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Perspective Chapter: Evidence-Based Medicine - A New Approach for Medical Education and Practice

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Abstract

The new concept is gaining worldwide recognition and acceptance in medical education and practice. Evidence-based medicine (EBM) is the term used to describe this novel approach to the teaching and practice of medicine. The purpose of this chapter is to give you a brief overview of the components of EBM, EBM principles, the steps of EBM practice, and the skills required for EBM that can shape your approach toward EBM. A review of the English-language literature was conducted in PubMed, Google Scholar, and Google to obtain EBM definitions, the components of EBM, EBM principles, the steps of EBM practice, and the skills required for EBM. EBM is the integration of the best available research evidence with clinical expertise and patient values. It consists of three basic components: the best available evidence, clinical expertise, and patient values. The integration of these three components can be effectively achieved by completing the five steps of the EBM practice. The five-step process of EBM is asking, acquiring, appraising, applying the evidence in clinical decisions, and assessing the outcome.

Keywords: evidence-based medicine, critical appraisal, levels of evidence, medical practice

1. Introduction

The new concept is gaining worldwide recognition and acceptance in medical education and practice. Evidence-based medicine (EBM) is the term used to describe this novel approach to the teaching and practice of medicine. EBM is the integration of the best available external clinical evidence with clinical expertise and individual patient values to inform clinical decision-making [1]. It is a new area of expertise that all medical learners and practicing physicians should ideally acquire to be more present in their daily practices [2, 3]. The inclusion of EBM in one's practice not only makes one a better physician but also allows one to provide the best possible medical care for their patients. Therefore, EBM can be integrated into the medical curriculum [4, 5].
The practice of EBM usually begins with patient encounters, which raise questions about diagnosis, treatment, or prognosis [6, 7]. EBM seeks to find the best answers to these questions based on a detailed review of the literature published in medical journals that apply strict criteria for research validity. Evidence does not make decisions on its own, but it helps clinicians make better decisions about the patient care process and increases the likelihood of better medical outcomes [8]. Because EBM supports the collection of evidence in an accurate, concise, and informative manner, the implementation of EBM in clinical practice provides guidance for the selection of the most appropriate patient care based on the best available evidence [9]. Therefore, all medical personnel on the cross-disciplinary medical care team must have EBM skills to appraise, interpret, and apply research findings to their clinical practice [3, 9]. The purpose of this chapter is to give you a brief overview of the components of EBM, EBM principles, the steps of EBM practice, and the skills required for EBM that can shape your approach toward EBM.

2. Methods

A literature search was conducted in PubMed, Google Scholar, and Google to retrieve definitions of EBM, components of EBM, principles of EBM, EBM practice procedures, and skills required for EBM. Numerous combinations of keywords, such as “evidence-based medicine,” “evidence-based practice,” “medical education,” “medical practice,” “clinical practice,” “teaching,” and “training,” were employed to ensure comprehensive coverage of the EBM literature. Website pages, research articles, and commentaries were selected based on insight, accurate content, and balance to ensure non-bias. Furthermore, examples were drawn from the EBM resources for illustrative purposes.

3. Components of EBM

Contrary to its name, EBM is not just about evidence. It consists of three basic components: the best available evidence, clinical expertise, and patient values [1].

The best research evidence: The best research evidence refers to the latest scientific research in various aspects of patient care, diagnosis, treatment, or prevention.

Clinical expertise: Clinical expertise is a combination of medical skills, medical knowledge, and professional experience acquired by physicians throughout their careers.

Patient values: Patient values are the unique priorities, concerns, expectations, beliefs, hopes, and stresses that each patient brings to the clinical encounter (Figure 1).

4. Principles of EBM

The basic principles of EBM include: [6]

• Clinical problems should be translated into answerable clinical questions.

• Medical decisions should be based on the best available scientific evidence.

• Clinical problems should determine the type of evidence to look for.
The best evidence should be critically appraised for validity, relevance, and applicability.

Findings from a critical appraisal of evidence should be applied in clinical practice.

Clinical performance should be constantly evaluated.

5. Steps to practice EBM

The EBM process consists of five main steps: formulating a clinical question, acquisition of the evidence, evaluating the evidence, application of evidence to clinical decisions, and evaluation of outcomes [10].

5.1 Step 1: formulating answerable clinical questions

The first and most important step of EBM is formulating answerable clinical questions. The PICO (population (P), intervention (I), comparison (C), and outcome (O)) framework helps turn clinical problems into answerable clinical questions.

5.1.1 Types of clinical questions

1. Therapy: Questions about the effectiveness of treatment in improving outcomes for patients/patients with the disease.

2. Diagnosis: Questions about the ability of the test or procedure to distinguish between those with the disease or those without the disease.
3. **Prognosis**: Questions about the potential cause of the patient’s illness or the likelihood that they will develop the disease.

4. **Etiology/harm**: Questions about the harmful effect of intervention or exposure on the patient.

Here are some examples of clinical scenarios for each type of clinical question to illustrate how you can design clinical questions using PICO.

### 5.1.2 PICO for therapy questions

When using PICO to formulate a therapy question, P is the patient or disease, I is medications or specific procedural interventions, C is comparison intervention (or no treatment), and O is the outcome of interest such as disease or condition management.

**Scenario:** Your preceptor wants you to search for literature. She is interested in whether acetaminophen is better than ibuprofen in reducing fever in young children.

**PICO:** P = Young children, I = Acetaminophen, C = Ibuprofen, and O = Reduced fever.

**Clinical question:** Is acetaminophen more effective than ibuprofen in reducing fever in young children?

### 5.1.3 PICO for diagnosis questions

To formulate diagnostic questions using the PICO framework, P is the population of interest or the target disease, I is a diagnostic test or procedure, C is an alternative diagnostic test or the current gold standard test for the problem, and O is a measure of the test utility such as the sensitivity and specificity of the diagnostic tool, although the outcome measures usually do not need to be included in database searches.

**Scenario:** You are part of a team reviewing local cervical screening guidelines. The most commonly used test is the Pap test, which detects abnormal cells but does not detect the HPV virus. In recent years, tests have been developed to detect the HPV virus. You may want to know what the latest evidence says about using HPV and Pap tests, or whether they should be used in combination.

**PICO:** P = cervical cancer, I = HPV test, C = Pap test, O = effect of both tests.

**Clinical question:** Is the HPV test or Pap test more effective in detecting cervical cancer?

### 5.1.4 PICO for prognosis questions

When using PICO to generate prognostic questions, P is the patient, population, or problem; I is the prognostic factor; C is usually not applicable; and O is the outcome of interest (e.g., deaths and recurrence). Many prognosis questions require only population and outcome because they are more often related to a broader population than to subgroup comparisons.

**Scenario:** The father of a twenty years old schizophrenic is worried about his son’s future health. He asks you about possible relapses.

**PICO:** P = 20-year-old man with schizophrenia, I = inapplicable, C = inapplicable, O = relapse.

**Clinical question:** What is the likelihood of relapse in a twenty years old schizophrenic man?
5.1.5 PICO for etiology questions

When using PICO to formulate an etiology question, P is the patient or population, I is exposure to certain conditions or risk behaviors, C means not being exposed to those conditions or hazardous behaviors, and O is the outcome of interest such as the development of a particular disease or condition.

**Scenario:** You have a 39-year-old patient who has experienced heavy bleeding for most of her life. After considering all other options, we discuss the possibility of cervical surgery as a solution, although one may wonder if her high blood pressure in the year after surgery increases her risk of severe myocardial infarction.

**PICO:** P = 39-year-old woman undergoing cervical surgery, I = high blood pressure, C = normal blood pressure, and O = increased risk of acute myocardial infarction.

**Clinical question:** Are hypertensive women at higher risk of developing acute myocardial infarction in the first year after cervical surgery compared to non-hypertensive women?

5.2 Step 2: acquire the evidence

The second step is to search for the best available evidence in the medical literature that provides an answer to the question. This step involves identifying the search terms, selecting resources to perform your search, and developing an effective search strategy.

5.2.1 EBM pyramid: the evidence hierarchy

The EBM pyramid is a diagram that helps you understand how to weigh different levels of evidence for clinical decisions. It allows you to take a top-down approach to identify the best available evidence, by first searching for the recent systematic review, and if it is not available, search for the next level of evidence to answer your question. EBM pyramid ranks study types based on the strength and accuracy of their research methods. Figure 2 below shows the hierarchy of evidence or the EBM pyramid.

At the top of the pyramid is filtered evidence, which represents the strongest level of evidence such as systematic reviews, meta-analyses, and critical appraisals. At the bottom of the pyramid is unfiltered evidence, including randomized controlled trials, cohort studies, and case-controlled studies. You should seek the highest level of evidence available, but be aware that filtered evidence may not be relevant to your specific clinical question. If so, you need to move the pyramid down to find strong evidence that will solve your clinical question.

5.2.2 Filtered resources

Filtered resources critically assess the quality of the study and recommend its application in practice. A critical appraisal of individual articles has already been done for you, which will save a great deal of time. As the critical appraisal is completed, the filtered literature is suitable to use for clinical decision-making during care. In addition to saving time, filtered literature often provides more accurate answers than individual research studies. Examples of filtered sources include systematic reviews from the Cochrane Database of Systematic Reviews, TRIP Database, JAMA Evidence, BMJ Best Practices, UpToDate, DynaMed Plus, ACP Journal Club, and PubMed (Medline).
5.2.3 Unfiltered resources

Unfiltered resources are primary studies that have not yet been synthesized. Therefore, they are challenging to read, interpret, and apply in practice. Examples of unfiltered resources are CINAHL, EMBASE, Web of Science, PsycINFO, and PubMed. If a current, well-designed systematic review is not available, proceed to a primary study to answer your question. The best type of primary studies varies depending on the type of clinical question. Table 1 lists the study types suitable for the main types of clinical questions.

5.2.4 Building a search strategy

There are many ways to find information using online resources. An overview of these strategies is provided below. However, note that each database you use handles these strategies differently.

**Boolean Operators (AND, OR, and NOT):** Boolean operators allow you to combine search terms to identify records that contain matching words.

**AND**

- AND narrows the search.
- Retrieve documents that contain both the specified search terms or keywords.
- The more terms you connect with AND, the fewer the search results.
Example: Hip AND Fracture retrieve documents containing both hip and fracture.

OR

• Use OR to expand your search.

• Retrieve documents that contain either of the specified keywords or both keywords, but not necessarily both.

• The more keywords you combine with OR, the more search results you will get.

• Use to search for similar keywords.

Example: Renal OR Kidney retrieves documents that contain either renal or kidney or both renal and kidney.

NOT

• Use NOT to remove terms from your search and find fewer results.

Example: pig NOT guinea will return items containing only the term pig but eliminates items containing the 2nd term (guinea) or both terms.

Nesting or parentheses: Use parentheses to group your search terms and Boolean operators in the order in which you want to process them. Using the advanced search screen in the database is another way to group your words so that you can find more relevant documents on the topic you want. Example: (dental anxiety OR dental fear OR dental phobia) AND (music therapy OR music).

Truncation and Wildcards: Using truncation and wildcards is a shortcut strategy for retrieving records that contain a word variation. Truncation markers allow you to add individual word endings and spellings without listing them as search terms. For example, educat* will retrieve documents that contain words such as education, educator, educating, educated, or educational. Wildcards are often used to find alternate spellings of a word, such as wom?n for woman or woman. Be careful when using truncation and wildcard symbols as different databases use different symbols. To determine which symbol to use in the database you are looking for, find the Help screen and look for information on wildcards, truncation, or word variation.
Field search: A field is a part of an electronic record of a database. Try narrowing or broadening your search by searching specific fields such as author, subject, title, or full text.

Controlled vocabularies: Few databases contain thesauruses, but some use subject headings. If the database you are using has either, it is worth checking how the topics are grouped and the database language used. A subject title search is more accurate than a keyword search.

5.3 Step 3: appraise the evidence

Once the evidence that answers the clinical question is identified, the next step is to evaluate the evidence for its validity/closeness to truth and applicability/clinical importance. Critical appraisal of each type of study requires answers to three basic questions, which are as follows:

• Are the study results valid?

• What are the results?

• Do the results help my patient care?

There are standard questions that can be used to assess the validity and applicability of evidence. The questions that can be asked depend on the type of clinical question and the study method. To see examples of these questions, refer to the worksheet below (Tables 2–5).

5.4 Step 4: apply the evidence

If you find evidence that is valid, important, and generalizable to your patient, you need to decide how to apply the findings to your patient care. Applying the best evidence is undoubtedly the EBM step that requires the most skill. It is at this stage that you synthesize your medical expertise and outstanding scientific knowledge with the patient’s specific values and circumstances to make a clinical decision: Before applying evidence from research to your patient, answer the questions listed in Table 6.

5.5 Step 5: assess the outcome

The final step is self-assessment of your performance in the EBM process. You should evaluate your application of research evidence, identify the effectiveness of the strategies you have applied, and examine whether you are able to provide a satisfactory result to the patient. Self-assessment of performance in EBM is the process of answering questions in Table 7.

6. Skills required for EBM practice

The five-step process of EBM requires a wide variety of knowledge and skills. To perform the first three steps, clinicians need to be able to question current clinical practice and answer clinical questions (Step 1), have knowledge of medical databases and skills in literature search (Step 2), ability to understand scientific methods and
In applying the evidence (Step 4), physicians rely on their medical expertise. Therefore, they need the ability to use both clinical skills and previous experience to identify a patient’s personal health status and diagnosis, their patient values and assessments, and the specific risks and benefits of screening.

**Screening**
- Does the study employ an appropriate study design?
- Does the PICO match your question?
- Is there a possible conflict of interest?

**Validity**
- **Patient follow-up**
  - Were all patients included in the trial adequately considered and included in their conclusions (loss to follow-up should be less than 20%)?
  - Is the follow-up of the patient complete?
- **Randomization**
  - Were the included subjects a good representative of the target population?
  - Was the patients’ allocation to the treatment random?
  - Was the allocation secret?
- **Intention to treat analysis**
  - Were patients analyzed in randomized groups?
  - Does the data of all randomized subjects analyzed?

**Baseline characteristics similar to patients**
- Were the groups similar at the start of the study?

**Blinding**
- Were patients, health care workers, and researchers “blinded” to the treatment?
- If blinding was not possible, were blinded mice and/or objective outcome measures used?

**Equal treatment**
- Apart from the experimental intervention, were the groups treated equally?

**Summary of the validity of the article**
- What are the significant research strengths, weaknesses, or concerns?
- How serious are the threats to validity, and in what ways might research results be biased?

**Clinical importance**
- How precise were the treatment effects? (confidence interval; in its absence p-value tells statistical significance)
- How large was the treatment effect? (see below)

Outcome present Outcome absent
Treated/exposed $A = B$
Control/non exposed $C = D$

**Experimental event rate (EER):** The proportion of patients in the experimental treatment group who are observed to experience the outcome of interest. $EER = A / (A + B)$

**Control event rate (CER):** The proportion of patients in the control group who are observed to experience the outcome of interest. $CER = C / (C + D)$

**Absolute risk reduction (ARR):** The calculated absolute difference in the incidence of adverse outcomes between experimental and control participants in a trial. $ARR = CER - EER$

**Relative risk reduction (RRR):** The relative reduction in the incidence of adverse outcomes between experimental and control participants in a trial. $RRR = CER / EER - 1$

**Number needed to treat (NNT):** The number of patients who need to be treated with the specified intervention to prevent one bad outcome or produce one good outcome over the period of time specified in the study. $NNT = 1 / ARR$


Table 2.
Critical appraisal worksheet to assess the validity and applicability of therapy studies.
Screening
• Why was the study conducted (what was the research question)?
• Does the study employ an appropriate study design?

Validity
• Did the study have a clear and specific question?
• Was the presence or absence of the target disease confirmed by the reference standard?
• Was the comparison with an independent reference standard blinded to the results of the research study?
• Was this test evaluated in a suitable range of patients?
• Were reference criteria applied to all patients?

Clinical importance

<table>
<thead>
<tr>
<th>Disorder present</th>
<th>Disorder absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive test result A B</td>
<td></td>
</tr>
<tr>
<td>Negative test result C D</td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity: The percentage of people with the target disease whose test is positive. Used to help evaluate and select diagnostic tests/symptoms.
Sensitivity = A/(A + C)

Specificity: The proportion of people whose tests are negative and do not have the desired disease. Used to help evaluate and select diagnostic tests/symptoms.
Specificity = D/(B + D)

Likelihood ratio for a positive test = sensitivity/1 - specificity
Likelihood ratio for a negative test = 1 - sensitivity/specificity

Table 3.
Critical appraisal worksheet for a diagnosis study.

Screening
• Why was the study conducted (what was the research question)?
• Does the study employ an appropriate study design?

Validity
• Is the defined representative sample collected in a common (usually early) stage of the disease?
• Was patient follow-up sufficient to achieve the desired clinical outcome?
• Is the follow-up of the patient complete?
• Do the outcomes of interest predefine?
• Were outcomes measured “blind” (i.e., without knowledge of patient clinical characteristics and prognostic factors)?

Clinical importance
• What are the risks of the outcome over time?
• How precise are the estimates?

Table 4.
Critical appraisal worksheet for a prognosis study.

Screening
• Why was the study conducted (what was the research question)?
• Does the study employ an appropriate study design?

Validity
• Did the study have a clear and specific question?
• Were there clearly defined and similar groups of patients?
• Were exposures and clinical outcomes measured in the same way in both groups?
• Was the follow-up complete and long enough?
• Is the proposed causal link reasonable?

Clinical importance
• Adverse outcome
  Present (case) Absent (control)
potential interventions [12]. Finally, to evaluate performance (Step 5), clinicians must be able to self-evaluate and reflect on their own performance in the EBM stages and on the application and integration of evidence into clinical practice [10].
7. Conclusion

EBM integrates the best available evidence with clinical expertise and patient values to inform clinical decisions. Thus, EBM has three essential elements: best available evidence, clinical expertise, and patient values. The integration of these three components defines evidence-based clinical decisions. This integration can be effectively achieved by completing the five steps of EBM practice. The five-step of the EBM process requires a variety of knowledge and skills. To perform the first step (Step 1), the practitioners need the skills to question current clinical practices and frame answerable clinical questions. To acquire the evidence (Step 2), you need to have knowledge of medical databases and literature search skills. To critically appraise the evidence (Step 3), you must be able to understand scientific methods and statistics (biostatistics and epidemiology). When using evidence (Step 4), clinicians need the ability to use both clinical skills and previous experience to identify patients’ health status and diagnosis, their patient values and assessments, and the specific risks and benefits of potential interventions. Finally, to evaluate the performance (Step 5), clinicians should be able to self-assess and reflect on their performance in the EBM phases and the application of evidence and its integration into clinical practice.

Conflict of interests

The authors report no conflicts of interest.

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