Handling Time in Economic Evaluation Studies

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The discount rates and time horizons used in a health technology assessment (HTA) can have a significant impact on the results, and thus the prioritization of technologies. Therefore, it is important that clear guidance be provided on the appropriate discount rates for cost and health effect and appropriate time horizons. In this paper, we conduct a review of relevant case studies and guidelines and provide guidance for all researchers conducting economic evaluations of health technologies in the Thai context. A uniform discount rate of 3% is recommended for both costs and health effects in base case analyses. A sensitivity analysis should also be conducted, with a discount range of 0-6%. For technologies where the effects are likely to sustain for at least 30 years, a rate of 4% for costs and 2% for health effects is recommended. The time horizon should be long enough to capture the full costs and effects of the programs.

Keywords: *Time horizon, Discounting, Economic evaluation guideline, Thailand*

J Med Assoc Thai 2014; 97 (Suppl. 5): S50-S58
Full text. e-Journal: *http://www.jmatonline.com*

Time horizon refers to the time period over which cost and outcome data can be measured. The length of a time horizon will vary depending on several factors, including the nature of the disease, the budget, the population, and the nature of the research. The time horizon should be designed so that is long enough to capture all relevant costs and outcomes, and to ensure that the results are useful, accurate, and relevant. In practice, short time horizons are often favored in study designs, as they are regarded as more practical and less expensive. However studies that use longer time horizons often result in economic evaluation data that are much closer to reality, as they allow the researcher to monitor the long-term consequences of the health technology under investigation, including those associated with medicinal side effects or drug resistance, which often manifest themselves later[1].

As both long and short time horizons offer various but differing benefits, choosing which time horizon should be used in any Health Technology Assessment (HTA) is often complex and challenging[2-5]. One unresolved issue related to the choice of time horizon is how best to incorporate the effect of interventions in complex scenarios, such as those associated with various non-communicable diseases (for instance, how best to capture the effect of cardiovascular therapy on diabetes). It is known, for instance, that many interventions that extend life may result in future unrelated costs and may have no health-related effect on the patient beyond those associated with the natural aging process[6]. The US Public Health Service Panel on Cost-Effectiveness in Health and Medicine[3] recommends that individual researchers use their own judgment when deciding whether to include or exclude these costs and benefits. If the costs are small relative to the magnitude of the cost-effectiveness ratio, they can be excluded. On the other hand, if the costs are large relative to the magnitude of the cost-effectiveness ratio, they recommend using a sensitivity analysis to assess the effect of these costs and benefits.

The WHO recommends[7] that a Cost Effectiveness Analysis (CEA) be used to evaluate all interventions over a period of 10 years at full implementation. However, this time horizon might not be appropriate in some situations, especially when evaluating vaccinations or treatments for chronic diseases, where the time horizon for the analysis clearly needs to be longer. Analyses must capture all of the health effects of the intervention that occur during the 10-year time horizon as well as those that occur subsequently. A general rule, which has been validated by a recent study review that compares different guidelines from various countries[8], is that the time

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horizon of any study should be long enough to capture the full effects of the intervention[6,9].

The theory behind discounting

For one-year projects, the net benefit, cost-benefit ratio, or cost-effectiveness ratio can be easily calculated, and the results of various alternatives can be compared. However, many projects continue for more than one year, and sometimes the costs and benefits of a project can occur more than a year after treatment. This makes it hard to compare the costs and benefits of treatments because their values may vary according to different time periods. In order to make costs and benefits compatible, all values should be adjusted to present values (present worth), and future values should be adjusted by a certain rate called "discount rate[2,3,10,11]". An overview of how discount rates work, and a summary of two well-known economic concepts related to discount rate–time preference and opportunity cost of capital–are explained in detail in the first edition of the HTA guidelines for Thailand[12].

Should discount rate be equal for both costs and effects?

Discounting is performed to adjust future costs and effects for their differential timing. This helps decision-makers compare costs and effects for the same point of time. It is a common practice in health economic evaluations to perform discounting on both future costs and benefits. Discounting future costs and benefit in cost-benefit analyses (CBAs) is widely accepted. However, the practice of discounting for life years saved and quality-adjusted life years (QALYs) in cost-effectiveness analyses (CEAs) and cost-utility analyses (CUAs) has become controversial in recent years. One reason for this is that health, unlike wealth, cannot be invested to produce future gains[13], which led some scholars to suggest that health effects should be discounted at a very low rate (1.5-2%) or even not discounted at all[13,14]. A detailed analysis of the advantages and disadvantages of utilising a uniform or differential discount rate in economic evaluations is given in the first edition of HTA guidelines for Thailand[12].

National Institute for Health and Clinical Excellence (NICE) guidance

Many countries follow the healthcare project, appraisal guidance of the UK's National Institute for Health and Clinical Excellence (NICE). In its first recommendation of this kind, published in 2001, NICE recommended that health benefits be discounted at a lower rate than costs (1.5% for health benefits as opposed to 6% for costs)[15], in line with the recommendation of the UK Department of Health[16]. The rationale behind using different discount rates was to adjust for the increasing the value of health effects. When health effects were measured in quantities such as QALYs, discounting the health effects at a lower rate than that used to adjust for costs enabled the analysis to take into account any increase in the future value of health effects. In 2004, NICE revised the guideline by requiring that both costs and effects be discounted at a 3.5 % rate[17], the social time preference rate (STPR)stipulated by the UK Treasury. This recommendation remains in use today[18], despite a suggestion, made in 2011, that NICE use a lower discount rate for health effects than costs. This was considered briefly as a way to capture accurate data from projects where the treatment cost is borne immediately and the health effects are felt far into the future, data that studies following the current guideline often missed. For example, the treatment of bone cancer in children and young people was originally deemed not cost-effective, based on the NICE threshold. However, the suggested revision of the guideline was not accepted; instead, a smaller modification was made in the form of suggesting that an additional sensitivity analysis be conducted when the treatment effects are both substantial in restoring health and sustained over a very long period (at least 30 years)[19].

Shortly after NICE stipulated that both health effects and costs be discounted at the same rate, a number of researchers challenged this recommendation, instead claiming that the use of different discount rates was more appropriate[14]. In economics, the policy objective of any government agency is the optimisation of social welfare within the constraints of the budget. This objective determines the criteria for the optimal rates that should be used when discounting costs and health effects[14,20-22]. It is clear, therefore, that government agencies should apply a lower discount rate for health effects than they do for costs, as the consumption value of health effects and the cost-effectiveness threshold increase overtime.

Claxton et al[22] have suggested that the social objectives of the health-care decision-makers for whom the CEA is being conducted should determine whether change in the cost-effectiveness threshold and the consumption value of health overtime be considered or not. These objectives are defined by either, 1) present net consumption value of health

maximisation, which is derived by monetising both the costs and the effects of the health technology or 2) present net value of health maximisation, which is derived by measuring the social welfare generated by the health technology. With the former objective, health technology is evaluated by monetising both costs and effects. The net health effect, given in terms of monetary value represents a measure of social welfare in economics, therefore guaranteeing that the technology that maximizes net monetary value will be chosen. In contrast, with the latter objective, health effects are measured in quantity rather than in monetary value, by comparing the incremental cost-effectiveness ratio (ICER) value with a cost-effectiveness threshold. An optimal health technology is one for which the ICER is less than the threshold. Nevertheless, satisfaction of this objective does not necessarily mean that the technology maximizes social welfare, because ICER is only used to prioritise health technologies. Therefore, the technology that maximises net monetary value should be chosen.

For this reason, when assessing health effects purely in terms of monetary benefit, any change in the consumption value of health effects and cost-effectiveness threshold are fully accounted for, making further adjustment unnecessary. In contrast, when assessing health effects in terms of the social benefit, health effects are not monetized and, therefore, some adjustments must be made to handle the changes in both values. One practical way to incorporate such changes is to modify the discount rates for costs and health effects[20].

Claxton et al[22] support NICE's recommendation that an STPR of 3.5% be used for consumption or social time preference rates (r_c), as the discount rates for costs (d_c) and health effects (d_h) are optimal only under some conditions. The appropriate discount rates vary according to the decision rule, which is related to the social objective. Table 1 shows the optimal discount rates for health effects and costs for both social objectives. Where the social objective is the maximising of welfare (net present consumption value of health), the health effects discount rate (d_h) is approximately equal tor$_{c,}$ less the growth rate of health value (g_v). This is because when g_v is positive, the value of health consumption will be valued by society more highly in the future, and d_h should be less than r_c. However, the discount rate for the costs (d_c) is r_c minus g_v because the health for gone by the adoption of the technology will also be valued more highly in the future. In addition, the discount rate for the costs must include the growth in the cost-effectiveness threshold (g_k). This adjustment is necessary because future costs will displace less future health if the threshold increases overtime. If technology is fixed but the health budget increases overtime, the positive value of g_k implies that the technology adopted in the future will be less cost-effective compared to that adopted in the present. It is clear, therefore, that an increase in health value does not justify the use of different discount rates. However, it does indicate that the use of a rate below the social time preference rate for both discount rates is fitting. The gap between the discount rates for costs and health effects depends on the growth rate of the threshold only. For the maximization of this welfare objective, therefore, NICE guidance should only be adopted where there is no growth in either the cost-effectiveness threshold or the health value ($g_k = 0$ and $g_v = 0$).

Where the social objective is the maximizing of the present net value of health, health benefits are measured using instruments such as QALYs. In this case, the discount rate for health effects (d_h) is approximately equal to the social time preference rate for health (r_h), while the discount rate for costs (d_c) is r_h plus g_k. If the cost-effectiveness threshold increases over time, then future cost becomes less important. Under this social objective, NICE guidance is appropriated only where there is no growth in the cost-

Table 1. Optimal discount rates for health effects and costs under different social objectives

Social objectives	Discount rate for health (d_h)	Discount rate for cost (d_c)
1. Net present consumption value of health maximisation	$\sim r_c - g_v$	$\sim r_c - g_v + g_k$
2. Net present value of healthmaximisation	$\sim r_h$	$\sim r_h + g_k$

Claxton K, et al[22]

d_h = Discount rate applied to unadjusted health gains; d_c = Discount rate applied to unadjusted costs; g_k = Growth rate of the threshold; r_h = Social time preference rate for health; g_v = Growth rate of consumption value of health; r_c = Social time preference rate for consumption

effectiveness threshold ($g_k = 0$), and the social time preference rate for health is equivalent to the social time preference rate for consumption ($r_h = r_c$).

When using the same discounting rate for costs and health effects (as recommended by NICE), social optimality is only obtained when the cost-effectiveness threshold is constant overtime. Theoretically, two factors affect a cost-effectiveness threshold: 1) expectation about health-care budget and 2) health technology development. The threshold will increase if the budget is expected to increase and it will decrease if the technology becomes more cost-effective. Therefore, fixing the cost-effectiveness threshold constant over time is an acceptable assumption. However, when policy makers adjust the optimal budget by changing the threshold to be consistent with the growth of health value ($g_k = g_v$), the appropriate discount rates for costs and effects must be different, as health values have been shown to grow overtime[23-26].

The impact of time horizon and discount rate: A case study in Thailand

In practice, whether the discount rates for costs and health effects are set as the same or whether a long or short time horizon is used in any given study, it will have an impact on how different health technologies are prioritized. This is especially true when policy-makers have to make decisions about whether treatment or prevention is a better option for a given condition. Given this, a review of existing Thai studies on economic evaluation of policy options for prevention and control of cervical cancer was conducted to examine the impact of time horizon and rate of discount on study findings in the Thai context[27]. The analysis attempted to reveal how the choice of different time horizons and whether a different or uniform discount rate was chosen for costs and health effects affected study findings. Given the willingness to pay threshold in Thailand of 160,000 THB, the main findings, also given in Table 2, were as follows:

1. For longer time horizons, new health technologies are more likely to be cost-effective. The ICER of all alternatives was likely to decline over longer time horizons. Under a lifetime horizon, an ICER of less than 160,000 THB/QALY was found for the following scenarios: a Papanicolaou test (pap smear) conducted every five years (in patients aged 30-60 years); a visual inspection with acetic acid (VIA) conducted every five years (in patients aged 30-45 years); a VIA conducted every five years (in patients aged 30-45 years) and pap smear conducted every five years (in patients aged 50-60 years).

2. Studies that did not use discount rates were likely to result in lower ICERs.

3. When a uniform discount rate was used for both cost and health effects, the greater the discount rate, the less likely it was that the treatment was found to be cost-effective. As Table 2 shows, given a 30-year time horizon, conducting a pap smear every 5 years (in patients aged 30-60 years), generated an ICER of 199,942, 239,032, and 365,388 THB/QALY when a discount rates of 3%, 5%, and 10% were used, respectively.

4. Applying a different discount rate to costs and health affects study findings on the efficiency of the health technology:

- When the health effect is discounted at a higher rate than cost, ICER goes up as the gap between the discount rate of the health effect and cost increases. For example, in studies with a 30-year time horizon, where the health effect of a pap smear every 5 years (for patients aged 30-60 years) was discounted at 3%, 5%, and 10%, and cost was not discounted, the ICER was equal to 326,885, 539,680, and 1,805,551 THB/QALY, respectively.

- When the health effect is discounted at a lower rate than cost, the ICER goes down as the gap between the discount rate of the health effect and cost increases. For example, within a 30-year time horizon, when health effect was not discounted but the cost of conducting a pap smear every 5 years (for patients aged 30-60 years) was discounted, discount rates of 3%, 5%, and 10% resulted in an ICER of 92,232, 66,787, and 30,515 THB/QALY, respectively.

- When health effect is discounted at a lower rate than cost, the time horizon within which the health technology becomes cost effective becomes shorter. For example, with a 30-year time horizon, where the health effect of conducting a pap smear every 5 years (in patients aged 30-60 years) was not discounted, but cost was (at a rate of 3%), the ICER was found to fall under the threshold (92,232 compared with 160,000 THB/QALY). If health effects and costs were both discounted at 3%, the ICER was found to be equal to 199,942 THB/QALY, rising to 326,885 THB/QALY when health effect was discounted at 3% and cost was not discounted.

This finding corroborates the findings of Bos et al[28], who reviewed the impact of discounting for vaccination programs, diabetes interventions, and cancer interventions, and showed that in preventive

Table 2. The impact of discount rate and time horizon upon Incremental Cost-Effectiveness Ratio

Technology	Incremental Cost-Effectiveness Ratio (ICER)*									
	Cost 0%	3%	3%	0%	5%	5%	0%	10%	10%	0%
	Effect 0%	3%	0%	3%	5%	0%	5%	10%	0%	10%
Pap smear every 5 years (age 30-60)										
20 years	6,221,664	9,218,510	3,972,326	14,438,512	12,952,865	2,966,938	27,162,136	105,015,895	1,465,128	445,949,745
30 years	150,790	199,942	92,232	326,885	239,032	66,787	539,680	365,388	30,515	1,805,551
Lifetime	-68,215	-59,714	-12,704	-320,642	-47,930	-4,009	-815,608	12,139	133	-6,235,762
VIA every 5 years (age 30-45)										
20 year	4,369,407	6,260,609	2,789,687	9,805,815	8,447,854	2,083,506	17,716,350	34,575,728	1,028,596	146,875,396
30 year	67,701	101,993	47,092	146,628	129,181	36,155	241,897	216,586	18,165	807,205
Lifetime	-74,354	-72,471	-16,836	-320,058	-65,979	-6,385	-768,327	-25,629	-367	-5,193,478
VIA every 5 years (age 30-45) + Pap smear every 5 years (age 50-60)										
20 years	4,369,407	6,260,609	2,789,687	9,805,815	8,447,854	2,083,506	17,716,350	34,575,728	1,028,596	146,875,396
30 years	67,701	101,993	47,092	146,628	129,181	36,155	241,897	216,586	18,165	807,205
Lifetime	-72,842	-69,031	-14,863	-338,316	-59,271	-4,874	-885,872	-18,288	-208	-6,397,858

Results provided only some examples.; *ICER negative meaning cost saving (cost reduced with better health effect); Base case scenario included 20% coverage of screening interventions, 100% coverage of human papillomavirus (HPV) vaccine, lifetime duration of vaccine protection and 15,000 THB for full immunization

Table 3. Discount rates for costs and health effects from international guidelines

Discount rate	Number of guidelines	Discount rate (percent)				
		Mean	Median	Mode	Minimum	Maximum
Same discount rate						
Single rate	19	4.32	4.66	5	3	7
Multiple rate	3	3.56	3	0,3,5	0	10
Others	5					
Differential discount rate						
Costs	5	4.4	4.4	5	3	5
Effects		1.6	1.6	1.5	0	3.5
Both	2					
Not specify	1					

ISPOR[29]

programs with distant future health gains, such as infant vaccination programs or certain screening programs, discounting health effects has a strong impact on the results of the cost-effectiveness analyses. In many studies, the impact is so large that the discount rate is likely to influence decision-making.

Comparisons of the international economic evaluation guidelines

The International Society of Pharmaco-economics and Outcomes Research (ISPOR)[29] compiles country-specific guidelines for economic assessment, using the criteria for economic assessment as defined by Hjelmgren et al[9], from around the world (they currently list 35 sets of guidelines from 34 countries around the world). ISPOR divides the guidelines into the following three types:

1) Published Pharmaco-economic Recommendations: Country-specific economic evaluation guidelines or recommendations published by experts in the field but, not officially recognised or required by the health care decision-making bodies/entities in the country/region for reimbursement.

2) Pharmaco-economic Guidelines: Country-specific official guidelines or policies concerning economic evaluation that are recognised or required by the health care decision-making bodies/entities in the country/region for reimbursement.

3) Submission Guidelines: country-specific, official guidelines or policies concerning drug submission requirements that include stipulations on economic evaluation must be adhered to by the health care decision-making bodies/entities in the country/region for reimbursement. Whereas most of the guidelines recommend that the time horizon of an economic evaluation should be long enough to capture all the essential costs and health effects, most do not stipulate a specific length of time. Four countries–Italy, Russia, Switzerland and Israel–do not include any information at all on appropriate time horizons for economic evaluations.

Most of the guidelines collected by ISPOR[29], stipulate the use of the same discount rate for costs and health effects, and many give specific rates. The average identical discount rate in the ISPOR selection was 4.32%, and the minimum rate and maximum rate were 3% and 7%, respectively (Table 3). Some countries do not specify a specific discount rate, and they were not included in this part of the analysis. For example, China recommends using a one-year interest rate for both costs and effects, whereas France, Switzerland, and Finland suggest the use of multiple equal discount rates. Guidelines from Belgium, the Netherlands, Poland, and Scotland all suggest that health effects should be set at a lower rate than that used for costs (which is consistent with the recommendation of British Medical Journal).

Our analysis show that equal discount rates for costs and effects should be used where the cost-effectiveness threshold is constant; a higher discount rate should be set for costs when the threshold is expected to increases overtime. The World Health Organisation (WHO) suggests that the threshold that should be used in CEAs of health care technologies should never be greater than three times the value of per capita Gross Domestic Product (GDP), which reflects the assumption that the GDP per capita tends to rise over time and thus, too will the threshold. In the

case of Thailand, in 2007, the cost-effectiveness threshold was initially set at 100,000 baht per QALY[30]. Later, the threshold was revised to 160,000 baht per QALY, where it has remained ever since[31], indicating that the threshold has not increased over time in Thailand.

Guidelines for Health Technology Assessment in Thailand (Second Edition): Recommendations for handling time in economic evaluations

Time horizon

The time horizon used in any economic evaluation of health technologies in Thailand should be long enough to capture the full costs and effects of the intervention. Researchers are encouraged to use modelling techniques and/or epidemiologic data to estimate future costs and effectiveness and then deploy appropriate discounting.

Discounting

Where appropriate, costs and health effects should be discounted at the same annual discount rate–3%, a sensitivity analysis should also be conducted using a uniform discount rate for costs and health effects ranging from 0-6%. The finding should be displayed as a tornado diagram. Where effects are substantial and exhibit over a very long period (30 years or more), a rate of 4% for cost and 2% for health effect should be applied, so that the cost-effectiveness threshold changes in line with the growth of health value ($g_k = g_v$). This ensures a difference between the two rates of 2%, which is in line with recommendations of other international guidelines and NICE.

Acknowledgement

The development of these guidelines would not have been possible without the technical support, challenging criticism and encouragement of many colleagues and institutions. As authors, we wish to acknowledge all individuals and related organizations that contributed throughout the process for guideline development. In addition, we would like to give particular thanks to the funding support through the Health Intervention and Technology Assessment Program (HITAP) from National Health Security Office, the Thailand Research Fund under the Senior Research Scholar on Health Technology Assessment (RTA5580 010) and Thai Health Global Link Initiative Program (TGLIP), supported by Thai Health Promotion Foundation.

Potential conflicts of interest

None.

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การจัดการกับเวลาในการประเมินความคุ้มค่าทางสาธารณสุข

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กรอบเวลาและการใช้อัตราลดที่เท่ากันหรือแตกต่างกันปรับลดต้นทุนและผลลัพธ์เป็นประเด็นสำคัญในการประเมินทางความคุ้มค่าทางสาธารณสุขซึ่งมีผลกระทบต่อการจัดลำดับความสำคัญของโครงการต่าง ๆ ที่เปรียบเทียบกัน บทความนี้ได้นำเสนอเหตุผลและกรณีศึกษาของประเทศไทยในการสนับสนุนอัตราลดของต้นทุน และผลลัพธ์ที่ใช้ รวมทั้งกรอบเวลาที่เหมาะสมในการประเมินความคุ้มค่าทางการแพทย์ในประเทศไทย อัตราลดของต้นทุนและผลลัพธ์ที่แนะนำในกรณีพื้นฐานทั่วไปคือร้อยละ 3 และทำการวิเคราะห์ความไวในช่วงอัตราลดร้อยละ 0-6 กรณีที่โครงการนั้น ๆ มีผลกระทบทางสุขภาพตั้งแต่ 30 ปีขึ้นไปให้ทำการวิเคราะห์ความไวที่อัตราลดร้อยละ 4 สำหรับต้นทุน และร้อยละ 2 สำหรับผลลัพธ์