Health Tech Asmnt Act. 5(4). doi: 10.18502/htaa.v5i4.10165

Research Article

Applying Multi-Criteria Decision Making (MCDM) in Health Technology Policy Making: Background, Current Challenges, and Path to Future

Mohammadreza Mobinizadeh[1], Alireza Olyaeemanesh[1], Marita Mohammadshahi[1]*, Zeinab Fakorfard[1]

[1] National Institute for Health Research, Tehran University of Medical Sciences, Tehran, Iran

Corresponding Author: National Institute for Health Research, Tehran University of Medical Sciences, Tehran, Iran. Email: m.mohamadshahi@gmail.com

Received 2021 August 13; Accepted 2021 September 05.

Abstract

Introduction: The science of health technology policy-making has, in recent years, gone beyond merely conducting health technology assessment studies, systematic reviews or economic evaluations. In fact, sciences based on decision-making in operational research, such as multi-attribute and multi-objective decision-making methods, have been added to this field.

Methods: Examining several prominent papers in the field of applying multi-criteria decision analysis to the science of health technology assessment, this study attempts to provide guidance for policy makers in the field of health technologies to acquaint them with the history, current challenges, and the future of this field.

Results: Mathematical approaches based on multi-criteria decision analysis began to be used in the fields of health policy making and economics in 2006 and 2008. These approaches are still being completed to adapt to the field of health. The main challenges in this regard are the existence of attributes such as equity and ethical issues facing the use of technology in health systems. The quantitative assessment of such attributes is really demanding. It is also very difficult to weight the attributes in such a way that all the considerations regarding technology stakeholders can be taken into account.

Conclusions: In general, the application of approaches from applied mathematics to the field of health technology policy making can help us clarify the prioritization process. At the same time, however, using the efforts made so far by researchers in this field from around the world, we have, to a large extent, been able to overcome the operational shortcomings in applying those approaches in the field of health.

Keywords: Decision Making; Health Technology; Policy Making

1. Introduction

Decision makers are always judged based on the results of the decisions they make. Therefore, they need to increase the accuracy of the models they use in decision making in order to respond to the hectic conditions of today's markets and make effective decisions. In addition, the rapid growth of economics and technology in recent decades has dramatically changed human life, leading to the confrontation of modern societies with complex decision-making problems. Today, the health sector is also facing restricted resources as other sectors all over the world (1). This limitation of resources leads to having no choice except finding the best possible way to spend the available resources. To do so, methods of prioritizing services and how to use them are required (1).

One of the most dominant ways in prioritizing services in the field of health is to use health technology assessment in choosing health technologies since, in recent years; there has been a significant growth in using medical technologies. Appropriate use of these technologies can help diagnose and treat diseases. On the other hand, unlimited import of these technologies may cause induced demand by service providers and the over-consumption of the technologies. This problem has been prevalent in many developed and developing countries, causing an increase of expenditures. Therefore, assessments should be systematically carried out before importing such technologies with regard to issuing permissions for import and how to use them so that the available resources are used optimally (2).

In recent years, the science of health technology policy making has hardly moved further than conducting a health technology assessment study or a systematic review or an economic assessment by including the science of decision-making in operational research like multi-cri-

teria decision making. In other words, health technology policy-making is based on the following process: (1) Prioritizing research topics in conducting health technology assessment, (2) determining the scope of research (PICOD), (3) conducting health technology assessment, (4) appraising technologies to be included in the package of health services or entering into the practice, (5) communication and appeal (3).

Multi criteria decision making majorly related to the operations research involving a wide range of methodologies. MCDA techniques have wide application in public-sector and also in private-sector decisions (4). Multicriteria decision analyses are classified into two general categories: multi-objective models (MODM) and multi-attribute models (MADM), with the former models being used in designing issues and the latter models used in selecting the best choice (4).

MCDA is increasingly used to support health care decision making. The MCDA includes decision makers who evaluate the options under consideration based on the explicit weighting of the criteria associated with the overall decision. A prime example of the MCDA used in health care decision-making has received much attention in recent years, is the selection of health "technologies" to fund. Other applications include prioritizing patients for surgery, prioritizing diseases for research (5).

Considering the increasing use of such methods in the field of health sector decision-making, especially in the field of health technologies, this study intends to draw a future path in this field by reviewing and interpreting the history of, and challenges in, using these approaches in the field of health technology policy making (included papers in this commentary majorly related to the technical ones which focused on the development of using MCDM models in health technology policy making).

2. The History of Applying the Model

Basically, there are two approaches for prioritizing health technologies: The first approach is the use of technical analyses, which rely on quantifiable epidemiological, clinical, financial as well as other types of data. The second approach is the use of interpretive evaluations, which is based on the consensus of the views of informed participants. Technical approaches depend on data accessibility, and priorities are made based on terms of measurable units such as diseases or interventions. The problem with quantitative approaches is that they may ignore the amount of judgments made by stakeholders who do not participate in the method. Approaches which are based on consensus among stakeholders rely solely on stakeholders' subjective judgments and this can lead to mistakes in health technology policy making because their opinions may not be in line with data-based scientific evidence (clinical and economic) or their opinions may result in inductive demand in health systems.

The first application of multi-criteria decision making models in prioritization goes back to two studies in 2006 and 2008 in which the possibility of applying these models in the field of health was introduced (6, 7).

Both models followed almost the same mechanism and could, in 2010 and 2012, help the researchers to decide on the use of growth hormone in the treatment of Turner syndrome and be implemented in prioritizing the use of public health packages in Thailand, all entirely based on a quantitative process (8, 9).

Given that both models were based on quantitative data, the authors of both models came to realize that many decisions in the field of health feature criteria and variables that cannot be completely quantified and, at the same time, have a high impact on the populations they cover (ethical and organizational criteria are a few examples). Therefore, the authors tried to develop models that, while being quantitative and transparent, could apply the views of health stakeholders (in the context of informed negotiation) in that area of decision-making and provide a comprehensive model.

In the included studies, analyses which are based on multi-criteria decision making are mainly conducted in 3 sections in the field of health technology policy making:

2.1. Prioritizing and Selecting Topics to Perform Health Technology Assessment

In this area, some studies have employed multi-criteria decision analysis methods to prioritize the conduction of research on the suggested topics and proposals for health technology assessment. One of the most important projects of this type is the project conducted in Canadian Agency for Drugs and Technologies in Health (CADTH) in 2010. Based on the stakeholders' opinions and in line with the Analytic Hierarchy Process (AHP) model, which is a kind of multi-criteria decision-making model based on the opinions of experts, the proposals are prioritized (10).

Another model is the one conducted in Iran in 2016 and 2020, which was based on different multi-criteria decision-making techniques and determining the roles of different influential attributes in the field of prioritizing research in health technology assessment and simultaneously receiving stakeholders' opinions (11, 12).

2.2. Prioritizing the Technology Under Study in Comparison with Its Control Group in a Health Technology Assessment Report

The decision-making process to allocate resources is a complex process. Taking into account the views of health care providers and recipients leads to better decision

making (13). In recent decades, multi-criteria decision analysis (MCDA) has also been used more frequently in the field of health technology assessment (HTA) (14). In this method, and under the EVIDEM framework, a set of appropriate criteria for decision making is determined through analysis, negotiation with stakeholders, and consultation with experts (7, 9). In a 2010 study in Canada, the use of tramadol for chronic noncancerous pain (CNCP) was studied using multi-criteria decision analysis under the EVIDEM framework in the Canadian Drug Advisory Committee. In this study, 14 criteria of MCDA were used to evaluate the health technology assessment (HTA) of tramadol. Data regarding each criterion was collected and then weighting and scoring of the set of criteria was done by the committee members during different meetings. In support of the systematic use of a wide range of criteria to evaluate health interventions, the country's Pharmacovigilance Committee has found it useful to use the multi-criteria decision analysis under the framework of EVIDEM in HTA (15). The main criteria used in this model were: improvement of effectiveness, the status of evidence, limitations related to comparable interventions, disease severity, type of medical service, cost effectiveness, attractiveness for public health, improvement of patient-related outcomes, improvement of safety and tolerability status, population size, impact on other expenditures, completeness of reported evidence, availability of clinical guidelines, and the budget impact (15).

2.3. Prioritizing Technologies for Entering Benefit Package or Insurance Coverage

Since making a decision to cover a drug or service by health insurance is a very complex process, the use of efficient and clear processes to ensure the transparency and consistency of the factors which are considered in choosing the technology is completely necessary. Using high-benefit and low-cost technology is one of the ideals of insurance companies in improving the health of the insured according to cost consciousness; however, decision-making becomes more complex in some cases, when other factors such as social benefits are to be considered. Thus, in deciding to cover drugs and services, decision makers may encounter a dilemma between the benefits of cost analysis and the reactions of people and professional staff (16). Therefore, to make rational and acceptable decisions from the views of all stakeholders, it is quite necessary to deploy systematic and transparent approaches for setting the priorities (17).

In recent years, the search for comprehensive, structured, and accurate solutions in health insurance coverage has been expanded. Health technology assessment is a multidisciplinary process that provides decision makers with clinical, social, economic, and ethical information. Health technology assessment has, however, been criticized so far as only aspects of clinical effectiveness, cost-effectiveness, and budget impact are considered in HTA, and other aspects are ignored under this framework. For this reason, analysis based on multi-criteria decision making is highly valued instrument which should be paid more attention for supporting decisions and considering a wider set of criteria in line with more social benefits and wider coverage of services in the decision-making process (18).

In this regard, the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) has developed relevant guidelines and, at the same time, has taken measures regarding coverage issues using this approach in countries such as Colombia, Italy and Thailand (19).

One of the most widely used applications of MCDA is in the pricing and refund process (P&R) of rare drugs and diseases. The reason behind using this method in this field is to discuss the exchange between economic and non-economic attributes. Given the economic burden of certain diseases, the price of rare drugs is a major challenge, especially in the P&R decision-making process (20); This is because most medications for rare diseases are not cost effective in health technology assessment (HTA) due to the small population of sufferers and the high cost of medications. Prioritizing rare drugs only by using cost-effectiveness data and ignoring other criteria can exclude potentially valuable options and limit the potential treatment options available to patients. That is why using MCDA in this field has received a lot of attention in many countries, especially in European countries (21).

3. Current Challenges

It seems that one example of the most important challenges facing the use of multi-criteria decision analyses in the field of health technology policy making is the existence of equity and ethical issues as two main attributes in using technology for health systems. The quantitative measurement of these two values is quite demanding and researchers all over the world are looking for solutions.

Another major challenge in applying this technique in the field of health technology assessment is weighting these two attributes so that all concerns of technology stakeholders can be considered (19). The remaining challenges can be considered in all the three main applications mentioned above. Some such challenges are mentioned below:

3.1. Prioritizing and Selecting Health Technology Assessment Topics

It seems that predicting economic attributes such as the degree of uncertainty about the cost-effectiveness of technology and the impact of technology budget requires the design of strong methodologies in this area since these attributes play a key role in determining the type of technology assessment reports (12). The reason is that some technologies may require full health technol-

ogy assessment (along with economic assessment studies) and others may only require a rapid review of health technology assessment, which will in turn have a significant impact on the allocation of research funding.

3.2. Prioritizing the Technology Under Study in Comparison with Its Control Group in a Health Technology Assessment Report

It seems that in a health technology assessment report, and considering different areas of assessment such as safety, effectiveness, cost-effectiveness, and ethical and organizational issues, making use of multi-criteria decision analysis can lead to mistakes. For example, the effectiveness has a duplicate value because they are also considered in cost- effectiveness and cannot be compensated comparatively (3). Also, attributes defining safety such as the rate of the incidence of side effects due to complications and mortality cannot be compared with other attributes such as effectiveness and cost-effectiveness for compensation (3).

3.3. Prioritizing Technologies for Entering into Benefit Package or Insurance Coverage

It seems here that one of the most important challenges for prioritizing technologies, which have been evaluated in different diseases, must first be a determination of the role of each attribute in the prioritization process (among the three roles of vetoing, compensatory and decision-making) (3). For example, does the effectiveness of technology have a vetoing role or can it be compared with other attributes, such as the size of the population of the target disease or its severity for compensation? There seem to be challenges regarding decision-making attributes, which are considered as the most important attributes derived from the economic and social environments of societies; in some countries, economic issues such as cost effectiveness and budget impact are important, whereas in other countries the significant issues are the ones related to justice or equity as well as the ethic and social issues, which should be clearly addressed in the health policy paradigms of the country (3).

4. Future Path

As mentioned earlier, the most important challenge facing the use of multi-criteria decision analyses in the field of health technology assessment is how to apply the views of stakeholders in the technology policy making process (both in determining the weights of the attributes and in the final stage of prioritization), considering the effectiveness attributes such as justice or equity, cost effectiveness and budget impact. As for an attribute such as justice, it is very difficult to quantify it or it is wrong to be quantified. With regard to cost-effectiveness and budget impact, determining their weights in the policy-making process and determining their relationship with other influential attributes such as the size of the target population of the disease and the availability of alternative technologies with the same level of effectiveness and safety are only a few of the obvious technical problems in this area.

In recent years, two main models in this field have tried to solve such issues. They seem to have a promising future in the field of health technology assessment:

(1) The first model is the evidence informed deliberative process (EDP) framework, developed by a team of researchers at Radboud University in the Netherlands, which has been able to mix the qualitative results of negotiations of stakeholder with the quantitative models which are based on multi-criteria decision analyses. The model is mainly for prioritizing health technology in the appraisal stage and is used to design a package of services for universal health coverage (3).

(2) The second model is " evidence and value: impact on decision-making " or "EVIDEM", which was initiated by a team of researchers at McGill University in Canada in 2008. The studies using this model have prioritized the target technology in comparison with its control group in a health technology assessment report. This framework has been tested and implemented for clinical decision-making and resource allocation in developed and developing countries such as Canada, South Africa and Italy. EVIDEM is being updated through a joint international non-profit network (17). These versatile instruments consist of an MCDA module and an HTA module. The criteria for decision analysis, on which the EVIDEM framework is based, have been identified via extensive literature analysis and detailed analysis of drug decision-making processes conducted in more than 20 decision-making and arbitration areas around the world. The MCDA model used in this method consists of 15 attributes (measurable / intrinsic criteria) that are universally usable (for example, low and high scales are universally agreed). The framework also entails detailed protocols for collecting, analyzing, evaluating, combining, and providing evidence for each decision criterion (HTA module) for preparing HTA reports that are directly integrated into the MCDA model (22). This approach has been developed to facilitate knowledge transfer, support the advisory process by systematically considering all decision criteria, prioritize health care interventions, and increase decision-related communication. It is now perfectly integrating informed negotiations of technology stakeholders into the quantitative results of multi-criteria decision analyses in order to solve the problems that exist in applying this field.

In addition to these two main models, a team of leading researchers in this field introduced another concept called "MCDM with decision rules" in November 2019. The model suggests that by correctly determining the

roles for the influential attributes in the field of prioritizing health technologies, the views of stakeholders in the field of health technologies can be considered perfectly in the form of evidence-based negotiations and within the attributes of effectiveness such as justice, cost effectiveness and budget impact (23). Also, this concept can be appropriately used in all the three sections of health technology policy-making process, namely "topic selection" (12), "assessment" and "appraisal".

Regarding the drawbacks of weighting as mentioned in some studies (19), it is suggested that the pairwise comparison technique be employed in which the views of all stakeholders are used. In this method, the relative importance of each attribute compared to other attributes is extracted in pairs and, using the geometric averaging technique, the opinions of all stakeholders are collected as consensus.

It is also necessary to point out that the studies mainly emphasize on the approach of "multi criteria decision analysis", which is only about its mathematical forms. Therefore, it is suggested that another approach in this field, ie, multi-objective decision making, be also considered in future studies because these mathematical models can clearly determine how to allocate budgets and technology to different geographical areas taking into account budget constraints.

5. Conclusions

In general, the application of applied mathematics approaches in the field of health technology policy making can help clarify the prioritization process (both in the field of ranking and in the field of allocating the resources). However, using the effort made by the researchers in this field working all around the world, we can, to a large extent, overcome the practical shortcomings of the applications of such approaches in the field of health, some of the examples of which were mentioned in this study.

Competing interests:

The authors declare that they have no competing interests.

Funding:

It was not declared by the authors.

Authors' contributions:

All authors contributed to design, data collection and drafting of this manuscript equally.

References

1. Dehnavieh R, Rashidian A, Maleki MR. Challenges of determining basic health insurance package in Iran. *Payesh (Health Monitor).* 2011;**10**(2):273-83.
2. Ravaghi H, Akbari Sari A, Sarvari SMM. The Effectiveness of PET-Scan in Diagnosis and Treatment of Non-Small Cell Lung Carcinoma (NSCLC) and Lymphoma: A Comprehensive Review of Literature. *J Isfahan Med Sch* 2012;**29**(167):1-10.
3. Oortwijn W, Jansen M, Baltussen R. *Evidence-informed deliberative processes. A practical guide for HTA agencies to enhance legitimate decision-making. Version 1.0. Nijmegen: Radboud University Medical Centre.* Radboud Institute for Health Sciences; 2019.
4. Kumar A, Sah B, Singh AR, Deng Y, He X, Kumar P, et al. A review of multi criteria decision making (MCDM) towards sustainable renewable energy development. *Renew Sustain Energy Rev.* 2017;**69**:596-609. doi:10.1016/j.rser.2016.11.191.
5. Hansen P, Devlin N. Multi-Criteria Decision Analysis (MCDA) in Healthcare Decision-Making. *Oxford Research Encyclopedia of Economics and Finance:* Oxford University Press; 2019.
6. Baltussen R, Niessen L. Priority setting of health interventions: the need for multi-criteria decision analysis. *Cost Eff Resour Alloc.* 2006;**4**:1-9. doi:10.1186/1478-7547-4-14. [PubMed:16923181]. [PubMed Central:PMCPMC1560167].
7. Goetghebeur MM, Wagner M, Khoury H, Levitt RJ, Erickson LJ, Rindress D. Evidence and Value: Impact on DEcisionMaking--the EVIDEM framework and potential applications. *BMC Health Serv Res.* 2008;**8**:1-16. doi:10.1186/1472-6963-8-270. [PubMed:19102752]. [PubMed Central:PMCPMC2673218].
8. Youngkong S, Baltussen R, Tantivess S, Mohara A, Teerawattananon Y. Multicriteria decision analysis for including health interventions in the universal health coverage benefit package in Thailand. *Value Health.* 2012;**15**(6):961-70. doi:10.1016/j.jval.2012.06.006. [PubMed:22999148].
9. Goetghebeur MM, Wagner M, Khoury H, Rindress D, Gregoire JP, Deal C. Combining multicriteria decision analysis, ethics and health technology assessment: applying the EVIDEM decision-making framework to growth hormone for Turner syndrome patients. *Cost Eff Resour Alloc.* 2010;**8**:1-15. doi:10.1186/1478-7547-8-4. [PubMed:20377888]. [PubMed Central:PMCPMC2856527].
10. Husereau D, Boucher M, Noorani H. Priority setting for health technology assessment at CADTH. *Int J Technol Assess Health Care.* 2010;**26**(3):341-7. doi:10.1017/S0266462310000383. [PubMed:20584365].
11. Mobinizadeh M, Raeissi P, Nasiripour AA, Olyaeemanesh A, Tabibi SJ. A model for priority setting of health technology assessment: the experience of AHP-TOPSIS combination approach. *Daru.* 2016;**24**:1-12. doi:10.1186/s40199-016-0148-7. [PubMed:27068692]. [PubMed Central:PMCPMC4827190].
12. Mobinizadeh M, Mohamadi E, Arman H, Nasiripour A, Olyaeemanesh A, Mohamadi S. Topic selection for health technology assessment: An approach combining multiple attribute decision making and decision rules. *Med J Islam Repub Iran.* 2021;**35**:305-13. doi:10.47176/mjiri.35.40. [PubMed:34211942]. [PubMed Central:PMCPMC8236113].
13. Dhalla I, Laupacis A. Moving from opacity to transparency in pharmaceutical policy. *CMAJ.* 2008;**178**(4):428-31. doi:10.1503/cmaj.070799. [PubMed:18268270]. [PubMed Central:PMCPMC2228347].
14. Hutton J, Trueman P, Facey K. Harmonization of evidence requirements for health technology assessment in reimbursement decision making. *Int J Technol Assess Health Care.* 2008;**24**(4):511-7. doi:10.1017/S0266462308080677. [PubMed:18828948].
15. Tony M, Wagner M, Khoury H, Rindress D, Papastavros T, Oh P, et al. Bridging health technology assessment (HTA) with multicriteria decision analyses (MCDA): field testing of the EVIDEM framework for coverage decisions by a public payer in Canada. *BMC Health Serv Res.* 2011;**11**:1-13. doi:10.1186/1472-6963-11-329. [PubMed:22129247]. [PubMed Central:PMCPMC3248909].
16. Viyanchi A, Rasekh HR, Ghatari AR, SafiKhani HR. Selecting the acceptance criteria of medicines in the reimbursement list of public health insurance of Iran, using the "Borda" method: a pilot study. *Iran J Pharm Res.* 2015;**14**(4):1305. [PubMed Central:PMCPMC4673963].
17. Castro Jaramillo HE, Goetghebeur M, Moreno-Mattar O. Testing Multi-Criteria Decision Analysis for More Transparent Resource-Allocation Decision Making in Colombia. *Int J Technol Assess Health Care.* 2016;**32**(4):307-14. doi:10.1017/S0266462316000350. [PubMed:27691990].
18. Diaby V, Goeree R. How to use multi-criteria decision analysis methods for reimbursement decision-making in healthcare: a step-by-step guide. *Expert Rev Pharmacoecon Outcomes Res.* 2014;**14**(1):81-99. doi:10.1586/14737167.2014.859525. [PubMed:24328890].
19. Bertram M, Dhaene G, Tan-Torres Edejer T. *Institutionalizing health*

technology assessment mechanisms: a how to guide. World Health Organization; 2021.
20. Kolasa K, Zwolinski KM, Kalo Z, Hermanowski T. Potential impact of the implementation of multiple-criteria decision analysis (MCDA) on the Polish pricing and reimbursement process of orphan drugs. *Orphanet J Rare Dis*. 2016;**11**:1-12. doi:10.1186/s13023-016-0388-0. [PubMed:26965710]. [PubMed Central:PMCPMC4787054].
21. Schey C, Krabbe PF, Postma MJ, Connolly MP. Multi-criteria decision analysis (MCDA): testing a proposed MCDA framework for orphan drugs. *Orphanet J Rare Dis*. 2017;12(1):1-9. doi:10.1186/s13023-016-0555-3. [PubMed:28095876]. [PubMed Central:PMCPMC5240262].
22. Goetghebeur MM, Wagner M, Khoury H, Levitt RJ, Erickson LJ, Rindress D. Bridging health technology assessment (HTA) and efficient health care decision making with multicriteria decision analysis (MCDA): applying the EVIDEM framework to medicines appraisal. *Med Decis Making*. 2012;**32**(2):376-88. doi:10.1177/0272989X11416870. [PubMed:21987539].
23. Baltussen R, Marsh K, Thokala P, Diaby V, Castro H, Cleemput I, et al. Multicriteria Decision Analysis to Support Health Technology Assessment Agencies: Benefits, Limitations, and the Way Forward. *Value Health*. 2019;**22**(11):1283-8. doi:10.1016/j.jval.2019.06.014. [PubMed:31708065].