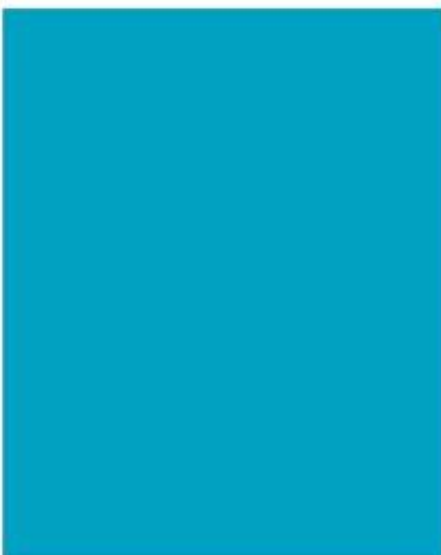
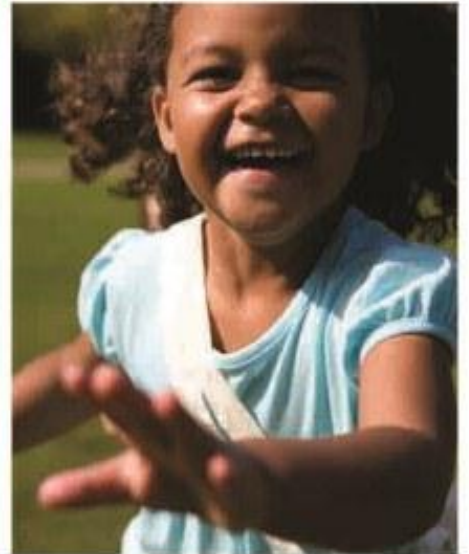


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*Update to reporting and  
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**Publications Gateway Reference: 00536**

<b>Document Purpose</b>	Guidance
<b>Document Name</b>	Patient Reported Outcome Measures: Update to reporting and case-mix adjusting hip and knee procedure data
<b>Author</b>	NHS England Analytical Team (Patient and Information)
<b>Publication Date</b>	October 2013
<b>Target Audience</b>	Care Trust CEs, Foundation Trust CEs , Medical Directors, Directors of Nursing, NHS Trust CEs
<b>Additional Circulation List</b>	
<b>Description</b>	
<b>Cross Reference</b>	Patient Reported Outcome Measures: An alternative aggregation methodology for case-mix adjustment
<b>Superseded Docs (if applicable)</b>	N/A
<b>Action Required</b>	N/A
<b>Timing / Deadlines (if applicable)</b>	N/A
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## **Patient Reported Outcome Measures (PROMs) in England:**

*Update to reporting and case-mix adjusting hip and knee procedure data.*

First published: October 2013

**Dafydd Richards, NHS England analytical team (patients and information)**

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## Introduction

1. Following a review of the way PROMs data for hip and knee replacements are reported and case-mix adjusted, this paper sets out some changes to the existing method<sup>1</sup>. Members of the clinical community, and other stakeholders in the orthopaedic PROMs programme have provided feedback on the way data for these procedures has been reported. They believe that combining the results of primary and revision procedures masks the complexity of revisions. Also, we believed that it will more useful to patients and clinicians to report the data separately when they use it for comparison and quality improvement purposes.
2. The following sections of this document set out: firstly, how the data will be reported; secondly, how it will be case-mix adjusted to take account of the differing complexity of patients conditions; thirdly, differences between these models and previous ones; fourthly, justification for the changes; fifth, a discussion of how providers' scores and outlier status changes when the new method is used; and finally, the data used to estimate the models.

## Data reporting format

3. Data for hip and knee replacement operations will be reported separately for primary and revision procedures. The primary/revision split is defined according to procedure codes as detailed in the PROMs guidance document<sup>2</sup>. This will take effect from November 2013 and apply to data from April 2012 onwards. Provisional data for 2012/2013 that have already been released will be split retrospectively. The data will be reported in a similar way to the current format, except that all the existing indicators (EQ-5D Index, EQ-5D Visual Analogue Scale "VAS", Oxford Score), will be reported separately for primary and revision procedures. The change will also apply to patient level data. Because of the relatively small number of revision procedures that are performed, in many cases, data at provider and patient level will have to be

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<sup>1</sup> See Patient Reported Outcome Measures (PROMs) in England: The case-mix adjustment methodology ([https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/216507/dh\\_133449.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/216507/dh_133449.pdf))

<sup>2</sup>Provisional Monthly Patient Reported Outcome Measures (PROMs) in England: A guide to PROMs methodology ([http://www.hscic.gov.uk/media/1537/A-Guide-to-PROMs-Methodology/pdf/PROMS\\_Guide\\_v5.pdf](http://www.hscic.gov.uk/media/1537/A-Guide-to-PROMs-Methodology/pdf/PROMS_Guide_v5.pdf))

suppressed for reasons of confidentiality<sup>3</sup>. In these instances data will be aggregated to the lowest level at which it can be reported without compromising patient anonymity.

## Case-mix adjustment method

4. Case-mix adjustment models have been developed separately for primary and revision procedures. These include individual ones for each outcome measure used for hip and knee procedures - Oxford Score, EQ-5D, and EQ-5D VAS. The algorithms formulated from these models are used to adjust for the differing complexity of cases faced by providers. This allows meaningful comparisons to be drawn between hospital and commissioner performance. The case-mix adjustment process has three stages:
  - a) Estimation of the impact of control variables
  - b) Generation of patient level predicted scores
  - c) Aggregation to organisation level and case-mix adjustment
5. The fundamental process by which we derive the models and generate the predicted scores (stages a. and b.) has not changed. It is the same as that stated in the previous methodology document<sup>4</sup>.
6. The aggregation method (stage c.) changed in July 2013. This new method is the one we use for these updated hip and knee models. Details of the revised aggregation method can be found at:  
<http://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2013/07/proms-agg-meth-adju.pdf>
7. Although the process of formulating the adjustment models remains the same, the variables in the resulting algorithms have changed<sup>5</sup>. This is because when we

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<sup>3</sup> As an illustration, in 2010/11, 84 providers out of the 179 hospitals/treatment centres nationally that performed revision operations performed less than 6 revision procedures – the lower limit under which results have to be anonymised. Only 14 performed more than 30 revision procedures – the minimum number of observations required to apply the case-mix models a provider level. However, these 14 providers accounted for 37% of all revision procedures performed in that year. The data from the providers that performed fewer than 30 revision procedures would have been reported only in raw form and not adjusted with the case-mix models - at lower sample sizes the models are unstable.

<sup>4</sup> [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/216507/dh\\_133449.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/216507/dh_133449.pdf)

<sup>5</sup> The variable selection and model estimation process takes place in two stages. Firstly we regress post operative score on pre operative score and all the other variables that are thought to determine the measured outcome of the procedure including, comorbidities, demographic characteristics and

consider primary and revisions procedures separately, different covariates are relevant for consideration. This in turn affects which variables have a statistically significant effect on health outcomes. Changes to the list of variables considered, and those that are statistically significant are discussed below.

## Changes to existing models

### *Candidate variables*

8. Firstly, we have excluded the variables that capture the type of prosthesis used in the hip or knee operation. These are usually within the control of the surgeon (For example, whether the surgeon chooses to use a cemented or un-cemented hip replacement) and are therefore not appropriate for inclusion in the adjustment model<sup>6</sup>.
9. Secondly, we have dropped the dummy variables capturing the number of comorbidities the patient has<sup>7</sup>. These capture similar information to the condition specific comorbidity dummy variables but are less reliable. Given that they are strongly correlated, including both leads to co-linearity. This reduces the overall effectiveness of the model.
10. Thirdly, we've also dropped the patient reported previous surgery variable, obtained from the PROMs data set. This captures whether or not the patient has had previous surgery in the same location as their current procedure. Given that the data is being split into primary and revisions procedures this variable is redundant.
11. Finally, we've added patients' diagnosis codes. Studies indicate that the indication for treatment can have a significant effect on the outcomes from surgery<sup>8</sup>.

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socioeconomic characteristics. (For a full list of the variables considered see appendices 1-4 to this document). Secondly, post operative score is regressed again on only those variables that are significant from the first round. From this we obtain the coefficients for inclusion in the casemix adjustment algorithm.

<sup>6</sup> These were dummy variables for HRGs H70 (Resurfacing of Hip), H71 Revisional Procedures to Hips, H80 (Primary Hip Replacement Cemented), H81 (Primary Hip replacement Un-cemented), H04 (Primary Knee replacement), H72 (Revisional procedures to knees)

<sup>7</sup> These were dummy variables capturing whether or not a patient had 1,2,3 or 4 self reported comorbidities.

<sup>8</sup> E.g. Carol A. Mancuso, Chitranjan S. Ranawat, John M. Esdaile, Norman A. Johanson, Mary E. Charlson [Indications for total hip and total knee arthroplasties: Results of orthopaedic surveys](#), *Journal of Arthroplasty* Januray 1996 & morbidity & Davis AM, Agnidis Z, Badley E, et al. Predictors of functional outcome two years following revision hip Arthroplasty. *Journal of Bone and Joint Surgery*, August 2006



12. Full details of the new list of candidate variables are provide in the 'Data' section towards the end of this document.

#### *Changes in the statistical significance of variables*

13. Splitting the data, and changing the list of variables that are considered for inclusion in the first stage of model development has an effect on the covariates that are statistically significant, and therefore included in the final model. For a full list of variables included in each new model see Annexes 1-4 to this document.

### **Rationale for the Changes**

#### *Statistical*

14. Statistical testing suggests that, by splitting the data, we obtain case-mix adjustment models which offer a better fit. We can therefore more accurately compare the true performance of different providers. To test the models, we used the estimated coefficients and provider effects<sup>9</sup> to predict the post-operative score of patients 'out of sample'. The 'out of sample' data are those which were kept back during the development stage and represent a third of the data from April 2009 – March 2012.
15. We compared the predicted post-operative scores in this test sample with their actual post-operative scores and measured the error in our prediction. The root mean squared error (RMSE), a common measure of prediction error, is lower for the separate models than the combined model, when the combined model is applied to primary and revision procedures separately<sup>10</sup>.

#### *Practical*

16. In addition to the statistical reasons for adopting this new method of adjusting and reporting the data, there are usage reasons for the change as well. Feedback received suggests that clinicians would prefer a model that splits primary and revisions. It is important that the PROMs Programme is responsive to this key user group.

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<sup>9</sup> Provider effects correspond to the provider specific error in the fixed effects models - i.e. each provider's average difference between the actual and predicted health gain for the patients they treat.

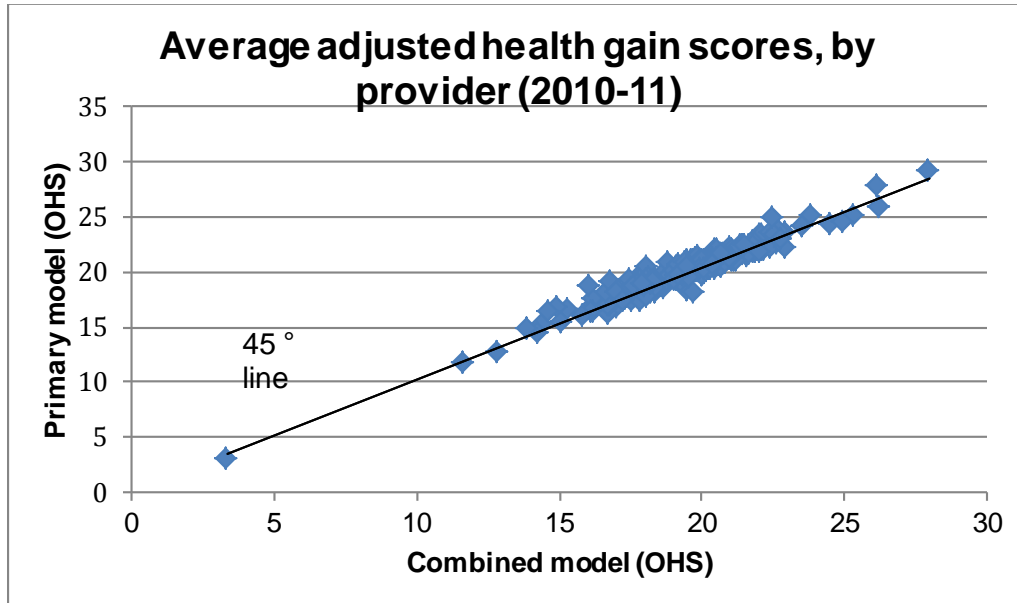
<sup>10</sup> As an illustration, the RMSEs of the respective models for the Oxford hip scores, using 2009-2012 data were: 8.3 for the primary only model and 8.4 for the combined model applied to primaries. 9.9 for the revision only model and 10.0 for the combined model applied to revisions.

- 17. In addition, from the point of view of a patient or commissioner, it may be more practical to present the data in this way. They are likely to be concerned with the provider's performance in a specific procedure, as opposed to a general score across both. This is important as informing patient choice and assisting commissioning is one of the main motivations behind the PROMs programme.

**Impact of new adjustment model on provider level scores**

- 18. To assess the differences between the new and existing models we analyse the composition of the 276 provider level scores for primary hip replacements in 2010-11. *Figure 1* below plots providers' average adjusted health gain scores calculated by the current method against the score calculated by the new proposed method. Obviously, if there were no change in score we would expect all providers to lie on the 45 degree line. The graph shows that the scores are very similar with the biggest difference in score being +/-2.47238 (on a scale of 0 to 48)

*Figure 1*



## Impact on identification of outliers

19. Changes to the methodology for calculating case-mix adjusted scores will also have an impact on those providers who are considered to be outside of the control limits. These are used to identify organisations that are statistically different from the England average. Comparing the outlier status of providers, in funnel plots, under the two methodologies gives an indication of whether the two approaches are consistent. It also shows any changes resulting from the new methodology. *Table 1* below shows the breakdown in outlier status under the two types of estimation as measured by the Oxford Hip Score.

**Table 1:** Breakdown of composition of provider scores under new and existing method. (2010-11 data)

		Separate primary (new method)					
Outlier category		over 99.8%	between 95% and 99.8%	between average and 95%	between 95% and average	between 99.8% and 95%	below 99.8%
Combined primary & revision (old method)	over 99.8%	3	2	2	0	0	0
	between 95% and 99.8%	3	8	7	0	0	0
	between average and 95%	1	3	89	20	0	0
	between 95% below and average	0	0	16	93	6	0
	between 99.8% below and 95%	0	0	0	3	6	0
	below 99.8%	0	0	0	1	7	6

20. Of the 276 providers, 74% would remain in the same category under both methodologies when looking at primary hip replacements in isolation.
21. The 8 providers that moved out of the lower 99.8% outlier category had an average revision rate of 11% of all hip replacement operations. This is compared to an all provider average of 4.8%. This suggests that those that do a relatively high proportion of this type of operation score differently under the current case-mix adjustment process. It is likely that it does not adequately account for the additional complications that are normally associated with this type of procedure. Those that remain below the 99.8% control limit are The Royal National Orthopaedic Hospital, Barking, Havering and Redbridge University Hospitals NHS Trust, Barnsley Hospital NHS Foundation Trust, Hitchingbrooke Health Care NHS Trust, Heart of England NHS Foundation Trust, Blackpool Teaching Hospital NHS Foundation Trust. Although 4 out of the six do see their average adjusted health gain scores improve.
22. At the other end of the spectrum, of the 7 providers that lie above the 99.8% upper control limit in the combined model, only 3 remain when the primary model is used to adjust the data. These are Shepton Mallet NHS Treatment Centre, The Cheshire & Merseyside NHS Treatment Centre and Euxton Hall Hospital.
23. In general, when judging providers based on their adjusted health gain scores for only primary procedures (in 2010/11), there are fewer outliers. This is reflected in a slightly lower standard deviation of provider scores - 1.4 for the combined model, 1.3 for primary.

## Data

24. The tables below show the variables used in the first stage of the model estimation process and represent all the variables considered for inclusion in the final models for hip and knee replacements (both primary and revision). The variables are grouped by the source of the data. Further details of the variables used from these sources for each model are given in annexes 1 – 4 to this document.
25. **Patient Reported Outcome Measures (PROMs) Dataset (collected within the PROMs questionnaires)**

Variable
Age
Sex: Female
Q1 score
Q2 score
Assisted at Q1
Assisted at Q2
Living arrangements
Disabled at Q1
Patient Reported Condition: Heart Disease
Patient Reported Condition: High blood pressure
Patient Reported Condition: Poor circulation
Patient Reported Condition: Lung disease
Patient Reported Condition: Diabetes
Patient Reported Condition: Kidney Disease
Patient Reported Condition: Nervous system diseases
Patient Reported Condition: Liver disease
Patient Reported Condition: Cancer
Patient Reported Condition: Depression
Patient Reported Condition: Arthritis
Symptom period >1 yr
Symptom period (1-5 yrs)
Symptom period (6-10 yrs)
Symptom period (10+ yrs)

26. The estimation models used data from the 2009/10 and 2010/11 finalised datasets, as well as provisional data from 2011/12. Further information about the PROMs data collection can be found on the HSCIC web site<sup>11</sup>

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<sup>11</sup> <http://www.hscic.gov.uk/proms>

## Variables from the Hospital Episode Statistics (HES) dataset

Variable
Age
Sex
Ethnicity: Mixed
Ethnicity: Asian
Ethnicity: Black
Ethnicity: Other
Ethnicity: Not given
Primary diagnosis codes

27. As with the PROMs data sets, the estimation models used data from 2009/10 and 2010/11 finalised datasets, as well as provisional data from 2011/12. Further information about the HES data collection can be found on the HSCIC web site.<sup>12</sup>

## Variables from other data sets

Variable
Index of multiple deprivation

28. This data set is published by the Department for Communities and Local Government. The models use the index for 2010<sup>13</sup>.

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<sup>12</sup>

<http://www.hscic.gov.uk/searchcatalogue?topics=0%2fHospital+care&sort=Relevance&size=10&page=1#top>

<sup>13</sup> <https://www.gov.uk/government/publications/english-indices-of-deprivation-2010>