WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Pharmacoeconomics: Basic Concepts and Clinical Implications

Anjali Ghanshala, Anand Raj, Amrita Bhattacharya, Dr.Nakul Gupta, Sheetal Soni*

IIMT College of Pharmacy, Knowledge Park 3, Greater Noida, Gautam Budha Nagar-201310, U.P., India

ABSTRACT:

Pharmacoeconomics is the study of how we can balance the cost of medicines with the benefits they bring to patients and society. As healthcare costs rise and resources remain limited, this field has become an essential guide for better choices in treatment, policy, and budgeting. This article outlines the main ideas of Pharmacoeconomics and describes common approaches such as Cost-Effectiveness, Cost-Utility, Cost-Minimization, And Cost-Benefit Analysis. These tools make it possible to compare therapies not only by their medical impact but also by their value for money and influence on patient's Quality of Life. The paper also highlights practical challenges, including gaps in reliable data and differences between healthcare systems worldwide, while pointing to the growing role of technology, insurance, and patient-focused care. By linking Clinical Outcomes, Financial Considerations, and Human well-being, Pharmacoeconomics provides a fair and evidence-based framework for decision-making. Its proper application can help governments, healthcare providers, and patients use limited resources more wisely and achieve better health results.

Keywords: Pharmacoeconomics, Healthcare costs, Economic evaluation, Global health systems, Clinical outcomes, Resource allocation, Health insurance

1. INTRODUCTION:

The term Pharmacoeconomics refers to the study of the economic value of medicines, looking at how much extra benefit they provide compared to the extra costs involved. In simple terms, it addresses whether the higher expense of a new therapy is justified by the potential additional advantages it offers compared to existing treatments [1]. Like any system, the main question people often ask is whether the money spent on healthcare is being used efficiently. To explore this concern, Pharmacoeconomics has emerged as a growing branch of study [2]. Though it is still a developing field, has steadily become an important part of global health technology. Its progress has been supported by pharmaceutical companies, academic researchers, and practicing pharmacists who see its role in improving healthcare choices. In general, it is defined as the structured study and explanation of both the costs and the health results linked with medical treatments. This also includes looking at how such therapies affect individual patients, improve the use and sustainability of healthcare systems, and influence the overall health and financial burden on society [3]. The main domains of Pharmacoeconomics comprise cost-effectiveness analysis, which evaluates the relative value of therapeutic options in terms of health outcomes achieved per unit cost; cost-minimization analysis, which identifies the least costly intervention among alternatives with equivalent efficacy; Cost-Utility Analysis, which incorporates patient-centered measures such as Quality-Adjusted Life Years (QALYs) to compare interventions; and Cost-Benefit Analysis, which expresses both costs and benefits in monetary terms to determine net economic value. The regular use of these methods grew with the development of evidence-based medicine, which encouraged detailed study of both the medical effects and the financial impact of medicines and healthcare services [4].

2. OBJECTIVES:

The objective is to highlight the key elements of pharmacoeconomic assessments.

1.These evaluations can and should be applied in the analysis of pharmacy practice services, including those delivered or supervised by pharmacists**.**

2.Additionally, the aim is to outline suggestions and future directions for upcoming studies in this area [5].

3.Promote systematic education in Pharmacoeconomics to strengthen the knowledge base.

4.Encourage the creation of a solid framework and infrastructure for applying pharmacoeconomic principles.

5. Medicine promotion must be truthful, research-based, balanced, and within legal limits, while drug license compliance needs proper approval, staff, storage, and records as per law [6].

6.Develop the required skills and capacity to ensure effective use of limited healthcare resources.

7.Support efficient allocation and management of healthcare budgets through evidence-based decision-making [7].

3. PHARMACOECONOMICS SCENARIO & THE WORLD:

In India, pharmacoeconomic studies are developing but at the same time encountering obstacles such as restricted availability of real-world evidence, the lack of nationwide reimbursement frameworks, and substantial out-of-pocket expenses. Novel approaches like machine learning and pharmacogenomics are being investigated to enhance the significance and accuracy of these assessments [8]. This is particularly relevant among economically disadvantaged and underserved populations in rural and peri-urban regions of low and middle-income countries.

To a large extent, these challenges are made worse by limited evidence-based pharmacoeconomic resource allocation and the absence of long-term healthcare financing plans [9]. A systematic review has shown that the current Cost-Effectiveness studies are of average quality, and the Decision-Making Models used still have room for improvement. A great example for is that, the methods for pharmacoeconomic research varies between countries, and studies found that Pembrolizumab was cost-effective in the United States and Switzerland, but not China, France, the UK or Singapore [10]. Many important studies show that the real growth of GDP (Gross Domestic Product) and the rising global need for healthcare services and medicines will mostly be led by Emerging Markets as we move toward the 2030s [11].

4. COST CLASSIFICATION & THEIR ASPECTS WITH ECHO (ECONOMIC, CLINICAL, HUMANISTIC OUTCOME) MODELS:

Cost represents the financial aspect of economic evaluation. It can be classified into.

1. Direct costs

- Medical – Hospitalization, diagnostic tests, medications.
- Non- Medical – Patient transportation, accommodation, caregiver expenses.
- Indirect costs
- As well as Intangible costs
- Opportunity costs [12]

1. Direct- Cost: - Direct costs include medical expenses such as hospital stays, doctor visits, diagnostic tests, and medicines, and they form a key part of pharmacoeconomic evaluation. Identifying and measuring direct costs is very important in giving solid reasons for using cost-effective treatments and helping policymakers and stakeholders make better use of limited healthcare resources. These costs play vital role in economic models, as they help researchers estimate the financial burden of medical treatments and compare the cost-effectiveness of different treatment options.

EXAMPLE - For instance, a drug administered solely for managing a specific Diagnosis-Related Group (DRG) and not for any other purpose [13].

2. Indirect-Cost: - Indirect costs are usually measured using information obtained from external data sources that provide benchmarks or standard reference values. Important stakeholders such as governments, insurers, and employers- are showing increasing interest in reducing indirect costs, since lowering them is important for easing the overall financial pressure caused by growing healthcare expenses.

EXAMPLE - Expenditures documented at the departmental level that are distributed across multiple patients, such as those related to physicians or nursing personnel [14].

3. Intangible-Cost: - This category includes the discomfort, distress, and emotional burden experienced by patients and their caregivers. Such costs are generally omitted when designing insurance policies [15].

The following methods exist for estimating prices:

- Cost/Sections
- Cost/Therapy
- Cost/Individual patient
- Cost/Patient/Year
- Cost/Case prevented
- Cost/Life-saved
- Cost/Disability-Adjusted life year

4. Opportunity-Cost: - It is clear that when money and resources are used for one purpose, they cannot be used for other options. As a result, the possible benefits from those other options are lost, and these lost benefits are called opportunity cost.

EXAMPLE: Employments, funds, Construction, Management etc [16].

ASPECTS OF PHARMACOECONOMICS

A. Patient-Related Aspects:

Covers all relevant expenses and outcomes experienced by the patient, including direct, indirect, and intangible costs.

B. Provider-Related Aspects:

Refers to the expenditure required to deliver goods and services, considering only direct costs.

C. Payer-Related Aspects:

Involves government bodies, insurance providers, or other third-party funders. It concerns managers and accounts for lost workdays as well as decreased productivity.

D. Societal Aspects:

Represents the most comprehensive perspective, evaluating every cost and consequence. It incorporates both direct and indirect costs while also recognizing the overall advantages to society.

5. ECHO (ECONOMIC, CLINICAL, HUMANISTIC OUTCOME) MODEL:

Pharmacoeconomics mainly emphasizes evaluating whether the added advantages derived from a medical intervention are worth the extra financial costs. This evaluation is based on three major categories of health outcomes: Economic, Clinical, And Humanistic together known as the ECHO Model.

The ECHO framework in pharmacoeconomic analysis views medicines as a combination of clinical, financial, and patient-centered attributes**.** Drug assessments now go beyond simply examining safety and therapeutic effectiveness, also considering their influence on healthcare expenditure, resource utilization, and overall patient well-being.

This approach highlights the value of pharmaceutical products or services by merging conventional clinical results with contemporary measures of cost-effectiveness and quality of life**.** Such a Holistic Model offers a conceptual basis for balancing trade-offs between clinical, economic, and humanistic aspects when determining the most efficient use of healthcare resources [17].

6. PHARMACOECONOMICS EVALUATION TECHNIQUES:

Pharmacoeconomic methods focus on analysing expenses, treatment procedures, and health outcomes linked to medical therapies. The main approaches include Cost-Minimization, Cost-Effectiveness, Cost-Utility, And Cost-Benefit Evaluations. These techniques play a vital role in regulatory approval, reimbursement policies, economic assessments, and maintaining the sustainability of pharmaceutical practices [18].

Types of Economic Evaluation: -

A. COST EFFECTIVE ANALYSIS:

Cost-Effective Analysis (CEA) is a structured method used to evaluate and compare the expected costs and health outcomes of multiple interventions. It has been widely applied across countries, particularly within Health Technology Assessments (HTAs), to improve the efficiency of healthcare systems. However, despite its advantages, CEA has some clear limitations, since it is mainly designed to maximize efficiency in health services, it does not consider other important goals such as improving health equity or reducing unfair differences in care. As a result, even if a treatment is found to be cost-effective, the related costs and benefits may not be shared fairly across all population groups, and traditional CEA methods cannot fully show these distributional effects to policymakers [19].

For instance, treatments made for people with serious illnesses or disabilities usually cost more, which makes them seem less efficient. In CEA, health improvements are valued the same way for everyone, no matter a patient's starting quality of life or whether the treatment extends life or treats a short-term condition leading to the saying, 'a QALY is a QALY is a QALY.' This means that a gain of 0.15 QALYs is treated as the same, whether it comes from helping someone with severe depression or a person already in good health [20].

"Incremental Cost-Effectiveness Ratio (ICER)" ICER is calculated by the difference in cost between an intervention of interest and a comparator divided by the difference in health outcomes between the intervention of interest and the comparator. CEA and CUA (Cost Utility Analysis) use the same formula for ICER. When quality-adjusted life years is used as the outcome measure, it could be called CUA or CEA. When natural units such as A1C or LDL-c are used as an outcome measure, it is called CEA.

ICER = (Cost of drug A - Cost of drug B) / (Benefits of drug A – Benefits of drug B) = Difference in costs (A-B) / Difference in benefits (A-B).

B. COST UTILITY ANALYSIS:

Cost-utility analysis (CUA) is a type of pharmacoeconomic study that goes beyond just looking at clinical results by also including health-related quality of life in its evaluation [21]. This is usually measured using Quality-Adjusted Life Years (QALYs), which show both how long and how well a person lives with a treatment. The main outcome in CUAs is the Incremental Cost–Utility Ratio (ICUR), which is calculated as the extra cost needed to gain one additional unit of benefit, usually measured as a QALY.

C. COST BENEFIT ANALYSIS:

Cost-benefit analysis (CBA) is a pharmacoeconomic method used to assess healthcare interventions and help decision-makers set priorities. In this approach, the benefits are expressed in money terms by looking at direct medical results, use of resources, and wider effects on society. Among these, the most important are usually the direct clinical and financial benefits, which are often measured as cost savings for patients and healthcare systems [22].

EXAMPLE:

The following is the cost-benefit analysis calculation formula:

Total benefits = Benefits minus cost

Benefit-cost ratio = Benefits / Costs

D. COST MINIMIZATION ANALYSIS:

In Cost-Minimization Analysis (CMA), the primary focus is on comparing the expenses of different treatment options. This method is applicable only when the health outcomes of the interventions are identical or sufficiently similar, eliminating the need for further outcome analysis. A typical illustration is when a physician chooses to prescribe a generic medicine over a branded counterpart, since both provide equivalent therapeutic effects but the generic is more economical [23].

EXAMPLE - Comparative research demonstrated that Ceftriaxone markedly lowered hospitalization expenses for patients suffering from serious infection primarily those affecting the Skin, bones and the joints by enabling them to receive all or part of their antimicrobial therapy during their hospital stay [24].

E. COST CONSEQUENCES ANALYSIS:

This is done primarily by using an illustrative table to indicate the effectiveness outcomes (primary and secondary outcomes) in a separate part of arrangement, combined with the calculated mean prices with Propecia. The Cost Consequences Analysis (CCA) is a method of economic analysis which expresses the outcomes of therapy and measures the cost of that given therapy to makes their own ideas on suitability and corresponding significance to their decision-making process.

F. COST OF ILLNESS:

It is commonly termed the "burden of disease*''* and includes evaluating both the direct and indirect expenses linked to a particular health condition. Estimates of the economic impact of conditions such as diabetes, mental illnesses, and cancer have been made in the United States. By accurately assessing these direct and indirect costs, it becomes possible to judge the comparative worth of a treatment or preventive approach [25].

EXAMPLE- By calculating the Societal Cost of a specific disease, the expense of a preventive measure can be deducted to estimate the advantage of applying such a strategy on a national scale. Cost-Of-Illness (COI) analysis is not intended to compare different therapeutic options but rather to approximate the economic impact of a disease. Consequently, the worth of both preventive and therapeutic interventions can be assessed in relation to this disease-related expenditure.

HUMANISTIC ANALYSIS:

Humanistic Outcomes are understood as the effects of a disease or its treatment on a patient's daily functioning and overall Quality of Life. This includes aspects such as physical ability, social interactions, general health, wellbeing, and life satisfaction. In line with this, our study measured humanistic outcomes by using quality-of-life scales and by assessing how well patients followed their prescribed treatments [26].

Humanistic outcomes consist of some mean parts: -

A. QUALITY OF LIFE:

When looking at QoL, the results were mixed. Some studies showed that MTM (Medication Therapy Management) services improved daily functioning and wellbeing, but other studies found little or no change. By adding measures that evaluate a patient's quality of life, it becomes possible to adjust the estimated effectiveness of different medicines. These quality-adjusted results can change both the clinical decisions made and the cost-

effectiveness comparisons of the drugs being studied Physical aspects of life (such as energy, mobility, and reduced symptoms) tended to improve more often than mental or emotional wellbeing [27].

B. PATIENT'S ADHERENCE:

Better Patient adherence can lead to fewer symptoms, fewer complications, better daily functioning, and less worry or stress for patients. Including factors that assess a patient's daily well-being allows us to adjust how effective different medicines are considered. These adjusted results can influence both treatment choices and the comparison of cost-effectiveness between the drugs being evaluated. Improving medication adherence isn't just about reducing costs or hospital visits it can also meaningfully improve how patients feel, their daily life, and their overall well-being [28].

7. PHARMACOECONOMIC MODELLING:

Pharmacoeconomics has recently become an important area of focus. It is a part of health economics that looks at and compares the value of different health policies or treatment approaches. In pharmacoeconomic modelling, the costs of a new drug or treatment plan are estimated along with their outcomes, such as money saved, improved treatment results, or better quality of life for patients. These models can be studied from different viewpoints, such as hospitals, doctors, patients, government, or society as a whole. Choosing the right viewpoint is a key step in making the analysis meaningful [29]. A key benefit of these models in pharmacoeconomic modelling is their ability to apply least-squares linear regression methods to study how different factors influence the additional cost-effectiveness of an intervention. This approach provides more detailed insights compared to traditional models that only combine overall cost and outcome differences. The models are frequently the sole reliable source of timely, adaptable, reasonably priced information regarding the clinical, humanistic, and financial outcomes of disease management agreements.

There are four types of Pharmacoeconomic modelling that is given below:

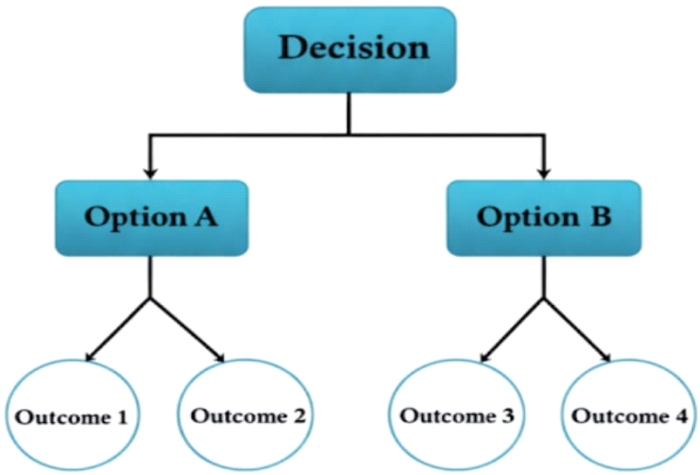
1. Decision tree models

2. Markov models

3. Discrete event stimulation models

4. Monte Carlo stimulation models

1. DECISION TREE MODELS:



For many years, decision tree models have been used to assess diagnostic tests, mainly to support reimbursement policies and healthcare decision-making. A wide range of references and materials are available that explain the detailed aspects of diagnostic decision modelling [30]. Decision tree models help map clinical pathways, combine evidence on costs and effectiveness, and assess the benefits of interventions. They can represent events over time, account for uncertainties, and point out areas for further research. These models are especially useful for one-time choices, short-term care decisions, and quick, routine decision-making in healthcare.

Example- Heparin for the prevention of Deep Vein Thrombosis (DVT) in hip replacement patients

-Patients are at risk of DVT (and pulmonary embolism) post-surgery

-Heparin can be injected pre-surgery and for 7-10 days post-surgery to try and prevent clots

-However, there are risks of bleeding [31].

LIMITATIONS:

1. Should capture the complete impact of each possible patient pathway.

2. Not very effective for long-term outcomes, even though extra branches can be added.

3. Managing repeated events is challenging [32]

2. MARKOV MODELLING:

The Markov model is a mathematical tool that works with a set of distinct health states, where a patient can either move from one state to another or stay in the same state. Each movement depends on certain probabilities, which usually remain constant. The time spent in each state is generally the same across the model. In Pharmacoeconomics, Markov models are mainly used to measure the cost-effectiveness of different treatment options, such as prevention strategies or hospital care. Beyond healthcare, they are also widely applied in other areas like economics, logistics, and marketing.

Example- The effectiveness of ACE inhibitors in treating heart failure is usually measured after six months. This period includes dose adjustment and the gradual reversal of harmful changes in the blood vessels, known as vascular remodelling. In most clinical and economic studies, a one-year cycle is used, as many large trials measure drug effectiveness over this time. However, the model can also use shorter cycles such as six months, one month, or even a week which are especially useful for studying acute illnesses or medical emergencies [33].

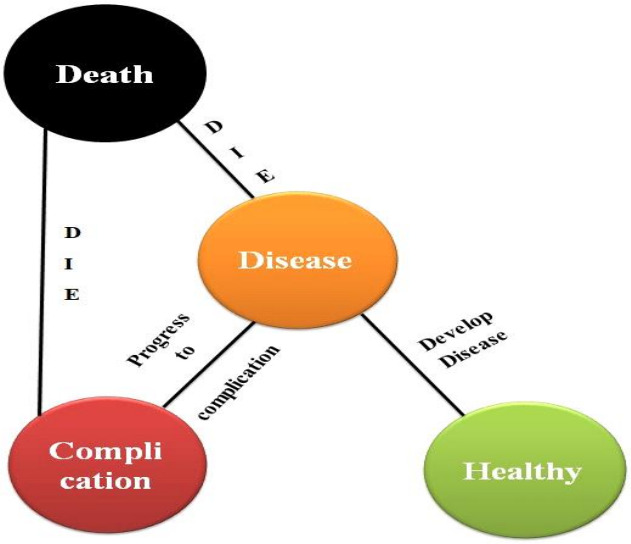
TYPES: -

A. Cohort simulation

A Cohort Markov Model is a decision tool that follows a group of patients as they move between different health states over time. At each step (called a cycle), a certain proportion of the group shifts to other states based on set probabilities [34].

B. Microsimulation model

A Microsimulation Model is a computer-based method that follows individual patients (or people) over time to see how their health, events, or behaviours change. By combining the results from many individuals, the model can estimate outcomes for the whole population and support healthcare decision-making.



LIMITATIONS:

1. Some real-world variations in patient conditions may not be well reflected in predefined Markov states.

2. Utility values are assumed to stay constant in each state, even though patient experiences and quality of life can change over time.

3. Markov models assume that the future state depends only on the current state, not on past history. This may oversimplify real disease progression [35].

3. MODELS FOR DISCRETE EVENT SIMULATION:

DES (Discrete Event Simulation) is a method that has been used for many years and is available in different programming languages and commercial software tools. It works by representing a system as a series of events that happen at specific moments in time. This approach makes it possible to model changing (dynamic) behaviour, interactions, and the use of resources—such as waiting lines (queues) and capacity limits at the level of individual people or items [36]. Although DES is being used more often in healthcare, its application for studying health and economic outcomes such

as in personalized medicine remains quite limited. The quality of published reports on DES has not really improved over time. Even so, DES can be a very suitable, and sometimes even the best, method for modelling health and economic results in specific situations, especially when assessing personalized medicine approaches [37,38].

Example- A case study on colon cancer is used to demonstrate how DES can be applied in practice. Since there is growing interest in including resource limitations in health-economic evaluations, the study also explains and shows functions that help model these capacity constraints [39].

4. MONTE CARLO SIMULATION MODEL:

The Monte Carlo method is a widely used simulation technique with multiple applications in healthcare. Its main strengths lie in its ability to provide a detailed picture of potential risks, making results more accurate. It is also highly flexible, as it allows the use of different probability distributions and can account for changing relationships between variables. In addition, the method is universal, meaning it can be applied to a wide range of problems, and it can be easily integrated with other risk assessment models or tools [40]. It can be understood as a way of using numerical integration with random sampling to handle uncertainty. A key point of this method is that the standard error reduces at a rate proportional to the square root of the number of simulations, rather than in direct proportion to the total size of the model [41].

Example- The method can also be used to reliably compare medicines from different groups, such as Fluoroquinolones versus Macrolides, or Beta-lactams versus Aminoglycosides, since separate evaluation targets are defined for each drug category.

8. SIGNIFICANCE:

Following are some applications of Pharmacoeconomics-

1. Pharmacoeconomics also helps guide decisions about how medicines are used. Most research in this field applies a cost-effectiveness approach to show how to reach a desired health outcome while spending the least amount of money.

2. A major use of Pharmacoeconomics in medical practice is to support both clinical and policy-related decisions. Pharmacists are now more often delivering services that help patients receive care more easily, use medicines properly, and achieve better health results [42].

3. It highlights how pharmacoeconomic studies such as cost-utility, cost-effectiveness, and cost-benefit analyses help guide policymaking, set drug prices, decide which medicines go on formularies, and improve patient access to treatments.

4. It also points out challenges like limited methods, lack of enough data, and uncertainty in results, while suggesting ways to strengthen the use of pharmacoeconomic evidence when making policy choices [43].

5. It points out major directions in health economics and outcomes research, including the increasing role of real-world data, clearer approaches to drug pricing, greater focus on patient-centered results, and the integration of digital health tools. These developments reflect the future path of Pharmacoeconomics and highlight the priorities of healthcare decision-makers [44].

6. Pharmacoeconomics brings structured tools to account for uncertainty (via sensitivity analysis or simulation), long-term outcomes, and patient preferences making decision-making more evidence-based, transparent, and justifiable.

7. Including pharmacoeconomic studies within clinical trials so that both medical outcomes and costs are evaluated together. By doing so, the results can directly support national decisions about whether a new medicine should be reimbursed, how it should be priced, and whether it offers enough value compared to existing treatments [45].

9. PHARMACOECONOMIC IMPLEMENTATION IN PUBLIC HEALTH PROGRAMS:

With healthcare costs rising and the growing need for medicines due to widespread diseases, it has become essential for every country to focus on Pharmacoeconomics. There is a need to create strategies and approaches to support the successful use of pharmacoeconomic in a country's healthcare system. Here are some clear recommendations to help improve the use of Pharmacoeconomics in a country.

Governments should set basic data standards and create committees to review medical records and data. They should also hold responsible those in charge of maintaining poor health records. It should be mandatory for both government and private hospitals to maintain accurate health records. This is crucial because having good-quality medication data is key to successfully implementing Pharmacoeconomics [46].

There should be strong collaboration between health policymakers and researchers to identify issues in the system and develop new, improved policies to address challenges in implementing Pharmacoeconomics.

Countries should create national organizations and agencies to oversee the implementation of Pharmacoeconomics, making the important decisions and taking actions needed to effectively use pharmacoeconomic analysis in healthcare systems.

National and regional pharmacoeconomic bodies should share the real costs of medicines and healthcare services for different treatments and procedures. This would create a standard reference for pharmacoeconomic studies and support researchers by giving them reliable and high-quality cost information [47].

10. PHARMACOECONOMICS AND HEALTH INSURANCE IN INDIA:

In the Indian health insurance system, most policies cover only inpatient services, which means a patient must stay in the hospital for at least one day to claim insurance. Instead of reducing expenses, this often increases overall costs. To control such unnecessary spending, insurers should work out agreements with hospitals and healthcare providers that focus on better cost management. Health insurance is an important way to strengthen Universal Health Coverage (UHC) by improving access to healthcare and offering financial protection. In Low- And Middle-Income Countries (LMICs), different types of insurance exist, which vary based on the provider (public or private), the coverage level, and the groups of people who benefit from them [48]. The latest initiative is 'Ayushman Bharat' or Pradhan Mantri Jan Arogya Yojana (PMJAY), introduced in 2018 to move towards (UHC). This scheme is completely funded by the government and aims to provide protection to nearly 500 million people, with health coverage of about US $7000 per family each year. Its main goal is to reduce the financial burden on poor and vulnerable populations while ensuring their access to healthcare services [49], knowing about and being aware of insurance schemes increases their use, which in turn improves access to healthcare services [50].

11. CONCLUSION:

In India, where people still spend a large share of their own money on healthcare and insurance coverage is limited, using pharmacoeconomic principles will be vital for building a fair and sustainable system. Bringing Pharmacoeconomics into public health programs through reliable data, transparent drug pricing, and strong collaboration between policymakers and researchers can improve both access and affordability. This approach will help shape policies on medicine costs, insurance coverage, and treatment guidelines so that healthcare remains effective as well as affordable. At the global level, Pharmacoeconomics is growing with the use of new technologies, real-world evidence, and patient-focused methods. It is no longer just a research tool but a practical requirement for achieving healthcare that is cost-effective, equitable, and centered on patient needs both in developed and developing countries.

REFERENCES:

1. Pradelli L, Wertheimer A, editors. Pharmacoeconomics: principles and practice. 2nd ed. Torino: SEEd; 2022. doi:10.7175/693.

https://books.google.com/books?hl=en&lr=&id=zeeREAAAQBAJ&oi=fnd&pg=PA1&dq=introduction+on+pharmacoeconomics+articles&ots=5qpyeZdkJE&sig=9SH4tI1gxskCh2GCSsfXGPkMNtM

2. Steed L, Sohan pal R, Todd A, et al. Community pharmacy interventions for health promotion: effects on professional practice and health outcomes. Cochrane Database Syst Rev. 2019;12(12):1207. doi:10.1002/14651858.

3. Haider R. Introduction to pharmacoeconomic. J Clin Res Notes. 2023;4(5). doi:10.31579/2690-8816/110. https://www.researchgate.net/profile/Rehan-Naqvi-3/publication/376889274_Introduction_to_Pharmacoeconomic/links/658dd03d0bb2c7472b18271b/Introduction-to-Pharmacoeconomic.pdf

4. Adunlin G, Ramachandran S, Omole KO, Odedina FT, Ezeani UI. The state of pharmacoeconomics education in the doctor of pharmacy curriculum amid the changing face of pharmacy practice. Healthcare. 2023;11(22). doi:10.3390/healthcare11222923. https://www.mdpi.com/2227-9032/11/22/2923

5. Tonin FS, Aznar-Lou I, Pontinha VM, Pontarolo R, Fernandez-Llimos F. Principles of pharmacoeconomic analysis: the case of pharmacist-led interventions. Pharm Pract (Granada). 2021;19(1):2302. doi:10.18549/pharmpract.2021.1.2302. https://scielo.isciii.es/scielo.php?pid=S1885-642X2021000100021&script=sci_arttext

6. Zhang SY MA, LI HC, Guan X. Instruments designed for quality assessment of pharmaceutical economic evaluations: an overview. Chinese Journal of Evidence-based Medicine. 2019; 19(7):844–850.

7. Farid S, Baines D. Pharmacoeconomics education in the Middle East and North Africa region: a web-based research project. Value Health Reg Issues. 2021; 25:182-8. doi:10.1016/j.vhri.2021.05.006. https://www.sciencedirect.com/science/article/pii/S2212109921000868

8. Agarwal U, Kapoor G, Singhal K, Tonk RK. The pharmacoeconomics and its evaluation in enhancing the Indian healthcare system. Curr Drug Res Rev. 2025. doi:10.2174/0125899775394503250626070441. https://www.benthamdirect.com/content/journals/cdrr/10.2174/0125899775394503250626070441

9. Timofeyev Y, Oksana D, Mihajlo J. The impact of transparency constraints on the efficiency of the Russian healthcare system: systematic literature review. J Med Econ. 2023;26(2):95-109. doi:10.1080/13696998.2022.2160608. https://www.tandfonline.com/doi/full/10.1080/13696998.2022.2160608

10. Zhang C, Zhang J, Tan J, Tian P, Li W. Cost-effectiveness of pembrolizumab for the treatment of non–small-cell lung cancer: a systematic review. Front Oncol. 2022; 12:815587. doi:10.3389/fonc.2022.815587. https://www.frontiersin.org/articles/10.3389/fonc.2022.815587/full

11. Jakovljevic M, Sugahara T, Timofeyev Y, Rancic N. Predictors of (in)efficiencies of healthcare expenditure among the leading Asian economies - comparison of OECD and non-OECD nations. Risk Manag Health Policy. (2020) 13:2261–80. Doi:10.2147/RMHP.S266386

12. Chua B, Morgan J, Yap KZ. Refill adherence measures and its association with economic, clinical, and humanistic outcomes among pediatric patients: a systematic review. Int J Environ Res Public Health. 2020;17(6):2133. doi:10.3390/ijerph17062133.

13. Chhatwal J, He T, Lopez-Olivo MA. Systematic review of modelling approaches for the cost effectiveness of hepatitis C treatment with direct-acting antivirals. Pharmacoeconomics. 2016;34(6):551-67. doi:10.1007/s40273-015-0373-9. https://pubmed.ncbi.nlm.nih.gov/26748919/

14. Chaudhry S. Quantifying pharmacoeconomics. J Pharm Biol Sci. 2020;8(1):32-7. doi:10.18231/j.jpbs.2020.005. https://jpbs.in/archive/volume/8/issue/1/article/2035/pdf

15. Anders B, Ommen O, Pfaff H, Lüngen M, Lefering R, Thüm S, Janssen C. Direct, indirect, and intangible costs after severe trauma up to occupational reintegration – an empirical analysis of 113 seriously injured patients. GMS Psycho-Soc-Med. 2013;10: Doc02. doi:10.3205/psm000092. https://pmc.ncbi.nlm.nih.gov/articles/PMC3687242/

16. Pizetta B, Raggi LG, Rocha KSS, Cerqueira-Santos S, de Lyra-Jr DP, Dos Santos Júnior GA. Does drug dispensing improve the health outcomes of patients attending community pharmacies? A systematic review. BMC Health Serv Res. 2021; 21:764. doi:10.1186/s12913-021-06785-9.

17. Gupta S, Periwal S, Nandy BC, Mahanti B. An overview of challenges, importance and evaluation of pharmacoeconomics: role of pharmacist's in health care system. J Biomed Pharm Res. 2020;9(3):33-43. doi:10.32553/jbpr.v9i3.757. https://www.researchgate.net/publication/341852135_AN_OVERVIEW_OF_CHALLENGES_IMPORTANCE_AND_EVALUATION_OF_PHARMAECONOMICS_ROLE_OF_PHARMACIST'S_IN_HEALTH_CARE_SYSTEM

18. Agarwal U, Kapoor G, Singhal K, Tonk RK. The pharmacoeconomics and its evaluation in enhancing the Indian healthcare system. In press. 2025 Jul 4. doi:10.2174/0125899775394503250626070441. https://www.eurekaselect.com/article/149209

19. Cookson R, Griffin S, Norheim OF, Culyer AJ, Chalkidou K. Distributional cost-effectiveness analysis comes of age. Value Health. 2021;24(1):118-20. doi:10.1016/j.jval.2020.10.001. https://www.sciencedirect.com/science/article/pii/S1098301520344168

20. Lancsar E, Gu Y, Gyrd-Hansen D, Butler J, Ratcliffe J, Bulfone L, Donaldson C. The relative value of different QALY types. J Health Econ. 2020; 70:102303. doi:10.1016/j.jhealeco.2020.102303.

21. Rascati K. Essentials of pharmacoeconomics. 3rd ed. Philadelphia: Wolters Kluwer Health; 2020. https://books.google.se/books?id=0pH-DwAAQBAJ

22. Australian Transport Assessment and Planning Guidelines: M1 Public Transport. Perth: Public Transport Authority; 2020 Aug. https://www.atap.gov.au/sites/default/files/documents/atap-m1-public-transport.pdf

23. Rai M, Goyal R. Pharmacoeconomics in healthcare. Pharm Med Transl Clin Res. 2018;465-72. doi:10.1016/B978-0-12-802103-3.00034-1. https://www.researchgate.net/publication/322181559_Pharmacoeconomics_in_Healthcare

24. Kumari P, Siddegowda JB, Krishnaiah V. Appropriateness and pharmacoeconomics of surgical antimicrobial prophylaxis in open reduction internal fixation surgery practiced in a tertiary hospital compared to recommendations in the National Center for Disease Control guidelines. Perspect Clin Res. 2019;10(4):172-6. doi:10.4103/picr.PICR_53_18. https://pubmed.ncbi.nlm.nih.gov/31649867/

25. Feng A, Lin W, Li L, Zeng M, Lyu J. Pharmacoeconomic evaluation of stroke and myocardial infarction prevention in hypertensive patients: Markov model based on the ACCOMPLISH trial. J Int Med Res. 2023;51(12). doi:10.1177/03000605231214921. Pharmacoeconomic evaluation of stroke and myocardial infarction prevention in hypertensive patients: Markov model based on the ACCOMPLISH trial - PMC

26. Gunter MJ. The role of the ECHO model in outcomes research and clinical practice improvement. Am J Manag Care. 1999;5(4 Suppl): S217-24. PMID:10387542. The role of the ECHO model in outcomes research and clinical practice improvement - PubMed

27. Deng ZJ, Gui L, Chen J, Peng SS, Ding YF, Wei AH. Clinical, economic and humanistic outcomes of medication therapy management services: a systematic review and meta-analysis. Front Pharmacol. 2023; 14:1143444. doi:10.3389/fphar.2023.1143444. https://pubmed.ncbi.nlm.nih.gov/37089963/

28. Schnorrerova P, Matalova P, Wawruch M. Medication adherence and intervention strategies: why should we care. Bratisl Lek Listy. 2025; 126:1196-1206. doi:10.1007/s44411-025-00227-0. https://link.springer.com/article/10.1007/s44411-025-00227-0#citeas

29. Thomas D, Hiligsmann M, John D, Al Ahdab OG, Li H. Pharmacoeconomic analyses and modelling. In: Thomas D, editor. Clinical pharmacy education, practice and research. Amsterdam: Elsevier; 2019. p. 261-75. doi:10.1016/B978-0-12-814276-9.00018-0. https://pubmed.ncbi.nlm.nih.gov/37089963/

30.National Institute for Health and Care Excellence. Diagnostics assessment programme manual. London: NICE; 2011 Dec. https://www.nice.org.uk/Media/Default/About/what-we-do/NICE-guidance/NICE-diagnostics-guidance/Diagnostics-assessment-programme-manual.pdf

31. Makoto K. Crecon medical assessment pharmacoeconomics: value for money of drugs/medical devices. Crecon Med Assess. 2019;3(2).

32. Abel L, Shinkins B, Smith A, Sutton AJ, Sagoo GS, Uchegbu I, Allen AJ, Graziadio S, Moloney E, Yang Y, Hall P. Early economic evaluation of diagnostic technologies: experiences of the NIHR diagnostic evidence co-operatives. Med Decis Making. 2019;39(7):857-66. doi:10.1177/0272989X19866415. Early Economic Evaluation of Diagnostic Technologies: Experiences of the NIHR Diagnostic Evidence Co-operatives - PubMed

33. Beck JR, Handorf EA. Markov modelling in decision analysis. In: Arnold RJG, editor. Pharmacoeconomics. 2nd ed. Boca Raton: CRC Press; 2020. p. 63-78. doi:10.1201/9780429491368-4. https://www.taylorfrancis.com/chapters/edit/10.1201/9780429491368-4/markov-modeling-decision-analysis-robert-beck-elizabeth-handorf

34. Alarid-Escudero F, Krijkamp E, Enns EA, Yang A, Hunink MGM, Pechlivanoglou P, Jalal H. An introductory tutorial on cohort state-transition models in R using a cost-effectiveness analysis example. Med Decis Making. 2023;43(1):3-20. doi:10.1177/0272989X221103163. https://pubmed.ncbi.nlm.nih.gov/35770931/

35. Feng A, Lin W, Lyu J. Pharmacoeconomic evaluation of stroke and myocardial infarction prevention in hypertensive patients: Markov model based on the ACCOMPLISH trial. J Int Med Res. 2023;51(12). doi:10.1177/03000605231214921. https://journals.sagepub.com/doi/full/10.1177/03000605231214921

36. Liu S, Li Y, Triantis KP, Xue H, Wang Y. The diffusion of discrete event simulation approaches in health care management in the past four decades: a comprehensive review. Inquiry. 2020; 57:2381468320915242. doi:10.1177/2381468320915242. https://pmc.ncbi.nlm.nih.gov/articles/PMC7278318/

37. Degeling K, Pereira-Salgado A, Corcoran NM, Boutros PC, Kuhn P, IJzerman MJ. Health economic evidence for liquid- and tissue-based molecular tests that inform decisions on prostate biopsies and treatment of localised prostate cancer: a systematic review. Eur Urol Suppl. 2021; 27:77-87. doi:10.1016/j.euros.2021.03.002. https://pubmed.ncbi.nlm.nih.gov/34337517/

38. Degeling K, Vu M, Koffijberg H, Wong H-L, Koopman M, Gibbs P, IJzerman MJ. Health economic models for metastatic colorectal cancer: a methodological review. Pharmacoeconomics. 2020;38(7):683-713. doi:10.1007/s40273-020-00908-4. https://pubmed.ncbi.nlm.nih.gov/32319026/

39. Wright SJ, Newman WG, Payne K. Accounting for capacity constraints in economic evaluations of precision medicine: a systematic review. Pharmacoeconomics. 2019;37(8):1011-27. doi:10.1007/s40273-019-00801-9. https://pubmed.ncbi.nlm.nih.gov/31087278/

40. Ramesh RP, Subramanian M, Lakshmanan E, Subramaniyan A, Ganesan G. Human health risk assessment using Monte Carlo simulations for groundwater with uranium in southern India. Ecotoxicol Environ Saf. 2021; 226:112781. doi:10.1016/j.ecoenv.2021.112781. https://www.sciencedirect.com/science/article/pii/S0147651321008939

41. Tang Y. A note on Monte Carlo integration in high dimensions. arXiv [preprint]. 2022. doi:10.48550/arXiv.2206.09036. https://www.researchgate.net/publication/361458603_A_Note_on_Monte_Carlo_Integration_in_High_Dimensions

42. Kosari S, Deeks LS, Naunton M, Dawda P, Postma MJ, Tay GH, Peterson GM. Funding pharmacists in general practice: a feasibility study to inform the design of future economic evaluations. Res Soc Adm Pharm. 2021;17(5):1012-6. doi:10.1016/j.sapharm.2020.07.030. https://pubmed.ncbi.nlm.nih.gov/32847733/

43. Alaklobi AAD, Alaklabi SM, Alkurbi ZA, Alqarni HM, Alqarni FM, Alqarni MA, Asiri AY, Bokhari MG, Almalki SM. Pharmacoeconomics and health policy: assessing the cost-effectiveness of pharmaceutical interventions and its insinuations for policy decision-making strategy. Ann Pharm Pharmacoecon. 2024;23(3):1-19. doi:10.61336/appj/24-03-19. https://www.azpharmjournal.com/en/2024-volume-23-issue-3/pharmacoeconomics-and-health-policy-assessing-the-cost-effectiveness-of-pharmaceutical-interventions-and-its-insinuations-for-policy-decision-making-strategy/

44. ISPOR. Top 10 HEOR trends 2024–2025. ISPOR—The Professional Society for Health Economics and Outcomes Research. Available from: https://www.ispor.org/heor-resources/top-10-heor-trends. Accessed 2025 Sep 14.

45. Pharmacoeconomics Committee of the Chinese Pharmaceutical Association. Expert consensus on pharmacoeconomic evaluations alongside clinical trials (2024 edition) [Article in Chinese]. Chin Med J. 2024;104(40):3736-44. doi:10.3760/cma.j.cn112137-20240422-00954. https://pubmed.ncbi.nlm.nih.gov/39463367/

46. Almazrou SH, Alaujan SS, Al-Aqeel SA. Barriers and facilitators to conducting economic evaluation studies of Gulf Cooperation Council (GCC) countries: a survey of researchers. Health Res Policy Syst. 2021;19(1):71. doi:10.1186/s12961-021-00721-1. https://pubmed.ncbi.nlm.nih.gov/33933093/

47. Hasamnis A, Patil SS, Krishnasamy N. A review of pharmacoeconomics: the key to “healthcare for all.” Syst Rev Pharm. 2019;10(1): S40-2. doi:10.5530/srp.2019.1s.21. https://www.researchgate.net/publication/343496660_A_Review_of_Pharmacoeconomics_the_key_to_Healthcare_for_All

48. van Hees SGM, O’Fallon T, Hofker M, et al. Leaving no one behind? Social inclusion of health insurance in low- and middle-income countries: a systematic review. Int J Equity Health. 2019; 18:134. doi:10.1186/s12939-019-1040-0. https://equityhealthj.biomedcentral.com/articles/10.1186/s12939-019-1040-0#citeas

49. Garg S, Bebarta KK, Tripathi N. Performance of India's national publicly funded health insurance scheme, Pradhan Mantri Jan Arogaya Yojana (PMJAY), in improving access and financial protection for hospital care: findings from household surveys in Chhattisgarh state. BMC Public Health. 2020; 20:949. doi:10.1186/s12889-020-09107-4. https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-020-09107-4#citeas

50. Maurya D, Mintrom M. Policy entrepreneurs as catalysts of broad system change: the case of social health insurance adoption in India. J Asian Public Policy. 2020;13(1):18-34. doi:10.1080/17516234.2019.1617955. https://www.tandfonline.com/doi/abs/10.1080/17516234.2019.1617955