

## METHODOLOGICAL APPROACHES IN HEALTH ECONOMIC EVALUATION

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### ABSTRACT

It is undeniable that there is an increasing trend in the healthcare expenditure worldwide due to various factors. Despite this fact, there is limited resource for healthcare and the sustainability is questionable. In line with this, a number of measures have been developed to ensure the health care resources are allocated and distributed efficiently. One of the measures to ensure the efficient resource allocation is by assisting policy makers in decision making through health economic evaluation. The health economic evaluation methods include cost minimisation analysis, cost-effectiveness analysis, cost-benefit analysis and cost-utility analysis. However, the decision to conduct these analyses depends on many factors and researchers should be well versed with the characteristics, strengths and limitations of each method. Hence, this article is aimed to analyse the characteristic of these health economic evaluation methodology in health care; namely the cost minimisation analysis, cost-effectiveness analysis, cost-benefit analysis and cost-utility analysis and to identify the strengths, weaknesses, issues and challenges related to them. A literature search on information related to health economic evaluation methods were conducted. Articles, journals and related publications from online databases including PubMed, CINAHL and Google Scholar as well as hardcopy publications were used for the materials search. This article used logic matrix framework to analyse the different methodological approaches in full health economic evaluation. The similarities, differences, strengths, limitations and public health perspective between different methods were analysed and discussed. Articles, journals and related publications from online databases and hardcopy publications were used in the analysis. Relevant issues and challenges of each method were discussed. Based on various methodological approaches in the health economic evaluations, there are a number of differences, such as the valuation outcomes, effectiveness measures, strengths and limitations related to each method. In conclusion, the suitability and appropriateness of each method in evaluating public health interventions is also very much dependent on various circumstances, such as the cost and consequences of the interventions.

**Keywords:** Health economic evaluation, economic evaluation method, economic evaluation approach.

## 1.0 Introduction

### 1.1 Overview of Health Economics and Health Care

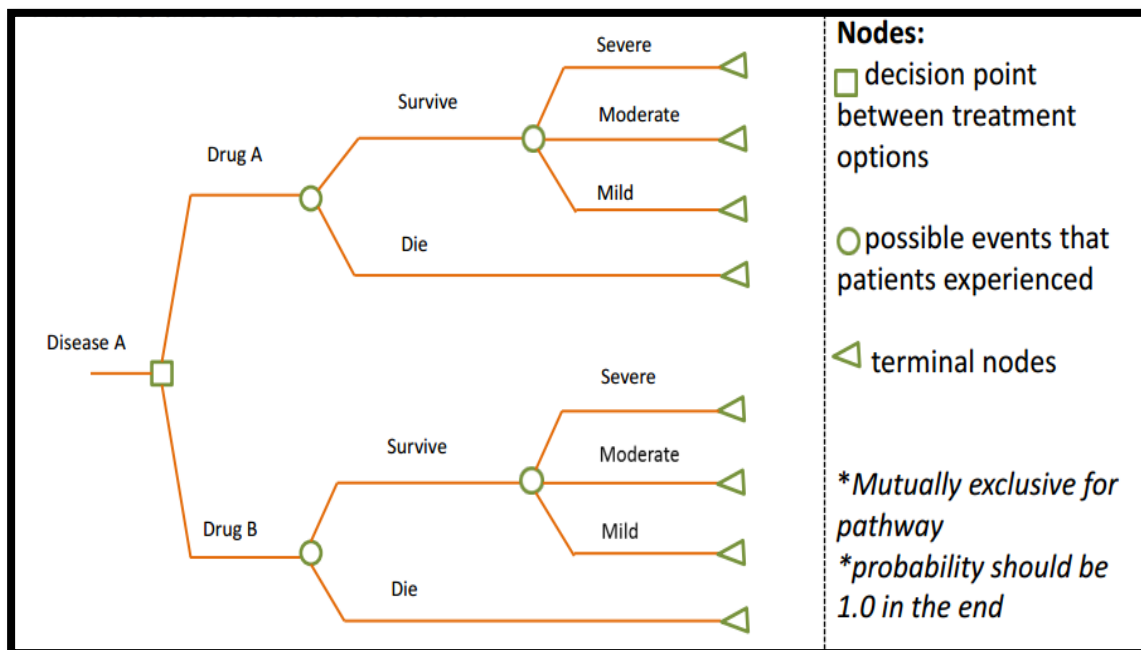
Over the years, the costs of providing health care services and treatment has increased dramatically worldwide. The World Health Organisation (WHO) estimated that 9.9% of the gross domestic product (GDP) was spent for health worldwide (WHO, 2016). There are numerous factors and challenges that contribute to the rise in the health care cost. Some of these include the change in disease pattern and the disease burden, the technology advancement, public expectation and demand, change in quality of life expectation, the relative price effect from the skilled intensify among the health providers as well as the aging population (Kobelt, 2013). The rise in health care costs has resulted a constraint in the health care provision due to the limited resources available and to which extent the resources is sustainable. Hence, efficient resource allocation is critically important in health care to ensure sustainability of the available resources in providing health care services and achieving the best possible health outcomes.

### 1.2 Health Economic Evaluation

In response to the rise in the health care cost, many countries have attempted to contain the cost using different measures. A number of methods, including the health economic evaluation have been developed with the aimed to assist decision maker to contain the health care cost and to sustain the resources.

Economic evaluation can be defined as a comparative analysis of alternative courses of action in terms of both their cost and consequences (Drummond et al., 2015). The health economic evaluation contributes to inform choices available in decision making and assists in health care policy decision making. In any economic evaluation including the health services, it always deals with the input and outputs which can be described as the cost and consequences and secondly it concerns with the choices. Therefore, an economic evaluation should identify, measure, value, and compare the cost and consequences of the alternatives being considered (Drummond et al., 2015).

Some of the tools that are commonly used in assisting decision making in health economic evaluation is by drawing a decision tree or adopting the analytic decision model under conditions of uncertainty called 'Markov model' (Sculpher et al., 2006). Markov model is applicable in health economic evaluation as it takes into consideration the use of resources and the outcomes (Sato & Zouain, 2010). Based on this technique, a patient may be assessed in a finite number of discrete states of health, in such a way that the important clinical events are modelled as transitions from one state to another (Sato & Zouain, 2010). Figure 1 below illustrates an example of a decision tree in deciding which treatment to be chosen for a disease condition.



**Figure 1:** Example of a decision tree in health economic evaluation (Source: Putri, 2015).

### 1.2.1 Methodological Approaches of Health Economic Evaluation

Several methods have been used in evaluating the health care including the full economic evaluation and the partial evaluation of the health care. Among the commonly used full economic evaluation in health care are the cost minimisation analysis (CMA), cost-effectiveness analysis (CEA), cost-benefit analysis (CBA) and cost-utility analysis (CUA). These four methods are considered as full economic evaluation as they fulfil the two main characteristics of economic evaluation which they compare at least two alternative choices in terms of the cost and consequences in the analyses. There are also other methods used in the health evaluation, such as the cost analysis, cost description, outcome description and effectiveness or efficiency evaluation. However, these methods are considered as partial evaluation of health economic as they may not fulfil all of the health economic evaluation characteristics.

The full economic evaluation methods in health care may vary in the valuation of cost, valuation of consequence they use as well the interpretation of the effectiveness measure, strength and limitations. Therefore, this article is aimed to analyse in detail the characteristic of the full economic evaluation in health care; namely the CMA, CEA, CBA and CUA as shown in the Figure 2. This article is also aimed to identify the strengths, weaknesses, issues and challenges related to these full health economic evaluation.

		Are both costs and consequences examined?		
		No		Yes
Is there a comparison of 2 or more alternatives?	No	Examines consequences only	Examines costs only	Cost-outcome description
		Outcome description	Cost description	
		Yes	Efficacy or effectiveness evaluation	

**Figure 2:** Forms of Economic Evaluation (Adapted from Mills & Gilson, 1988 & Drummond et al., 2015).

## 2.0 Materials and Methods

A literature search on information related to health economic evaluation methods were conducted. Articles, journals and related publications from online databases including PubMed, CINAHL and Google Scholar as well as hardcopy publications were used for the materials search. Keywords for the search terms included health economic evaluation, health economic evaluation methods, economic evaluation in health care, health economic evaluation approach, full health economic evaluation, cost minimisation analysis, cost-effectiveness analysis, cost-benefit analysis and cost-utility analysis. Articles on partial economic evaluation were excluded. This article used logic matrix framework to analyse the different methodological approaches in full health economic evaluation. The similarities, differences, strengths, limitations and the public health perspectives between different methods were analysed and discussed. Relevant issues and challenges of each method were also discussed.

## 3.0 Result and Discussion

In this section, the characteristics of the full economic evaluation; CMA, CEA, CBA and CUA were identified and depicted in Table 1. The similarities and the differences between the methods were analysed and compared. In addition, the strengths, limitations, a list of issues, challenges and public health perspectives for different methods in the full health economic evaluation were generated from the analysis.

### 3.1 Analysis of the Full Economic Evaluation Methods

**Table 1:** Logic Matrix Framework for Comparison between the Different Full Economic Evaluation Methods

<b>Methods Characteristics</b>	<b>Cost Minimisation Analysis</b>	<b>Cost Effectiveness Analysis</b>	<b>Cost Benefit Analysis</b>	<b>Cost Utility Analysis</b>
<b>Valuation of cost</b>	- Monetary unit (Drummond et al., 2015).	- Monetary unit (Drummond et al., 2015).	- Monetary unit (Drummond et al., 2015).	- Monetary unit (Drummond et al., 2015).
<b>Valuation of outcomes</b>	- Natural unit  - Two or more of the treatments or programmes are broadly equivalent (Briggs & O'Brien, 2001).  - The effectiveness of the interventions is known to be equivalent based on prior studies (Robinson, 1993).	- Natural unit (Brazier, Ratcliffe, Salomon & Tsuchiya, 2017).  - Outcomes are one dimensional (Shiell et al., 2002).	- Monetary unit  - Consequences of an intervention is translated into monetary term (Drummond et al., 2015).  - Benefit can be measured by actual market or hypothetical market, such as the willingness to pay (WTP) (Drummond et al., 2015).  - Benefit often best measured by the maximum WTP for the outcomes of a project (Kobelt, 2013).	- Using a generic measure of health gain called utility, such as healthy year equivalent (HYE), quality adjusted life years (QALYs) or disability- adjusted life years (DALYs) (Drummond et al., 2015 & Tan-Torres Edejer et al., 2003).

Methods Characteristics	Cost Minimisation Analysis	Cost Effectiveness Analysis	Cost Benefit Analysis	Cost Utility Analysis
<b>Effectiveness measure</b>	<ul style="list-style-type: none"> <li>- No specific effectiveness measure (Kobelt, 2013).</li> <li>- In two or more options with similar outcomes, the option with the least cost will be the option of choice (Briggs &amp; O'Brien, 2001).</li> </ul>	<ul style="list-style-type: none"> <li>- Effect per unit of cost (Drummond et al., 2015).</li> <li>- Cost effectiveness ratio (CER) is the comparison of cost and effects of each intervention (Drummond et al., 2015).</li> <li>- Incremental cost effectiveness ratio (ICER) which depicts the extra cost per unit outcome when comparing one option to another (Shiell et al., 2002 &amp; Drummond et al., 2015). ICER can be estimated by dividing the difference in cost of two interventions by the difference in their effects (Kobelt, 2013).</li> </ul>	<ul style="list-style-type: none"> <li>- Simple sum of net benefit or loss from an intervention over another (Drummond et al., 2015).</li> <li>- Ratio of cost to benefit (Drummond et al., 2015).</li> <li>- An intervention is acceptable if the incremental benefits are greater than the incremental cost (Kobelt, 2015).</li> </ul>	<ul style="list-style-type: none"> <li>- Incremental cost utility ratio (ICUR), usually expressed in cost per healthy year gained or cost per QALYs gained by undertaking one programme instead of another (Luyten, Naci &amp; Knapp, 2016 &amp; Drummond et al., 2015).</li> </ul>
<b>Public health perspectives</b>	-In very limited resources condition, CMA provides aid in decision making in determining the least cost intervention for the public	-Useful in assisting decision making by comparing effectiveness of two or more interventions outcomes for public health major concerns.	-It assists in advocating for public health policy decision making by enabling resource allocation for public health	-It may provide a holistic analysis in the public health care economic evaluation as multi-dimension of health can be included in the

Methods Characteristics	Cost Minimisation Analysis	Cost Effectiveness Analysis	Cost Benefit Analysis	Cost Utility Analysis
	<p>health benefits where equivalent outcomes are known.</p> <p>-For example, CMA can be conducted in determining the least cost therapeutic treatment with the known equivalent outcomes for a particular condition or disease, such as in identifying the least cost between three conservative treatments in patients with acute back pain in primary care setting (Seferlis, Lindholm &amp; Nemeth, 2000).</p>	<p>-It informs whether or not the interventions provide good value for money (Polinder et al., 2011).</p> <p>- For example, there were a number of CEA studies conducted to aid decision making on public health care programmes. One of the examples was the CEA of the Ministry of Health Malaysia Dialysis Programme, comparing between different dialysis modalities, with the number of life years saved was used as the outcome (Lim et al., 1999).</p>	<p>programmes to be compared to non-health programmes resource allocation in monetary values.</p> <p>- One of the examples of CBA that was applied in public health including a study on global CBA of water supply and sanitation interventions (Hutton, Haller &amp; Bartram, 2007).</p>	<p>analysis.</p> <p>-Useful in priority setting and programme planning as comparable analysis can be performed within and between countries.</p> <p>-One of the example of CUA in public health was the CUA on various tobacco consumption reduction interventions which were helpful in assisting the governments from different countries to take action on the WHO Framework Convention on Tobacco Control (Shibuya et al., 2003).</p>

Among all of these four full health economic evaluation methods, the similarity was observed in the cost valuation. All of these methods translated the cost valuation into the monetary unit where costs are defined as the costs related to the treatment used compared to the costs with an alternative treatment (Kobelt, 2013). The costs include a function of the inputs or resources used and their prices (Kobelt, 2013).

Another important feature of health economic evaluation is the outcomes valuation. There are some differences identified in the outcomes valuation across these four full economic evaluation methods. As for the CMA and CEA, it was found that both of these methods used natural units, such as number of gallstones avoided as the outcomes valuation (Brazier et al., 2017 & Drummond et al., 2015). However, in CMA, the outcomes of the intervention options should be equivalent and often known from prior studies (Briggs & O'Brien, 2001). In contrary, in CEA the outcomes between the interventions can be different but they must be in one dimension (Shiell et al., 2002). A different method on outcomes valuation is observed in CBA where the valuation of outcomes is in the monetary unit. In CBA, the benefits from an intervention are translated into monetary term. The benefits can be measured by actual market or hypothetical market, such as the willingness to pay when revealed preference is not available (Drummond et al., 2015). As for the CUA, which is the special form of CEA, a generic measure of health outcomes called 'utility', such as QALYs, DALYs or HYE are used as the outcomes valuation (Drummond et al., 2015 & Tan-Torres Edejer et al., 2003).

Form the analysis, it was also found that the interpretation of these four full health economic evaluation methods are also varied. In CMA, there is no specific effect measure but the intervention with the least cost is the option of choice (Briggs & O'Brien, 2001). In contrary, in CEA, cost effectiveness ratio (CER) or incremental cost effectiveness ratio (ICER) is used as the effectiveness measure (Drummond et al., 2015). The average CER represents the average cost in achieving an outcome given a specific intervention but it has no value in the resource allocation (Kobelt, 2013). In contrary, ICER that can be estimated by dividing the difference in cost of two intervention by the difference in their effects provides an estimate of the additional resources needed to be spent in order to obtain the additional benefit (Kobelt, 2013). If a treatment is more effective and less costly, it is the 'dominant' alternative and it will be the option of choice (Kobelt, 2013). However, decision maker can make a decision whether or not to allocate resources to the more costly alternative by considering whether or not the extra cost is justified by the extra benefits gained (Kobelt, 2013). In CBA, the ratio of cost to benefit is used as the effectiveness measure (Drummond et al., 2015). A health care intervention is considered to be good value when the total value for the total benefits exceeds the total costs (Kobelt, 2013). In the CUA, the incremental cost utility ratio (ICUR) which indicate the cost per healthy year gained or cost per QALYs gained by undertaking one programme instead of another is used as the effectiveness measure (Drummond et al., 2015).

### ***3.2 Strengths and Limitations of The Health Economic Evaluation Methods***

Upon analysing the different methods in the full health economic evaluation, there are some strengths and limitations that are related to each method. The advantage that is observed with CMA is that it is simpler compared to other health economic evaluation methods and it is justified for the interventions with similar outcomes (Briggs & O'Brien 2001). As for CEA, it was found that the results is more accurate and less bias compared to the CMA as it takes into account the uncertainty; the incremental benefits in the analysis (Dakin & Wordsworth, 2011). Besides, the use of natural unit in CEA provides meaningful analysis to the study users



compared to the CUA that used utility (Polinder, Toet, Panneman & van Beeck, 2011). As CBA translates the outcomes into monetary term, one of its advantages compared to the CEA and CUA is that it enables the comparison of investment not only between different intervention in health care sector but also with investment in non-health sectors (Kobelt, 2013). In addition, CBA also informs the willingness to pay as it is used as a method for the outcomes valuation in the analysis (Kobelt, 2013). In terms of CUA, one of its main strength is that it combines the life expectancy and the overall quality of life aspect in the analysis (Kobelt, 2013). Besides that, CUA can be used to compare interventions that affect more than one dimension of health as well as interventions for similar health conditions affecting different dimension of health can be compared (Brazier et al., 2017). In addition, as CUA used standard outcome measures, it enables comparison between interventions for different conditions affecting different dimension of health in different areas of health care to be analysed (Brazier et al., 2017 & Kobelt, 2013). Subsequently, CUA enables the assessment on opportunity cost of adopting programmes (Drummond et al., 2015).

Apart from the strengths, there are also some limitations associated with each of the full health economic evaluation method. There are a few limitations that are associated with CMA as it is only restricted to be carried out on the interventions with known effects. Hence, it cannot be applied in the analysis of interventions with unknown effects. Besides, CMA may produce a bias result as it assumes the incremental efficacy to be zero (Dakin & Wordsworth, 2011). As for the CEA, a number of limitations were observed. One of them is that CEA cannot be used to compare interventions that affect more than one outcome as only one measure of outcome can be used in the analysis (Brazier et al., 2017). Subsequently, it leads to the difficulty in assessing the opportunity cost, such as the benefits forgone in conducting other health programme with similar amount of budget due to using one specific outcome measure (Drummond et al., 2015). Besides, CEA also does not inform WTP compared to the CBA. As for the CBA, one of the main limitations is the difficulty to translate the benefits into the monetary term especially in the benefits with no well-defined market prices, leading to inaccuracy and bias of the results (NCCHPP, 2014). Even though CUA seems to be quite a concrete health evaluation method, there are still a number of limitations of CUA identified. One of them is the differences on the ICUR generated between different studies as different methods to estimate utilities may be used by different studies leading to differences in the values generated (Kobelt, 2013). Besides, there are certain intended indirect benefits from a health intervention that require longer time frame may not be able to be captured in the CUA (NCCHPP, 2014).

### ***3.3 Issues and Challenges Related To The Full Health Economic Evaluation Methods***

In this section, some of the issues and challenges related to the full health economic methods were discussed. Some of the issues and challenges identified were the appropriateness of CMA as full health economic evaluation method, the ethical issue in outcome valuation in CBA, the challenges in translating the benefits into monetary term in CBA as well as the outcome valuation issue in CUA.

One of the issues argued in the full health economic evaluation methods is the appropriateness of the CMA. As CMA is only comparing the cost between different interventions with known similar effect, it is argued that CMA can no longer be considered as a method for full health economic evaluation (Drummond et al., 2015). Even though by definition, CMA fulfils the characteristics of full health economic evaluation, the assumptions that the incremental effects equals to zero with no uncertainty in CMA makes the results less accurate compared to other

methods, such as the CEA (Dakin & Wordsworth, 2011). Besides that, the methods in determining the different interventions having equivalent outcomes under uncertainty by the analysts are also questionable (Briggs & O'Brien, 2001). Based on the limitations of the CMA, it may only be justifiable to be conducted in the interventions with known similar outcomes, such as in drugs trial in the same class with equal effectiveness (Dakin & Wordsworth, 2011).

There are also some controversial issues related to the CBA. One of them is the challenges in translating the benefits into monetary term. As the outcome valuation can be done through estimating stated preference when there is no actual market, such as in WTP method, measuring the value may lead to inaccuracy and bias (NCCHPP, 2014). Besides, the WTP was also found to be associated with the level of income and this subsequently raised the possibility of CBA is actually informing the ability to pay (ATP) instead of WTP for certain intervention for health improvement. This is because a much lower value will be placed by those with lower income compared to a higher value by the higher income group. Hence, it is argued that placing priority in a health intervention based on CBA may only benefit the wealthy compared to options that primarily benefit the less well-off individuals (NCCHPP, 2014). Besides, it was also found that individuals may value harm reduction benefits at a similar monetary value regardless the size of the reduction (NCCHPP, 2014). In addition to these, there is also strong ethical objection against placing monetary value on health in CBA, especially in valuing human life (Kobelt, 2013).

Even though CUA seems to have the most advantages compared to other full health economic methods, there are still a few issues and challenges pertaining to the CUA. One of the main issues in CUA is the issue in its outcome valuation. As the outcome valuation is based on the individual preference, a variation in the evaluation of one condition may be derived from different individuals as a result from difference in their experience and socio-economic factors (NCCHPP, 2014). Besides that, there is also equity issue related to the outcome valuation in CUA. There is an argument on treating QALYs equally regardless of the age and gender (NCCHPP, 2014). By treating QALYs equally, this could lead to various forms of discrimination, such as to the older group. For example, by giving intervention to the younger age group, more QALYs will be gained compared to the older age group just because the younger will live much longer compared to the older group. This will lead to the decision makers to favour intervention targeting the younger group instead of the older group (NCCHPP, 2014).

#### **4.0 Conclusion and recommendation**

Based on various methodological approaches in the full health economic evaluation, there are a number of strengths and limitations related to each method. The suitability and appropriateness of each method in evaluating public health interventions is also very much dependent on various circumstances, such as the cost and consequences of the interventions. To date, more researchers are conducting CUA to ensure that the results of the analysis are comparable. However, CBA seems to be more applicable when the aim of the analysis is to compare or for resource allocation between intervention in health sector comparing to those in non-health sector. In conclusion, any of these full health economic evaluation methods namely; the CMA, CEA, CBA and CUA can be applied in order to fully evaluate the health

intervention economically taking into consideration the strengths and limitations of each method.

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No conflict of interest is declared.

## Author's contribution

Author 1: information gathering, preparation and drafting of manuscript

Author 2: editing and final review of manuscript

Author 3: review of manuscript

Author 4: review of manuscript

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