

A Guide To Health Economics For Those Working in Public Health

A concise desktop handbook



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1. Purpose of this concise desktop handbook

This handbook, written by health economists at Bangor University is intended to provide an introduction and define key economic terms, so that those without health economics expertise can better understand and appraise economic evidence. In particular, we are aware that you may need to find and interpret economic evidence; this handbook is a quick reference guide to key methods and terminology.

Bold key terms in the handbook are described in detail in the “Definitions” section below.

2. Definitions of key health economics terminology

List compiled from Berger et al., (2003); Pass et al., (1993) and the BMJ (2012).

Allocative efficiency – allocation of resources between types of health services in a way that results in maximum gain to all parties.

Cost-benefit analysis – compares the costs and benefits of an intervention, procedure or programme in monetary terms.

Cost-consequence analysis – describes the costs and outcomes of an intervention in a disaggregated form.

Cost-effectiveness acceptability curve – the curve illustrates the probability of ‘intervention A’ being more cost-effective than ‘intervention B’ given a range of values that a decision-maker may attach to an additional quality adjusted life year to reflect uncertainty in the estimates.

Cost-effectiveness analysis – costs are compared with a treatment’s common therapeutic goal, expressed in terms of one main outcome measured in natural units (e.g., improvement in blood pressure or cholesterol level).

Cost-effectiveness plane – a graphic representation of the Incremental cost-effectiveness ratio. See Incremental cost-effectiveness ratio definition below.

Cost-minimisation analysis – a method of evaluation utilised when the intervention, procedures or programmes are expected to have exactly the same outcome. The analysis then identifies the less costly option.

Cost-utility analysis – a method of evaluation that measures health benefits in preference-based non-monetary units such as Quality Adjusted Life Years (QALYs) or Disability Adjusted Life Years (DALYs).

Decision analysis – a structured way of thinking about how an action taken in a current decision would lead to a result, constructed as a logical model describing the relationships between inputs and results.

Decision analytic modelling – a modelling technique used to estimate the costs, outcomes and cost-effectiveness of different interventions and programmes in health care and public health.

Disability Adjusted Life Years (DALYs) – used to generate health related measures of utility for those living with a disability measured in terms of time lost due to premature death (mortality) and time lived with a disability (morbidity).

Discounting – a method of incorporating positive time preference (higher value given to costs and benefits that occur now, compared to those occurring in the future) into the evaluation when the costs and benefits do not occur in the same time period.

Discount rate – the rate chosen to express the strength of preference over timing of costs and benefits. Since 2003 the Treasury recommends a 3.5% discount rate. To check the discount rate consult the HM Treasury Green Book.

Direct medical costs – associated with the service/programme under consideration. These are organisational and operational costs borne by the health sector (e.g., health professionals' time, supplies, equipment, power etc).

Direct nonmedical costs – incurred by patient/families in the course of treatment (e.g., transport costs, parking).

Health capital - defined by Grossman (1972) as the present value of a person's lifetime health.

Herd immunity – a form of indirect protection from infectious diseases that occurs when a large percentage of the population becomes immune to an infection and consequently provides a measure of protection to those who are not immune.

Incremental cost – the difference between the costs of one intervention and the costs of its comparator/alternative.

Incremental cost-effectiveness ratio (ICER) – obtained by dividing the difference between the costs of the two interventions by the difference in the outcomes, i.e. the extra cost per extra unit of outcome.

Indirect costs – losses in production due to absence from work. Indirect costs can also fall on people other than the person receiving treatment, for example, other members of the family may need to take time off work to take a family member to the local GP clinic or A&E department.

Intangible costs – non-physical costs to the patient and their families from ill health such as pain and anxiety.

Marginal costs – the additional cost increases or savings arising as a consequence of small output changes within a health care programme. Important to consider as part of resource allocation alongside wider considerations such as capacity, staffing and equipment.

Opportunity cost – the value of benefits foregone by not using resources in their next best alternative use.

Perspective – the point of view from which an analysis is conducted (e.g., public sector or societal).

Positive externalities – a benefit that is enjoyed by a third-party as a result of an economic transaction (e.g., herd immunity through vaccination programmes).

Quality Adjusted Life Years (QALYs) – calculated by aggregating the number of years gained from a drug or health care intervention, weighted by a proportion that represents the relative value attached to a given health state of quality of life in those years.

Sensitivity analysis – analysis that tests the robustness of an economic model by examining the changes in results when adjusting key parameters.

Social Return on Investment (SROI) – analysis that results in a ratio of benefits to costs, estimating the value created for every £1 invested.

Technical efficiency – the use of health care resources in such a way that maximises output from given resources or minimises resource use for a given level of output.

3. What is health economics?

Health economics is a sub-discipline of economics, which is the study of how society uses scarce resources to meet its wants and needs.

Health economics views health and health care as an economic good (as in goods and services) and is predominately concerned with how society uses scarce health care resources to meet these wants and needs.

There are three basic economic questions:

1. What goods and services to produce?
2. How can we produce goods and services?
3. How should we distribute goods and services between members of society?

Economic principles are applied to health and health care because;

- Resources are finite (e.g. there are only so many doctors and local community services such as GP surgeries and pharmacies that are open generally during business hours)
- In contrast, demand for health and health care is infinite
- To create a balance between finite resources and infinite wants and needs, choices are necessary and consequently costs and benefits must be compared
- Prioritisation is also required for investment and disinvestment (e.g. do you utilise your scarce resources to implement interventions to increase physical exercise or reduce tobacco consumption?)

Public health and health care is different to how other goods and services operate in a market because:

- Individual ill-health is unpredictable (individuals are not able to control when they will fall ill, how long it will take them to recover or how serious the illness is)
- There are indirect consequences to public health and health care, these include **positive externalities** (whereby a benefit is enjoyed by a third-party as a result of an economic transaction) such as **herd immunity** through vaccination programmes
- Consumers have limited knowledge. They rely upon providers (e.g. doctors, nurses, social workers, etc) to provide health care,

medicines, information, interventions and referrals to specialist services if required

- Doctors, nurses, social workers, etc act as “gatekeepers”, deciding who requires and receives treatment, and what type of treatment they receive
- There are educational and financial barriers to entry into the medical profession, thus maintaining limited consumer knowledge in the general population
- The demand for health care is a derived demand, created from the demand for health. Consumers typically want more **health capital** and in order to achieve this, individuals allocate resources in order to both consume and produce health (e.g. by engaging in health promotion activities such as lifestyle changes)

4. Purpose of economic evaluation

Health economics is interested in the interplay between costs and outcomes/benefits. Economic evaluation techniques provide a framework for identifying the costs and benefits of different health interventions. We conduct economic evaluations, as we need to consider scarcity of resources and **opportunity costs** - the value of benefits foregone by not using resources in their next best alternative use.

5. Methods of economic evaluation

There are five main methods of economic evaluation:

- **Cost-Minimisation Analysis (CMA)**
- **Cost-Effectiveness Analysis (CEA)**
- **Cost-Utility Analysis (CUA)**
- **Cost-Benefit Analysis (CBA)**
- **Cost-Consequence Analysis (CCA)**

There are also alternative techniques which include the consideration of costs and outcomes, but generally the five methods listed above are most commonly used. A range of methods are listed in Table 1.

Method	Full or Partial Economic Evaluation
Cost-Minimisation Analysis (CMA)	Full Economic Evaluations They compare alternative services/procedures/interventions in terms of both their costs and outcomes/effects/benefits. It is worth noting that each method measures outcomes differently
Cost-Effectiveness Analysis (CEA)	
Cost-Utility Analysis (CUA)	
Cost-Benefit Analysis (CBA)	
Cost-Consequence Analysis (CCA)	Partial Economic Evaluations They focus solely on costs or resources used
Cost-analyses	
Cost-description studies	
Cost-outcome descriptions	

Table 1. Methods used in health economics categorised by whether or not they would be considered full or partial economic evaluations.

Each method of economic evaluation is described in turn below, with limitations highlighted and an example paper listed demonstrating the method.

5.1 Cost-minimisation analysis (CMA)

Cost-minimisation analysis is a form of economic evaluation used when an intervention or service and its alternative (e.g. usual care or current practice) achieve outcomes that are the same (Brazier et al., 2007; Robinson, 1993a). Under these circumstances, cost-minimisation analysis aims to identify the least costly option (Brazier et al., 2007, Robinson, 1993a).

Limitations of cost-minimisation analysis

In practice, it is difficult to find interventions or services with the same outcomes, as there is often uncertainty around the outcome measure of choice (Brazier et al., 2007). The use of cost-minimisation analysis highlights questions about the gathering of cost data such as, what **perspective** should be chosen. For example, a public sector perspective would include costs accrued by primary care and NHS secondary care, personal social services and local government. A societal perspective would include costs such as provider costs of equipment and staff,

individual costs of lost wages, travel and costs to relatives such as childcare costs or transport. Other questions to consider include should costs reflect opportunity costs and should one take account of the effects of inflation and **discounting**. Discounting is a method of incorporating positive time preference (higher value given to costs and benefits that occur now, compared to those occurring in the future) into the evaluation when the costs and benefits do not occur at the same time period.

Example of cost-minimisation analysis in practice

Jones J, Wilson A, Parker H, Wynn A, Jagger C, Spiers N, Parker G. (1999). Economic evaluation of hospital at home versus hospital care: cost minimisation analysis of data from randomised controlled trial. *BMJ*, 319 (7224), 1547–1550.

5.2 Cost-effectiveness analysis (CEA)

Cost-effectiveness analysis compares the costs of alternative procedures, services or interventions with a treatment's common therapeutic goal, expressed in terms of one main outcome measured in natural units (e.g., improvement in blood pressure or cholesterol level) (Berger et al., 2003).

An **incremental cost-effectiveness ratio (ICER)** is used in this method. An ICER calculates the difference in costs between one intervention and an alternative, divided by the difference in outcomes (OHE, 2008). Effectiveness data is typically collected from economic evaluations alongside clinical trials or randomised controlled trials (Robinson, 1993b).

An ICER can also be illustrated graphically using a diagram named the **cost-effectiveness plane**, shown in Figure 1.

The horizontal axis represents the difference in effect between the intervention (I) and the alternative (A). The vertical axis represents the difference in cost between the intervention and the alternative.

If point I falls in the North East (NE) quadrant, the intervention is more effective and more costly than the alternative (point A).

If point I falls in the South West (SW) quadrant, the intervention is less effective and less costly than the alternative (point A).

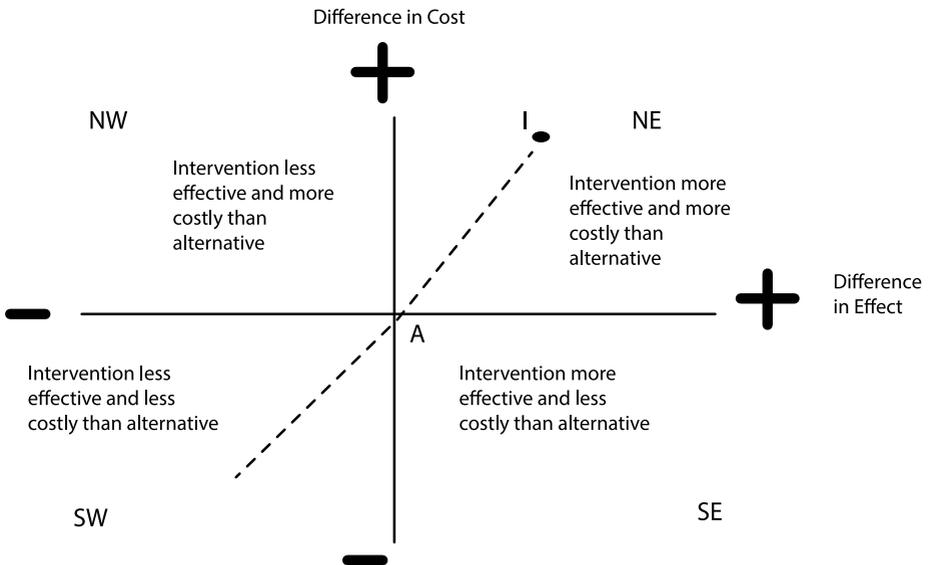
If point I falls in the South East (SE) quadrant, the intervention is more effective and less costly than the alternative (point A). In other words it *dominates*, (i.e. prevails over) the alternative and would be considered cost-effective.

If point I is in the North West (NW) quadrant, the intervention is less effective and more costly than the alternative (point A).

If point A falls in either the NE and SW quadrants, the choice of whether to implement the intervention or the alternative depends upon the maximum cost-effectiveness ratio one is willing to accept. The slope of the line IA gives the cost-effectiveness ratio.

Figure 1. Example cost-effectiveness plane adapted from Black (1990).

An amended version of the cost-effectiveness plane diagram from Black, W. C. (1990)”. The CE Plane: A Graphic Representation of Cost-Effectiveness. Medical Decision Making Vol. 10 (3) pp. 212-214. Copyright © 1990 by Society for Medical Decision Making. Reprinted by permission of SAGE Publications, Inc



Cost-Effectiveness Acceptability Curves (CEACs)

CEACs illustrate the uncertainty surrounding the estimate of cost-effectiveness. A CEAC (Figure 2) shows the probability that an intervention is cost-effective compared with the alternative for a range of ceiling ratios or thresholds that a decision-maker might be willing to pay for a particular unit of outcomes. Care must be taken when interpreting the information provided by a CEAC. It simply presents the probability that an intervention is cost-effective compared with the alternative for a range of values. The CEAC should not be used to make statements about the implementation of the intervention (Fenwick & Byford, 2005).

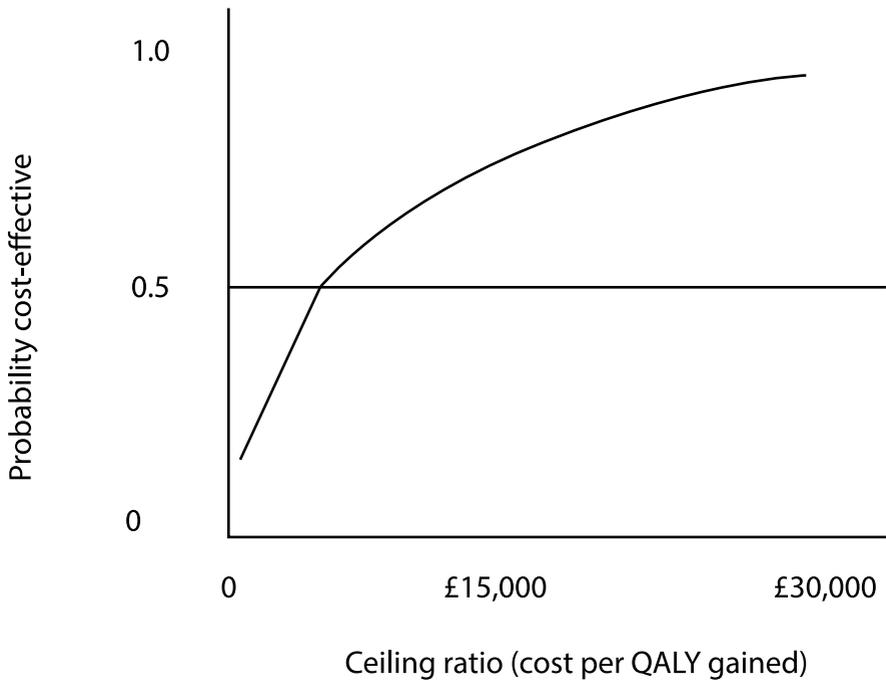


Figure 2. Example cost-effectiveness acceptability curve (CEAC).

Figure 2 demonstrates at £7,500 per QALY, the probability of the intervention being cost-effective is 50%.

A word of caution regarding cost-effectiveness analysis

It is worth noting that the **perspective** of an analysis is key when performing cost-effectiveness analysis.

If the perspective is restricted and does not cover all the relevant stakeholders/payers, then this can lead to cost shifting from one part of the system to another or from one agency to another, rather than providing a cost-effective solution. To reduce the likelihood of this occurring, researchers should use as comprehensive a perspective as possible (Berger et al., 2003). For public health evaluations, the National Institute for Health and Care Excellence (NICE) recommend a public sector perspective (NICE,2012).

Example of cost-effectiveness analysis in practice

Edwards RT, C elleachair A, Bywater T, Hughes DA, Hutchings J. (2007). Parenting programme for parents of children at risk of developing conduct disorder: cost effectiveness analysis. *BMJ*, 334 (7595), 682.

Owen L, Morgan A, Fischer A, Ellis S, Hoy A, Kelly MP. (2012). The cost-effectiveness of public health interventions. *Journal of Public Health*, 34 (1), 37-45.

5.3 Cost-utility analysis (CUA)

Cost-utility analysis is an extension of cost-effectiveness analysis. It is a form of economic evaluation in which health benefits are usually measured in preference-based non-monetary units such as **Quality Adjusted Life Years (QALYs)** or **Disability Adjusted Life Years (DALYs)**. QALYs are calculated by aggregating the number of years gained from a drug or health care intervention, weighted by the proportion that represents the relative value attached to a given health state (utility) (Robinson, 1993c). DALYs are calculated by aggregating the time lost due to premature death and time lived with a disability.

QALY = length of life x quality of life

DALY = years lived with disability + years of life lost

Health utility scores typically range between 0 (death) and 1 (perfect health). One QALY is equal to one year of life lived in perfect health. There are health states with negative values, which would be considered worse than death. There are many measures available to produce utility scores, (e.g. EQ-5D, EuroQol Group 1990; SF-36, Brazier et al., 1992; HUI, Horsman et al., 2003). The choice of measure is based upon the research question, suitability for the population under study and previous literature. An individual may choose to use a particular measure in order to allow comparability with previously published studies.

Limitations of cost-utility analysis

There are equity issues associated with QALYs. As length of life is used in the equation, it is argued that the young gain more QALYs due to the fact they have more life left to live than the elderly. Thus, resource allocation based upon the maximisation of QALYs would cause a redistribution of health care resources away from the elderly, favouring the young (Wagstaff, 1991). Kelly et al., (2005) and Weatherly et al., (2009) have

argued that the QALY approach may be too narrow to capture the full range of benefits from public health interventions. Though multiple measures exist to generate utility scores, it is worth noting that different measures produce different utility scores, making comparisons with other studies sometimes difficult. Consideration of the population and plans to compare the study with other published studies should be undertaken before choosing a particular utility measure.

Example of cost-utility analysis in practice

Edwards RT, Linck P, Hounscome N, Raisanen L, Williams N, Moore L Murphy S. (2013). Cost-effectiveness of a national exercise referral programme for primary care patients in Wales: results of a randomised controlled trial. *BMC Public Health*, 13 (1), 1021.

Use of ICERs in Economic Evaluations such as CUA and CEA

In the UK, governing bodies such as NICE use ICERS applying a ceiling ratio/threshold to determine if an intervention, programme or service is cost-effective. NICE typically use cost per QALY equations to determine cost-effectiveness. NICE (2008) states the QALY should be used because it is a standardised and internationally recognised method to compare and measure clinical effectiveness and cost-effectiveness across different treatments and patient groups. In the UK, the ceiling ratio has been suggested at £20,000-£30,000 per QALY (NICE, 2008). In the USA, the ceiling ratio is set at \$50,000 per QALY, and between A\$42,000-A\$76,000 per QALY in Australia (Eichler et al., 2004).

5.4 **Cost-benefit analysis (CBA)**

Cost-benefit analysis places monetary values on both costs and outcomes. It aims to answer the question is the benefit worth the cost (Morris et al., 2007). However, it can only value tangible outcomes e.g. money. It struggles to value intangible outcomes, which are yet to be quantified e.g. happiness, relief from pain. In evaluations of health care services or procedures, the use of monetary values allows you to determine if a service or procedure offers an overall gain to society if its total benefits surpass its total costs (Robinson, 1993d; Brazier et al., 2007; McIntosh et al., 2010).

Benefits in this method can be valued using the human capital approach, an approach that values benefits in terms of productivity gains or by individual's preferences using willingness to pay (Robinson, 1993d) or willingness to accept (Drummond & McGuire, 2007).

Willingness to pay requires asking individuals how much they would be prepared to pay to obtain the benefits or avoid the costs (e.g., money or negative effects) of illness (Robinson, 1993d; Brazier et al., 2007; McIntosh et al., 2010). Willingness to accept requires asking individuals how much they would accept to be paid to abandon a good or put up with something negative (e.g., side-effects from a medication that reduced other symptoms) (Drummond & McGuire, 2007). Willingness to pay and willingness to accept are often dependent upon how the individual values money itself, as well as their valuation of benefits and negative effects (Robinson, 1993d).

Limitations of cost-benefit analysis

By using the same outcome measure (costs/money), the method allows you to compare interventions that can be unrelated (e.g. smoking cessation intervention and a physical activity intervention as both aim to benefit population health) (Berger et al., 2003). However, in order to convert non-monetary outcomes into costs, assumptions are required. Depending on the outcome, the evaluation could be based on rather large assumptions. In order to perform the analysis, these assumptions will be required. Researchers should be transparent in their assumptions and test them through sensitivity analyses. Cost-benefit analysis has also been criticised for giving greater weight to the preferences of the wealthy (Berger et al., 2003). It is worth noting that asking individuals to apply monetary values to outcomes will be rooted in their circumstances and relative to their own earnings - what is expensive to one person would not necessarily be considered expensive by another.

Example paper of cost-benefit analysis in practice

Reynolds AJ, Temple JA, Robertson DL, Mann EA. (2002). Age 21 Cost-Benefit Analysis of the Title I Chicago Child-Parent Centers. *Educational Evaluation and Policy Analysis*, 24, 267-303.

5.5 Cost-consequence analysis (CCA)

Cost-consequence analysis collects, categorises and lists the cost components of a chosen intervention (Brazier et al., 2007). This type of analysis lists the components of an intervention in a disaggregated format, without making judgements of their relative importance. The verdict is left to the decision maker (Brazier et al., 2007). By providing the information in this format, the decision maker can focus upon the

outcomes that are most important or salient to them (Berger et al., 2003). The biggest criticism of cost-consequence analysis is that it has no weighting system to appraise the results. Costs and consequences are presented disaggregated, requiring the decision makers themselves to devise a system to appraise the results (Berger et al., 2003). These decisions, made at an individual level, may not always be in the best interest of the patients or society.

Example paper of cost-consequence analysis in practice

Gage H, Kaye J, Owen C, Trend P, Wade, D. (2006). Evaluating rehabilitation using cost-consequences analysis: an example in Parkinson's disease. *Clinical Rehabilitation*, 20, 232-238.

5.6 General considerations for all evaluation methods

When reading the results of the economic evaluation methods in Section 5, there are few key points to note. The Drummond Checklist (Drummond et al., 2015) highlights key points to be aware of when reading an economic evaluation - in addition, we wish to emphasise the following:

Perspective – The perspective should be stated and you - as the reader - should critically appraise if this perspective covers all relevant costs and outcomes.

Sensitivity analysis – Sensitivity analyses should be conducted to explore the extent to which assumptions made in the analysis are upheld, whilst adjusting key variables (e.g., dosage of intervention received).

Discounting – Discounting incorporates positive time preference – meaning benefits that occur now are valued higher than those that occur in the future. The Treasury recommends a **discount rate** of 3.5%. Costs and outcomes that occur after 1 year should be discounted by applying the discount rate to account for positive time preference.

6. Social Return on Investment (SROI)

Social Return on Investment (SROI) analysis, which is common in the USA, is becoming of interest to UK policy makers, local service commissioners and charities. The method results in a ratio of benefits to costs, estimating the value created for every £1 invested.

The central purpose of SROI is to address the challenge of measuring a

wider concept of value, capturing aspects across the triple bottom line of economic, social and environmental value. SROI involves a stakeholder consultation from the outset and throughout the process to help establish boundaries, indicators and verify assumptions made in the analysis.

The Cabinet Office (2011) have published ‘A Guide to Social Return on Investment’. This guide provides step-by-step instructions on how to conduct an accurate SROI. It was produced to help third sector organisations better communicate their impact to the public, funders and the Government.

The guide outlines six key stages to conducting an SROI analysis, which are presented below.

The six stages to SROI as stated by The Cabinet Office (2011).

Stage	Brief description of activity undertaken during that stage
1	<p>Establishing scope and identifying key stakeholders</p> <ul style="list-style-type: none"> - Be clear about who is directly impacted by the intervention or service - What impact has the intervention had? - How will these stakeholders be consulted during the process?
2	<p>Map outcomes</p> <ul style="list-style-type: none"> - Engage with stakeholders to develop an impact map or theory of change which is a diagram that shows the relationship between inputs, outputs and outcomes - Inputs are what a stakeholder puts into an intervention (e.g. time to attend an exercise class as part of an intervention) - Outputs are evidence that an activity has taken place (e.g. number of hours conducting exercise or sessions attended) - Outcomes are evidence that a change has taken place (e.g. improvements in physical health from the intervention)

Stage	Brief description of activity undertaken during that stage
3	<p>Evidencing outcomes and giving them a value</p> <ul style="list-style-type: none"> - Find data from published sources or collect own data to show whether outcomes have happened and value outcomes
4	<p>Establishing impact</p> <ul style="list-style-type: none"> - After collecting evidence on outcomes, assign a monetary value to these outcomes - Also establish what changes would have happened without the intervention (i.e. what happened in a control condition or as a result of usual care) - Are there changes from outside factors or other activity that are not directly attributable to the intervention? (e.g. is the improvement seen in physical health just from the intervention or has the participant been engaging in exercise outside the intervention – for example daily walks) - How long are effects likely to last?
5	<p>Calculating the SROI</p> <ul style="list-style-type: none"> - This stage involves adding up all the benefits, subtracting any negatives and comparing the result to the investment. This is also where the sensitivity of the results can be tested
6	<p>Reporting, using and embedding</p> <ul style="list-style-type: none"> - Share findings with stakeholders and respond to any comments or suggestions - Be clear on your audience - Create a technical appendix detailing assumptions and calculations - Verify results through an assurance process or work with an expert to improve credibility

7. Critical appraisal of economic evaluations and decision analytical models

7.1 The Drummond et al., (2015) Checklist for a Sound Economic Evaluation

In order to assess the results of a published economic evaluation, Drummond et al., (2015) developed a checklist to identify elements they considered to demonstrate a sound economic evaluation. It is worth noting that it is unlikely that every study will satisfy all the points raised in the checklist. However, the checklist provides a guide to the types of questions one should be asking when reading published economic evaluations, so they can assess the strengths and weaknesses of the study and make their own judgement of the usefulness and relevance of the findings for their purposes. The checklist questions are presented below.

The Drummond Checklist comprises of 10 main questions (adapted from Drummond et al., 2015)

The Drummond Checklist adapted from Drummond et al (2015) Methods for the Economic Evaluation of Health Care Programmes pp. 42-44. Copyright © 2015 Oxford University Press. Reprinted by permission from Oxford University Press. This reprinted Oxford University Press content is excluded from the Handbook's Creative Commons license. Anyone wishing to use the material outside of this handbook needs to contact Oxford University Press for permission (<http://global.oup.com/?cc=gb>)

1.	Was a well-defined question posed in an answerable form? <ul style="list-style-type: none">- Were both costs and effects examined?- Were alternatives considered?- Was the perspective of the analysis stated? Is the analysis embedded in any decision making context?
2.	Was a comprehensive description of the competing alternatives given? <ul style="list-style-type: none">- Were any alternatives that were relevant to evaluation omitted?- Was a do-nothing alternative considered or should it be?

3.	<p>Was the effectiveness of the programmes or services established?</p> <ul style="list-style-type: none"> - Was this done through a randomised controlled trial? Did the trial reflect what happens in usual care or routine practice? - Was this done through a systematic review of evidence from clinical studies? If so, was the search strategy including inclusion and exclusion criteria clearly described? - Were observational data or assumptions used when establishing effectiveness? If so, are there any potential biases in the results?
4.	<p>Were all the important and relevant costs and consequences for each alternative identified?</p> <ul style="list-style-type: none"> - Was the range wide-enough for the research question at hand? - Were all relevant perspectives covered (e.g., community, NHS, patient)? - Were capital costs as well as operating costs included? <p>Capital costs are one-time expenses typically incurred to set up a service Operating costs are the recurrent delivery costs of a service, e.g. staff</p>
5.	<p>Were costs and effects measured accurately in appropriate physical units (e.g., QALYs)?</p> <ul style="list-style-type: none"> - Were sources of service utilisation described and acceptable? - Were any items omitted? If so, what effect does this have on the analysis? - Were there any special circumstances that made measurement difficult? Were these difficulties addressed?

6.	<p>Were costs and effects valued credibly?</p> <ul style="list-style-type: none"> - Were all sources of the values clearly identified? - Were market values employed for changes involving resources gained or depleted? - Where market values were absent (e.g. volunteer labour) or market values did not reflect actual values (e.g. equipment given at a reduced rate), were adjustments made to approximate market values? - Was the valuation of effects appropriate for the question posed? Was the appropriate type of analysis/analyses (e.g. cost-effectiveness, cost-benefit or cost-utility analysis) undertaken? <p><i>Market value</i> is the price an asset would fetch in the marketplace</p>
7.	<p>Were costs and effects adjusted for differential timing?</p> <ul style="list-style-type: none"> - Were future costs and effects discounted to their present value? - What was the discount rate used and was the justification for this rate specified?
8.	<p>Was an incremental analysis of costs and effects of alternatives performed?</p> <ul style="list-style-type: none"> - Were the additional (incremental) costs generated by one alternative over another compared to the additional effects, benefits, or utilities generated?

9.	<p>Were allowances made for uncertainty in the estimates of costs and effects?</p> <ul style="list-style-type: none"> - Were appropriate analyses undertaken on patient-level data of costs and effects? - If sensitivity analyses were undertaken, were the justification for the ranges and distribution of values chosen (for key parameters) specified and explained? - Were conclusions drawn sensitive to uncertainty from the statistical and/or sensitivity analyses?
10	<p>Did the presentation and discussion of study results include all issues of concern to users?</p> <ul style="list-style-type: none"> - Were conclusions of the analysis based on an index or ratio (e.g. cost-effectiveness or cost-benefit ratio)? Was this ratio interpreted intelligently or in a mechanistic fashion? - Were the results compared with those of others who have investigated the same question? If so, were allowances made for potential differences in methodology? - Did the study discuss the potential of generalisability of the results to other settings or patient/population groups? - Did the study take in account other important factors in the choice or decision under consideration (e.g. ethical issues, limited staff numbers or wider policy context and relevance)? - Did the study discuss issues of implementation (e.g. feasibility of adopting recommendations)? Are there any potential issues regarding finance and resources? Could resources be relocated from other areas to assist the implementation?

7.2 Philips et al., (2004) checklist for critically appraising decision analytic models

Decision analytic modelling is widely used in the field of health economics as a means of estimating the costs, outcomes and cost-effectiveness of different interventions and programmes in health care and public health. A logical model is presented with mathematical representation of the relationships between inputs and results. These methods are often used to predict health outcomes and costs when the intervention cannot be evaluated directly or the scope of the evaluation falls outside of the existing evidence base. The checklist questions are presented below.

The Philips et al., (2004) checklist for critically appraising decision analytic models (adapted from Philips et al., 2004)

Permission to reproduce the Philips checklist has been granted by the authors and the publishers of the checklist the National Institute for Health Research (NIHR)

Dimension of quality	Questions to ask
Statement of decision problem / objective	<ul style="list-style-type: none">- Is there a clear statement of the decision problem?- Is the objective of the evaluation and model specified and consistent with the stated decision problem?- Is the primary decision-maker specified?
Statement of scope / perspective	<ul style="list-style-type: none">- Is the perspective of the model stated clearly?- Are the model inputs consistent with the stated perspective?- Has the scope of the model been stated and justified?- Are the outcomes of the model consistent with the perspective, scope and overall objective of the model?

Dimension of quality	Questions to ask
Rationale for structure	<ul style="list-style-type: none"> - Is the structure of the model consistent with a coherent theory of the health condition under evaluation? - Are the sources of data used to develop the structure of the model specified? - Are the causal relationships described by the model structure justified appropriately?
Structural assumptions	<ul style="list-style-type: none"> - Are the structural assumptions transparent and justified? - Are the structural assumptions reasonable given the overall objective, perspective and scope of the model?
Strategies/ comparators	<ul style="list-style-type: none"> - Is there a clear definition of the options under evaluation? - Have all feasible and practical options been evaluated? - Is there justification for the exclusion of feasible options?
Model type	<ul style="list-style-type: none"> - Is the chosen model type appropriate given the decision problem and specified causal relationships within the model?
Time horizon	<ul style="list-style-type: none"> - Is the time horizon of the model sufficient to reflect all important differences between options? - Are the time horizon of the model, the duration of treatment and the duration of treatment effect described and justified?

Dimension of quality	Questions to ask
Disease states/ pathways	<ul style="list-style-type: none"> - Do the disease states (state transition model) or the pathways (decision tree model) reflect the underlying biological process of the disease in question and the impact of interventions?
Cycle length	<ul style="list-style-type: none"> - Is the cycle length defined and justified in terms of the natural history of disease?
Data identification	<ul style="list-style-type: none"> - Are the data identification methods transparent and appropriate given the objectives of the model? - Where choices have been made between data sources, are these justified appropriately? - Has particular attention been paid to identifying data for the important parameters in the model? - Has the quality of the data been assessed appropriately? - Where expert opinion has been used, are the methods described and justified?
Data modelling	<ul style="list-style-type: none"> - Is the data modelling methodology based on justifiable statistical and epidemiological techniques?
Baseline data	<ul style="list-style-type: none"> - Is the choice of baseline data described and justified? - Are transition probabilities calculated appropriately? - Has a half-cycle correction been applied to both cost and outcome? - If not, has this omission been justified?

Dimension of quality	Questions to ask
Treatment effects	<ul style="list-style-type: none"> - If relative treatment effects have been derived from trial data, have they been synthesised using appropriate techniques? - Have the methods and assumptions used to extrapolate short-term results to final outcomes been documented and justified? Have alternative assumptions been explored through sensitivity analysis? - Have assumptions regarding the continuing effect of treatment once treatment is complete been documented and justified? Have alternative assumptions been explored through sensitivity analysis?
Costs	<ul style="list-style-type: none"> - Are the costs incorporated into the model justified? - Has the source for all costs been described? - Have discount rates been described and justified given the target decision-maker?
Quality of life weights (utilities)	<ul style="list-style-type: none"> - Are the utilities incorporated into the model appropriate? - Is the source for the utility weights referenced? - Are the methods for derivation for the utility weights justified?

Dimension of quality	Questions to ask
Data incorporation	<ul style="list-style-type: none"> - Have all data incorporated into the model been described and referenced in sufficient detail? - Has the use of mutually inconsistent data been justified (are assumptions and choices appropriate)? - Is the process of data incorporation transparent? - If data have been incorporated as distributions, has the choice of distribution for each parameter been described and justified? - If data have been incorporated as distributions, is it clear that second order uncertainty is reflected?
Assessment of uncertainty	<ul style="list-style-type: none"> - Have the four principal types of uncertainty been addressed? - If not, has the omission of particular forms of uncertainty been justified?
Methodological	<ul style="list-style-type: none"> - Have methodological uncertainties been addressed by running alternative versions of the model with different methodological assumptions?
Structural	<ul style="list-style-type: none"> - Is there evidence that structural uncertainties have been addressed via sensitivity analysis?
Heterogeneity	<ul style="list-style-type: none"> - Has heterogeneity been dealt with by running the model separately for different subgroups?
Parameter	<ul style="list-style-type: none"> - Are the methods of assessment of parameter uncertainty appropriate? - If data are incorporated as point estimates, are the ranges used for sensitivity analysis stated clear and justified?

Dimension of quality	Questions to ask
Internal Consistency	<ul style="list-style-type: none"> - Is there evidence that the mathematical logic of the model has been tested thoroughly before use?
External Consistency	<ul style="list-style-type: none"> - Are any counterintuitive results from the model explained and justified? - If the model has been calibrated against independent data, have any differences been explained and justified? - Have the results of the model been compared with those of previous models and any differences in results explained?

7.3 Standards of Reporting for Economic Evaluations

The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement was developed to provide consistency in the reporting of economic evaluations. The checklist is similar to the Consolidated Standards of Reporting Trials (CONSORT) format and provides consistency with other approaches. The CONSORT statement and checklists are an evidence-based, minimum set of recommendations for reporting randomised trials. They were developed to create standardisation in reporting, to facilitate transparency and aid critical appraisal and interpretation. The 24 item CHEERS checklist describes the key recommendations of the information that should be included under headings for example: title, abstract, background/objectives, target population, study perspective, comparators, time horizon, study parameters, incremental cost and outcomes, limitations and generalisability. For the full checklist, see Husereau et al., (2013).

8. Useful Health Economics Resources

Health Knowledge

An online resource for anyone working in health, social care and well-being. The website offers a broad range of learning materials, divided into four different learning styles:

- A Public Health Textbook organised in relation to the Faculty of Public Health Part A syllabus.
- Text courses with text, questions, answers and feedback on a range of topics.
- Podcasts and Video PowerPoints with supporting resources.
- Management training with PowerPoint slides, workbooks and trainer notes in four clinical areas: diabetes, coronary heart disease, stroke and child health.

This online resource has a specific section on health economics.

www.healthknowledge.org.uk/public-health-textbook/medical-sociology-policy-economics/4d-health-economics

Service Utilisation and Costs

Database of Instruments for Resource Use Measurement (DIRUM)

DIRUM is an open-access database of resource-use questionnaires for use by health economists involved in trial-based economic evaluations. Funded by the Medical Research Council Network of Hubs for Trial Methodology Research, DIRUM offers a unique (and permanent) web address for each resource use measure for citation in papers and reports. DIRUM also provides a repository of methodological papers related to resource use and cost measurement.

<http://www.dirum.org/>

Unit Costs of Health and Social Care

A downloadable PDF containing unit costs of health and social care contacts and care developed by the Personal Social Services Research Unit at the University of Kent at Canterbury and the London School of Economics and Political Science. This document is used in economic evaluations, quantifying and applying a cost to GP appointments and community care.

<http://www.pssru.ac.uk/project-pages/unit-costs/>

NHS reference costs

A downloadable Excel file containing average unit costs to the NHS of providing secondary health care to NHS patients. It is used in economic evaluations to apply a cost to treatment received by participants to calculate the cost of secondary care.

<https://www.gov.uk/government/collections/nhs-reference-costs>

Systematic Reviewing

Shemilt and colleagues (2013) reflect on the value and desire for the consideration by end users for coverage of an economic perspective in a Cochrane review and outlines two potential approaches and future directions. This paper provides a good introduction to economic perspectives and considerations when conducting systematic reviews.

<http://www.systematicreviewsjournal.com/content/2/1/83>

Useful Databases containing economic evidence

The Health Technology Assessment Database

<http://www.crd.york.ac.uk/CRDWeb/>

NHS Economic Evaluation Database

<http://www.crd.york.ac.uk/CRDWeb/>

RePEc (Research Papers in Economics)

<http://www.repec.org/>

EconLit

<https://www.aeaweb.org/econlit/>

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