Patient Reported Outcome Measures (PROMs) in England

The case-mix adjustment methodology

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PROMs in England

The case-mix adjustment methodology

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Introduction

1. This paper sets out the case-mix adjustment methodology for the national Patient Reported Outcome Measures (PROMs) programme. It sets out the generic approach and specific adjustments for each outcome measure and for each of the four elective procedures currently covered by the PROMs programme: groin hernia surgery; varicose vein repair; hip replacement; and knee replacement. Details of the specific adjustments for each procedure can be found in the annexes.

2. Case-mix adjusted outcomes for the PROMs programme have been published by the Health and Social Care Information Centre (HSCIC) since August 2010[1].

3. In September 2010, the first guide to the case-mix adjustment models was published following the conclusion of detailed analysis commissioned by the Department of Health[2].

4. In August 2011, the pre-operative PROMs questionnaires were amended, when a question asking respondents about their general health was removed. This change necessitated an update to the case-mix adjustments. We have taken this opportunity to review and update the underpinning statistical models. The variables and coefficients used in each model have been checked and revised as appropriate. Further refinements to the models were made possible by an increase in the volume of PROMs data available since the original analysis was carried out in 2010.

5. The updated case-mix adjustments and underpinning statistical models are presented in separate annexes, one each for the four procedures covered by the PROMs programme.

[1] http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=1295
[2] http://www.northgate-proms.co.uk/docs/PROMS_risk_adjustment_methodologies_SEPT_10.pdf

Background

6. Since April 2009, PROMs data has been routinely collected for four elective procedures: groin hernia surgery; varicose vein surgery; and hip and knee replacement. The data series was first published by the HSCIC in September 2010. In August 2011, the pre-operative questionnaires were altered, which necessitated updates to the case-mix adjustments .

7. The HSCIC publishes a range of statistics that is derived from the PROMs data. These include an average post-operative health status score and average health gain aggregated for either the hospital undertaking the procedure or the relevant commissioning organisation. Comparing unadjusted average scores between providers can be misleading as the patient profiles that one provider treats may be different to the patient profile at another provider.

8. In order to make comparisons meaningful, a methodology is needed to adjust for these different profiles. We have developed a general case-mix adjustment methodology and specific adjustments for each outcome measures, for each procedure. These specific adjustments are based on statistical models which predict outcomes taking account of patient characteristics and factors which are beyond the the control of providers. This means more accurate comparisons between the average scores of different providers are possible.

9. The following sections of this document set out the methodology. Details of each adjustment for each procedure can be found in the accompanying annexes.

Methodology

10. The case-mix adjustment methodology has three steps, which are set out in detail, below. These are:
    a. Estimation of the impact of the control variables
    b. Generation of patient level predicted scores
    c. Aggregation to organisation level and case-mix adjustment

Estimation: the model

11. The estimation part of the methodology uses a Generalised Least Squares (GLS) fixed effects model. The model allows us to identify which patient characteristics and control variables have an important statistical relationship with the health status of patients, and also estimates the magnitude of these effects. Using a fixed effects model gives a more accurate estimate of these relationships by taking account of the separate impacts on health status attributable to the providers themselves. This is important as we only want to adjust the patient's score by factors beyond the control of providers. We do not want to adjust for factors the hospital does have influence over.

12. A general form of the GLS fixed effects model is given by:

$$Q2_i = \alpha + \beta_1 Q1_i + x'\beta_2 + z'\beta_3 + u_j + \varepsilon_{ij} \quad \text{; for patient i and provider j}$$

Where:

- $Q2_i$ = the post-operative score for patient i
- $Q1_i$ = the patient's pre-operative score
- x' = vector of patient characteristics
- z' = vector of control variables
- α= a constant term (scalar)
- β_1 = the coefficient on the patient's pre-operative (Q1) score
- β_2 = a vector of coefficients on the patient's characteristics (e.g. age, gender, ethnicity, comorbidities)
- β_3 = a vector of coefficients on other control variables (e.g. HRG code, day case patient, type of procedure)
- u_j = an error term that is specific to provider j (i.e. this is the 'provider effect')
- ε_{ij} = an error term that is specific to patient i at provider j

Estimation: selection of variables

13. The variables that are included in the model have an important bearing on the adjustment that is applied to the outcome scores. Selection was done on the basis of clinical significance using expert advice and reviews of the literature. The relationships between these variables and the outcome measures of interest were tested for statistical significance using t-tests. Only factors that were believed to be clinically important and when then proved to be statistically significant were included in the models.

14. The precise variables included in each model are different for each procedure depending on what is clinically and statistically significant and reflect the differences in the profiles of the patients receiving them. Details of the variables for each model and the size of their importance can be found in the annexes.

Generation of predicted scores

15. Once the significant variables have been identified and the size of their relationship with the outcome variable has been estimated, they are included in the prediction model. This takes the estimated values of the coefficients from the estimated model and combines them for each patient as follows:

$$\hat{Q2}_i = \hat{\alpha} + \hat{\beta}_1 Q1_i + x'\hat{\beta}_2 + z'\hat{\beta}_3 \qquad \text{; for patient i}$$

Where:

- $\hat{Q2}_i$ = the predicted post-operative score for patient i
- $Q1_i$ = the pre-operative score for patient i
- x' = the patient characteristics of patient i
- z' = the control factors for patient i
- $\hat{\alpha}$ = the estimated constant term
- $\hat{\beta}_1$ = the estimated coefficient on the patient's pre-operative (Q1) score
- $\hat{\beta}_2$ = the estimated vector of coefficients on the patient's characteristics
- $\hat{\beta}_3$ = the estimated vector of coefficients on other control variables

16. This gives us the predicted value of the post-operative health score for each patient given their pre-operative health status, their individual characteristics like age, and their other circumstances like co-morbidities. As the prediction model does not contain a variable for provider effects (we do not wish to control for these) the constant term is adjusted to maintain statistical integrity[3].

Aggregation

17. The first step of the aggregation process is to create a ratio at individual patient level of the actual reported post-operative health status relative to their predicted health status (derived from the preceding step, described above). This ratio is called the Relative Performance Factor (RPF) and is calculated as follows:

$$\text{RPF}_i = \frac{Q2_i}{\hat{Q2}_i} = \frac{\text{Actual PostOp Health}_i}{\text{Predicted PostOp Health}_i} \quad \text{for patient i}$$

[3] The constant term is adjusted by adding the mean of the provider effects.

18. A ratio value of, say, 1.3 means that actual health reported by the patient is 30% more than one would expect given the details we know about the patient. Or to put it another way, the patient has outperformed the national average given their characteristics. A value of, say, 0.9 means that the patient only reported a health score 90% of that predicted.

19. RPFs for individual patients can be combined to give an average RPF at an organisation level, e.g. hospital provider level. This is calculated using the following equation:

$$\text{RPF}_{\text{provider}} = \frac{1}{\text{N}}\sum_{\text{i=1}}^{\text{N}}(\text{RPF}_{\text{i}}) = \frac{1}{\text{N}}\sum_{\text{i=1}}^{\text{N}}\left(\frac{\text{Actual PostOp Health}_{\text{i}}}{\text{Predicted PostOp Health}_{\text{i}}}\right)$$

where the provider treats N patients.

20. The final stage of the aggregation process is to apply the organisation level relative performance factor to the average post-operative health score for all patients in the dataset. This stage means that the adjusted average Q2 score for each organisation is calculated using the same casemix (the national average). This is calculated below:

$$Adjusted\ average\ Q2\ score_{provider} = RPF_{provider} * National\ Average\ Q2\ Score$$

21. The adjusted average health gain at an organisation level is then calculated using the following equation:

$$Adjusted\ Average\ Health\ Gain_{provider} = Adjusted\ average\ Q2\ score_{provider} - National\ Average\ Q1\ Score$$

Changes to the Models

22. The three steps of the methodology – estimation, prediction and aggregation – remain the same after this update as used previously. The main changes have occurred specifically within the estimation step.

23. The original methodology used an Ordinary Least Squares (OLS) model to estimate the coefficients of patient characteristics and other control factors. It also used control variables as proxies for the provider impact/effect. The revised methodology uses a Generalised Least Squares (GLS) fixed effects model. This fixed effects model control for the provider effects directly. Therefore, the proxy control variables are not required and have been removed from the model[4].

24. The review process also looked again at which variables are appropriate to include in the model. The principles used to select the variables remains the same. The actual variables relating to co-morbidities has changed as a result of more data now being available. Further work has identified further potential control variables which have also been included. The selection of the particular variables varies between procedures, depending on their clinical and statistical significance. Details of which variables have been included can be found in the annexes. The annexes have been arranged by procedure.

[4] These proxy control variables included, for instance, the type of provider, SHA of treatment, length of stay, and the time between questionnaires.

Data

25. The tables below shows the variables used in the estimation step of the case-mix adjustment methodology. The variables are grouped by the source of the data. Further details of the variable used from these sources for each model is given in the annexes that accompany this paper.

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: Live alone
Disabled at Q1
Previous Surgery: (Yes/No)
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
Patient has 2 Patient Reported Conditions
Patient has 3 Patient Reported Conditions
Patient has 4 Patient Reported Conditions
Symptom period >1 yr
Symptom period (1-5 yrs)
Symptom period (6-10 yrs)
Symptom period (10+ yrs)

Table 1: Variables from the PROMs dataset employed for case-mix adjustment

26. The estimation models used data from the 2009/10 finalised dataset, as well as data from the 2010/11 provisional and 2011/12 provisional datasets. Further information about the PROMs data collection can be found at HES Online[5]

[5] http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937&categoryID=1295

or from the Health and Social care Information Centre website[6]:

Variables from the Hospital Episode Statistics (HES) dataset

Variable
Age
Sex: Female
Ethnicity: Mixed
Ethnicity: Asian
Ethnicity: Black
Ethnicity: Other
Ethnicity: Not given
Procedure: Total Hip Replacement, Revision
HRG[7] Code F41
HRG Code H72
HRG Code H80
HRG Code H81
Charlson Index of Comorbidities[8] (via diagnosis codes)
Day case patient
Patient has 1 HES Reported Comorbidity
Patient has 2 HES Reported Comorbidity
Patient has 3 HES Reported Comorbidity
Self-discharged

Table 2: Variables from the HES datasets for casemix adjustment

27. As with the PROMs datasets, the estimation models used data from the 2009/10 finalised dataset, and also the 2010/11 provisional and 2011/12 provisional datasets. Further information about the HES data collection can be found at HES Online[9] at the following address:

Variables from other datasets

Variable
Index of Multiple Deprivation

Table 3: Variables used from other datasets for case-mix adjustment

28. This data set is published by the Department for Communities and Local Government. The models use the index for 2004[10].

[6] http://www.ic.nhs.uk/proms
[7] HRG = Health Resource Group http://www.ic.nhs.uk/services/the-casemix-service/new-to-this-service/what-are-healthcare-resource-groups-hrgs
[8] http://www.ic.nhs.uk/webfiles/Services/SHMI/Methodology_Charlson_v1_1.pdf
[9] http://www.hesonline.nhs.uk/Ease/servlet/ContentServer?siteID=1937
[10] http://webarchive.nationalarchives.gov.uk/20100410180038/http://www.communities.gov.uk/archived/general-content/communities/indicesofdeprivation/216309/