

## **Appendix A: Displacement by ICD code**

This document is based on an appendix (Appendix 1: Clarification on aspects of the threshold project proposed to be used within VBP, Marta Soares and Karl Claxton, University of York. July 2013) to a Briefing paper (Department of health proposals for including burden of illness into value based pricing: a description and critique, Nice Decision Support unit, Alec Miners, John Cairns and Allan Wailoo, July 2013), that was presented to the NICE Methods Working Party on VBP, Meeting 2, 19<sup>th</sup> July 2013.

## **Displacement by ICD code – accounting for the burden of disease associated with displaced QALYs and displaced wider social benefits**

Research funded by the MRC and NIHR on methods to estimate the NICE cost effectiveness threshold provides estimates of the amount and type of health that is likely to be displaced as a consequence of additional NHS costs (see <http://www.york.ac.uk/che/research/teehta/thresholds>).

The Department of Health (UK), in the context of the proposals for value based pricing, requested an evaluation of whether the evidence and estimates from this research can be used to adjust the threshold in a way that reflects the implications of incorporating considerations of burden of illness and wider social benefits in the assessment of value. We provided estimates based on this research that can be used assess the burden of illness associated with displaced QALY effects and (in combination with Appendix B: methods to estimate wider social benefits) the wider social Benefits that are also likely to be displaced. It provides the inputs required to adjust the 'basic' QALY threshold. The set of estimates are reported in the accompanying Excel file (Displacement by ICD code.xlsx).

A brief description of the estimates provided.

### *Brief description of the most up-to-date estimate of the cost-effectiveness threshold*

The research developed methods to estimate the NICE cost-effectiveness threshold, making use of routinely available data. These included programme budgeting data for the English NHS (which allocates the entire volume of health care expenditure to broad programme budget categories according to primary diagnosis) which is available for each primary care trust (PCT). This and ONS data on death by ICD code also available at PCT was used to estimate the relationship between changes in overall NHS expenditure and changes in mortality (see Chapter 3 and Appendix B of CHE RP81). This measure of health effect was extended to life years, then to QALYs, by estimating the quality of life (QoL) associated with additional years of life, and then to the impact on quality of life (see Chapter 4 and Appendix C of CHE RP 81). To do so, there was the need to describe expected burden within each programme budgeting category (PBC) based on estimates which were available at 3 digit ICD-10 code (a lower level of disaggregation than PBC). Four aspects of this work can be used within the type of VBP assessment being considered by NICE - a brief description of each is provided below.

### *Data sources used within the threshold work to get measures of QALY burden and assumptions required for displaced QALYs*

**Displaced QALY:** The estimates include the **proportion of a notional displaced QALY (by each ICD code)**. This was obtained directly from the threshold research, as estimates of the cost per QALY threshold also provide information on the PBCs where more health is expected to be displaced, i.e. if one unit of health is to be displaced within the whole of the NHS, how much health is expected to be

lost within each PBC. These PBC level proportionate effects were allocated to the ICD codes contributing to each PBC (see below and Chapter 4 of CHE RP 81).

The threshold work evaluated the effect on health of changes in the overall NHS expenditure. The estimated outcome elasticities represent the proportionate effect on mortality in one year due to a proportionate change in expenditure. Note that such analysis assume deaths averted by expenditure in one year return the individual to the mortality risk of the general population, i.e., the years of life gained associated with each death averted are based on what would have been their life expectancy taking account of their of age and gender (using life tables for the general population).

The proportionate effect on health of changes in expenditure estimated in the econometrics is applied to measures of QALY burden (obtained from external data for ICDs, 3-digit level, that compose the PBCs). Estimates of mortality and life year effects are thus used as 'surrogate outcomes' for a more complete measure of the health effects of a change in expenditure. In those PBCs where mortality effects could not be estimated, the proportional effect of changes in expenditure on QALY burden of disease is assumed to be the same as the overall proportional effect on the life year burden of disease across those PBCs where mortality effects could be estimated (see Chapter 5 of CHE RP 81 for a summary and discussion of assumptions required).

The health effects that can be estimated based on observations of expenditure available at PBC level must be allocated in some way to the component ICD codes. The ICD specific QALY effects are then summed across all the contributing ICD codes. The distribution of health effects from PBC level to ICD level is based on weighing the effects by the proportion of the total PBC population within each contributing ICD code.

#### Estimates of burden of disease

The excel spread sheet (Displacement by ICD code.elsx) reports **per patient burden of disease in a year** (imputed by mean of bin in PBC when missing) and **per patient total burden of disease**, i.e burden of disease over the whole of disease duration. These were obtained from estimates of total QALY burden of disease for the population with disease in a particular year. This includes: i) the quality adjusted years of life lost due to all the disease related mortality that could occur in this population over their remaining duration of disease and ii) the reduction in quality of life while alive also for their remaining disease duration.

The conservative assumption that changes in expenditure will only have health effects in one year for the population with disease in that year was adopted throughout (see Chapter 5 of CHE RP 81). Therefore, we did not require a measure of total burden, but a measure of the QALY burden of disease during one year for the population with disease (prevalent and incident) in that year.

Some of the inputs required to derive such a measure were based on the WHO Global Burden of Disease (GBD) study, updated in 2008 using 2004 data (see Addendum 1 in Appendix C of CHE RP81 for more details) that provide a range of summary health indicators for the UK. GBD classifies diseases by U-codes, which are groups of three digit ICD-10 codes (see Addendum 1 in Appendix C for details of how U-codes map to ICD-10 codes).

#### Age and gender distribution of the at risk population and number of patients in ICD

The proportion of patients in **age and gender bins** has been requested by the DH and is presented in the spread sheet. This was derived from the information on the prevalence of sequelae from the WHO GBD study. In the GBD study, each U-code is defined using one or more disease sequelae (Addendum C1 to Appendix C). An individual may be represented in multiple sequela in a single U-code, thus to avoid double counting in the event of multiple sequela in a given U-code our analysis uses prevalence estimates based on the sequela with the largest prevalent population. The age and gender distributions for each U-code are based on those reported within GBD.

The **number of patients in an ICD** was calculated from the at risk population in one year, adjusted to represent the population in England. The at risk population uses the information on prevalence from GBD described above.

#### Norm QoL scores and disease decrements:

In the spread sheet we present **starting QoL scores**; these have been derived from evidence on disease decrements associated with disease, which were applied to age and gender specific normal QoL scores.

There is good evidence that, on average, the general population is not in full health, i.e. the quality of life score associated with the health states experienced by the general population are less than 1, decline with age and differ by gender. These quality of life 'norms' for the general population by age and gender were based on an analysis of data from the Health Survey for England (see Addendum C1 for a description on HSE data).

The expected quality of life decrement associated with each ICD code (i.e. for diseased patients) was estimated using existing datasets. The Health Outcome Data Repository (HODaR) provides over 30,000 observations of EQ-5D measures of quality of life by ICD code and the age and gender of the patients in the sample (see Addendum C1). Although this is a rich UK data set, there were a limited number of observations for some of the less common ICD codes. For this reason HODaR was supplemented with information from the Medical Expenditure Panel Survey (MEPS) which also provides EQ-5D by ICD and reports the average age of respondents (see Addendum C1). These data provided a means of estimating the quality of life associated with each ICD code at the average age of respondents in the pooled sample (datasets were pooled considering the number of patients from each contributing to estimates, i.e. a weighted average).

The average quality of life scores across the ICDs which contribute to each U-code and the average age and gender of respondents from HODaR and MEPS were used to calculate a disease decrement, based on quality of life norms from the general population. These disease decrements are applied to the age and gender distribution of each U-code. Note that this decrement is fixed (subtractive), rather than proportionate (see Chapter 4 of CHE RP 81).

*Additional assumptions required if weight QALY effects according to burden*

The estimates of the proportion of a notional QALY displaced in each ICD (can be interpreted as the probability of displacing one QALY) can be used to estimate the burden of disease associated with the average of the displaced QALY effects. If a set or mechanism of weighting QALY for any measure of burden (absolute or proportionate) is chosen then it is possible to either estimate an overall weighted QALY threshold or (with information about the weights attached to QALYs gained) specify a 'multiplier' that can be applied to the basic QALY threshold.

If length or quality effects do not need to be distinguished, then no further assumptions are required other than those used to estimate the proportion of displaced QALYs across ICDs and burden estimates. If length and 'pure' quality effects need to be distinguished, a further assumption is required on how a proportionate effect on total burden affects each component, i.e., length and quality effects (this assumption was not required in threshold research). To calculate **proportion of the QALY gain due to life extension**, we have assumed that these components are affected proportionally to their contribution to overall burden (thus, for example, any effects on diseases that mainly compromise length of life will mainly occur over this component of burden).

*When WSB are function of length or quality of life effects as well as age, gender and ICD code*

The estimates of the proportion of a notional QALY displaced in each ICD can also be used to estimate the wider social benefits associated with the average of the displaced QALY effects (e.g., if changes in wider social benefits are a function of health effects, quality of life age, gender and ICD code). If a some QALY value of wider social benefits (£) is specified (i.e., a consumption value of health) then it is possible to either estimate an overall QALY threshold (weighted for WSB effects) or (with information about the WSBs associated with the QALYs gained) specify a 'multiplier' that can be applied to the basic QALY threshold.

If estimates of WASBs depends on burden of illness, QoL score of diseased (starting QoL score), age, gender and ICD code (3-digit or any higher level of aggregation), then no further assumptions are required other than those used to generate proportion of displaced QALYs across ICDs, i.e. burden of illness, age and gender (see Appendix B: methods to estimate wider social benefits).

However, if WSB depends on QoL score 'after displacement' (**finishing QoL score**), further assumptions are required. Firstly, for each QALY displaced in an ICD, QALYs associated with pure

QALY effects need to be isolated from length of life QALY effects. Taking the total QALYs associated with pure QoL effects, and by assuming a constant effect on QoL over time, the duration of effect can be used to evaluate the QoL score 'after displacement' (finishing QoL).

*Additional assumptions that might be required if these estimates are used as defaults on the benefits rather than displaced side.*

As well as estimating the burden of disease and WSBs associated with displaced QALYs the estimates could provide some evidence about the likely WSB and burden of disease for the QALYs gained due to the use of a specific technology in a particular ICD code, i.e., they could be used as default values for burden and WSB for the assessment of benefits. Specifically, information on the age and gender distribution could be used to describe the eligible population in an appraisal. Also, information available on expected QoL decrement due to disease could also be relevant.

It would be consistent to use these estimates for both assessment of displacement and an assessment of the benefits of a specific technology in a particular disease area. However, these estimates are unlikely to be regarded as plausible or represent the best evidence for the appraisals of particular technologies used for specific indications for the following reasons:

- The 3 -digit ICD codes, for which we have evidence about the 'at risk' population from GBD (prevalent and incident) are a much broader population (so may be unrepresentative) of the specific population of interest in a particular appraisal (the estimates represent averages over the whole ICD code).
- The information from GBD relates to the year 2004, and may be judged unrepresentative if incidence, duration of disease or mortality changed over time (possible, for example, if NHS care changed). The same argument can be applied to evidence on QoL score.
- To apply the information available from HoDAR and MEPS on QoL decrements one would need to assume QoL to be constant over the duration of disease. However, more detailed evidence about how QoL evolves is commonly available within the appraisals.
- The evidence on age and gender distribution of the at risk population in GBD relates to a point in time (one particular year) and reflects the joint effect of incidence, duration of disease and mortality under NHS care up to that point in time. GBD evidence does not tell us directly how the age and gender distributions of a cohort of patients changes over time by mortality, which may be important to evaluate WSB and burden weights in particular and more narrowly defined target populations.
- Also, GBD (or HoDAR and MEPS) cannot inform of the effect of a 'new' treatment on the age and gender distribution over time.