between 'best practice' and 'usual' care creates an incentive for providers to shift  
180 from the latter to the former. A notable feature of BPTs is that they incentivise hospitals to admit,  
181 treat and discharge patients on the same day (when clinically appropriate) by paying a higher price  
182 for day care than for an overnight stay [20]. The fall in inpatient elective care activity (Figure 3) is  
183 more pronounced after 2011/12 and an empirical analysis has confirmed that most BPTs for elective  
184 care were effective in achieving this aim [20].

185 Although demographic factors such as population ageing [21] are associated with rises in inpatient  
186 HCE, the 'red herring' hypothesis proposes that time-to-death (TTD), rather than age, is the key  
187 demographic driver [22] though the interaction of the two factors is also important [23, 24].

188 However, TTD does not perform well as a predictor of spend on some nonlife threatening conditions  
189 such as long-term conditions and diseases treated predominantly with elective inpatient care [25]. It  
190 is self-evident that clinical factors, such as morbidities also drive inpatient HCE and indeed, TTD may  
191 itself be a proxy for morbidity [26]. A decomposition analysis of English inpatient data showed the  
192 prevalence of morbidities had a larger impact on inpatient costs than demographic drivers like age  
193 and sex [27]. The interaction between health status and mortality is also important when projecting  
194 HCE [28], and relates to the debate on compression and expansion of morbidity [26].

## 195 Outpatient care

1  
2 196 Outpatient figures, which capture care provided by NHS hospital trusts, show that the 57.2% growth  
3  
4  
5 197 in total expenditure was mainly driven by a 47.3% growth in activity whilst the increase in costs was  
6  
7 198 relatively modest (9.4%). These findings are consistent with a Dutch investigation of individual HCE  
8  
9 199 drivers [10], which revealed a move away from inpatient care coupled with a higher rate of day case  
10  
11 200 admissions, shorter inpatient stays and greater use of outpatient clinics. A Spanish study [29] found  
12  
13 201 per capita outpatient expenditure rose by 50% in real terms from 1998 to 2008, with the largest rise  
14  
15 202 in people of working age. Evidence regarding the effect of age and TTD on outpatient utilisation and  
16  
17 203 expenditure is mixed [13, 30]. A US analysis identified higher use of outpatient care was  
18  
19 204 independently associated with unemployment and also with higher income, suggesting a non-linear  
20  
21 205 relationship between utilisation and socioeconomic status [30]. However, socioeconomic status was  
22  
23 206 not predictive of expenditure at the individual level.  
24  
25  
26  
27  
28

## 29 Accident & Emergency attendances

30  
31 208 The Accident & Emergency (A&E) setting comprises activity performed in Emergency Departments  
32  
33 209 and other A&E services (e.g. ophthalmology, dental, NHS walk in centres). Overall, total expenditure  
34  
35 210 rose by almost 60.0%, translating into a year-on-year rise of 6.0%. This annual rate of increase is at  
36  
37 211 the top of the range cited by a recent systematic review of international studies [31], and in the case  
38  
39 212 of England reflects rises in both activity (30.2%) and cost (22.5%).  
40  
41  
42

43 213 An Australian study [32] assessed changes in emergency department visits between 2010 and 2014.  
44  
45 214 The rise in attendance rates per 1000 population exceeded population growth, with the highest rise  
46  
47 215 observed in those aged 85 and over.  
48  
49

50 216 The rise in A&E activity could be linked to reduced access to primary care services [31]. There is  
51  
52 217 evidence that A&E is used as an out-of-hours substitute for primary care, and also that younger  
53  
54 218 people perceive A&E as being generally more convenient [31]. Results from the GP (General  
55  
56 219 Practice) Patient Survey for England show that the percentage of people reporting having seen a  
57  
58 220 family doctor in the last three months fell by four percentage points between 2011/12 and 2016/17  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

221 [33]. A potential explanation is the increasing difficulty in booking an appointment, with the  
222 percentage of patients reporting easy access to GP surgery falling by eight percentage points over  
223 the same period [34]. These findings suggest that a lack of capacity in primary care could be an  
224 underlying reason for the rise in A&E activity. However, the lack of comprehensive data on primary  
225 care consultations prevents the computation of growth trends for that setting.

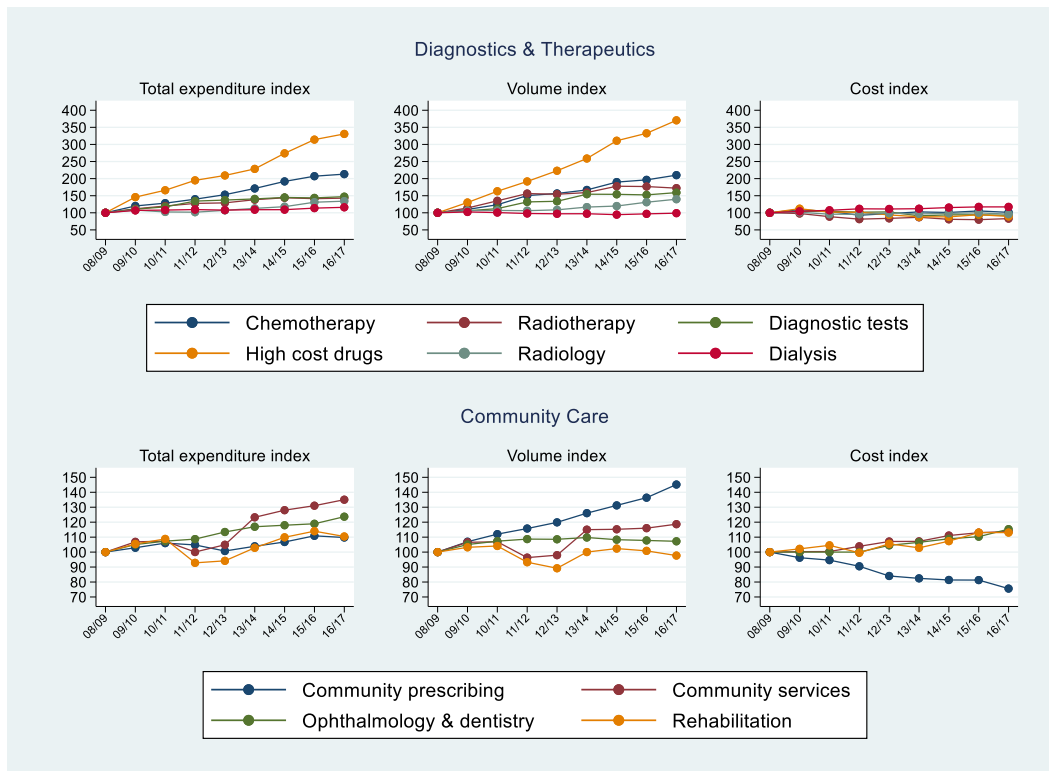
### 226 Specialist services

227 In the National Schedule of Reference Costs data, 'specialist services' comprises of activity in four  
228 distinct services: adult critical care, specialist palliative care, care for cystic fibrosis and – since  
229 2011/12 – cancer multidisciplinary team meetings. Together, these services account for  
230 approximately 7.8% of HBC expenditure. Total expenditure rose by 34.8% from 2008/09 to 2016/17  
231 and breakdowns into a growth of 21.7% in activity and of 10.8% in cost.

### 232 Diagnostics & Therapeutics (D&T)

233 The Diagnostics and Therapeutics category encompasses six types of care: chemotherapy,  
234 radiotherapy, high cost drugs (HCD), radiology, diagnostic tests and renal dialysis. D&T accounted for  
235 approximately 7% of total NHS expenditure in England over the study period. Trends for D&T are  
236 shown in Figure 4.

237 **Figure 4** Trends in Expenditure, Activity and Costs for Diagnostics & Therapeutics and Community Care



238

239 D&T total expenditure grew by 255.2%, driven by an extraordinarily large growth in activity (291.1%)

240 that was slightly offset by a reduction in the cost index (-7.05%). Activity rose in all types of D&T

241 care, with the exception of renal dialysis (-1.0%). The largest activity growth was for HCD (270.5%)

242 and chemotherapy (110.2%). Although the patient classification system (Healthcare Resource

243 Groups or HRGs) has been fairly stable since 2013/14, the HRGs used to classify chemotherapy,

244 radiotherapy, and HCD have been subject to substantial revision over time [33]. Better recording of

245 activity and the introduction of new coding that spilt activity in more than one HRG (when previously

246 the activity was captured by a single HRG) could overstate the observed increase in activity.

247 Nonetheless, the drivers of large rises in activity, and relatively small increases in costs, for HCDs and

248 chemotherapy are worth considering. In England, the availability of new technologies is influenced

249 by appraisals of cost-effectiveness by the National Institute for Health and Care Excellence (NICE)

250 [35]. NICE assesses the value of many HCDs, a category that captures drugs<sup>2</sup> whose cost is  
251 disproportionately high and that are used to treat a limited number of patients. Although NICE  
252 assessments inform value-based pricing, NICE does not negotiate the price of new drugs. Over our  
253 study period, prices of branded medicines were regulated by a voluntary scheme known as the  
254 Pharmaceutical Price Regulation Scheme (PPRS). The aims of the scheme were to keep expenditure  
255 on branded medicines within 'affordable limits', whilst improving access to new medicines and  
256 encouraging innovation [36]. The scheme limited the growth of NHS spend on new drugs, included  
257 pricing flexibilities such as Patient Access Schemes (i.e. commercial arrangements), and allowed  
258 manufacturers to offer local discounts to hospitals. Therefore, the PPRS is a potential explanation  
259 for the observed trends in HCD activity and costs. The Cancer Drug Fund (CDF), which covers the  
260 costs of certain drugs that are not recommended by NICE due to their lack of proven cost-  
261 effectiveness, was introduced in England in 2011 [37]. The CDF is another plausible driver of the  
262 accelerated growth in the volume of HCD observed from 2012/13 onwards.

263 For settings with negative trends in total cost, values ranged from -4.1% (radiology) to -17.4%  
264 (radiotherapy). Growth in the cost of chemotherapy was small but positive (1.4%) whereas costs for  
265 renal dialysis rose by 17.3%. The reason for the rise in the costs of renal dialysis is unclear, but could  
266 be linked to higher levels of multimorbidity [38]. There is also some evidence of positive and linear  
267 relationships between TTD and expenditure on D&T [39], which suggests frailty may also be a factor.

268 Other important drivers of HCE are the introduction of new health technologies and institutional  
269 characteristics. Evidence from the Netherlands showed that structural factors such as changes in  
270 regulation, policy and greater use of new technologies increased costs particularly for the highest  
271 cost patients [10].

---

<sup>2</sup> The drugs listed vary by year, but include treatments for cancer, hepatitis C, HIV, transplant patients, juvenile arthritis and cystic fibrosis among others.

## 272 Community Care (CC)

273 Community care encompasses community prescribing, community services, optometry, dentistry,  
274 and rehabilitation, and accounts for over one-fifth of the total expenditure in the English NHS.

275 Trends for CC are shown in Figure 4. Overall growth in CC expenditure, activity and cost were 19.2%,  
276 34.7% and -7.1% respectively, but conceal large variations across settings.

277 Community prescribing, the largest setting as a share of CC expenditure (55%), exhibits a modest

278 total expenditure growth of 9.8% comprising a 45.2% total activity growth and a fall in cost of 24.4%  
279 between 2008/09 and 2016/17. The reduction in pharmaceutical prices may reflect the relatively

280 low price of generics during our study period [40], the Pharmaceutical Price Regulation Scheme [36],  
281 and the use of health technology assessment to inform the price of new branded medicines [41, 42].

282 Our findings contrast with the findings from a Dutch study [10] which found that prescribing

283 expenditure rose by 69% from 2004 to 2013. The authors found that the increase in expenditure was

284 driven principally by structural shifts such as technological progress (e.g. the highest cost cases were

285 treated with even more expensive drugs). Changes in the distribution of determinants, such as

286 population ageing and a rise in the number of outpatient visits, played a lesser role but were also

287 important explanatory factors. For community prescribing, proximity to death might be a more

288 important driver than age as there is evidence that the effects of age on prescribing expenditure are

289 smaller when models control for TTD [13, 43, 44]. Gender also seems to be a driver of

290 pharmaceutical expenditure: there is evidence that females in all age groups incur higher

291 expenditure [29] and receive more prescriptions [13].

292 With regard to community services and rehabilitation, activity rose by 35.0% and 10.4% respectively,

293 with steeper rates of increase from 2013/14 onwards. On average, costs rose by around 13% to 14%

294 across the period for both settings. The cost of optometry and dentistry rose by 15%, equating to a

295 mean year-on-year rate of 1.8%, whereas the rise in activity was lower: 7.2% overall, with an

296 average annual rise of 0.9%.



## 297 Discussion

1  
2  
3 298 This study of trends in English HCE reveals how much was due to changes in the activity and how  
4  
5  
6 299 much was due to cost, and how this varied across care settings. Overall, HCE grew by approximately  
7  
8 300 50% over the nine year study period (2008/09 to 2016/17) driven mainly by a 40% rise in activity,  
9  
10 301 and a comparatively modest growth in costs (7%). Aggregate figures conceal large variations across  
11  
12 302 settings. Specifically, total expenditure on Hospital Based Care (HBC) rose by 54%, spend on  
13  
14 303 Diagnostics and Therapeutics (D&T) rose by 155%, and spend on Community Care (CC) grew by 19%.  
15  
16  
17 304 The rise in HBC expenditure was driven mainly by a rise in activity (29%) but also by a considerable  
18  
19 305 growth in costs (16%).

20  
21  
22 306 In the majority of the individual settings, with the exception of renal dialysis and rehabilitation,  
23  
24 307 growth in expenditure was driven primarily by growth in activity. This finding accords with  
25  
26  
27 308 Newhouse's argument that technological change - "the march of science" – increases the capacity of  
28  
29 309 healthcare systems to supply healthcare [45] and is a major factor driving rising healthcare  
30  
31 310 expenditure. However, whilst there is evidence of a strong, positive relationship between new  
32  
33 311 technologies and aggregate HCE [5, 9], the relationship at the individual level is complex and  
34  
35  
36 312 dynamic, and varies depending on the context and particular type of technology [46]. A better  
37  
38 313 understanding how new technology influences the process of care therefore appears pivotal in  
39  
40  
41 314 determining its impact on HCE and so the financial viability of the future NHS.

42  
43 315 HBC is the largest setting within the NHS in terms of overall spend, and also exhibited the largest rise  
44  
45 316 in cost. This points to the need to understand the reasons why cost pressures appear greater in HBC,  
46  
47 317 and future research could examine whether these are due to labour costs, capital costs or factors  
48  
49 318 outside of the HBC setting. Faced with an ageing population and with utilisation rates predicted to  
50  
51 319 continue to increase, greater efficiency may be called for. Alternatively, an improvement in NHS  
52  
53 320 productivity (i.e. the ratio of output growth over input growth) could help alleviate financial  
54  
55 321 pressures. Accounting for 45% of the total input expenditure in 2016/17 [33], labour is the largest  
56  
57 322 single input in the NHS. Therefore, improvements in the labour productivity, such as through  
58  
59  
60  
61  
62  
63  
64  
65

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

323 reductions in the avoidable use of bank and agency staff, changes in the skill-mix of labour (perhaps  
324 via digitally enabled care), or stronger preventative care in ambulatory settings, have potential to  
325 curb the growth in HCE.

326 The NHS Long Term Plan [47] recognises the pressures faced by emergency services. Various  
327 remedial measures are proposed, including £4.5 billion new investment in primary care and  
328 community care, and the expansion and reform of urgent and emergency care services including the  
329 national implementation of ‘urgent treatment centres’ and the roll-out of ‘same day emergency  
330 care’ as an alternative to an overnight emergency admission.

331 Regarding individual drivers, the prevalence of disability, morbidity and multimorbidity appear  
332 critical in determining future trends in HCE. International studies have documented changes in the  
333 patterns of disability and chronic morbidity, with the age of onset of these conditions occurring later  
334 in life (compression of morbidity) [26]. However, the effect on individual lifetime HCE will depend on  
335 changes in life-expectancy, and how much of any extra life is disability- or morbidity-free. For  
336 example, if individuals live longer and have more years in ill-health (expansion of morbidity) then  
337 HCE would likely be higher. Even if morbidity is compressed (fewer years in ill-health), if the  
338 complexity of their health needs increases then HCE may also rise. The net impact on aggregate  
339 (population level) HCE will also depend on changes in the age structure of the population.

340 The data used in this study is at an aggregate level. We describe trends in **activity**, cost and  
341 expenditure but can only conjecture how the demand drivers identified in the literature may impact  
342 those trends. No causal link is claimed. Moreover, the heterogeneity of the available studies (see [3]  
343 for a comprehensive review) makes it very difficult to compare their findings in a robust way. For  
344 example, there are large gaps in the evidence for many care settings, and a dearth of studies from  
345 the UK. In the future the availability of patient level cost data (PLICS<sup>3</sup>) appears a promising dataset  
346 for a more comprehensive study of the HCE drivers at the individual level.

---

<sup>3</sup> PLICS: Patient Level Information Costing Data Set.

## 347 Conclusions

348 Our contribution is to shed light on how much each type of setting has contributed to past trends in  
349 healthcare expenditure growth and how much of that growth is due to changes in the costs of care  
350 or due to changes in the level of activity. Our analyses demonstrate that aggregate trends in HCE  
351 mask enormous variation across healthcare settings. This information is useful for policy makers in  
352 charge of planning, because it clarifies whether cost pressures or rising activity are the principal  
353 reason for rising HCE in the different healthcare settings. Nonetheless, there is a lack of relevant  
354 studies for the NHS on how individual drivers affect HCE. Further research is needed to discern the  
355 impact of those on cost and to model future healthcare demand.

## 356 List of abbreviations

- 357 A&E accident and emergency (department)
- 358 BPT Best Practice Tariff
- 359 CC Community Care
- 360 CDF Cancer Drug Fund
- 361 D&T Diagnostics and therapeutics
- 362 FCE Finished Consultant Episode
- 363 GDP Gross Domestic Product
- 364 GP general practice
- 365 HBC Hospital Based Care
- 366 HCE healthcare expenditure
- 367 HRG Healthcare Resource Group
- 368 NHS National Health Service
- 369 NICE National Institute for Health and Care Excellence
- 370 OECD Organisation for Economic Co-operation and Development

371 PPRS Pharmaceutical Price Regulation Scheme

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

372 TTD time-to-death

373 US United States

374

## 375 References

- 1  
2  
3 376 1. Harker, R., *NHS funding and expenditure*. House of Commons Library, 2012. **Standard Note**  
4 377 **SN/SG/724**: p. 11.
- 5 378 2. Organisation for Economic Co-operation and Development (OECD), *Fiscal sustainability of*  
6 379 *health systems: bridging health and finance perspectives*. 2015: OECD.
- 7 380 3. Mason, A., I. Rodriguez Santana, M.J. Aragon Aragon, N. Rice, M.J. Chalkley, R. Wittenberg,  
8 381 et al., *Drivers of Health Care Expenditure*, in *CHE Research Paper 169*. 2019: Centre for  
9 382 Health Economics, University of York. p. 56.
- 10 383 4. Hernandez-Aceituno, A., R.F. Perez-Tasigchana, P. Guallar-Castillon, E. Lopez-Garcia, F.  
11 384 Rodriguez-Artalejo, and J.R. Banegas, *Combined Healthy Behaviors and Healthcare Services*  
12 385 *Use in Older Adults*. American Journal of Preventive Medicine, 2017. **53**(6): p. 872-881.
- 13 386 5. Martin, J.J.M., M.P. Lopez del Amo Gonzalez, and M.D.C. Garcia, *Review of the Literature on*  
14 387 *the Determinants of Healthcare Expenditure*. Applied Economics, 2011. **43**(1-3): p. 19-46.
- 15 388 6. Astolfi, R., L. Lorenzoni, and J. Oderkirk, *Informing policy makers about future health*  
16 389 *spending: A comparative analysis of forecasting methods in OECD countries*. Health Policy,  
17 390 2012. **107**(1): p. 1-10.
- 18 391 7. Hartwig, J. and J.E. Sturm, *Testing the Grossman model of medical spending determinants*  
19 392 *with macroeconomic panel data*. European Journal of Health Economics, 2018. **16**: p. 16.
- 20 393 8. Cortaredona, S. and B. Ventelou, *The extra cost of comorbidity: multiple illnesses and the*  
21 394 *economic burden of non-communicable diseases*. BMC Medicine, 2017. **15**(1): p. 216.
- 22 395 9. Murthy, V.N.R. and N. Ketenci, *Is technology still a major driver of health expenditure in the*  
23 396 *United States? Evidence from cointegration analysis with multiple structural breaks*.  
24 397 International Journal of Health Economics and Management, 2017. **17**(1): p. 29-50.
- 25 398 10. de Meijer, C., O. O'Donnell, M. Koopmanschap, and E. van Doorslaer, *Health expenditure*  
26 399 *growth: looking beyond the average through decomposition of the full distribution*. Journal  
27 400 of Health Economics, 2013. **32**(1): p. 88-105.
- 28 401 11. Licchetta, M. and M. Stelmach, *Fiscal sustainability and public spending on health*. OBR Fiscal  
29 402 sustainability analytical paper, 2016: p. 45.
- 30 403 12. Organisation for Economic Co-operation and Development (OECD) and European Union,  
31 404 *Health at a Glance: Europe 2018*. 2018.
- 32 405 13. Hakkinen, U., P. Martikainen, A. Noro, E. Nihtila, and M. Peltola, *Aging, health expenditure,*  
33 406 *proximity to death, and income in Finland*. Health Economics, Policy, & Law, 2008. **3**(Pt 2): p.  
34 407 165-95.
- 35 408 14. Department of Health, NHS England, and NHS Improvement, *Reference Cost Collection:*  
36 409 *National Schedule of Reference Costs, 2016-17 - NHS trusts and NHS foundation trusts*. 2017,  
37 410 NHS Improvement: London.
- 38 411 15. NHS Digital Prescribing and Medicine Team, *Prescription Cost Analysis - England, 2016*. 2017,  
39 412 NHS Digital: Leeds.
- 40 413 16. NHS Digital Primary Care Domain, *NHS Dental Statistics for England - 2016-17*. 2017, NHS  
41 414 Digital: Leeds.
- 42 415 17. NHS Digital Primary Care Domain, *General Ophthalmic Services activity statistics - England,*  
43 416 *year ending 31 March 2017*. 2017, NHS Digital: Leeds.
- 44 417 18. Bojke, C., A. Castelli, K. Grasic, D.D.H. Howdon, A.D. Street, and I.D.L.N. Rodriguez Santana,  
45 418 *Productivity of the English NHS: 2014/15 update*. *CHE Research Paper 146*. 2017, Centre for  
46 419 Health Economics, University of York: York, UK. p. 1-81.
- 47 420 19. Castelli, A., D. Dawson, H. Gravelle, and A. Street, *Improving the measurement of health*  
48 421 *system output growth*. Health Economics, 2007. **16**(10): p. 1091-1107.
- 49 422 20. Gaughan, J., N. Gutacker, K. Grašič, N. Kreif, L. Siciliani, and A. Street, *Paying for efficiency:*  
50 423 *Incentivising same-day discharges in the English NHS*. Journal of Health Economics, 2019. **68**:  
51 424 p. 102226.

- 425 21. Hartwig, J., *What drives health care expenditure?--Baumol's model of 'unbalanced growth'*  
1 426 *revisited*. Journal of Health Economics, 2008. **27**(3): p. 603-23.
- 2 427 22. Zweifel, P., S. Felder, and M. Meiers, *Ageing of population and health care expenditure: a red*  
3 428 *herring?* Health Economics, 1999. **8**(6): p. 485-96.
- 4 429 23. Geue, C., A. Briggs, J. Lewsey, and P. Lorgelly, *Population ageing and healthcare expenditure*  
5 430 *projections: new evidence from a time to death approach*. European Journal of Health  
6 431 Economics, 2014. **15**(8): p. 885-96.
- 7 432 24. Geue, C., P. Lorgelly, J. Lewsey, C. Hart, and A. Briggs, *Hospital expenditure at the end-of-life:*  
8 433 *what are the impacts of health status and health risks?* PLoS ONE [Electronic Resource],  
9 434 2015. **10**(3): p. e0119035.
- 10 435 25. Wong, A., P.H. van Baal, H.C. Boshuizen, and J.J. Polder, *Exploring the influence of proximity*  
11 436 *to death on disease-specific hospital expenditures: a carpaccio of red herrings*. Health  
12 437 Economics, 2011. **20**(4): p. 379-400.
- 13 438 26. Howdon, D. and N. Rice, *Health care expenditures, age, proximity to death and morbidity:*  
14 439 *Implications for an ageing population*. J Health Econ, 2018. **57**: p. 60-74.
- 15 440 27. Rice, N. and M.J.M. Aragon Aragon, *The determinants of health care expenditure growth*.  
16 441 *CHE Research Paper 156*. 2018, Centre for Health Economics, University of York: York, UK.
- 17 442 28. Wouterse, B., B.R. Meijboom, and J.J. Polder, *The relationship between baseline health and*  
18 443 *longitudinal costs of hospital use*. Health Economics, 2011. **20**(8): p. 985-1008.
- 19 444 29. Blanco-Moreno, A., R.M. Urbanos-Garrido, and I.J. Thuissard-Vasallo, *Public healthcare*  
20 445 *expenditure in Spain: measuring the impact of driving factors*. Health Policy, 2013. **111**(1): p.  
21 446 34-42.
- 22 447 30. Frees, E.W., J. Gao, and M.A. Rosenberg, *Predicting the Frequency and Amount of Health*  
23 448 *Care Expenditures*. North American Actuarial Journal, 2011. **15**(3): p. 377-92.
- 24 449 31. Coster, J.E., J.K. Turner, D. Bradbury, and A. Cantrell, *Why Do People Choose Emergency and*  
25 450 *Urgent Care Services? A Rapid Review Utilizing a Systematic Literature Search and Narrative*  
26 451 *Synthesis*. Academic emergency medicine : official journal of the Society for Academic  
27 452 Emergency Medicine, 2017. **24**(9): p. 1137-1149.
- 28 453 32. Dinh, M.M., S. Berendsen Russell, K.J. Bein, D. Chalkley, D. Muscatello, R. Paoloni, et al.,  
29 454 *Understanding drivers of Demand for Emergency Service Trends in Years 2010-2014 in New*  
30 455 *South Wales: An initial overview of the DESTINY project*. Emergency Medicine Australasia,  
31 456 2016. **28**(2): p. 179-86.
- 32 457 33. Castelli, A., M.J. Chalkley, J.M. Gaughan, M.L. Pace, and I. Rodriguez Santana, *Productivity of*  
33 458 *the English National Health Service: 2016/17 update*. CHE Research Paper 163. 2019, Centre  
34 459 for Health Economics, University of York: York, UK. p. 77.
- 35 460 34. Castelli, A., M. Chalkley, and I.D.L.N. Rodriguez Santana, *Productivity of the English National*  
36 461 *Health Service: 2015/16 update*. CHE Research Paper 152, in *2015/16 update*. 2018, Centre  
37 462 for Health Economics, University of York: York, UK. p. 1-78.
- 38 463 35. Mason, A.R. and M.F. Drummond, *Public funding of new cancer drugs: Is NICE getting*  
39 464 *nastier?* European Journal of Cancer, 2009. **45**(7): p. 1188-92.
- 40 465 36. Department of Health and Association of the British Pharmaceutical Industry, *The*  
41 466 *Pharmaceutical Price Regulation Scheme 2014* 2013, Department of Health: London. p. 135.
- 42 467 37. Wood, E.M. and D.A. Hughes, *The New and Non-Transparent Cancer Drugs Fund*.  
43 468 PharmacoEconomics, 2020. **38**(1): p. 1-4.
- 44 469 38. Dieleman, J.L., R. Baral, E. Johnson, A. Bulchis, M. Birger, A.L. Bui, et al., *Adjusting health*  
45 470 *spending for the presence of comorbidities: an application to United States national inpatient*  
46 471 *data*. Health Economics Review, 2017. **7**(1): p. 30.
- 47 472 39. Moorin, R., D. Gibson, D. Holman, and D. Hendrie, *The contribution of age and time-to-death*  
48 473 *on health care expenditure for out-of-hospital services*. Journal of Health Services & Research  
49 474 Policy, 2012. **17**(4): p. 197-205.
- 50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65

475 40. National Audit Office, *Investigation into NHS spending on generic medicines in primary care. HC 1122 SESSION 2017–2019*. 2018, National Audit Office: London.

1 476

2 477 41. Drummond, M. and A. Towse, *Is rate of return pricing a useful approach when value-based*

3 478 *pricing is not appropriate?* The European Journal of Health Economics, 2019. **20**(7): p. 945-

4 479 948.

5 480 42. NHS England, *NHS Commercial Framework for Medicines: Draft for Engagement (version 1)*.

6 481 2019. p. 33.

7 482 43. Moore, P.V., K. Bennett, and C. Normand, *The importance of proximity to death in modelling*

8 483 *community medication expenditures for older people: evidence from New Zealand*. Applied

9 484 Health Economics & Health Policy, 2014. **12**(6): p. 623-33.

10 485 44. Thiebaut, S.P., T. Barnay, and B. Ventelou, *Ageing, Chronic Conditions and the Evolution of*

11 486 *Future Drugs Expenditure: A Five-Year Micro-simulation from 2004 to 2029*. Applied

12 487 Economics, 2013. **45**(13-15): p. 1663-72.

13 488 45. Newhouse, J.P., *Medical Care Costs: How Much Welfare Loss?* Journal of Economic

14 489 Perspectives, 1992. **6**(3): p. 3-21.

15 490 46. Sorenson, C., M. Drummond, and B. Bhuiyan Khan, *Medical technology as a key driver of*

16 491 *rising health expenditure: disentangling the relationship*. Clinicoeconomics & Outcomes

17 492 Research, 2013. **5**: p. 223-34.

18 493 47. NHS England, *NHS Long Term Plan*. 2019. p. 136.

19 494

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65