Summary Hospital-level Mortality Indicator (SHMI)

Indicator specification

Indicator code: I00699
Version: 1.25
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Version history

Version	Date	Details
1.0	29th July 2011	• First release.
1.1	23rd August 2011	• Amended following initial public review.
1.2	24th August 2011	• Clarified the handing of R codes and the derivation of DIAG_GROUP. • Removed references to the number of diagnosis groups.
1.3	25th August 2011	• Adjusted the exclusion of spells with unknown gender.
1.4	26th August 2011	• Amended list of excluded trusts and clarified the use of the first episode unless otherwise stated.
1.5	31st August 2011	• Added the Charlson Comorbidity Index methodology into specification in an Appendix. • Data periods changed to three years for model creation and one year for indicator scoring.
1.6	13th September 2011	• Updated section on joining HES-ONS linked mortality data to HES provider spells dataset for more clarity. • Added new field YEAR_INDEX to facilitate year case-mix adjustment. • Amended SHMI upper and lower control limits calculation to be based on expected deaths. • Added organisations to list of excluded trusts.
1.7	13th October 2011	• Updated section on joining HES-ONS linked mortality data to HES provider spells dataset for more clarity. • Updated risk modelling section to include logistic regression options for model convergence. • Amended standardised residuals to be based on expected deaths in the calculation of the control limits. • Updated SHMI bandings and output table to report on two bandings: exact Poisson control limits at a 99.8 per cent level and over-dispersion control limits at a 95 per cent level. • Removed several trusts from list of excluded trusts. • Updated to make the use of P_SPELL_EPIORDER explicit.
1.8	25th October 2011	• Corrections made to the calculation of the control limits.

1.9	17th January 2012	• Removed appendix on gender specific diagnosis groups. • Excluded regular night attenders from the dataset. • Specified reference category as the first category for all case-mix variables in the risk model. • Added new trusts to the list of excluded trusts. • Updated SHMI bandings and csv output table to report on one banding: 95 per cent random effects model control limits with an adjustment for over-dispersion.
1.10	11th April 2012	• Appended new trusts to the list of excluded trusts.
1.11	11th July 2012	• Added fields needed for the calculation of SHMI contextual indicators to list of data fields. • Added link to the SHMI publication timetable. • Specified that the dataset for calculating the contextual indicators is the same as that used for scoring the SHMI. • Appended new trusts to list of excluded trusts. • Changed SAS model fitting option from RIDGING = NONE to RIDGING = ABSOLUTE.
1.12	10th October 2012	• Updated Charlson Comorbidity Index methodology to reflect ICD-10 4th edition codes and updated introduction to this section to improve clarity. • Removed P_SPELL_DISDEST from list of data fields. • Added IMD04RK to list of data fields, as this is required in the calculation of a new SHMI contextual indicator.
1.13	14th January 2013	• Removed DEATH_RECORD_USED from list of data fields, as this is no longer used in the calculation of contextual indicator I00733. • Updated data processing following the creation of the organisation ‘R1F – Isle of Wight NHS Trust’.
1.14	11th April 2013	• Appended new trust to list of excluded trusts. • Updated with new HSCIC logo, links and contact details.

1.15	15th January 2014	• Updated appendix on category levels with changes made to admission method codes following the release of version 6.2 of the Commissioning Data Sets (CDS). • Updated summation notation to improve clarity. • Updated description of the indicator. • Updated document management section. • Updated description of which episode is used in the calculation of the Charlson Comorbidity Index to improve clarity. • Added reference to mapping between ICD-10 codes and CCS categories, which is available to download from the SHMI homepage.
1.16	10th April 2014	• Changed reference category for AGE_GROUP, ADMIMETH and GENDER case-mix variables to be the category with highest number of records across the three-year dataset for each diagnosis group.
1.17	9th October 2014	• Removed P_SPELL_CHARLSON from list of source data fields, as this is a calculated field defined later in the document. • Updated risk modelling section so records which have a missing or unknown value for the AGE_GROUP, ADMIMETH or GENDER variables are re-categorised to belong to the corresponding reference category for that variable and diagnosis group.
1.18	14th January 2015	• Added table explaining the calculation of the SHMI broken down by trust and diagnosis group, which will be published from the January 2015 SHMI release onwards. • Added details of small number suppression used for SHMI data broken down by trust and diagnosis group. • Updated the descriptions in csv output table for SHMI to improve clarity.
1.19	10th June 2015	• Updated rules for joining HES-ONS linked mortality data to HES provider spells dataset for cases where there are multiple spells with the same maximum discharge date and added EPIKEY to list of data fields required. • Removed trust RBB from list of excluded trusts, as this trust has now merged with trust RD1.
1.20	3rd August 2015	• Updated list of fields and rules for joining HES-ONS linked mortality data to HES provider spells dataset to use PSEUDO_HESID rather than HESID and PSEUDO_HESID_MAPPED rather than HESID_MAPPED. • Updated csv output table to reflect updated csv output files.

1.21	7th December 2015	• Removed trust R1G from list of excluded trusts, as this trust has now merged with trust RA9. • Removed 'Directorate' from title page.
1.22	24th February 2016	• Added DIAG_COUNT to list of data fields, as this is required in the calculation of new SHMI contextual indicators. • Ordered list of fields alphabetically. • Updated section on small number suppression to clarify that some secondary suppression rules must be applied repeatedly until all conditions are met.
1.23	1st December 2016	• Removed trust RJX from list of excluded trusts, as this trust has now merged with trust RW4. • Moved content to new NHS Digital corporate template. • Updated description of indicator for consistency with other documentation.
1.24	26th April 2017	• Updated list of excluded trusts following the merger of trusts RRD and RWN to form trust R1L.
1.25	19th July 2017	• Added E135 to the list of ICD-10 codes for diabetes in the calculation of the Charlson Comorbidity Index. • Updates to various sections to improve clarity, including updates to notation. • Changed STARTAGE to AGE_GROUP and P_SPELL_STARTAGE to STARTAGE in list of data fields to reflect names in source data. • Removed original Charlson Comorbidity Index weights from Appendix D to avoid confusion. • Removed additional data processing for trust 5QT as this is no longer required. • Removed trust RLU from list of excluded trusts, as this trust has now merged with trust RQ3. • Removed trusts RBF, RHX, RT6 and RWQ from list of excluded trusts, as these are now obsolete. • Corrected age category levels to show that STARTAGE codes for those under one year old range from 7001-7007.

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Indicator title

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Indicator code

I00699

Indicator family name

Summary Hospital-level Mortality Indicator (SHMI)

Reporting frequency

Quarterly (both recalibration of the statistical models and indicator calculation)

Description

The SHMI reports on mortality at trust (provider) level across the NHS in England using a standard and transparent methodology. It is produced and published quarterly as a National Statistic by NHS Digital.

The SHMI is the ratio between the actual number of patients who die following hospitalisation at the trust and the number that would be expected to die on the basis of average England figures, given the characteristics of the patients treated there.

It covers all deaths reported of patients who were admitted to non-specialist acute trusts in England and either die while in hospital or within 30 days of discharge.

The expected number of deaths is calculated from statistical models derived to estimate the risk of mortality based on the characteristics of the patients (including the condition the patient is in hospital for, other underlying conditions the patient suffers from, age, gender and method of admission to hospital).

SHMI values for each trust are published along with bandings indicating whether a trust's SHMI is 'higher than expected', 'as expected' or 'lower than expected'.

The statistical models are derived using a three-year dataset from trusts throughout England. Data from the final year of this period are used to calculate the SHMI and accompanying contextual indicators for each individual trust. Data for the month following the end of the reporting period are required to identify deaths which occurred within 30 days of discharge. For details of the data periods used in the construction of the statistical models and in the generation of the indicator, please refer to the SHMI publication timetable[1].

[1] The SHMI publication timetable is available to download from http://digital.nhs.uk/SHMI.

Data

Data sources

- Hospital Episode Statistics (HES) provider spells dataset[2], NHS Digital
- HES linked to Office for National Statistics (HES-ONS) mortality dataset[3], NHS Digital

Data fields

The data fields required for the calculation of this indicator and the SHMI contextual indicators are as follows:

HES provider spells dataset:

• CLASSPAT	Patient classification
• DIAG_01	Primary diagnosis code
• DIAG_02 – DIAG_20	Secondary diagnosis codes
• DIAG_COUNT	Number of diagnosis codes for an episode
• EPIKEY	Identifies unique episodes in provider spell
• IMD04RK	Index of Multiple Deprivation (IMD) overall rank
• PROCODET_MAPPED	Trust code for spell mapped to current trusts
• PSEUDO_HESID_MAPPED	Pseudonymised individual patient identifier
• P_SPELL_ADMIDATE	Admission date for provider spell
• P_SPELL_ADMIMETH	Method of admission to hospital
• P_SPELL_DISDATE	Discharge date for provider spell
• P_SPELL_DISMETH	Discharge method for provider spell
• P_SPELL_EPIORDER	Order of episode within provider spell
• P_SPELL_FIRST_EPISODE	Flag to identify first episode in provider spell
• P_SPELL_LAST_EPISODE	Flag to identify last episode in provider spell
• P_SPELL_NUMBER	Identifies unique provider spells
• SEX	Sex of patient
• STARTAGE	Age of patient at start of episode

[2] Further information on the HES provider spells dataset is available at http://digital.nhs.uk/SHMI.

[3] Further information on the HES-ONS linked mortality dataset is available at http://digital.nhs.uk/SHMI.

• TRETSPEF	Specialty in which the consultant was working during episode of care

HES-ONS linked mortality dataset:

• DOD	Date of death
• PSEUDO_HESID	Pseudonymised individual patient identifier

Data linkage

Data filters applied prior to data linkage

Prior to joining the HES provider spells dataset to the HES-ONS linked mortality dataset, the following filters are applied to the HES provider spells dataset:

Field name: PROCODET_MAPPED

Condition: PROCODET_MAPPED begins with 'R' AND does not appear in the list of excluded trusts in Table 8 and Table 9 in Appendix C.

Rationale: Selects non-specialist acute NHS trusts, excluding independent sector providers, mental health trusts, community trusts and specialist trusts.

Field name: P_SPELL_DISDATE

Condition: P_SPELL_DISDATE >= first day in the reporting period minus two years
AND
P_SPELL_DISDATE <= last day in the reporting period plus one month

Rationale: This filter selects the three-year dataset used to build the statistical models, including an additional month of data to ensure that deaths occurring in the 30 days after discharge are assigned to the correct provider spell. For example, for the reporting period April 2016 – March 2017, spells with a discharge date between 1st April 2014 and 30th April 2017 are selected by this filter.

Data linkage rules

The latest provider spell in the dataset for each patient is identified by ordering them in the following way for each PSEUDO_HESID_MAPPED:

- Order provider spells by P_SPELL_DISDATE.
- If multiple provider spells have the same P_SPELL_DISDATE then order these so that any spell where P_SPELL_DISMETH = 4 (discharge method is died) is ordered last.
- If multiple provider spells have the same P_SPELL_DISDATE and either no spell has P_SPELL_DISMETH = 4 or multiple spells have P_SPELL_DISMETH = 4 then order these spells by EPIKEY (using the EPIKEY from the discharge episode, identified by P_SPELL_LAST_EPISODE = Y).

The latest provider spell in the dataset is then joined to the HES-ONS linked mortality dataset using the PSEUDO_HESID_MAPPED and PSEUDO_HESID fields.

Spells which are not the latest spell for a particular value of PSEUDO_HESID_MAPPED are retained in the dataset, but are not joined to the HES-ONS linked mortality data. This ensures that deaths are only counted once and are attributed to the last non-specialist acute trust that the patient was discharged from.

Data processing

Definition of event

For this indicator the event is defined as a death that occurred either in hospital or within 30 days (inclusive) of being discharged from hospital. Two new variables are created and defined as follows:

Field names: DIED, SURVIVED

Condition: IF (DOD – P_SPELL_DISDATE < 31) AND (P_SPELL_ADMIDATE ≤ DOD) THEN DIED = 1 AND SURVIVED = 0,

ELSE DIED = 0 AND SURVIVED = 1.

Rationale: Identifies deaths that occurred either in hospital or within 30 days of discharge. The second part of the condition prevents events being assigned where a patient is recorded as dead before their spell in hospital begins. It is possible for DOD – P_SPELL_DISDATE to return a negative number. Possible causes for this are that the patient may have died late at night and the hospital were unable to record the discharge until the next day, or the patient may have died on a previous day but was not released until tests were performed on a subsequent day.

Data filters

The following filters are applied to the dataset:

Field name: P_SPELL_DISDATE

Condition: P_SPELL_DISDATE >= first day in the reporting period minus two years

AND

P_SPELL_DISDATE <= last day in the reporting period

Rationale: This filter selects a three-year dataset for creating the statistical models upon which the SHMI is based.

Field name: P_SPELL_DISMETH

Condition: P_SPELL_DISMETH not equal to 5

Rationale: This filter removes stillbirths from the dataset.

Field name: P_SPELL_FIRST_EPISODE

Condition: P_SPELL_FIRST_EPISODE = ‘Y’

Rationale: This filter selects only the first episode in the spell to prevent double counting for spells with more than one episode.

Field name: CLASSPAT

Condition: CLASSPAT not in (2, 3, 4)

Rationale: This filter removes patients admitted as day cases, regular day attenders and regular night attenders from the dataset.

Additional data processing

Field name: DIAG_01 – DIAG_20

Condition: For each provider spell, DIAG_01 – DIAG_20 are taken from the first episode in the provider spell (see above), unless DIAG_01 for the first episode begins with 'R'.

If DIAG_01 for the first episode begins with 'R' then DIAG_01 – DIAG_20 are replaced with those from the second episode in the provider spell (identified by P_SPELL_EPIORDER = 2) if it exists and DIAG_01 for this episode does not begin with 'R'.

If a second episode does not exist or DIAG_01 for the second episode also begins with 'R' then DIAG_01 – DIAG_20 are taken from the first episode in the provider spell.

Rationale: Selects the diagnosis codes from the diagnosis dominant episode for each provider spell.

Field name: P_SPELL_CHARLSON

Condition: P_SPELL_CHARLSON is calculated using DIAG_02 – DIAG_20 according to the methodology set out in Appendix D: Charlson Comorbidity Index calculation.

Rationale: Calculates the Charlson Comorbidity Index using the secondary diagnosis codes from the diagnosis dominant episode for each spell (see above).

Field name: P_SPELL_ADMIMETH

Condition: IF P_SPELL_ADMIMETH is NULL THEN P_SPELL_ADMIMETH = 99

Rationale: This condition sets all missing methods of admission to 'not known'.

Field name: SEX

Condition: IF SEX is NULL THEN SEX = 9

Rationale: This condition sets all missing sexes of patients to 'not specified'.

Categorisation

The following new variables are created and defined as follows:

Field name: DIAG_GROUP

Condition: DIAG_GROUP is assigned by

(a) mapping DIAG_01 to a Clinical Classifications Software (CCS) category (using the mapping available on the SHMI website at http://digital.nhs.uk/SHMI) and then

(b) mapping CCS categories to diagnosis groups using the mapping given in Table 3 in Appendix A (this mapping is also available on the SHMI website at http://digital.nhs.uk/SHMI) .

Rationale: Creates a field containing the diagnosis group, based on the primary diagnosis of the diagnosis dominant episode in the provider spell.

Field name: AGE_GROUP

Condition: AGE_GROUP is assigned by mapping STARTAGE to the categories given in Table 4 in Appendix B.

Rationale: Creates a field containing the age group of the patient.

Field name: CHARLSON_INDEX

Condition: CHARLSON_INDEX is assigned by mapping P_SPELL_CHARLSON to the categories given in Table 5 in Appendix B.

Rationale: Creates a field containing the Charlson Comorbidity Index group of the patient.

Field name: ADMIMETH

Condition: ADMIMETH is assigned by mapping P_SPELL_ADMIMETH to the categories given in Table 6 in Appendix B.

Rationale: Creates a field containing the admission method group of the patient.

Field name: GENDER

Condition: GENDER is assigned by mapping SEX to the categories given in Table 7 in Appendix B.

Rationale: Creates a field containing the sex group of the patient.

Field name: YEAR_INDEX

Condition: YEAR_INDEX is assigned using the P_SPELL_DISCHARGE field as follows:

$$\text{YEAR\_INDEX} = \begin{cases} 1 \text{ for the } 1^{st} \text{ most recent one-year period in the dataset} \\ 2 \text{ for the } 2^{nd} \text{ most recent one-year period in the dataset} \\ 3 \text{ for the } 3^{rd} \text{ most recent one-year period in the dataset} \end{cases}$$

Rationale: Creates a field identifying the one-year period that the patient was discharged in.

Risk modelling

A logistic regression model is constructed for each diagnosis group (DIAG_GROUP) *d* to calculate the probability of the event (as defined above) using the three-year dataset and the following case-mix adjustment variables. The models are fitted in the SAS software using the LOGISTIC procedure with the model-fitting options RIDGING = ABSOLUTE and NOCHECK.

- AGE_GROUP (categorical variable)
- CHARLSON_INDEX (categorical variable)
- ADMIMETH (categorical variable)
- GENDER (categorical variable)
- YEAR_INDEX (categorical variable)

CHARLSON_INDEX = 1 and YEAR_INDEX = 1 are used as the reference categories for these variables. The category with the highest number of records across the three-year dataset for each diagnosis group is used as the reference category for the AGE_GROUP, ADMIMETH and GENDER variables.

Records which belong to the 'unknown' category for the AGE_GROUP, ADMIMETH or GENDER variables are re-categorised to belong to the corresponding reference category for that variable and diagnosis group.

The following notation is used to describe the estimates of the logistic regression model parameters.

Let:

- α_d denote the intercept term for diagnosis group *d*
- $\beta_{d,\ age_i}$ denote the parameter estimate for diagnosis group *d* and AGE_GROUP *i*
- $\beta_{d,\ charlson_j}$ denote the parameter estimate for diagnosis group *d* and CHARLSON_INDEX *j*
- $\beta_{d,\ admimeth_k}$ denote the parameter estimate for diagnosis group *d* and ADMIMETH *k*
- $\beta_{d,\ gender_m}$ denote the parameter estimate for diagnosis group *d* and GENDER *m*
- $\beta_{d,\ year_n}$ denote the parameter estimate for diagnosis group *d* and YEAR_INDEX *n*

Note that the parameter estimates for the reference categories of each variable are zero by definition.

Indicator calculation

The SHMI is calculated using a one-year dataset, which is obtained by applying the following filter to the three-year dataset used in the construction of the logistic regression models:

Field name: YEAR_INDEX

Condition: YEAR_INDEX = 1

Rationale: Selects spells with a discharge date in the final year of the three-year dataset used in the construction of the logistic regression models.

For each record in the one-year dataset with DIAG_GROUP = *d*, AGE_GROUP = *i*, CHARLSON_INDEX = *j*, ADMIMETH = *k* and GENDER = *m*, the risk (probability) of an event is calculated as

$$\text{RISK}_{dijkm} = \frac{e^{(\alpha_d + \beta_{d,\,age_i} + \beta_{d,\,charlson_j} + \beta_{d,\,admimeth_k} + \beta_{d,\,gender_m} + \beta_{d,\,year_1})}}{1 + e^{(\alpha_d + \beta_{d,\,age_i} + \beta_{d,\,charlson_j} + \beta_{d,\,admimeth_k} + \beta_{d,\,gender_m} + \beta_{d,\,year_1})}}$$

For example, the risk of an event for a provider spell where DIAG_GROUP = 20, AGE_GROUP = 15, CHARLSON_INDEX = 1, ADMIMETH = 2 and GENDER = 3 is given by

$$\text{RISK}_{20,15,1,2,3} = \frac{e^{(\alpha_{20} + \beta_{20,\,age_{15}} + \beta_{20,\,charlson_1} + \beta_{20,\,admimeth_2} + \beta_{20,\,gender_3} + \beta_{20,\,year_1})}}{1 + e^{(\alpha_{20} + \beta_{20,\,age_{15}} + \beta_{20,\,charlson_1} + \beta_{20,\,admimeth_2} + \beta_{20,\,gender_3} + \beta_{20,\,year_1})}}$$

For each trust *p* the SHMI is defined as

$$\text{SHMI}_p = \frac{\text{OBSERVED}_p}{\text{EXPECTED}_p} = \frac{\sum_d \text{OBSERVED}_{pd}}{\sum_d \text{EXPECTED}_{pd}}$$

where

OBSERVED_{pd} = count of those provider spells where DIED = 1 for trust *p* and diagnosis group *d*,

OBSERVED_p = count of those provider spells where DIED = 1 for trust *p*

$\text{EXPECTED}_{pd} = \sum_i \sum_j \sum_k \sum_m \text{RISK}_{dijkm}$, the number of expected deaths for trust *p* and diagnosis group *d*, calculated as the sum of the calculated risks for trust *p* and diagnosis group *d* over all case-mix adjustment categories *i*, *j*, *k and m*,

$\text{EXPECTED}_p = \sum_d \sum_i \sum_j \sum_k \sum_m \text{RISK}_{dijkm}$, the number of expected deaths for trust *p*, calculated as the sum of the calculated risks for trust *p* over all diagnosis groups *d* and case-mix adjustment categories *i*, *j*, *k and m*,

SPELLS_{pd} = count of all provider spells for trust *p* and diagnosis group *d*,

SPELLS_p = count of all provider spells for trust *p*.

Upper and lower control limits

For the first publication of the SHMI in October 2011, two different sets of control limits were used to categorise trusts having a 'higher than expected', 'as expected' or 'lower than expected' SHMI (this categorisation is referred to as the SHMI banding):

- 95 per cent control limits adjusted for over-dispersion
- 99.8 per cent exact Poisson control limits

From the January 2012 SHMI publication onwards, only one SHMI banding has been published, corresponding to the control limits which are adjusted for over-dispersion. The exact Poisson control limits will continue to be made available as part of the published data for transparency and to support those who wish to make use of them, but without the corresponding banding.

Control limits adjusted for over-dispersion

The 95 per cent control limits are calculated using an additive random-effects model with a 10 per cent trim for over-dispersion[4,5]. The control limits are calculated on the log scale and then exponentiated. Under standard Poisson assumptions, the standard error of $\log_e \text{SHMI}_p$, denoted by s_p, is given by

$$s_p = \frac{1}{\sqrt{\text{EXPECTED}_p}}$$

and so the standardised Pearson residual (also known as the z-score) for $\log_e \text{SHMI}_p$ is defined as

$$Z_p = \frac{\log_e \text{SHMI}_p}{s_p} = \sqrt{\text{EXPECTED}_p} \times \log_e \text{SHMI}_p$$

The trusts are then ranked by Z_p and the top and bottom 10 per cent of observations are excluded from the calculation of τ^2 set out below.

Let N^* denote the number of trusts remaining after excluding the top and bottom 10 per cent of trusts according to the value of Z_p. The over-dispersion factor ϕ is calculated as

$$\phi = \frac{1}{N^*} \sum_{p=1}^{N^*} (Z_p)^2$$

Then the over-dispersion parameter τ^2 is given by

[4] Spiegelhalter D. J. Funnel plots for comparing institutional performance. Statistics in Medicine 2005; 24: 1185-1202.

[5] Spiegelhalter D. J. Handling over-dispersion of performance indicators. Quality & Safety in Health Care 2005; 14: 347-351.

$$\tau^2 = \max\left(0, \frac{N^*\phi - (N^* - 1)}{\sum_{p=1}^{N^*} EXPECTED_p - \left.\sum_{p=1}^{N^*} (EXPECTED_p)^2 \middle/ \sum_{p=1}^{N^*} EXPECTED_p\right.}\right)$$

The lower and upper control limits for $SHMI_p$ are then defined as

$$OD\_LL_p = e^{z_{0.025}\left(\sqrt{\frac{1}{EXPECTED_p} + \tau^2}\right)}$$

$$OD\_UL_p = e^{z_{0.975}\left(\sqrt{\frac{1}{EXPECTED_p} + \tau^2}\right)}$$

where z_α is the α quantile of the standard normal distribution.

Exact Poisson distribution

The upper and lower limits, PO_UL_p and PO_LL_p are derived from a 99.8 per cent control limit from an exact Poisson distribution[6] based on the target $EXPECTED_p$.

SHMI banding

The SHMI banding, $OD\_BANDING_p$, indicates whether a trust's SHMI is 'higher than expected' ($OD\_BANDING_p = 1$), 'as expected' ($OD\_BANDING_p = 2$) or 'lower than expected' ($OD\_BANDING_p = 3$). This is calculated as

$$OD\_BANDING_p = \begin{cases} 1 & \text{IF } SHMI_p > OD\_UL_p \\ 2 & \text{IF } OD\_LL_p \leq SHMI_p \leq OD\_UL_p \\ 3 & \text{IF } SHMI_p < OD\_LL_p \end{cases}$$

[6] Daly L. Simple SAS macros for the calculation of exact binomial and Poisson Confidence limits. Computers in Biology and Medicine 1992; 22: 351-361.

Presentation

Table 1 provides details of the csv output data from the indicator calculations at trust level.

Table 1: csv output table for SHMI data at trust level

Field name	Type	Length	Source / details
INDICATOR_CODE	CHAR	6	I00699
PROVIDER_CODE	CHAR	3	Trust code given by the PROCODET_MAPPED field
PROVIDER_NAME	CHAR	100	The name of the trust corresponding to the PROVIDER_CODE
SHMI_VALUE	FLOAT		$SHMI_p$, the SHMI value for trust *p*
SHMI_BANDING	INT		$OD\_BANDING_p$, the SHMI banding for trust *p*
SPELLS	INT		$SPELLS_p$, the number of provider spells for trust *p*
OBSERVED	INT		$OBSERVED_p$, the number of observed deaths for trust *p*
EXPECTED	FLOAT		$EXPECTED_p$, the number of expected deaths for trust *p*
PO_LL	FLOAT		PO_LL_p, the lower 99.8 per cent Poisson control limit for trust *p*
PO_UL	FLOAT		PO_UL_p, the upper 99.8 per cent Poisson control limit for trust *p*
OD_LL	FLOAT		OD_LL_p, the lower 95 per cent control limit adjusted for over-dispersion for trust *p*
OD_UL	FLOAT		OD_UL_p, the upper 95 per cent control limit adjusted for over-dispersion for trust *p*

Note: INDICATOR_CODE will be the same for all records in the dataset.

Table 2 provides details of the csv output data from the indicator calculations at trust and diagnosis group level.

Table 2: csv output table for SHMI data at trust and diagnosis group level

Field name	Type	Length	Source / details
INDICATOR_CODE	CHAR	6	I00699
DIAGNOSIS_GROUP	INT		Diagnosis group given by the DIAG_GROUP field
PROVIDER_CODE	CHAR	3	Trust code given by the PROCODET_MAPPED field
PROVIDER_NAME	CHAR	100	The name of the trust corresponding to the PROVIDER_CODE
SPELLS	INT		$SPELLS_{pd}$, the number of spells for trust *p* and diagnosis group *d*
OBSERVED	INT		$OBSERVED_{pd}$, the number of observed deaths for trust *p* and diagnosis group *d*
EXPECTED	FLOAT		$EXPECTED_{pd}$, the number of expected deaths for trust *p* and diagnosis group *d*

Note: INDICATOR_CODE will be the same for all records in the dataset.

Small number suppression

The following small number suppression is applied to the SHMI data at trust and diagnosis group level:

Primary suppression

Field name: $SPELLS_{pd}$

Condition: IF $SPELLS_{pd} < 6$ AND $SPELLS_{pd} > 0$ THEN $SPELLS_{pd} = *$

Field name: $OBSERVED_{pd}$

Condition: IF $OBSERVED_{pd} < 6$ AND $OBSERVED_{pd} > 0$ THEN $OBSERVED_{pd} = *$

Rationale: Where the number of finished provider spells for a particular trust *p* and diagnosis group *d* is greater than zero and less than 6, this value is replaced with the special character * for the purposes of disclosure control. Similarly, where the number of observed deaths for a particular trust *p* and diagnosis group *d* is greater than zero and less than 6, this value is replaced with the special character *.

Secondary suppression

Field name: $EXPECTED_{pd}$

Condition: IF $SPELLS_{pd} = *$ AND $EXPECTED_{pd} \geq 4$ AND $EXPECTED_{pd} \leq 5$

THEN $EXPECTED_{pd} = *$

Rationale: The expected number of deaths for a particular trust *p* and diagnosis group *d* is constrained to be less than or equal to the number of finished provider spells. In cases where the expected number of deaths for a particular trust *p* and diagnosis group *d* is greater than or equal to 4 and less than or equal to 5 and the corresponding number of finished provider spells has undergone primary suppression then the expected number of deaths is also suppressed. Otherwise it can be inferred that the suppressed number of finished provider spells is equal to 5.

Field name: $SPELLS_{pd}$

Condition: If the values of $SPELLS_{pd}$ that have been suppressed for a particular trust *p* are all equal to one then the smallest unsuppressed value of $SPELLS_{pd}$ for trust *p* is also replaced with the special character *. If there is more than one diagnosis group *d* with the same value of $SPELLS_{pd}$ then the value with the lowest diagnosis group number *d* is chosen for secondary suppression.

Field name: $OBSERVED_{pd}$

Condition: If the values of $OBSERVED_{pd}$ that have been suppressed for a particular trust *p* are all equal to one then the smallest unsuppressed value of $OBSERVED_{pd}$ for trust *p* is also replaced with the special character *. If there is more than one diagnosis group *d* with the same value of $OBSERVED_{pd}$ then the value with the lowest diagnosis group number *d* is chosen for secondary suppression.

Field name: $SPELLS_{pd}$

Condition: If the values of $SPELLS_{pd}$ that have been suppressed for a particular diagnosis group *d* are all equal to one then the smallest unsuppressed value of $SPELLS_{pd}$ for diagnosis group *d* is also replaced with the special character *. If there is more than one trust *p* with the same value of $SPELLS_{pd}$ then the first trust when the trust codes are arranged alphabetically is chosen for secondary suppression.

Field name: $OBSERVED_{pd}$

Condition: If the values of $OBSERVED_{pd}$ that have been suppressed for a particular diagnosis group *d* are all equal to one then the smallest unsuppressed value of $OBSERVED_{pd}$ for diagnosis group *d* is also replaced with the special character *. If there is more than one trust *p* with the same value of $OBSERVED_{pd}$ then the first trust when the trust codes are arranged alphabetically is chosen for secondary suppression.

Rationale: This secondary suppression is applied to prevent the calculation of suppressed values via differencing. For example, if the values of $SPELLS_{pd}$ that have been suppressed for a particular trust *p* are all equal to one then it is possible to infer that the suppressed values are equal to one by subtracting the unsuppressed values of $SPELLS_{pd}$ from $SPELLS_{p}$, the total number of finished provider spells for trust *p*, and comparing this value to the count of suppressed values of $SPELLS_{pd}$ for trust *p*.

Field name: $SPELLS_{pd}$

Condition: If only one value of $SPELLS_{pd}$ has been suppressed for a particular trust *p* then the smallest unsuppressed value of $SPELLS_{pd}$ for trust *p* is also replaced with the special character *. If there is more than one diagnosis group *d* with the same value of $SPELLS_{pd}$ then the value with the lowest diagnosis group number *d* is chosen for secondary suppression.

Field name: $OBSERVED_{pd}$

Condition: If only one value of $OBSERVED_{pd}$ has been suppressed for a particular trust *p* then the smallest unsuppressed value of $OBSERVED_{pd}$ for trust *p* is also replaced with the special character *. If there is more than one diagnosis group *d* with the same value of $OBSERVED_{pd}$ then the value with the lowest diagnosis group number *d* is chosen for secondary suppression.

Field name: $SPELLS_{pd}$

Condition: If only one value of $SPELLS_{pd}$ has been suppressed for a particular diagnosis group *d* then the smallest unsuppressed value of $SPELLS_{pd}$ for diagnosis group *d* is also replaced with the special character *. If there is more than one trust *p* with the same value of $SPELLS_{pd}$ then the first trust when the trust codes are arranged alphabetically is chosen for secondary suppression.

Field name: $OBSERVED_{pd}$

Condition: If only one value of $OBSERVED_{pd}$ has been suppressed for a particular diagnosis group *d* then the smallest unsuppressed value of $OBSERVED_{pd}$ for diagnosis group *d* is also replaced with the special character *. If there is more than one trust *p* with the same value of $OBSERVED_{pd}$ then the first trust when the trust codes are arranged alphabetically is chosen for secondary suppression.

The four secondary suppression rules listed above are repeated in order until there are no values satisfying the conditions listed.

Rationale: This secondary suppression is applied to prevent the calculation of suppressed values by differencing. For example, if only one value of $SPELLS_{pd}$ has been suppressed for a particular trust *p* then it is possible to calculate the suppressed value by subtracting the unsuppressed values of $SPELLS_{pd}$ from $SPELLS_{p}$, the total number of finished provider spells for trust *p*.

Queries and comments

We welcome queries and comments on the methodology set out in this specification. Please email them to enquiries@nhsdigital.nhs.uk (quoting 'SHMI' in the subject line of your email). All comments and suggestions will be considered as part of the continuous review process for this indicator.

Every effort has been made to ensure that this specification is definitive and clearly states the methodology which NHS Digital will follow to construct the indicator from the stated data sources. In the event that there is an error or omission in the written content of this specification, it will be updated under full version control and the new version republished on the NHS Digital website.

Acknowledgements

We would like to thank the School of Health and Related Research (ScHARR) at the University of Sheffield for working with us to ensure that we have interpreted their final report[7] appropriately.

We would like to thank Dr Paul Aylin from the Dr Foster Unit at Imperial College London for supplying the amended Agency for Healthcare Research and Quality (AHRQ) mapping from ICD-10 codes to CCS categories.

We would like to thank the members of the Technical Working Group of the National Review of the Hospital Standardised Mortality Ratio (HSMR) for their expert guidance.

We would also like to thank our colleagues at NHS Digital for their help and advice in reviewing this specification document.

[7] ScHARR's report 'An evaluation of the Summary Hospital Mortality Index' can be accessed from http://digital.nhs.uk/SHMI.

Appendix A: SHMI diagnosis groups

Table 3: SHMI diagnosis groups[8]

Diagnosis group	CCS category(s)	CCS label(s)
1	1	Tuberculosis
2	2, 249	Septicaemia (except in labour), Shock
3	3	Bacterial infection; unspecified site
4	4	Mycoses
5	5	HIV infection
6	6, 7, 8, 9, 10	Hepatitis, Viral infection, Other infections; including parasitic, Sexually transmitted infections (not HIV or hepatitis), Immunizations and screening for infectious disease
7	11	Cancer of head and neck
8	12	Cancer of oesophagus
9	13	Cancer of stomach
10	14	Cancer of colon
11	15	Cancer of rectum and anus
12	16	Cancer of liver and intrahepatic bile duct
13	17	Cancer of pancreas
14	18	Cancer of other GI organs; peritoneum
15	19	Cancer of bronchus; lung
16	20	Cancer; other respiratory and intrathoracic
17	22, 23	Melanomas of skin, Other non-epithelial cancer of skin
18	24	Cancer of breast
19	25	Cancer of uterus
20	26, 28	Cancer of cervix, Cancer of other female genital organs
21	27	Cancer of ovary
22	29, 30, 31	Cancer of prostate, Cancer of testis, Cancer of other male genital organs
23	32	Cancer of bladder
24	33, 34	Cancer of kidney and renal pelvis, Cancer of other urinary organs
25	35	Cancer of brain and nervous system
26	37, 38	Hodgkin's disease, Non-Hodgkin's lymphoma
27	39	Leukemias
28	40	Multiple myeloma
29	41, 45	Cancer; other and unspecified primary, Maintenance chemotherapy; radiotherapy
30	42	Secondary malignancies
31	21, 36, 43	Cancer of bone and connective tissue, Cancer of thyroid, Malignant neoplasm without specification of site

[8] The mapping from ICD-10 codes to CCS categories is produced by the Agency for Healthcare Research and Quality (AHRQ) and can be referenced at http://digital.nhs.uk/SHMI.

Diagnosis group	CCS category(s)	CCS label(s)
32	44, 167	Neoplasms of unspecified nature or uncertain behavior, Nonmalignant breast conditions
33	46, 47	Benign neoplasm of uterus, Other and unspecified benign neoplasm
34	49	Diabetes mellitus without complication
35	50	Diabetes mellitus with complications
36	48, 51	Thyroid disorders, Other endocrine disorders
37	55	Fluid and electrolyte disorders
38	52, 53, 58	Nutritional deficiencies, Disorders of lipid metabolism, Other nutritional; endocrine; and metabolic disorders
39	59, 60	Deficiency and other anemia, Acute posthemorrhagic anemia
40	63	Diseases of white blood cells
41	57, 61, 62, 64	Immunity disorders, Sickle cell anemia, Coagulation and hemorrhagic disorders, Other hematologic conditions
42	65, 68	Mental retardation, Senility and organic mental disorders
43	66, 67, 69, 72	Alcohol-related mental disorders, Substance-related mental disorders, Affective disorders, Anxiety; somatoform; dissociative; and personality disorders
44	71	Other psychoses
45	70, 73, 74, 75	Schizophrenia and related disorders, Preadult disorders, Other mental conditions, Personal history of mental disorder
46	76, 77, 78	Meningitis (except that caused by tuberculosis or sexually transmitted disease), Encephalitis (except that caused by tuberculosis or sexually transmitted disease), Other CNS infection and poliomyelitis
47	79	Parkinson's disease
48	80, 81	Multiple sclerosis, Other hereditary and degenerative nervous system conditions
49	82, 113	Paralysis, Late effects of cerebrovascular disease
50	83	Epilepsy; convulsions
51	85	Coma; stupor; and brain damage
52	84, 86, 87, 88, 89, 90, 91, 92, 93, 94	Headache; including migraine, Cataract, Retinal detachments; defects; vascular occlusion; and retinopathy, Glaucoma, Blindness and vision defects, Inflammation; infection of eye (except that caused by tuberculosis or sexually transmitted disease), Other eye disorders, Otitis media and related conditions, Conditions associated with dizziness or vertigo, Other ear and sense organ disorders
53	95	Other nervous system disorders
54	96	Heart valve disorders
55	97	Peri-; endo-; and myocarditis; cardiomyopathy (except that caused by tuberculosis or sexually transmitted disease)
56	98, 99	Essential hypertension, Hypertension with complications and secondary hypertension
57	100	Acute myocardial infarction
58	101	Coronary atherosclerosis and other heart disease
59	102	Nonspecific chest pain
60	103	Pulmonary heart disease
61	104	Other and ill-defined heart disease

Diagnosis group	CCS category(s)	CCS label(s)
62	105	Conduction disorders
63	106	Cardiac dysrhythmias
64	107	Cardiac arrest and ventricular fibrillation
65	108	Congestive heart failure; nonhypertensive
66	109	Acute cerebrovascular disease
67	110, 111, 112	Occlusion or stenosis of precerebral arteries, Other and ill-defined cerebrovascular disease, Transient cerebral ischemia
68	114	Peripheral and visceral atherosclerosis
69	115	Aortic; peripheral; and visceral artery aneurysms
70	116	Aortic and peripheral arterial embolism or thrombosis
71	117	Other circulatory disease
72	118, 119, 120, 121	Phlebitis; thrombophlebitis and thromboembolism, Varicose veins of lower extremity, Hemorrhoids, Other disease of veins and lymphatics
73	122	Pneumonia (except that caused by tuberculosis or sexually transmitted disease)
74	125	Acute bronchitis
75	127	Chronic obstructive pulmonary disease and bronchiectasis
76	128	Asthma
77	129	Aspiration pneumonitis; food/vomitus
78	130	Pleurisy; pneumothorax; pulmonary collapse
79	131	Respiratory failure; insufficiency; arrest (adult)
80	132	Lung disease due to external agents
81	56, 133	Cystic fibrosis, Other lower respiratory disease
82	123, 124, 126, 134, 136, 137	Influenza, Acute and chronic tonsillitis, Other upper respiratory infections, Other upper respiratory disease, Disorders of teeth and jaw, Diseases of mouth; excluding dental
83	135	Intestinal infection
84	138	Esophageal disorders
85	139	Gastroduodenal ulcer (except hemorrhage)
86	140, 141	Gastritis & duodenitis, Other disorders of stomach and duodenum
87	143	Abdominal hernia
88	144	Regional enteritis and ulcerative colitis
89	145	Intestinal obstruction without hernia
90	146, 147	Diverticulosis & diverticulitis, Anal and rectal conditions
91	142, 148	Appendicitis and other appendiceal conditions, Peritonitis and intestinal abscess
92	149	Biliary tract disease
93	150	Liver disease; alcohol-related
94	151	Other liver diseases
95	152	Pancreatic disorders (not diabetes)
96	153	Gastrointestinal hemorrhage
97	154	Noninfectious gastroenteritis
98	155	Other gastrointestinal disorders

Diagnosis group	CCS category(s)	CCS label(s)
99	157	Acute and unspecified renal failure
100	156, 158	Nephritis; nephrosis; renal sclerosis, Chronic renal failure
101	159	Urinary tract infections
102	160, 161, 162	Calculus of urinary tract, Other diseases of kidneys and ureters, Other diseases of bladder and urethra
103	163	Genitourinary symptoms and ill-defined conditions
104	164, 165, 166	Hyperplasia of prostate, Inflammatory conditions of male genital organs, Other male genital disorders
105	168, 169, 170, 171, 172, 173, 175	Inflammatory diseases of female pelvic organs, Endometriosis, Prolapse of female genital organs, Menstrual disorders, Ovarian cyst, Menopausal disorders, Other female genital disorders
106	174, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 218	Female infertility, Contraceptive & procreative management, Spontaneous abortion, Induced abortion, Prostabortion complications, Ectopic pregnancy, Other complications of pregnancy, Hemorrhage during pregnancy; abruption placenta; placenta previa, Hypertension complicating pregnancy; childbirth; or the puerperium, Early or threatened labor, Prolonged pregnancy, Diabetes or abnormal glucose tolerance complicating pregnancy; childbirth; or the puerperium, Malposition; malpresentation, Fetopelvic disproportion; obstruction, Previous C-section, Fetal distress and abnormal forces of labour, Polyhydramnios and other problems of amniotic cavity, Umbilical cord complication, OB-related trauma to perineum and vulva, Forceps delivery, Other complications of birth; puerperium affecting management of mother, Normal pregnancy and/or delivery, Livebirths
107	197	Skin and subcutaneous tissue infections
108	198, 199, 200	Other inflammatory condition of skin, Chronic ulcer of skin, Other skin disorders
109	201	Infective arthritis and osteomyelitis (except that caused by tuberculosis or sexually transmitted disease)
110	204	Other non-traumatic joint disorders
111	205, 206	Spondylosis; intervertebral disc disorders; other back problems, Osteoporosis
112	207	Pathological fracture
113	211	Other connective tissue disease
114	54, 202, 203, 208, 209, 210, 212	Gout and other crystal arthropathies, Rheumatoid arthritis and related disease, Osteoarthritis, Acquired foot deformities, Other acquired deformities, Systemic lupus erythematosus and connective tissue disorders, Other bone disease and musculoskeletal deformities
115	213	Cardiac & circulatory congenital anomalies
116	214, 215, 216, 217	Digestive congenital anomalies, Genitourinary congenital anomalies, Nervous system congenital anomalies, Other congenital anomalies
117	219	Short gestation; low birth weight; and fetal growth retardation
118	220, 221, 222, 223	Intrauterine hypoxia and birth asphyxia, Respiratory distress syndrome, Hemolytic jaundice and perinatal jaundice, Birth trauma
119	224	Other perinatal conditions
120	226	Fracture of neck of femur (hip)
121	229	Fracture of upper limb
122	230	Fracture of lower limb

Diagnosis group	CCS category(s)	CCS label(s)
123	225, 227, 228, 231, 232	Joint disorders and dislocations; trauma-related, Spinal cord injury, Skull and face fractures, Other fractures, Sprains and strains
124	233	Intracranial injury
125	234	Crushing injury or internal injury
126	235	Open wounds of head; neck; and trunk
127	236	Open wounds of extremities
128	237	Complication of device; implant; or graft
129	238	Complication of surgical procedures or medical care
130	239	Superficial injury; contusion
131	240	Burns
132	241, 242, 243	Poisoning by psychotropic agents, Poisoning by other medications and drugs, Poisoning by nonmedicinal substances
133	244	Other injuries & conditions due to external causes
134	245	Syncope
135	246	Fever of unknown origin
136	247, 248	Lymphadenitis, Gangrene
137	250	Nausea and vomiting
138	251	Abdominal pain
139	252	Malaise and fatigue
140	253, 254, 255, 256, 257, 258, 259, 260	Allergic reactions, Rehabilitation care; fitting of prostheses; and adjustment of devices, Administrative/social admission, Medical examination/evaluation, Other aftercare, Other screening for suspected conditions (not mental disorders or infectious disease), Residual codes; unclassified, E Codes: All (external causes of injury and poisoning)

Appendix B: Category levels used for case-mix adjustment

Table 4: Age groups used for case-mix adjustment

AGE_GROUP category number	STARTAGE values
1	7001 – 7007
2	1 – 4
3	5 – 9
4	10 – 14
5	15 – 19
6	20 – 24
7	25 – 29
8	30 – 34
9	35 – 39
10	40 – 44
11	45 – 49
12	50 – 54
13	55 – 59
14	60 – 64
15	65 – 69
16	70 – 74
17	75 – 79
18	80 – 84
19	85 – 89
20	90 – 120
21	Unknown

Table 5: Charlson comorbidity index groups used for case-mix adjustment

CHARLSON_INDEX category number	P_SPELL_CHARLSON values
1	0
2	1 – 5
3	> 5

Table 6: Admission method groups used for case-mix adjustment

ADMIMETH category number	Category description	P_SPELL_ADMIMETH values
1	Elective	11, 12, 13
2	Unknown	99
3	Acute	21, 22, 23, 24, 25, 2A, 2B, 2C, 2D, 28, 31, 32, 81, 82, 83, 84, 89, 98

Note: The release of version 6.2 of the Commissioning Data Sets (CDS) introduced an updated set of admission method codes to be used from 1st April 2013 onwards. Admission method code 25 was introduced as part of this update and admission method code 28 was replaced with codes 2A, 2B, 2C, 2D. Historic data with admission method code 28 will continue to be categorised as ‘Acute’ admissions.

Table 7: Gender groups used for case-mix adjustment

GENDER category number	Category description	SEX values
1	Male	1
2	Female	2
3	Unknown	0, 9

Appendix C: List of excluded trusts

Table 8: List of specialist trusts

Trust code	Trust name
RBS	Alder Hey Children's NHS Foundation Trust
RQ3	Birmingham Women's and Children's NHS Foundation Trust
RP4	Great Ormond Street Hospital for Children NHS Foundation Trust
RBQ	Liverpool Heart and Chest Hospital NHS Foundation Trust
REP	Liverpool Women's NHS Foundation Trust
RP6	Moorfields Eye Hospital NHS Foundation Trust
RGM	Papworth Hospital NHS Foundation Trust
RPC	Queen Victoria Hospital NHS Foundation Trust
RT3	Royal Brompton and Harefield NHS Foundation Trust
RAN	Royal National Orthopaedic Hospital NHS Trust
RCU	Sheffield Children's NHS Foundation Trust
RBV	The Christie NHS Foundation Trust
REN	The Clatterbridge Cancer Centre NHS Foundation Trust
RL1	The Robert Jones and Agnes Hunt Orthopaedic Hospital NHS Foundation Trust
RPY	The Royal Marsden NHS Foundation Trust
RRJ	The Royal Orthopaedic Hospital NHS Foundation Trust
RET	The Walton Centre NHS Foundation Trust

Table 9: List of mental health and community trusts

Trust code	Trust name
RTQ	2gether NHS Foundation Trust
RVN	Avon and Wiltshire Mental Health Partnership NHS Trust
RRP	Barnet, Enfield and Haringey Mental Health NHS Trust
RWX	Berkshire Healthcare NHS Foundation Trust
RXT	Birmingham and Solihull Mental Health NHS Foundation Trust
RYW	Birmingham Community Healthcare NHS Foundation Trust
RY2	Bridgewater Community Healthcare NHS Foundation Trust
RT1	Cambridgeshire and Peterborough NHS Foundation Trust
RYV	Cambridgeshire Community Services NHS Trust
RV3	Central and North West London NHS Foundation Trust
RYX	Central London Community Healthcare NHS Trust
RXA	Cheshire and Wirral Partnership NHS Foundation Trust
RJ8	Cornwall Partnership NHS Foundation Trust
RYG	Coventry and Warwickshire Partnership NHS Trust
RNN	Cumbria Partnership NHS Foundation Trust

Trust code	Trust name
RY8	Derbyshire Community Health Services NHS Foundation Trust
RXM	Derbyshire Healthcare NHS Foundation Trust
RWV	Devon Partnership NHS Trust
RDY	Dorset Healthcare University NHS Foundation Trust
RYK	Dudley and Walsall Mental Health Partnership NHS Trust
RWK	East London NHS Foundation Trust
R1L	Essex Partnership University NHS Foundation Trust
R1J	Gloucestershire Care Services NHS Trust
RXV	Greater Manchester Mental Health NHS Foundation Trust
RY4	Hertfordshire Community NHS Trust
RWR	Hertfordshire Partnership University NHS Foundation Trust
RY9	Hounslow and Richmond Community Healthcare NHS Trust
RV9	Humber NHS Foundation Trust
RXY	Kent and Medway NHS And Social Care Partnership Trust
RYY	Kent Community Health NHS Foundation Trust
RW5	Lancashire Care NHS Foundation Trust
RGD	Leeds and York Partnership NHS Foundation Trust
RY6	Leeds Community Healthcare NHS Trust
RT5	Leicestershire Partnership NHS Trust
RY5	Lincolnshire Community Health Services NHS Trust
RP7	Lincolnshire Partnership NHS Foundation Trust
RY1	Liverpool Community Health NHS Trust
RW4	Mersey Care NHS Foundation Trust
RMY	Norfolk and Suffolk NHS Foundation Trust
RY3	Norfolk Community Health and Care NHS Trust
RAT	North East London NHS Foundation Trust
RLY	North Staffordshire Combined Healthcare NHS Trust
RTV	North West Boroughs Healthcare NHS Foundation Trust
RP1	Northamptonshire Healthcare NHS Foundation Trust
RX4	Northumberland, Tyne and Wear NHS Foundation Trust
RHA	Nottinghamshire Healthcare NHS Foundation Trust
RNU	Oxford Health NHS Foundation Trust
RPG	Oxleas NHS Foundation Trust
RT2	Pennine Care NHS Foundation Trust
RXE	Rotherham, Doncaster and South Humber NHS Foundation Trust
R1D	Shropshire Community Health NHS Trust
R1C	Solent NHS Trust
RH5	Somerset Partnership NHS Foundation Trust
RV5	South London and Maudsley NHS Foundation Trust
RRE	South Staffordshire and Shropshire Healthcare NHS Foundation Trust
RQY	South West London and St George's Mental Health NHS Trust

Trust code	Trust name
RXG	South West Yorkshire Partnership NHS Foundation Trust
RW1	Southern Health NHS Foundation Trust
R1E	Staffordshire and Stoke on Trent Partnership NHS Trust
RXX	Surrey and Borders Partnership NHS Foundation Trust
RDR	Sussex Community NHS Foundation Trust
RX2	Sussex Partnership NHS Foundation Trust
RNK	Tavistock and Portman NHS Foundation Trust
RX3	Tees, Esk and Wear Valleys NHS Foundation Trust
RKL	West London Mental Health NHS Trust
RY7	Wirral Community NHS Foundation Trust
R1A	Worcestershire Health and Care NHS Trust

Appendix D: Charlson Comorbidity Index calculation

Introduction

The Charlson Comorbidity Index was developed in 1987 based on one-year mortality data from internal medicine patients admitted to a single New York Hospital and was initially validated within a cohort of breast cancer patients[9]. The original index included 17 medical conditions with weights ranging from one to six.

A revision to the weights used in the Charlson Comorbidity Index was presented by Dr Foster Intelligence (DFI) in their Hospital Standardised Mortality Ratio (HSMR) methodology documentation[10]. The updated weights reflect changes in mortality over time (e.g. HIV had the highest weight in the original index but its mortality has fallen greatly, particularly in hospitalised patients) and were calibrated using English data due to differences in coding practice and patient characteristics between England and the USA.

The methodology used to derive the Charlson Comorbidity Index in the calculation of the SHMI is based on information provided by the Dr Foster Unit at Imperial College London (with some amendments – see below) and uses the updated weights described above. Table 10 contains a list of conditions included in the Charlson Comorbidity Index, the ICD-10 codes used to identify these conditions and the updated weights for each condition.

If the calculated Charlson Comorbidity Index has a negative value then it is assigned a value of zero. If cancer and metastatic cancer are both present then the weight for cancer is ignored.

Methodology

The Charlson Comobidity Index for each provider spell is derived using the secondary diagnosis fields (DIAG_2 to DIAG_20 inclusive) from the same episode in the spell that is used to derive the SHMI diagnosis group (see 'Additional data processing' section above). The Charlson Comorbidity Index has the field name P_SPELL_CHARLSON and is calculated for each provider spell using the following methodology.

Let $WEIGHT_i$ denote the updated weight for condition *i* (see Table 10). The following new variables are created and defined as follows:

Field name: $P\_SPELL\_WEIGHT_i$

Condition: For each $i = 1, 2, \ldots, 17$ IF one or more of the ICD-10 codes for condition *i* (see Table 10) is present in any of the fields DIAG_2 to DIAG_20 inclusive THEN $P\_SPELL\_WEIGHT_i = WEIGHT_i$

ELSE $P\_SPELL\_WEIGHT_i = 0$

[9] Charlson M. E., Pompei P., Ales K. L., MacKenzie C. R. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. Journal of Chronic Diseases 1987; 40: 373-383.

[10] Details of the Charlson methodology used can be referenced at http://www.drfosterhealth.co.uk/hospital-guide/methodology/.

Rationale: Assigns the weight for the condition if it is coded as a secondary diagnosis in the provider spell. If multiple codes are present for the same condition then the weight is only counted once.

Field name: $P\_SPELL\_WEIGHT_{11}$

Condition: IF $P\_SPELL\_WEIGHT_{11} > 0$ AND $P\_SPELL\_WEIGHT_{15} > 0$ THEN $P\_SPELL\_WEIGHT_{11} = 0$

Rationale: If cancer and metastatic cancer are both present then the weight for cancer is ignored.

The following new variable is created and defined as follows:

Field name: P_SPELL_CHARLSON

Condition: $P\_SPELL\_CHARLSON = \sum_{i=1}^{17} P\_SPELL\_WEIGHT_i$

Rationale: Calculates the Charlson Comorbidity Index by summing the weights for each condition that is coded as a secondary diagnosis in the provider spell.

Field name: P_SPELL_CHARLSON

Condition: IF $P\_SPELL\_CHARLSON < 0$ THEN $P\_SPELL\_CHARLSON = 0$

Rationale: If the calculated Charlson Comorbidity Index has a negative value then it is assigned a value of zero.

Table 10: Charlson Comorbidity Index conditions, ICD-10 codes and updated weights

Condition number	Condition name	ICD-10 codes	Updated weight
1	Acute myocardial infarction	I21, I22, I23, I252, I258	5
2	Cerebral vascular accident	G450, G451, G452, G454, G458, G459, G46, I60-I69	11
3	Congestive heart failure	I50	13
4	Connective tissue disorder	M05, M060, M063, M069, M32, M332, M34, M353	4
5	Dementia	F00, F01, F02, F03, F051	14
6	Diabetes	E101, E105, E106, E108, E109, E111, E115, E116, E118, E119, E131, E135, E136, E138, E139, E141, E145, E146, E148, E149	3
7	Liver disease	K702, K703, K717, K73, K74	8
8	Peptic ulcer	K25, K26, K27, K28	9
9	Peripheral vascular disease	I71, I739, I790, R02, Z958, Z959	6
10	Pulmonary disease	J40-J47, J60-J67	4
11	Cancer	C00-C76, C81-C97	8
12	Diabetes complications	E102, E103, E104, E107, E112, E113, E114, E117, E132, E133, E134, E137, E142, E143, E144, E147	-1
13	Paraplegia	G041, G81, G820, G821, G822	1
14	Renal disease	I12, I13, N01, N03, N052-N056, N072-N074, N18, N19, N25	10
15	Metastatic cancer	C77, C78, C79, C80	14
16	Severe liver disease	K721, K729, K766, K767	18
17	HIV	B20, B21, B22, B23, B24, O987	2