Evidence-Based Medicine: Present Status and Future Directions

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Abstract

Evidence-based medicine (EBM) emphasizes the systematic and judicious use of the best available evidence in clinical decision-making aligning treatment options with individual patients' values and circumstances. It integrates clinical expertise, patient preferences, and research evidence to optimize patient care. By adopting EBM principles, clinicians improve care quality, ensure ethical decision-making, and adapt to the evolving landscape of medical science. This dynamic paradigm advances patient outcomes while providing a compassionate and evidence-driven healthcare environment. However, challenges such as information overload, resource constraints, and variations in evidence quality necessitate continuous learning and systematic approaches. This article explores the historical evolution of EBM, its foundational principles, and the structured five-step process: Assess, Ask, Acquire, Appraise, and Apply.

Keywords: critical appraisal, evidence-based medicine, health care, medical literature, research

Introduction

Healthcare is an evolving field where decisions must balance innovation, empirical research, and individual patients' nuanced needs and values. The evidence-based medicine (EBM) is a subset of evidence-based practice with the former focusing on clinical medicine and the latter covering a wider range of healthcare practices. As defined by Dr. David Sackett and colleagues, evidence-based medicine (EBM) is "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients."1 This philosophy underpins the shift from opinion-based practices to a methodology that is systematic, patient-centered, and adaptable.

The modern clinician is not only a caregiver but also a decision-maker, a researcher, and a critical thinker. EBM equips healthcare professionals with tools to navigate the complexities of medicine, ensuring that their practice is informed by data, yet responsive to individual circumstances. Despite its origins over a century ago, neurosurgery continues to evolve rapidly, with numerous diagnostic and management challenges persisting. Many neurosurgical conditions present multiple diagnostic and treatment options. In this article, the author discusses the origins, principles, methodologies, and challenges of EBM, emphasizing its indispensable role in contemporary medicine, especially neurosurgery.

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Historical Context

The journey of EBM is marked by several milestones:

1.James Lind's Scurvy Trial (1747): Lind conducted the first comparative trial, demonstrating the role of citrus fruits in preventing scurvy among a group of sailors. This marked the beginning of systematic experimentation in medicine.[2]

2.Bradford Hill's Randomized Trial (1940s): A randomized controlled trial (RCT) is considered a gold standard for evaluating therapeutic interventions. The first randomized controlled trial (RCT) assessing the effectiveness of streptomycin in treating tuberculosis was published in 1948.3 Its findings demonstrated that tuberculosis was no longer an untreatable disease.

3.Thalidomide Tragedy (1960s): This pharmaceutical disaster (the use of thalidomide as a sleeping pill during pregnancy leading to the birth of children with limb defects) underscored the need for rigorous drug approval processes, catalyzing regulatory reforms.[4,5]

4.Archie Cochrane's Contributions (1971): Cochrane emphasized the lack of systematic evidence in healthcare, leading to the establishment of the Cochrane Collaboration and systematic reviews.[6]

5.EBM's Formal Introduction (1992): Gordon Guyatt and colleagues introduced the term "Evidence-Based Medicine" in the medical literature, formalizing the discipline.[7]

These milestones reflect a transition from anecdotal practices to a robust, evidence-oriented approach.

Core Principles of EBM

Three key components of EBM are clinical expertise, the best available evidence, and patient preferences.1 True EBM is achieved when these elements are seamlessly integrated into practice.

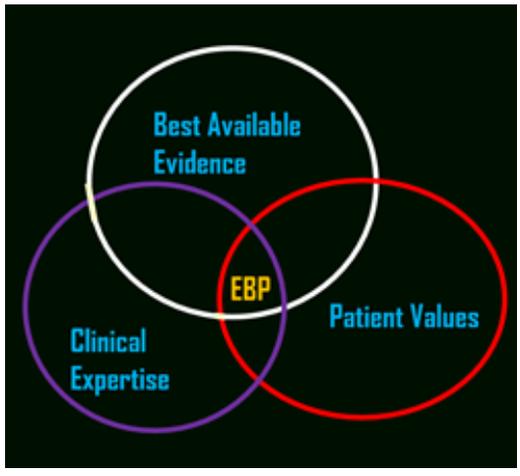

Figure 1. Venn diagram showing the concept of evidence-based medicine

1.Best Available Evidence: High-quality research is the foundation of EBM. It prioritizes data from systematic reviews, meta-analyses, and RCTs while acknowledging that evidence evolves over time.

2.Clinical Expertise: Experience and practical knowledge equip clinicians to assess evidence and determine its relevance to individual patient situations. This encompasses understanding patient history, family dynamics, and available community resources. Such expertise enhances the clinician's ability to evaluate whether a study's findings are credible, significant, and applicable to their patients.

3.Patient Values and Preferences: Patient-centered care, which values individual beliefs, cultural factors, and personal priorities, lies at the heart of EBM. It ensures that medical decisions are both evidence-based and tailored to each patient's unique needs.

Essence of EBM

The concept of EBM follows a systematic process that capitalizes on a fundamental principle of human behavior: achieving goals with the minimal effort required.[8,9] By emphasizing efficiency and precision, EBM enables clinicians to make well-informed decisions using the best available evidence, ensuring optimal patient care without unnecessary or redundant work. The following represent the core principles of EBM:[10]

1.All evidence is sought and examined systematically: The process of evidence-based practice begins with a thorough and structured search for relevant information. This involves using reliable sources, applying standardized methodologies, and critically appraising the evidence to ensure its validity and relevance. Systematic examination helps minimize bias and ensures a comprehensive understanding of the available data.

2.Evidence is, wherever possible, quantified: Whenever feasible, evidence is represented in measurable terms, such as statistical outcomes, risk ratios, or effect sizes. Quantification allows for objective comparison, clarity in interpretation, and greater reliability in applying findings to clinical practice, making decision-making more transparent and evidence-driven.

3.Evidence is considered in all decisions in healthcare: In every aspect of healthcare decision-making, from diagnostics to treatment planning, evidence serves as the cornerstone. By integrating research findings with clinical expertise and patient values, healthcare providers ensure that decisions are both scientifically grounded and tailored to individual patient needs.

The 5 A's of EBM

Implementing EBM involves a systematic process that involves five "A's".[7,11]

1.Assess: Clinicians begin by identifying and prioritizing the patient's problems. This step involves recognizing symptoms, understanding patient history, and classifying issues for targeted investigation.

2.Ask: Framing clinical questions is crucial. Using models like PICO (Population, Intervention, Comparison, Outcome), clinicians can structure their inquiries to guide efficient evidence searches developing an answerable & searchable question.[12]

3.Acquire: This step involves sourcing evidence from reputable databases, journals, and systematic reviews. PubMed and Scopus, Google scholar, and NepJOL are the best databases for retrieving the literature. It demands discernment to filter reliable information amidst the overwhelming volume.

4.Appraise: This step helps you understand the levels of evidence provided by various types of research. Evidence is critically evaluated for validity, reliability, and applicability. Questions regarding research design, statistical methods, and relevance to the clinical scenario should be satisfactorily addressed.

5.Apply: Finally, clinicians integrate the evidence with their expertise and patient values, implementing it in practice while considering individual circumstances.

The PICO Model in Framing Clinical Questions

First, you need to determine the domain on which you are trying to get the answer, such as etiology, diagnosis, treatment, prognosis, etc. The PICO model provides a structured framework for crafting researchable questions:[12]

P (Patient/Population/Problem): Identifies the specific patient group, population, or health issue under consideration. For example, "adults with low back pain" or "children with seizures."

I (Intervention): Refers to the treatment, procedure, diagnostic test, or exposure being evaluated. For example, "physical therapy" or "novel antiepileptic drug."

C (Comparison): Describes the alternative intervention or standard of care for comparison, if applicable. This could be "bed rest" or "existing treatment."

O (Outcome): Specifies the desired result or effect to be measured, such as "reduction in pain severity or alleviation of pain" or "control of seizure."

This model enhances the precision of literature searches, ensuring relevant and actionable findings (figure 2)

Figure 2. An example of the PICO model (from Sharma MR, Principles of Heath Science Research, 2021)13

	COMPONENTS	EXAMPLES
P	Problem	Risk of getting COVID-19
I	Intervention	Use of face masks
C	Comparison	Not wearing face masks
O	Outcome of interest	Reduced infection

Critical Appraisal: Evaluating Evidence

Critical appraisal is a cornerstone of EBM, enabling clinicians to assess research quality systematically. As defined by Hill and Spittlehouse, it is a "process of systematically examining research evidence to assess its validity, results, and relevance before using it to form a decision".[14] It involves scrutinizing the methodology, data analysis, and relevance of studies. It should be undertaken by all health professionals as part of their work.[15] Key 10 appraisal questions include:[16]

1.Did the study address a clearly focused issue?
2.Is the sample size justified?
3.Is the design appropriate to the stated objectives?
4.Are the statistical methods described?
5.Did untoward events occur during the study?
6.Were the baseline data adequately described?
7.What do the findings mean? Are statistically significant results clinically relevant?
8.Are important effects overlooked?
9.Do the results justify the conclusions?
10.What implications does the study have for your practice?

By answering these questions, clinicians can distinguish between robust evidence and studies with methodological flaws.

Grading and Levels of Evidence

Evidence is categorized into hierarchies based on scientific rigor:[17]

1.Randomized Controlled Trials (RCTs): The gold standard for therapeutic evidence, offering high reliability through randomization and control groups.

2.Cohort Studies: Provide insights into prognosis by following well-defined groups over time.

3.Case-Control Studies: Useful for identifying risk factors in rare conditions.

4.Case series and case reports: These are descriptive and often illustrate observations of interest in usually consecutive patients with similar diagnoses or undergoing similar procedures.

5.Expert Opinions: Though valuable, they rank lower due to potential biases.

Frameworks like the Oxford Centre for Evidence-Based Medicine guide clinicians in evaluating evidence quality and relevance.[16]

Challenges in Implementing EBM

Despite its transformative potential, EBM faces significant challenges:

1.Information Overload: The sheer volume of medical publications can overwhelm clinicians, delaying decision-making.[18]

2.Access Disparities: Resource limitations in certain regions hinder access to up-to-date evidence, impacting care quality. Many high-impact factor journals are often subscription-based and accessing the full-text articles is always a problem, especially for researchers in low and middle-income countries (LMICs). Bias insted of biased toward LMICS from so-called HICs cannot be ignored.[19] Additionally, various factors may prevent potential researchers from publishing their work, despite having produced a substantial volume of research.[20]

3.Time Constraints: The rapid pace of clinical work often limits the time available for thorough evidence review.

4.Variability in Evidence Quality: Not all research meets high methodological standards, requiring careful appraisal.

Addressing these challenges requires investment in medical education, decision-support tools, and fostering a culture of critical thinking in healthcare.

Balancing Evidence with Patient-Centric Care

In EBM, emphasis is placed on tailoring interventions to meet the unique needs and circumstances of each patient. This patient-centered approach considers multiple factors that influence decision-making, such as:

- **Is the treatment accessible and affordable?** Ensuring that the proposed intervention is both financially and logistically feasible for the patient is essential to adherence and effectiveness.
- **Are the patient's cultural beliefs and values considered?** Respecting cultural and personal values fosters trust and improves the likelihood of treatment acceptance.
- **How does the patient perceive the potential benefits and risks of treatment?** Understanding the patient's perspective on the outcomes helps align medical recommendations with their priorities and concerns.

Patient preferences often require balancing competing priorities. For example, a patient might choose immediate comfort or convenience over a longer-term health benefit, such as preferring a less restrictive diet despite knowing it could increase their risk of developing diabetes. This highlights the importance of shared decision-making in EBM, where clinicians and patients collaborate to find a plan that is both evidence-based and aligned with the patient's values and lifestyle.

The Role of Technology in EBM

Advances in technology have revolutionized the application of EBM:

- **Electronic Health Records (EHRs):** Enable data integration and personalized treatment plans.[21–23]
- **Clinical Decision Support Systems (CDSS):** Provide real-time evidence-based recommendations.[24]
- **Artificial Intelligence (AI):** Enhances literature search and identifies patterns in complex datasets.[25]

These tools enable clinicians to efficiently access, interpret, and apply evidence, enhancing the quality of care while reducing cognitive load. Regular EBM training for faculty is essential to keep them updated on the latest methodologies and evidence, ensuring they can effectively integrate evidence-based practices into clinical decision-making and teaching. [26–28]

EBM and the Future of Healthcare

As medicine advances, the role of EBM continues to evolve, adapting to new discoveries, technologies, and the growing complexity of healthcare. Emerging trends include:

●**Semantic Medicine:** The use of semantics in the medical field plays a crucial role in shaping a patient's understanding of their condition, influencing their decision-making process, and impacting their emotional and psychological response to treatment. Clear, precise, and empathetic language encourages better communication, reduces misunderstandings, and empowers patients to make informed choices about their healthcare. Conversely, ambiguous or overly technical language can create confusion, increase anxiety, and hinder patient engagement. Tailoring medical communication to the patient's level of understanding and cultural context is an essential aspect of patient-centered care. Leveraging AI to process and synthesize large volumes of data can help with this aspect.[29,30]

●**Patient Involvement:** Encouraging shared decision-making and empowering patients with evidence-based insights.

●**Dynamic Guidelines:** Updating clinical protocols in real-time as new evidence emerges.

●**Precision Medicine:** Precision medicine is an innovative approach to healthcare that tailors treatment and prevention strategies to the individual characteristics of each patient, including their genetic, environmental, and lifestyle factors. Utilizing advanced technologies such as genomics and data analytics enhances the effectiveness of treatments while minimizing side effects. This personalized approach is vital in oncology, neurology, and rare genetic disorders, enabling targeted interventions that improve outcomes and enhance the patient experience.[31,32]

These advancements ensure that EBM remains relevant in an era of rapid technological and scientific progress.

Conclusion

The concept of EBM has advanced significantly over the past three decades, transforming how medical decisions are made and implemented. It is not merely a method but a philosophy that defines modern healthcare. Integrating research evidence, clinical expertise, and patient preferences, ensures that care is both effective and compassionate. The structured processes of EBM empower clinicians to make informed decisions while navigating challenges like information overload and disparities in evidence quality. EBM underscores the importance of adaptability, recognizing that medicine is dynamic and evidence evolves over time. As clinicians embrace this paradigm, they become agents of innovation, delivering care that is scientifically rigorous, ethically sound, and deeply patient-centered. By fostering a culture of critical thinking and continuous learning, EBM not only enhances patient outcomes but also redefines the role of healthcare professionals in the information age.

Conflict of Interest: None

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