

POLISH GUIDELINES FOR CONDUCTING PHARMACOECONOMIC EVALUATIONS

A. Introduction

Sine qua non condition in use of economic evaluations in healthcare decision making is their high quality and ability to compare them against each other. The above leads to the necessity to elaborate guidelines which define the principles and basic methods of performing economic analysis and presenting results. The general recommendations included in guidelines set quite specifically the methods of evaluation to be selected and therefore maximise the ability to compare such evaluations as well as reduce significantly the possibility of misleading conclusions. Nevertheless they do not block potential progress in methodology and are not meant to restrain scientific freedom in this domain.

B. Guidelines for conduction economic evaluation of health technologies.

1. Aim and use of economic evaluation of health technologies.

Economic evaluation is defined as the systematic attempt to identify, measure and compare the costs and outcomes of alternative interventions. The main purpose is to assess the value for money of alternative services, in order to support decisions about priorities for resource allocation. The aim is to maximise the benefits to service users by funding those services that generate the greatest outcomes for the money available.

2. Methods

2.1. Defining the decision problem.

The decision problem, which will be addressed by economic evaluation should be carefully defined. The description must contain information on given technology and health problem, for which the intervention in question is to be used taking into account ,

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basic epidemiological (incidence, prevalence, mortality), population characteristics, the natural disease history, prognosis and the currently used diagnostic or therapeutic methods.

2.2. Population.

The target population is selected along with the registered indication for health technology in query: population as a whole and also in sub-groups which can be defined based on potential variance in efficacy, costs and/or preferences. The choice of target population should be justified.

2.3. Perspective

It is recommended to perform the analysis from the societal perspective because:

- 1) health outcomes of given technology can concern not only the patients, but also other members of the society (family, caregivers)
- 2) the desired aim of economic analysis is the optimal allocation of resources at the societal level (because society pay public money),
- 3) broad societal perspective minimizes the risk of avoiding aspects, which could be important for decision makers.

The societal perspective means that all that all costs and all health benefits resulting from a given health technology should be taken into consideration, inside as well as outside the healthcare system. It is recommended to show results accounting for the direct and indirect costs, and results accounting exclusively for the costs incurred by the public payer in the healthcare system, separately.

2.4. Time horizon

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The time horizon should be long enough to capture all the meaningful differences in costs and outcomes between the intervention and comparators. It should be the same for cost and for outcomes measurement. Many technologies have impacts on costs and outcomes over a patient's lifetime. This is particularly the case with treatments for chronic disease. In such instances, a lifetime time horizon for clinical and cost effectiveness is appropriate. Such a time horizon is also required in order to quantify the implications of any differential mortality effect between alternative technologies. For a lifetime time horizon, extrapolation modelling is often necessary. In this case, the short- and long-term results should be presented separately.

2.5. Comparator (s)

The evaluated technology should be compared to the alternative (or alternatives) which is most likely to replace this technology in real practice ("existing practice").

It is also recommended to perform additionally a comparison with other comparators, i.e. the following technologies:

- 1) the most efficient for target population
- 2) the cheapest for target population

2.6. Analytical techniques

In health economic evaluation a number of different techniques may be used:

- Cost Minimisation Analysis (CMA),
- Cost-Effectiveness Analysis (CEA),
- Cost-Utility Analysis (CUA),
- Cost-Benefit Analysis (CBA),
- Cost-Consequences Analysis (CCA).

Analytical technique is always selected according to health effects identified and measured. The choice should always be justified. The recommended technique is the

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Cost-Effectiveness/Utility analysis. The choice of one technique does not exclude using another one as an additional analysis, if the author finds it justified.

2.6.1. Cost-Minimisation analysis.

Cost minimization analysis may be applied if valid scientific evidence confirms that health outcomes of the compared interventions are equal. In such a case, the analysis consists in comparing the costs only.

2.6.2. Cost-Effectiveness/Utility Analysis

Cost-Effectiveness Analysis consists in comparing costs and health outcomes of alternative health technologies; the results have to be expressed in the same natural units (e.g. number of adverse events avoided, disease free time, life years gained).

Cost-Utility Analysis CUA is a specific form of Cost-Effectiveness Analysis. As with CEA, a measure of relative cost-effectiveness can be derived, but outcomes are measured in terms of utility (level of satisfaction, well-being, quality of life, etc.). One example of a utility based measure is the quality-adjusted life year (QALY)

CUA should be used when:

- 1) the health-related quality of life is one of the significant outcomes of the analysed technologies,
- 2) the compared technologies give very different clinical effects and it is necessary to find a common denominator enabling their comparison,
- 3) we compare given program with another one evaluated with CUA method

Advantage of QALY as a measurement of results of health programs is ability to define at the same time the benefits resulting from decrease of mortality (quantitative gain) and from decrease of morbidity (qualitative gain).

2.6.3. Cost-Benefit Analysis

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In Cost-Benefit Analysis both costs and outcomes are expressed in monetary units. The most appropriate method of valuations results is willingness to pay, WTP. As The methodology of willingness to pay is still under development, CBA is not currently recommended as the unique method of economic evaluation of health technologies.

2.6.3. Cost-Consequence Analysis

Cost-Consequence Analysis involves the presentation of a range of outcome measures alongside the costs. No attempt is made to formally combine costs with benefits and decision makers are left to form their own opinion regarding the relative importance of the alternative outcomes presented. CCA may be used as independent analysis for comparison of two or more alternatives or as an intermediate step in reporting the analysis, with the outcomes and costs presented in a disaggregate form before combining them in another type of evaluation.

2.7. Outcome identification and measurement.

Unit of outcome has to reflect key aspects of health problem and allow to discover potential differences between compared technologies. Evaluated health outcomes should be clinically significant. Economic evaluation should focus on final outcomes. For studies using surrogate outcomes (intermediate outcomes), the surrogate should be highly predictive of an important patient outcome. As decision-makers are primarily concerned with the "real life" impact that the intervention will have on patients who will be treated in routine practice, measurements should focus on effectiveness (i.e. the results obtained in real conditions) rather than efficacy (the results obtained in controlled clinical trials). Because of good "real world" evidence is seldom available before the intervention is used in the market, analysts are encouraged to translate efficacy data into effectiveness estimates, using the best available evidence and appropriate modelling techniques, where feasible and scientifically credible.

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2.8. Evidence

2.8.1. Data sources

Clinical and economic data used in economic evaluation must be relevant to jurisdiction of interest (specific country, setting). Data, that have been collected in trials performed in other countries or setting, can be applied if :

- 1) they meet quality requirements
- 2) the setting for the study is sufficiently similar to the jurisdiction of interest in terms of population characteristics, reference alternative, clinical pattern and unit costs.

2.8.1.1. Valuation of health outcome

The treatment effect of a technology can, in essence, be summarised as the difference between the health state or quality of life that would be experienced on average by patients receiving the technology and the health state or quality of life of the same group were they to receive alternative care. The primary research methods and designs that are used to measure the treatment effect can be broadly categorised into experimental or observational studies. The most reliable evidence about the relative treatment effects of a technology is obtained from experimental studies with high internal and external validity that have inclusion and exclusion criteria that have been defined a priori.

The different types of study design can be ranked according to a hierarchy that describes their relative validity for estimating relative treatment effect. Hierarchies typically grade studies as follows:

- 1) level 1 - randomised controlled clinical trials (RCTs),
- 2) level 2 - controlled observational studies (e.g. cohort studies, case-control studies),
- 3) level 3 - observational studies without control groups (e.g. case series)
- 4) level 4 - expert opinion based on pathophysiology, bench research or consensus views.

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The value of evidence from anywhere in the hierarchy depends on its quality and relevance. In general studies lower in the hierarchy are more prone to bias. However, it is important to recognise that RCT data are often limited to selected populations, short time horizon and selected comparator treatments. Therefore, good-quality observational studies will often be needed to supplement the RCT data.

2.8.1.1.1. Randomised controlled clinical trials

RCTs are designed to minimise potential external influences in order to isolate the effects of a single variable in a precisely defined patient group. RCTs are therefore ranked first in the hierarchy of evidence for measures of relative treatment effect.

Evidence from 'head-to-head' RCTs that directly compare the technology and the appropriate comparator are preferred over other study designs. Where no head-to-head trials are available, consideration is given to indirect comparisons, subject to careful and fully described analysis and interpretation. Important considerations are the size of the trial (its precision), the selection of outcomes (its relevance) and analysis by intention to treat. External validity concerns the generalisability of the trial evidence – that is, the applicability of the results to wider patient groups over a longer follow-up and to routine clinical practice)

2.8.1.1.2. Data from trials other than randomised controlled trials

Evidence from non-RCT studies may be needed to supplement what is available from RCTs to estimate relative treatment effect over longer time horizons than is reported in RCTs. In the absence of valid RCT evidence, evidence from the highest available level of study design will be considered with reference to the inherent limitations of the specific design.

2.8.1.2. Valuing health effects in terms of preferences

To quantify effects of technologies in terms of preferences, it is recommended to use the following methods:

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- 1) direct methods: based on choice (time trade off, standard gamble)
- 2) indirect methods : standardised and validated generic instruments ((e.g. EQ-5D)

It is preferred that analysts measuring preferences use a representative sample of the general public, who are suitably informed about the health states being valued. Patients who have direct experience of the relevant health states may be also an acceptable source of preferences if this choice can be justified and makedly alter the results.

2.8.1.3. Costs.

The economic analysis s should comprise only the costs corresponding to consumable resources used during the application of a given technology in daily clinical practice. Detailed information about evidence are presenetd in chapters 2.9.3 i 2.9.4.

2.8.2. Data collection process

The process of assembling evidence for health technology assessment needs to be systematic. That is, evidence must be identified, quality assessed and, where appropriate, pooled using explicit criteria and justifiable and reproducible methods. These principles apply to all categories of evidence that are used to estimate health outcomes and costs, evidence for which will typically be drawn from a number of different sources (e.g. cohort studies for parameters relating to the natural history of the condition, randomised trials for relative treatment effects, and cross-sectional surveys for resource use and costs).

Searching, data extraction and quality assessment should be performed according to rules of systematic review. As systematic review of literature is performed retrospectively, it should be conducted according to a previously prepared protocol, which include a description of searching strategy, specify the eligibility criteria for the selection of relevant studies to be included in the review, reporting format.

Many factors can potentially affect the overall estimate of health effects obtained from a study (characteristics of population, severity of disease, care setting, additional routine care). Such treatment effect modifiers need to be identified before data analysis and discussed.

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2.8.3. Synthesising the evidence

There are various ways of synthesizing the evidence found in various studies (e.g., fixed or random effects meta-analysis, either frequentist or Bayesian), but there is not one optimal method of synthesizing data currently available, and the typical meta-analyses cannot straightforwardly be applied to synthesize data for cost-effectiveness models.

One reason is that meta-analysis has been developed to combine quantitative results of several similar studies into a pooled estimate of the treatment effect (e.g., odds ratio, relative risk, difference in change from baseline). It uses the magnitude of the treatment effect and its uncertainty from each individual study to produce a weighted mean of the treatment effect. However, in modeling studies, the parameter to be estimated is not only a treatment effect like the odds ratio of having an event. Typically, models contain parameters like transition probabilities between disease states, event probabilities, rate ratios of treatment effects, quality of life or utility values, and costs. These parameters have different distributions which need to be combined.

2.9. Cost calculation in economic evaluation of health technology

The economic analysis should comprise only the costs corresponding to consumable resources used during the application of a given technology in daily clinical practice. The perspective and time horizon of costing should be the same as the perspective and time horizon of outcomes evaluation. The choice of perspective and time horizon is strictly linked to further stages of the analysis in which cost categories selected are identified and the method of their measurement and evaluation are defined.

2.9.1. Cost categories.

The costs are divided into following categories: direct medical and non-medical costs, indirect costs and intangible costs. Analysis prepared prepared from a a broader societal

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would include all categories mentioned above. It is recommended to show results accounting for the direct and indirect costs, and results accounting exclusively for the costs incurred by the public payer in the healthcare system, separately.

2.9.2. Identification of resources used

Identification of resources used involves the need to determine, which resources are relevant for an examined problem (disease, intervention). It is recommended first to describe in detail a given procedure in order to define which resources units should be taken into account in the analysis. Then it is proposed to decide which elements should be measured and assessed separately. In order to identify resources with largest contribution to total and incremental costs it is recommended to conduct a sensitivity analysis. Sensitivity analysis shall also be used to determine which costs should be measured and evaluated in details (using micro-costing methodology) from those which can be evaluated via gross-costing methodology.

2.9.3. Measurement of resources used

There are two different ways for determining resource use: either by collecting primary data within a properly designed research, or by collecting secondary data from existing databases. The selection of data sources depends on the level of detail required and should be based on following criteria:

- 1) the perspective of study,
- 2) the contribution of units to total and incremental costs,
- 3) availability of data,
- 4) the balance between internal and external validityperspektywa badania,

High accuracy is the advantage of the primary data, while their disadvantage consists in the fact, that their collection is time-consuming and labour-intensive. Another disadvantage is the fact that the data collected within the framework of a clinical trial also contain information on resources, the use of which is induced by the trial protocol. Secondary data, e.g. from national registers, are characterized by a generally high

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external reliability. However, they may turn out to be incomplete, as such databases do not cover all types of resources.

Methods of measurement resources used differ in the precision. Micro-costing method starts with the detailed inventory and measurement of all inputs consumed in a healthcare intervention and is frequently associated with primary data collection. Gross-costing method Gross costing method uses large components as the basis for costing. The distinguishing features of gross-costing are its simplicity, practicality and its (intended) insensitivity to sitespecific details and patient-level characteristics. iBoth the micro-costing method and the gross-costing method, can be used within a single analysis. In general, the higher the impact of a given cost component on the total or incremental cost, the higher should be the precision of its assessment. Thus, the micro-costing method is better suited for aspects of the alternatives under consideration that are likely to diverge in cost, and for intervention and events occurring in the present. Gross-costing is acceptable when using a more exact micro-cost estimate cost will not have an important effect on the analysis. Precision is generally less critical in estimating resources that will be consumed far in the future.

2.9.4. Monetary valuation of resources units.

Unit costs used in the analysis must be determined in accordance with the research perspective. The following methods of assessing the monetary value of resources can be implemented:

- 1) use the list of standard costs,
- 2) use the previously published research in health economics or use of local lists of tariffs or charges
- 3) direct calculation.

The choice of the method of monetary valuation units of resources is determined by the choice of methodology used in the measurement of resources used. For example there is little point in performing valuation of resources used based on direct calculation whenever the measurement of resources used was based on national registries.

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The use of the list of standard costs, if it was published, is recommended while presenting analyses for the purpose of reimbursement of new technology. Nevertheless for units of resources with considerable share in the total or incremental cost, it may be indispensable to use more precise methods, e.g. the direct calculation of a unit cost.

The availability of prices derived from national registries or previous research is limited and often there is insufficient information about the way these prices have been determined. The use of local charges or tariffs can be indicated in particular when the therapy in question is available only in certain type of healthcare institution. The attractiveness of this method, as in the case of standard costs, lies in the extensive list of procedures and services for which charges or tariffs are available, in simplicity and in availability without additional expense and time to the analyst. However, the use of charges is a controversial area. On the one hand there are arguments for their adoption such as that they are often more appropriate and sometimes the only available method. On the other hand they do not always reflect actual unit cost of the procedure or service but are merely the vehicle for transferring money from payers to providers. Application of charges is a method of choice only in the case of analysis conducted from the healthcare payer perspective. In the other cases the analyst should try to get some insight into whether the charge is good estimate of the actual unit cost of a procedure and can be used in the economic evaluation.

Direct calculation of cost is much more laborious than other methods. It is used for the valuation of units which have a substantial impact on total or incremental cost, and for which no adequate unit cost estimate from other sources are available. Important choices regarding the direct calculation of cost concern:

- 1) the selection of a specific setting in which costs will be calculated,
- 2) the use of .top-down. or .bottom-up. methods,
- 3) the allocation of costs of supportive departments, buildings, general equipment, etc

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Since unit costs can differ between healthcare providers and consequently the choice of medical service centre can influence the cost calculation, it is recommended to collect data in more than one centre and vary unit costs in a sensitivity analysis based on differences in unit costs that have been found in centres.

In the "top-down" methodology the cost of department are derived from cost-accounting data and assigned to the products and services produced by the department. In the .bottom-up. methodology the cost of each service in each product line is computed as the sum of the labour and non-labour inputs estimated to be used in that service.s production.It starts therefore with the detailed measuring the actual use of materials, equipment, personnel and time spent on a certain procedure for a single patient. "Top-down" calculation can be applied in the case of a department with relatively homogenous production, in other cases the "bottom-up" method is more appropriate. The disadvantage of "bottom-up" calculations is that they are usually very time consuming and a researcher will not always have the opportunity to perform such detailed measurements. In practice a combination of both mentioned above methodologies is applied.

There are several methods for the allocation of costs of supportive departments, buildings, equipment, etc. The method most often used in economic evaluation is direct allocation. In this method a distinction is made between departments that directly serve patients (i.e. surgery department) and supporting departments (i.e. kitchen, financial services).Cost of supporting departments are firstly allocated to the departments that directly serve patients, and then allocated among the products of these latter departments.

2.9.5. Standard values.

Standard values define the parameters used in the calculation of unit costs. The standard values are for example: gross salary, working hours per year, the number of workable hours of medical staff per year, yearly income in healthcare sector, the average distance

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of a household to a hospital (to calculate costs of transport), discount rate, inflation rate. The use of standard values results in the decrease of differences in unit costs estimates between studies. Use of standard values is recommended while presenting analyses for the purpose of reimbursement of new technology.

2.9.6. Valuation of productivity costs.

Two main methods of valuing productivity costs have been suggested: the human capital and the friction cost approaches. Human capital approach involves calculating productivity costs (or benefits) on the basis of an individual's gross wage rate, to reflect the actual loss of productivity resulting from premature death or disability, or the gains that result from improvements in a person's well-being. The main criticism of the human capital approach is that it ignores the fact that workers absent for short periods of time can often 'catch up' on return to work or their work can be covered by other staff members. For longer periods of absence, the existence of unemployment allows workers to be replaced at little cost, thus reducing the impact of the productivity losses. For this reason, attention has turned towards a new method of calculating productivity losses – the friction cost approach. This method attempts to account for the level of scarcity in the labour market and involves adjustments to human capital estimates. Productivity losses are valued on the basis of the average time that unfilled positions are left vacant plus the costs of training and recruitment, so the loss in productivity as a result of premature death is calculated over the time it takes to replace and train a new worker.

As the application of friction costs method may be complicated due to difficulties in collection of relevant data, the use human capital approach method is recommended.

2.10. Modelling

Modelling provides an important framework for synthesising available evidence and generating estimates of economic evaluation. Situations where modelling is likely to be required include those where:

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- the long-term costs and benefits of the technologies extend beyond trial follow-up.
- intermediate outcomes measures are used rather than effect on health related quality of life and survival
- relevant comparators have not been used or trials do not include evidence on relevant subgroups
- patients participating in trials do not match the target population.

Modelling is the best of available methods in the following situations:

- early stage in the development of the new technology, when there are only limited number of data
- there is no other way to obtain information needed for decision making

Principles of good practice of modelling and guidelines for critical appraisal of models are presented in table 1. In general, all structural assumptions and data inputs should be clearly documented and justified. This is particularly important in the case of modelling to extrapolate costs and health benefits over an extended time horizon. In such circumstances alternative time horizon scenarios should be considered in order to compare the implications of different assumptions for the results. Scenarios might include that treatment benefit in the extrapolated phase is (a) the same as during the treatment phase and continues at the same level; b) diminishes in the long term, or c) nil.

Table1. Principles of good practice of modelling and guidelines for critical appraisal of models.

<i>Subject of assessment</i>	<i>Principles of good practice</i>	<i>Questions for critical appraisal</i>
Model structure		
States of health	Structure of the model should be as simple as possible and, at the same time, it has to correspond to the decision-related problem and compliant to generally accepted knowledge on the course of	Are the decision-related problem, the context and the perspective clearly defined? Are important details of the course of the modelled disease described? Are the model assumptions

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	<p>the modelled disease, as well as cause-effect relation between the variables.</p> <p>Lack of data does not justify elimination of states or simplification of the model.</p>	<p>described and justified?</p> <p>Is the selection of the model states justified? If so, is it compliant to the knowledge on the disease?</p> <p>Are any important health states missing?</p>
Comparators	<p>The model should take into account comparators defined in these guidelines, especially those used in real-life practice.</p>	<p>Were comparators identified?</p> <p>Do they cover all the scope of options justified and possible to be made in the model?</p>
Time horizon	<p>Time horizon of the model should be sufficient to show durable differences in costs and results of the compared strategies.</p>	<p>Was the time horizon of the trial defined? If so, is it appropriate to the analyzed situation?</p>
Cycle length (if Markov model is applied)	<p>A cycle should be the shortest time span in which changes of examined parameters are expected; it should correspond to characteristics of the disease process.</p>	<p>Was the length of cycles defined in the model?</p> <p>Was the cycle length justified? If so, does it correspond to the disease process?</p>
Input data for the model		
Identification of input data	<p>The model should take advantage of the best data available. A systematic review of the relevant literature should be carried out to obtain the crucial input data for the model. Proof of such review or a justification of its absence should be presented. If experts' opinions are the source of input data, the methods of obtaining the data should be described.</p>	<p>Are the data sources presented in the model?</p> <p>Have the proper methods of data source searching been implemented?</p> <p>Has the range of parameter variability been determined?</p> <p>Are there premises, suggesting the data have been used selectively?</p> <p>Is the manner of obtaining data provided (e.g. criteria for selecting experts, their number, the method of obtaining information) if values of certain parameters have been assessed on the basis of experts' opinions?</p>
Data modelling	<p>Data modelling should be carried out on the basis of generally accepted biostatistical and epidemiological methods.</p>	<p>Have the methods used for data modelling been described? Have the generally accepted criteria of biostatistical and epidemiological methods been complied with</p>
Inclusion of data into the model	<p>Measurement units, time intervals and population characteristics must be</p>	<p>Are the measurement units, time intervals and population characteristics</p>

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	mutually compatible in the entire model. Both deterministic and probabilistic simulations are acceptable. The half-cycle correction should be implemented to adjust time-dependent assessment.	mutually compatible in the model? Has the half-cycle correction been implemented?
Sensitivity analysis		
Sensitivity analysis	Each model must include the sensitivity analysis of the crucial parameters and a justification of the analyzed range of parameter variability.	Have sensitivity analyses been carried out for all crucial parameters? Has the scope of variability of the parameters tested in sensitivity analysis been justified?
Model validation		
Internal validation	In order to identify errors related to data introduction and the model structure, the model should be tested systematically; for instance, it should be checked, whether expected results are obtained in the case zero or extreme input values are used; the code of the software should be analysed to identify syntactic errors or repeatability of results should be tested by means of equivalent input values. If there are external sources of input and output data (independent of those used in the model), the model should be calibrated.	Has a report on internal validation been provided?
Convergence validation	The model should be compared to other models focused on the same problem; in case of varying results, the reasons for such differences should be identified.	Have any other models of the same problem been identified? If so, have the results of different been compared, and in case of varying results, have the reasons for such differences been identified?
External validation	External validation focuses on compatibility of modelling results with direct empirical evidence. It can consist, for instance, in comparing indirect output data of a model with published results of long-term research (if there are any).	Has any research been identified, the results of which could be compared to the model results? Have the results been compared? Have any differences been identified and their reasons explained?

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2.11. Discounting

Discounting is conducted in order to bring costs and results to one time point. It is very important in case where implementation of analysed health program is spread across a long period of time. The suggested discount rate of discount is:

- 1) in the base case analysis : 5% for costs and health outcomes
- 2) in sensitivity analyses: 0% for for costs and health outcomes, 0% for health outcomes and 5% for costs.

2.12. Presentation of data and results.

2.12.1. Presenting data.

All data used should be presented clearly in tabular form and include details of data sources. For all variables, measures of precision should be detailed. For probabilistic analyses, the distributions used to characterise the uncertainty in input parameters should be defined and justified. The methods of data collection and analysis should be described and justified. The forms used to collect data should be attached as annexes to the report

2.12.2. Presenting results.

The presentation of results should be clear enough to ensure proper interpretation of the analysis and the possibility of data recovery and utilization in the future.

The expected value of total costs and expected value of total health outcome for each option compared in the analysis should be presented. Incremental cost-effectiveness ratios (the ratio of expected cost to expected outcome) should be calculated as appropriate. Standard decision rules should be followed in combining costs and outcomes. These should reflect any situation where dominance or extended dominance exists.

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2.13. Sensitivity analysis.

The sensitivity analysis is the method employed to test the robustness of the conclusions of an economic evaluation to the uncertainty and underlying assumptions made.

Uncertainty can result from the absence of certain data, insufficient precision in value assessment, and to methodology-related controversies. The sensitivity analysis also allows to tackle the problem of generalizing analysis results, i.e. it examines whether and to what extent the results based on measurements in a given sample population of patients and/or in a specific context are true for the entire population and/or in other contexts

The simple sensitivity analysis assesses the impact of a change in the value of one variable (*one-way sensitivity analysis*) or several variables (*multi-way sensitivity analysis*) on the final conclusion. The threshold analysis requires the critical variable values, leading to a change in the final conclusion, to be calculated. The extreme values analysis assesses the impact of the situation, when one or several variables assume minimum or maximum values (the analysis of the most pessimistic or the most optimistic scenarios). The probabilistic sensitivity analysis accounts for the probability of the appearance of particular values from the scope of variability of a given parameter.

It is necessary to carry out at least a simple one-way and multi-way sensitivity analysis.

In sensitivity analysis it is necessary to:

- identify “uncertain parameters”
- define credible range of variations of “uncertain parameters”,
- calculate results of analysis assuming defined variation of “uncertain parameters”.

Analysts should define the plausible ranges of values and justify the selected ranges. a plausible range can be determined by reviewing the literature, consulting expert opinion, and using a specified confidence interval around the mean. One can also assume a probable range of parameter variability (e.g. individual cost item could be varied in the range between -15% and +25% in relation to base case values). In probabilistic

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sensitivity analyses any assumptions regarding the range of values for key parameters and, the form of probability distributions should be stated and justified.

It is recommended to present the results of the sensitivity analysis in the tabular or graphical form.

2.13.1. Identifying future research needs

One of the aim of the sensitivity analysis is to identify the parameter uncertainty to which the decision is most sensitive. This information can then be fed into decisions about future research priorities.

2.14. Discussion.

The evaluation should include the discussion of the data, applied methods and results. All limitation of the study should be described and their relevance to the jurisdictions of interest discussed. Results of other analyses of the same problem should also be presented and used as a background for discussing the obtained results, justifying possible differences.