

The power of health economics and outcomes research (HEOR) in making decisions that matter

El poder de la economía de salud e investigación de resultados en salud en la toma de decisiones que importan

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Abstract

Deciding on approving and granting market access to new medical technologies such as pharmaceutical products, vaccines, or medical devices is a multifactorial research problem. Balancing out clinical performance, epidemiological implications, burden of disease, economic value, and patient preferences, among other factors, is in itself a challenging endeavor. However, this should be a mandatory requirement when making approval and market access decisions that might affect millions of people in a specific country setting. The aim of this reflection research article is twofold; first, it provides context on the important role that health economics and outcomes research (HEOR) plays in informing decision-making for market access and reimbursement of new medical technologies. Second, it outlines the power of HEOR studies in guiding discussions when assessing the value of new medical technologies. Overall, this article aims at highlighting key HEOR considerations for healthcare professionals, students, and institutions interested in building analytical capabilities around this exciting and uninterrupted growing field of knowledge.

Resumen

Decidir sobre la aprobación y acceso al mercado de nuevas tecnologías médicas, como por ejemplo, productos farmacéuticos, vacunas, o dispositivos médicos es un problema de investigación multifactorial. Encontrar el balance entre desempeño clínico, implicaciones epidemiológicas, secuela de la enfermedad, valor económico, y preferencias de pacientes, entre otros factores, es en sí mismo un tema retador. Sin embargo, esto debería ser un requerimiento obligatorio para tomar decisiones que afectarían millones de personas en un país determinado. El objetivo de este artículo de reflexión es doble; primero, contextualiza el importante rol que la economía de la salud juega en informar la toma de decisiones en cuanto acceso al mercado y reembolso de nuevas tecnologías médicas. Segundo, resalta el poder de los estudios en economía de la salud con respecto a guiar discusiones sobre el valor añadido propuesto por nuevas tecnologías médicas. En general, este artículo proporciona consideraciones claves para profesionales de la salud, estudiantes e instituciones interesadas en consolidar capacidades analíticas alrededor del excitante y creciente campo de la economía de la salud.

Introduction

Recently, there has been a growing interest in health economics across the world, especially in developing countries. This highlights the importance of the health-care sector in any economy. Indeed, political stability and economic growth go hand in hand with improved societal health and well-being. To achieve the latter, implementing decision making processes where equity on healthcare coverage and access are needed [1].

Latin America have a greater need to prioritize the use of scarce resources when compared with developed countries [2]. Increased awareness of the importance of health economics and outcomes research (HEOR), for evidence-based decision making, has been reported in the region. Several cases of country-specific economic evaluations for health policy decision making can be found in the literature [3].

The continuous growth of disease burden has created a sense of urgency around the economic appraisal of health interventions and/or new medical technologies. The main goal is then to prioritize health interventions and/or new medical technologies offering better value for money in a given setting [4]. Countries such as Australia, United States (US), Canada and the United Kingdom (UK) can be considered examples to follow regarding the implementation of evidence-based decision making in healthcare [4,5].

Within this context, the main objective of this article is to provide an overview of the important role that HEOR plays in informing decision-making for market access and reimbursement of new medical technologies. Moreover, this article highlights the power of HEOR studies in guiding discussions when assessing the value of new medical technologies. Finally, this reflection also outlines key HEOR considerations for healthcare professionals, students, and institutions interested in building analytical capabilities around this exciting and uninterrupted growing field of knowledge.

HEOR role in informing market access and reimbursement decision making

We all make decisions everyday: where to go, what to do, and when to do it are examples of decisions driven

by reasons, prompting actions, and hence, producing specific results. Decision making is fully engrained in human actions, and its analysis leads to understand *what decisions are based on, how they are made, who makes them, what evidence is used to support them, what (un)intended consequences those decisions have for decision makers and other individuals, and how uncertainty can affect choices and results?* Decision making analysis as a formalized approach to make optimal choices is not exclusive of healthcare settings; indeed, it is widely used in fields such as engineering, finances, public administration, information technologies, etc. However, the use of decision-making analysis in healthcare is key due to the direct impact that medical technologies have on millions of lives across the world.

How healthcare systems should allocate limited resources (i.e., financial, human, infrastructure) to maximize the value of health outcomes to patients, health plans, providers, and society? HEOR can provide answers to this question. Traditionally, clinical development research (i.e., clinical trials assessing efficacy and safety) has been the strongest source of evidence to make regulatory decisions for approval of new medical technologies. The recent COVID-19 vaccine clinical trials are examples of clinical development research being used to make decisions on vaccine approval, vaccination roll-out, and disease monitoring. Nevertheless, HEOR as a discipline driven by decision-making analysis provides an evidence-driven framework that complements clinical development research evidence. HEOR considers concerns on resource allocation when comparing the impact of a new medical technology versus the current standard of care. For instance, under a scenario where a new drug A shows a better efficacy than the current treatment B, but its probability of adverse events (which can lead to further complications) is higher than treatment B as well as its costs, *should drug A being granted market access and reimbursement by healthcare payers only based on clinical development data?* Definitely, a more robust approach to guide this decision would be to incorporate HEOR, leveraging a more holistic concept of comparability. HEOR-driven comparisons assess new medical technologies versus current treatments through a multi-factorial perspective. Not only clinical benefits are considered, but also aspects associated to quality-of-life (QoL) of patients,

resource allocation of providers/payers, and societal burden. Note that HEOR does not look at suggesting substitution of current medical technologies by new ones, but to objectively inform about the performance of both technologies from multiple dimensions (e.g., clinical, direct and indirect costs, QoL, etc.). Figure 1 shows examples of key HEOR modeling domains as well as concepts or inputs considered when assessing new medical technologies in oncology.

Surprisingly and despite of its value, HEOR is not widely incorporated into medical school curricula [7]. Colombia is not the exception to this trend.¹ HEOR commonly takes a place within economics and pharmacy educational curricula, providing an opportunity for interdisciplinary research and collaboration among healthcare professionals. In the US, HEOR has gained traction at the graduate education level (masters and doctoral degrees), nurturing a research-driven professional base that keeps growing in numbers, presence, relevance, and influence with respect to both regulatory public health policy and market access decision making. Examples of HEOR-driven organizations are the International Society for Pharmacoeconomics and Outcomes Research (ISPOR [8]) and the Institute for Clinical and Economic Review (ICER [9]).

Speaking about Colombia, Restrepo et al. [10] studied the evolution of HEOR in the country. This study points at a prolific nationwide growth in HEOR publications and professional events since the 1993 health reform. However, it also highlights challenges for the future development of HEOR in the country, namely: *i)*

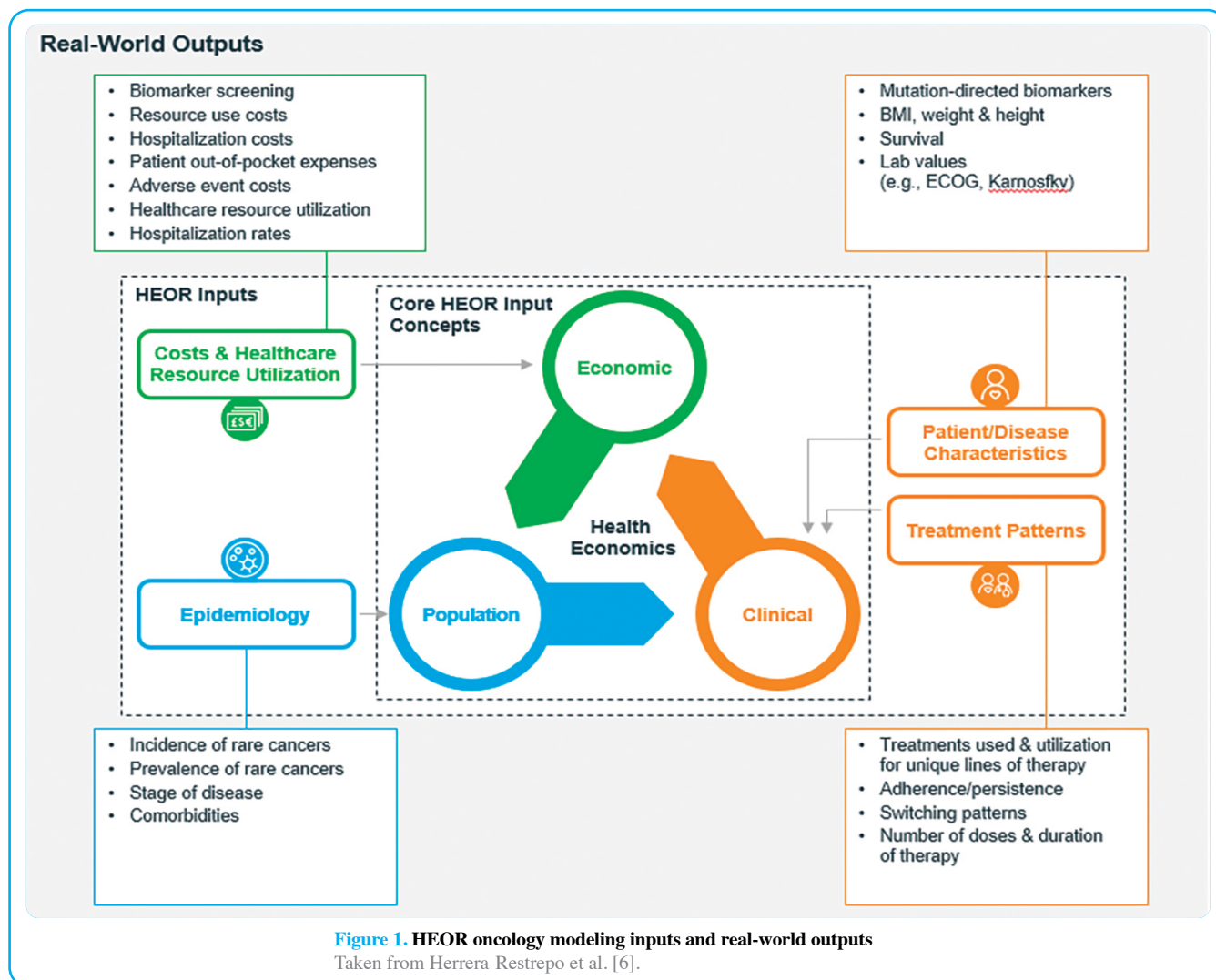
¹ HEOR training is mainly offered at the graduate level in selected Universities across the country; e.g., Universidad CES, Universidad Pontificia Bolivariana, Universidad de Antioquia, Universidad Nacional de Colombia, etc.

ii) promoting new research among undergraduate and graduate students, and academic research groups across the country; *iii)* consolidating HEOR topics in undergraduate and graduate curricula of medical and non-medical programs; *iv)* supporting joint academic ventures/research via events, projects, congresses and conferences and *v)* strengthening the role of the Asociación Colombiana de Economía de la Salud (ACOES, Colombian Association of Health Economics in English).

The latter, as ISPOR equivalent in Colombia, can certainly play a key role in shaping the future of HEOR in the country by leading and guiding HEOR activities, leveraging its deep knowledge of the country's needs, while collaborating with and following guidance from international peers such as ISPOR or advisory organizations as The National Institute for Health and Care Excellence (NICE [11]) in the UK.

HEOR studies guiding value-driven decision-making

Moving from the general HEOR context toward the technicalities of its application, let us touch base on the methodological aspects of HEOR. HEOR studies help in guiding relevant discussions among key healthcare stakeholders when assessing the value of new medical technologies. For the sake of simplicity, a selection of some of the most common HEOR studies are described below. For readers interested in getting a deeper understanding of each type of HEOR study along with others not included here, please refer to MacKinnon III [12] and check the references provided below.



Burden of illness (BOI) studies

Burden of illness or disease studies help in answering how much a disease costs and what its consequences are regarding deaths and loss of health for a country, region, municipality, or healthcare system. BOI studies are observational and non-technology specific in nature. Their importance resides in providing objective evidence to inform public health policy, budgetary prioritization for medical interventions, and alignment with national and international healthcare goals (e.g., global vaccination roll-out during a pandemic) [12]. BOI is heavily supported by disease-specific HEOR data collected by public and private sources. The collection, analysis and interpretation of different data sources allow to put together a story on the burden of

a disease, quantifying metrics as the number of years of life a person loses as a consequence of dying early because of the disease (Years of Life Lost [YLL]); and the number of years of life a person lives with disability caused by the disease (called Years of Life lived with Disability [YLD]) [13]. As mentioned by the World Health Organization (WHO [13]), “adding together the Years of Life Lost and Years of Life lived with Disability gives a single-figure estimate of disease burden, called the Disability Adjusted Life Year (or DALY). One DALY represents the loss of one year of life lived in full health.” Other important concept is quality-adjusted life-years (QALY), which combines both the quality and quantity of life lived. For more details on BOI studies, please refer to the *Practical Guide on National Burden of Disease Studies* by WHO [14].

Limitations of BOI studies include: *i*) lack of generalizability when available national-level data is incomplete or not reliable; *ii*) risk of bias regarding data source selection and analysis and *iii*) lack of national-level data on specific population or therapeutic area of interest, especially when relating to rare diseases.

Systematic literature review (SLR)

There can be many published studies regarding disease-specific medical technologies derived from clinical studies. These clinical studies can certainly relate to the same technology, but their design, patient population, and outcomes definitions can vary. One of the main challenges when assessing new medical technologies versus the current standard of care (including no intervention) lies on the difficulty of comparing and combining different studies to draw robust insights on clinical performance in a population of interest. The purpose of an SLR is to provide an objective overview and summary of primary studies on a medical technology used as an intervention in a population of interest suffering a disease. What makes a SLR an objective type of HEOR study is that it contains a statement of objectives and methods that ensure reproducibility, encouraging transparency and reducing bias [12].

SLR results have allowed understanding treatment effects magnitude when considering multiple studies, their similarities and differences. As an observational method, SLRs do not substitute experimental studies such as clinical trials, but provide the possibility of comparing available evidence while acknowledging heterogeneity and guiding decisions with scientific rigor. Common steps in the development of SLRs include: *i*) Definition of objectives and eligibility criteria of studies to be included in the review; *ii*) literature search according to eligibility criteria; *iii*) data extraction per outcomes and/or patient characteristics of interest; *iv*) analysis of results of eligible studies (use of statistical techniques for comparative purposes) and *v*) final report highlighting the fulfillment of objectives, methodological considerations and challenges, as well as study limitations [15].

Regarding limitations, risk of bias is common in relation to study selection, inclusion and exclusion criteria, and study review. Other technical limitations

can include incomplete number of relevant studies (either because of ill-defined search terms or incomplete databases) and incorrect or inconsistent statistical analysis techniques when comparing different types of outcomes (e.g., nominal or continuous outcomes). For more methodological details on SLRs, please refer to Cochrane Training [16].

Retrospective studies

Clinical evidence from randomized clinical trials (RCTs) is considered the gold standard when making regulatory decisions for new medical technologies market access. However, developing RCTs implies ethical considerations along with vast financial and human resources. Within this context, HEOR studies looking at clinical performance (e.g., effectiveness, adverse events) and/or healthcare-related resource use (HRCU – along with costs) can leverage existing data in the form of medical claims data, disease registries, and/or electronic medical records (EMR), among others [17].

Advantages of retrospective studies include: *i*) data availability, which nowadays is a growing field bringing together advanced techniques as machine learning [18]; *ii*) usefulness in detecting and characterizing patients with rare diseases who are difficult to recruit in RCTs; and *iii*) the possibility of exploring HEOR outcomes of interest for long follow-up periods, which is very costly in RCTs or other type of prospective studies.

Common steps in the development of retrospective studies include: *i*) definition of study type. Typical studies include cohort-based or case-control [10]; *ii*) definition of inclusion/exclusion eligibility criteria; *iii*) identification of interest variables; *iii*) definition of index dates (i.e., period of time of interest) along with time required for prior enrollment; *iv*) data analysis through consistent, relevant and reproducible statistical techniques (e.g., multivariate regression models) and *v*) interpretation of results based on the objective study and level of statistical difference regarding the outcomes of interest. For best practices related to retrospective studies, refer to Berger et al. [17,19]. The main limitation of retrospective studies is the fact that their insights do not determine causality as in the case of RCTs. Additionally, data quality issues during the phases of collection, archiving and processing

can lessen the quality of the results. As in the case of other HEOR studies, other limitations include selection bias regarding databases, patient population, and result interpretation, among others.

Cost-effectiveness analysis (CEA)

Clinical performance and healthcare resource use by themselves do not allow to quantify the incremental health and cost benefits generated by the adoption of a new medical technology in a specific patient population. Important concepts to quantify those benefits include setting (e.g., region, country); time horizon (e.g., 20 years or lifetime), and perspective (e.g., provider, healthcare sector, an/or societal perspective). Cost effectiveness analysis (CEA) allows comparison, via mathematical modeling, of the projected health benefits and costs of a new medical technology versus the current standard of care. The projection of health benefits follows rigorous statistical techniques to ensure that treatment effects, fed from RCTs, are accurately extrapolated over time. The projection of costs considers the natural history of the disease, where multiple disease-related complications and comorbidities might arise, and hence, the accrual of direct and indirect costs over time is required. Direct costs relate to disease and comorbidity management, while indirect costs can include productivity loss and caregiving costs. The final goal of a CEA is to report an incremental metric combining costs and health benefits called incremental cost-effectiveness ratio [9].

When using QoL as a surrogate for measuring health benefits, the ICER can be interpreted as the additional amount of costs assumed (\$) for each additional quality-adjusted life year (QALY). Regulatory agencies around the world use ICER thresholds for discussing on the approval of new medical technologies [20].

The rationale for establishing thresholds for cost-effectiveness is driven by the fact that financial resources for healthcare systems are limited, and therefore, decisions on approval must balance out both value regarding health benefits and economic burden for the overall system (i.e., costs). Examples of cost-effectiveness analysis developed in the Colombian setting are presented in Londoño et al. 2019 [21] and Aponte et al. [22]. For well-known international best modeling practices for cost-effectiveness analysis, refer to ISPOR [23,24].

Budget impact analysis (BIA) is another type HEOR study focusing on the budgetary (or fiscal year) implications that adopting a new medical technology have for a health plan offered by insurers. For the sake of simplicity, BIA is not included in this article. For readers interested in this type of HEOR study, some publications in the Colombian setting relate to the work carried out by Gomez et al. [25] and Guevara et al. [26], while international best modeling practices for BIA are reported in Sullivan et al. [27].

Bringing together multiple perspectives: the power of HEOR

HEOR studies are far from being the solution to all healthcare problems or the perfect tools for market access and reimbursement decisions on new medical technologies. Though, they have shown multiple strengths in bringing together fundamental concepts from key healthcare fields as medicine and pharmacy along with humanistic ones as economics, and numerical-driven fields as engineering and computational science. Those strengths have allowed to assess medical technologies defining *value to patients* as a multidimensional construct, where not only clinical performance is important, but also patient preferences, resource allocation, and long-term humanistic and economic burden matter. These are certainly exciting times to keep diving into the importance and application of HEOR to country settings such as Colombia; more so when considering its recent entry to the Organization for Economic Cooperation and Development (OECD) [28]. Joining this club of industrialized economies brings many opportunities to promote and enhance biopharma research, access to new medical technologies, and transferring cutting-edge knowledge in areas such as oncology, vaccinology, and rare diseases, among others. The call to action is then for relevant decision-makers to fine tune their HEOR skills looking at improving the country's health and well-being.

To round up the two-fold intention of this article, it is important to highlight key HEOR considerations for healthcare professionals, students, and healthcare-related institutions interested in building HEOR capabilities. Note that these considerations are not by any mean comprehensive, but they provide a good departure point for those interested in HEOR.

Learn and share. HEOR is a multidisciplinary domain, and hence, sharing perspectives, knowledge, practices and anecdotes with professionals outside your professional, research or study field enriches the conversation. Indeed, this multidisciplinary exercise strengthens the results of any HEOR analysis. Keep in mind that economists, statisticians, engineers (disease modelers), and epidemiologists are some professionals to keep in mind.

Learn by design. Although there are many ways to learn HEOR methods/techniques, as for example, tutorials, trainings or workshops at conferences (e.g., ISPOR, including its Latin American edition [29]). the reality is that HEOR should be included as a core (or elective) course or series of courses into the undergraduate and graduate curricula of medical, pharmacy, economy and statistical programs. Engineering curricula should also include elective courses on healthcare-specific modeling and simulation techniques, especially in the case of industrial engineering, systems engineering, and bioengineering programs.

Look, find and connect. Epidemiological surveillance will certainly help in understanding the following aspects: *i*) country-specific disease priorities and their implications for resource allocation, e.g., Centers for Disease Control and Prevention (CDC) in the US [30] or the Instituto Nacional de Salud en Colombia [31]; *ii*) monitoring the availability of formal and continuing HEOR education programs can help in providing options to those interested in fine tuning HEOR skills for health technology assessment, and market access and reimbursement decision-making and *iii*) finding and connecting with local and international HEOR organizations can provide a better understanding of current HEOR capabilities, best practices, and opportunities for networking and research collaboration (e.g., Asociación Colombiana de Economía de la Salud (ACOES) [32]; Instituto de Evaluación Tecnológica en Salud (IETS) [33] and Grupo de Economía de la Salud (GES) of the Universidad de Antioquia [34]. Do not forget to monitor research and development pipelines of pharmaceutical companies since they provide valuable information on what is coming, and what is important about different therapeutic areas.

Identify, follow, and reach out. HEOR studies must be reflective of current needs and grounded on discussions involving key decisions makers, e.g., government,

pharmaceutical companies, healthcare providers, insurers, etc. Consequently, keeping up to date on public announcements, meetings and documents from regulatory bodies (e.g., CDC in the US, INS and IETS in Colombia, or any other country-specific institution) is critical to make HEOR studies reflective of real-world needs, to gather concerns and recommendations from key stakeholders, and to provide feasible guidance to decision making.

As pointed by MacKinnon III [12], “*the challenge for the 21st century will be to find ways to bring innovative, effective therapies to patients faster, without sacrificing quality and safety, to improve health outcomes, and at the same time lower health care costs*” [12]. To overcome this ambitious challenge, universities and colleges have a key role to play. Therefore, this reflection article leaves an open invite to institutions as the Unidad Central del Valle del Cauca (UCEVA) [35] to pioneer education in HEOR while fostering relationships with Colombian government agencies and local/international medical and HEOR organizations.

Consent for publication

The author read and approved the final manuscript.

Competing interests

Author declares have no competing interests. This document only reflects the points of view of the author and not those of GlaxoSmithKline (GSK)

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References

- [1] Collazo Herrera M, Cárdenas Rodríguez J, González López R, Abreu RM, María Gálvez González A, Casulo JC. Temas de actualidad / Current topics La economía de la salud: ¿debe ser de interés para el campo sanitario? 1. 12. 2002. <https://www.scielo.org/pdf/rpsp/2002.v12n5/359-365/es>
- [2] Santos J, Palumbo F, Molsen-David E, Willke RJ, Binder L, Drummond M, et al. ISPOR Code of Ethics 2017 (4th Edition). *Value in Health* 2017;20. <https://doi.org/10.1016/j.jval.2017.10.018>.
- [3] Hughes VS, Ferreira De Azeredo-Da-Silva AL, Hincapie AL. Health Economics and Outcomes Research (HEOR) Knowledge Needs Assessment for Latin America. *Value in Health Regional Issues* 2019;20. <https://doi.org/10.1016/j.vhri.2018.10.006>.
- [4] Zarate Víctor. Evaluaciones económicas en salud: Conceptos básicos y clasificación. *Rev Med Chile* 2010;138:93–7. <http://dx.doi.org/10.4067/S0034-98872010001000007>
- [5] National Association of Pharmacy Regulatory Authorities (NAPRA). Health Canada Document: Recommended Guidance for Community Pharmacists. Ottawa, Ontario: 2019. <https://napra.ca/general-practice-resources/health-canada-document-recommended-guidance-community-pharmacists>
- [6] Herrera-Restrepo O, Ruthwik Anupindi V, Wehler E, Kowal S. US Healthcare Databases for Health Economic Modeling in Precision Medicine: An Oncology-Based Comparative Landscape Assessment (CLA). Copenhagen, Denmark: 2019.
- [7] Beecroft C. Why health economics deserves a place in the medical curriculum Editorial 2016. <https://doi.org/10.2217/cer-2016-0028>.
- [8] International Society for Pharmacoeconomics and Outcomes Research (ISPOR). The leading professional society for health economics and outcomes research (HEOR) globally. The Society's mission is to promote HEOR excellence to improve decision making for health globally 2021. <https://www.ispor.org/>
- [9] Institute for Clinical and Economic Review (ICER). Fair Pricing, Fair Access, Future Innovation 2021. <https://icer.org/>
- [10] Restrepo Zea JH, Ramírez Gómez L. Dos décadas de economía de la salud en Colombia. *Cuadernos de Economía* 2020;39. <https://doi.org/10.15446/cuad.econ.v39n79.73067>.
- [11] National Institute for Health and Care Excellence (NICE). Guidance and advice list 2021. <https://www.nice.org.uk/guidance/published?type=apg,csf,sg,mpg,ph,sg,sc,dg,hst,ipg,mtg,qs,ta>
- [12] Alkhateeb FM, Osias K, MacKinnon III, G. Understanding Health Outcomes and Pharmacoeconomics. Burlington, MA. Jones & Bartlett Learning 2011. *American Journal of Pharmaceutical Education* 2012;76. <https://doi.org/10.5688/ajpe76235>.
- [13] World Health Organization (WHO). Burden of disease: what is it and why is it important for safer food? . 2004. https://www.who.int/foodsafety/foodborne_disease/Q%26A.pdf
- [14] World Health Organization (WHO). National burden of disease studies: a practical guide. Geneva: 2001. <https://www.who.int/healthinfo/nationalburdenofdiseasemanual.pdf>
- [15] University of Maryland. Steps to conducting a systematic review. University Libraries 2021. <https://lib.guides.umd.edu/SR/steps>
- [16] Higgins JPT T, Chandler J, Cumpston M, Li T, Page M. *Cochrane Handbook for Systematic Reviews of Interventions*. 2nd edition. Cochrane Training 2021. <https://training.cochrane.org/handbook>
- [17] Berger ML, Mamdani M, Atkins D, Johnson ML. Good Research Practices for Comparative Effectiveness Research: Defining, Reporting and Interpreting Nonrandomized Studies of Treatment Effects Using Secondary Data Sources: The ISPOR Good Research Practices for Retrospective Database Analysis Task Force Report—Part I. *Value in Health* 2009;12. <https://doi.org/10.1111/j.1524-4733.2009.00600.x>.
- [18] Corey KM, Kashyap S, Lorenzi E, Lagoo-Deenadayalan SA, Heller K, Whalen K, et al. Development and validation of machine learning models to identify high-risk surgical patients using automatically curated electronic health record data (Pythia): A retrospective, single-site study. *PLOS Medicine* 2018;15. <https://doi.org/10.1371/journal.pmed.1002701>.
- [19] Berger ML, Sox H, Willke RJ, Brixner DL, Eichler H-G, Goettsch W, et al. Good practices for real-world data studies of treatment and/or comparative effectiveness: Recommendations from the joint ISPOR-ISPE Special Task Force on real-world evidence in health care decision making. *Pharmacoepidemiology and Drug Safety* 2017;26. <https://doi.org/10.1002/pds.4297>.
- [20] Schwarzer R, Rochau U, Saverno K, Jahn B, Bornschein B, Muehlberger N, et al. Systematic overview of cost-effectiveness thresholds in ten countries across four continents. *Journal of Comparative Effectiveness Research* 2015;4. <https://doi.org/10.2217/cer.15.38>.
- [21] Londoño Trujillo D, Sandoval Reyes NF, Taborda Restrepo A, Chamorro Velasquez CL, Dominguez Torres MT, Romero Ducuara SV, et al. Cost-effectiveness analysis of newborn pulse oximetry screening to detect critical congenital heart disease in Colombia. *Cost Effectiveness and Resource Allocation* 2019;17. <https://doi.org/10.1186/s12962-019-0179-2>.

- [22] Aponte-González J, Fajardo-Bernal L, Diaz J, Eslava-Schmalbach J, Gamboa O, Hay JW. Cost-Effectiveness Analysis of the Bivalent and Quadrivalent Human Papillomavirus Vaccines from a Societal Perspective in Colombia. *PLoS ONE* 2013;8. <https://doi.org/10.1371/journal.pone.0080639>.
- [23] Husereau D, Drummond M, Petrou S, Carswell C, Moher D, Greenberg D, et al. Consolidated Health Economic Evaluation Reporting Standards (CHEERS)—Explanation and Elaboration: A Report of the ISPOR Health Economic Evaluation Publication Guidelines Good Reporting Practices Task Force. *Value in Health* 2013;16. <https://doi.org/10.1016/j.jval.2013.02.002>.
- [24] Caro JJ, Briggs AH, Siebert U, Kuntz KM. Modeling Good Research Practices—Overview. *Medical Decision Making* 2012;32. <https://doi.org/10.1177/0272989X12454577>.
- [25] Gomez J, Moreno LE, Constenla D, Caceres D, Rodriguez E. Budget impact analysis of pneumococcal conjugate vaccines in Colombia. *Expert Review of Pharmacoeconomics & Outcomes Research* 2021;21. <https://doi.org/10.1080/14737167.2021.1855978>.
- [26] Guevara-Cuellar CA, Soto VE, Molina-Echeverry MI. Budget impact analysis of the adoption of new hypertension guidelines in Colombia. *Cost Effectiveness and Resource Allocation* 2018;16. <https://doi.org/10.1186/s12962-018-0152-5>.
- [27] Sullivan SD, Mauskopf JA, Augustovski F, Jaime Caro J, Lee KM, Minchin M, et al. Budget Impact Analysis—Principles of Good Practice: Report of the ISPOR 2012 Budget Impact Analysis Good Practice II Task Force. *Value in Health* 2014;17. <https://doi.org/10.1016/j.jval.2013.08.2291>.
- [28] Organization for Economic Cooperation and Development (OECD). *The OECD and Colombia: A mutually beneficial relationship* 2021. <https://www.oecd.org/latin-america/countries/colombia/>
- [29] International Society for Pharmacoeconomics and Outcomes Research (ISPOR). Latin America Consortium. The Professional Society for Health Economics and Outcomes Research 2021. <https://www.ispor.org/member-groups/global-groups/consortia/latin-america-consortium>
- [30] Centers for Disease Control and Prevention (CDC). Division of Health Informatics and Surveillance 2021. <https://www.cdc.gov/>
- [31] Instituto Nacional de Salud (INS). *Epidemiología aplicada* 2021. <https://www.ins.gov.co/Direcciones/Vigilancia/Paginas/Epidemiolog%C3%ADa-aplicada.aspx>
- [32] Asociación Colombiana de Economía de la Salud (ACOES). *Boletines ACOES*. Universidad de Antioquia Facultad de Ciencias Económicas 2021. <https://www.acoes.org.co/boletines>
- [33] Instituto de Evaluación Tecnológica en Salud (IETS). *Evaluación de efectividad y seguridad* 2021. <https://www.iets.org.co/Busqueda/FrmResumen.aspx?valor=Efectividad%20y%20seguridad>
- [34] Universidad de Antioquia. Grupo Economía de la Salud (GES). *Acerca del grupo* 2021. <https://www.udea.edu.co/wps/portal/udea/web/generales/interna/>
- [35] Unidad Central del Valle del Cauca (UCEVA). Facultad de Ciencias de la Salud 2021. <https://www.uceva.edu.co/facultad-de-ciencias-de-la-salud/>