EVIDENCE-BASED PRACTICE

RUSH UNIVERSITY MEDICAL CENTER
MEDICAL STUDENT USERS GUIDE

Prepared by the Rush University Medical Center
Evidence-Based Practice Interest Group
May 7, 2012
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction: Essay on EBM</td>
<td>3-5</td>
</tr>
<tr>
<td><strong>Section 1: The Basics</strong></td>
<td></td>
</tr>
<tr>
<td>What is Evidence-Based Practice (EBP)</td>
<td>6</td>
</tr>
<tr>
<td>Basic steps of EBP</td>
<td>6</td>
</tr>
<tr>
<td>o Background vs Foreground questions</td>
<td>6</td>
</tr>
<tr>
<td>o Formulating an answerable clinical question: PICO</td>
<td>6-7</td>
</tr>
<tr>
<td>o Types of studies/evidence domains</td>
<td>7-8</td>
</tr>
<tr>
<td>o Levels of evidence</td>
<td>9</td>
</tr>
<tr>
<td><strong>Section 2: Searching the Literature</strong></td>
<td></td>
</tr>
<tr>
<td>Searching the literature</td>
<td>10</td>
</tr>
<tr>
<td>o Databases</td>
<td>10</td>
</tr>
<tr>
<td>o MeSH terms</td>
<td>11</td>
</tr>
<tr>
<td>o Limits</td>
<td>12</td>
</tr>
<tr>
<td><strong>Section 3: Evaluating the Literature</strong></td>
<td></td>
</tr>
<tr>
<td>The clinical approach</td>
<td>13-17</td>
</tr>
<tr>
<td>The epidemiology approach</td>
<td>18-23</td>
</tr>
<tr>
<td><strong>Section 4: Communicating the Evidence</strong></td>
<td></td>
</tr>
<tr>
<td>Do we teach a unified approach to communicating evidence to patients? Some references for instructors.</td>
<td>24</td>
</tr>
</tbody>
</table>
Evidence based medicine: what it is and what it isn't

BMJ 1996; 312 doi: 10.1136/bmj.312.7023.71 (Published 13 January 1996)

David L Sackett, William M C Rosenberg, J A Muir Gray, R Brian Haynes, W Scott Richardson

It's about integrating individual clinical expertise and the best external evidence

Evidence based medicine, whose philosophical origins extend back to mid-19th century Paris and earlier, remains a hot topic for clinicians, public health practitioners, purchasers, planners, and the public. There are now frequent workshops in how to practice and teach it (one sponsored by the BMJ will be held in London on 24 April); undergraduate and postgraduate training programmes are incorporating it (or pondering how to do so); British centres for evidence based practice have been established or planned in adult medicine, child health, surgery, pathology, pharmacotherapy, nursing, general practice, and dentistry; the Cochrane Collaboration and Britain's Centre for Review and Dissemination in York are providing systematic reviews of the effects of health care; new evidence based practice journals are being launched; and it has become a common topic in the lay media. But enthusiasm has been mixed with some negative reaction. Criticism has ranged from evidence based medicine being old hat to it being a dangerous innovation, perpetrated by the arrogant to serve cost cutters and suppress clinical freedom. As evidence based medicine continues to evolve and adapt, now is a useful time to refine the discussion of what it is and what it is not.

Evidence based medicine is the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice. Increased expertise is reflected in many ways, but especially in more effective and efficient diagnosis and in the more thoughtful identification and compassionate use of individual patients' predicaments, rights, and preferences in making clinical decisions about their care. By best available external clinical evidence we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient centred clinical research into the accuracy and precision of diagnostic tests (including the clinical examination), the power of prognostic markers, and the efficacy and safety of therapeutic, rehabilitative, and preventive regimens. External clinical evidence both invalidates previously accepted diagnostic tests and treatments and replaces them with new ones that are more powerful, more accurate, more efficacious, and safer.

Good doctors use both individual clinical expertise and the best available external evidence, and neither alone is enough. Without clinical expertise, practice risks becoming tyrannised by evidence,
for even excellent external evidence may be inapplicable to or inappropriate for an individual patient. Without current best evidence, practice risks becoming rapidly out of date, to the detriment of patients.

This description of what evidence based medicine is helps clarify what evidence based medicine is not. Evidence based medicine is neither old hat nor impossible to practice. The argument that “everyone already is doing it” falls before evidence of striking variations in both the integration of patient values into our clinical behaviour and in the rates with which clinicians provide interventions to their patients. The difficulties that clinicians face in keeping abreast of all the medical advances reported in primary journals are obvious from a comparison of the time required for reading (for general medicine, enough to examine 19 articles per day, 365 days per year) with the time available (well under an hour a week by British medical consultants, even on self reports).

The argument that evidence based medicine can be conducted only from ivory towers and armchairs is refuted by audits from the front lines of clinical care where at least some inpatient clinical teams in general medicine, psychiatry (J R Geddes et al, Royal College of Psychiatrists winter meeting, January 1996), and surgery (P McCulloch, personal communication) have provided evidence based care to the vast majority of their patients. Such studies show that busy clinicians who devote their scarce reading time to selective, efficient, patient driven searching, appraisal, and incorporation of the best available evidence can practice evidence based medicine.

Evidence based medicine is not “cookbook” medicine. Because it requires a bottom up approach that integrates the best external evidence with individual clinical expertise and patients’ choice, it cannot result in slavish, cookbook approaches to individual patient care. External clinical evidence can inform, but can never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision. Similarly, any external guideline must be integrated with individual clinical expertise in deciding whether and how it matches the patient’s clinical state, predicament, and preferences, and thus whether it should be applied. Clinicians who fear top down cookbooks will find the advocates of evidence based medicine joining them at the barricades.

Some fear that evidence based medicine will be hijacked by purchasers and managers to cut the costs of health care. This would not only be a misuse of evidence based medicine but suggests a fundamental misunderstanding of its financial consequences. Doctors practising evidence based medicine will identify and apply the most efficacious interventions to maximise the quality and quantity of life for individual patients; this may raise rather than lower the cost of their care.

Evidence based medicine is not restricted to randomised trials and meta-analyses. It involves tracking down the best external evidence with which to answer our clinical questions. To find out about the accuracy of a diagnostic test, we need to find proper cross sectional studies of patients
clinically suspected of harbouring the relevant disorder, not a randomised trial. For a question about prognosis, we need proper follow up studies of patients assembled at a uniform, early point in the clinical course of their disease. And sometimes the evidence we need will come from the basic sciences such as genetics or immunology. It is when asking questions about therapy that we should try to avoid the non-experimental approaches, since these routinely lead to false positive conclusions about efficacy. Because the randomised trial, and especially the systematic review of several randomised trials, is so much more likely to inform us and so much less likely to mislead us, it has become the “gold standard” for judging whether a treatment does more good than harm. However, some questions about therapy do not require randomised trials (successful interventions for otherwise fatal conditions) or cannot wait for the trials to be conducted. And if no randomised trial has been carried out for our patient’s predicament, we must follow the trail to the next best external evidence and work from there.

Despite its ancient origins, evidence based medicine remains a relatively young discipline whose positive impacts are just beginning to be validated, and it will continue to evolve. This evolution will be enhanced as several undergraduate, postgraduate, and continuing medical education programmes adopt and adapt it to their learners’ needs. These programmes, and their evaluation, will provide further information and understanding about what evidence based medicine is and is not.

References
Section 1: The Basics

What is Evidence Based Practice (EBP)?

“Evidence Based Practice is the integration of best research evidence with clinical expertise and patient values to guide medical decision-making.”

Basic steps of Evidence Based Practice

A. Recognize that you need more information.

Clinical encounters often reveal gaps in our understanding of a disease process. Our knowledge base can be built by answering background questions or foreground questions.

**Background questions** are questions regarding anatomy, pathophysiology, pharmacology, or microbiology that, when answered, serve to better understand the fundamentals of any particular disorder.

**Foreground questions** are questions regarding diagnostic tests, therapies, or exposures that, when answered, serve to better understand the relationship of an intervention to a particular outcome.

B. When it is clear that you have a foreground question, formulate an answerable clinical question.

There are 4 major components to an answerable clinical question. These components are easily described using the PICO mnemonic.

**P: Population**
Which factors, demographic and otherwise, best describe your patient scenario? These may include age, gender, diagnosis, severity of diagnosis, clinical setting, and so on. Keep in mind that the more specific this part of the question becomes, the more difficult it may be to find relevant studies.

**I: Intervention**
What is the intervention of interest? This may be a diagnostic test, a new medication, an interventional program, or an exposure, to name a few. Again you want to best describe the intervention that you are considering for your patient, and this may include factors such as timing, duration, or dose of the intervention. Keep in mind that at times you may want to know if an intervention is *better than* the standard intervention, and at other times you may want to know if an intervention is *as good as* the standard intervention.
C: Comparison
What is the comparison of interest? If you are looking for studies regarding a diagnostic test, the comparison should be to the “gold standard” diagnostic test. If you are looking for studies regarding a new medication or therapy, the comparison should either be to placebo or to the “standard of care” medication or therapy. If you are looking for studies regarding exposures, the comparison should be to no exposure. If you are looking for studies regarding prognosis, there usually is no comparison group.

O: Outcome
What is the outcome or outcomes of interest? The outcome of interest should be measurable and should be patient-oriented. This often is described simply as “improved outcome for the patient”, but this may be measured in a number of ways. Be cognizant of whether a measured outcome is clinically relevant.

C. Once you have your question, recognize what type of study will best answer your question. (See Section 3, The Epidemiology Approach, for more details)

<table>
<thead>
<tr>
<th>Question</th>
<th>Type of study</th>
</tr>
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<tbody>
<tr>
<td>Diagnostic tests</td>
<td>- Cohort</td>
</tr>
<tr>
<td>Treatments or therapies</td>
<td>- Randomized controlled trial</td>
</tr>
<tr>
<td></td>
<td>- Intervention study</td>
</tr>
<tr>
<td></td>
<td>- Cohort study</td>
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<tr>
<td></td>
<td>- Meta-analysis</td>
</tr>
<tr>
<td>Associations between exposure and outcome</td>
<td>- Cohort study</td>
</tr>
<tr>
<td></td>
<td>- Case-control study</td>
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<tr>
<td>Prognosis</td>
<td>- Cohort study</td>
</tr>
<tr>
<td></td>
<td>- Meta-analysis</td>
</tr>
</tbody>
</table>

Studies evaluating diagnostic tests: These studies are usually cohort studies in which a group of consecutive patients who are suspected to have a particular disease are enrolled. Both the “new” diagnostic test and the “gold standard” diagnostic test are applied to every patient. This enables an accurate calculation of sensitivity, specificity, positive predictive value, and negative predictive value for the “new” diagnostic test, as well as a comparison of these values to the “gold standard” in the given population.

Studies evaluating treatments or therapies: These studies are usually randomized controlled trials in which a group of consecutive patients, often with a confirmed diagnosis, are randomly assigned to receiving either the “new” treatment or the comparison treatment, which could be placebo, no treatment, or standard treatment. The outcomes measured often enable calculations of the experimental event rate and the control event rate, or otherwise provide results on the differences between the groups studied. Cohort studies also can be used to look at treatments or therapies.
Studies evaluating associations between an exposure and an adverse outcome: These studies may be prospective cohort studies, retrospective cohort studies, or case-control studies that look at a group of subjects exposed to a risk factor and compares them to a group of subjects not exposed to the risk factor. The comparison is often made in regards to the development of an adverse outcome. This comparison can generate calculations of relative risk (for cohort studies) or odds ratios (for case-control studies). These studies can help elucidate potential new etiologies for disease processes.

Studies evaluating prognosis: These studies are usually cohort studies of patients with a disease or disorder who are followed for a period of time, but often without comparison to another group. These studies can provide information on long term outcomes for patients with certain characteristics that may be helpful in explaining potential outcomes to similar patients.

Systematic reviews and Meta-analyses: Systematic reviews involve a critical appraisal and rigorous review of the available literature around a clinical question. Meta-analyses do the same and also compile data from multiple studies and provide an analysis of the compiled data. A meta-analysis of homogenous studies is considered to provide the highest level of evidence.
D. Levels of Evidence

- Case reports
- Case series
- Ecologic studies
- Cross-sectional studies
- Case-control studies
- Cohort studies
- Randomized controlled trials
- Meta-analysis

GENERATE HYPOTHSES

ESTABLISH CAUSALITY
Section 2: Searching the Literature

The primary database for researching the medical literature is Medline. Medline is the largest biomedical information database in the world. The National Library of Medicine produces the Medline database. It can be accessed for via the Rush Library’s website (http://www.rushu.rush.edu/library) through PubMed. The link to PubMed found on the Library’s page provides full text access to the electronic collections of the Library. (http://www.ncbi.nlm.nih.gov/sites/entrez?otool=iluruslib)

Enter the search terms into the box on the main screen to perform a keyword search; this is the same type of search you would be doing if you used Google. One of the nice features of the Medline database is the indexing of the material the database contains. Users can search that index to find material that has been pre-screened for them by the subject specialists at the National Library of Medicine.

MeSH stands for medical subject headings and allows the users more control over the way the terminology is used within the search results. Searching using MeSH terms helps ensure consistency. The MeSH database is incorporated into most Medline records in PubMed. Selecting one or two appropriate MeSH terms and a few **limits** allows users to decrease the number of results to a manageable number.

One of the most relevant limits a searcher can use is **Core Clinical Journals**. This limits the number of journal titles searched to gather results. The full Medline database searches about 5500 journal titles. Using the Core Clinical Journals limit, decreases that number to 120 titles. The 120 titles contained in Core Clinical Journals are the most frequently read and cited in medicine and its subspecialties.
Access to the Library's journal collection is simplified through Rush’s PubMed specific url shown on the previous page. Simply click the red **GetIt! button** attached to the citation for which you’d like to retrieve the full text. The GetIt! button will link you wherever the article is found in Rush’s electronic collection.
Section 3: Evaluating the Literature

There are different approaches to how to evaluate medical literature.

A. **The Clinical Approach** uses the Sackett guidelines. You can use these rubrics for the types of evidence assuming the study design matches the rubric.
   i. Therapy → RCT, prospective cohort
   ii. Association → prospective cohort, retrospective cohort, case-control
   iii. Diagnosis → cohort, usually not RCT
   iv. Systematic review/meta-analysis → meta-analysis
   v. Prognosis → cohort

B. **The Epidemiology Approach**: If study design does not match the Sackett rubric or additional evaluation criteria are desired, use Study Design Evaluation Guide.
   i. Randomized controlled trial
   ii. Cohort
   iii. Case Control
A. The Clinical Approach: The Sackett Rubrics for Evaluating Medical Literature

**Therapy**
Adapted from Straus SE, Glasziou P, Richardson WS, Haynes RB.
Evidence Based Medicine, How to Practice and Teach It, Fourth Edition.

*For a more detailed discussion from the Evidence Based Medicine Working Group, visit [www.cche.net/text/usersguides/therapy.asp](http://www.cche.net/text/usersguides/therapy.asp)*

<table>
<thead>
<tr>
<th>Are the results likely to be valid?</th>
<th>Adverse Event</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present</td>
<td>Absent</td>
<td>Totals</td>
<td></td>
</tr>
<tr>
<td>Treatment Group</td>
<td>Drug</td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td></td>
<td>Placebo</td>
<td>c</td>
<td>d</td>
<td>c+d</td>
</tr>
<tr>
<td>Totals</td>
<td>a+c</td>
<td>b+d</td>
<td>a+b+c+d</td>
<td></td>
</tr>
</tbody>
</table>

Experimental Event Rate (EER) = \( \frac{a}{a+b} \)
Control Event Rate (CER) = \( \frac{c}{c+d} \)
Absolute risk reduction (ARR) = CER – EER (If negative, this is an absolute risk increase (ARI))
Number needed to treat (NNT) = \( \frac{1}{ARR} \) (Number needed to harm (NNH) = \( \frac{1}{ARI} \))

<table>
<thead>
<tr>
<th>Are the results important?</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Are the results applicable to my patient?</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Is our patient so different from those in the study that its results cannot apply?</td>
<td></td>
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<tr>
<td>Is the treatment feasible in our setting?</td>
<td></td>
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<tr>
<td>What are our patient's potential benefits and harms from the therapy?</td>
<td></td>
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<tr>
<td>What are our patient's values and expectations for both the outcome we are trying to prevent and the adverse effects we may cause?</td>
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</tr>
</tbody>
</table>
Association – Harm or Etiology


For a more detailed discussion from the Evidence Based Medicine Working Group, visit www.cche.net/text/usersguides/harm.asp

### Are the results likely to be valid?
- Were there clearly defined groups of patients, similar in all important ways other than exposure to the treatment or other cause (the risk factor)?
- Were treatments/exposures and clinical outcomes measured in the same ways in both groups?
- Was the assessment of outcomes either objective or blinded to exposure?
- Was the follow-up of the study patients sufficiently long (for the outcome to occur) and complete?
- Do the results of the harm study fulfill some of the diagnostic tests for causation?
  - a. Is it clear that the exposure preceded the onset of the outcome?
  - b. Is there a dose-response gradient?
  - c. Is there any positive evidence from a “dechallenge-rechallenge” study?
  - d. Is the association consistent from study to study?
  - e. Does the association make biological sense?

### Are the results important?

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Adverse outcome</th>
<th>Present</th>
<th>Absent</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>c</td>
<td>d</td>
<td>c+d</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>a+c</td>
<td>b+d</td>
<td>a+b+c+d</td>
</tr>
</tbody>
</table>

Relative Risk (RR) = \[\frac{a/(a+b)}{c/(c+d)}\]
Odds Ratio (OR) = \[\frac{ad}{bc}\]

### Are the results applicable to my patient?
- Is our patient so different from those in the study that its results cannot apply?
- What are our patient’s potential benefits from the treatment/exposure?
- What are our patient’s preferences, concerns and expectations from this treatment/exposure?
- What alternative treatments or therapies are available?
Diagnosis

For a more detailed discussion from the Evidence Based Medicine Working Group, visit www.cche.net/text/usersguides/diagnosis.asp

<table>
<thead>
<tr>
<th>Are the results likely to be valid?</th>
<th>Was there an independent, blind comparison with a reference (&quot;gold&quot;) standard of diagnosis?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Was the diagnostic test evaluated in an appropriate spectrum of patients (like those in whom we would use it in practice)?</td>
</tr>
<tr>
<td></td>
<td>Was the reference (&quot;gold&quot;) standard applied regardless of the diagnostic test result?</td>
</tr>
<tr>
<td></td>
<td>Was the cluster of tests validated in a second, independent group of patients?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are the results important?</th>
<th>Disease</th>
<th>Present</th>
<th>Absent</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Result</td>
<td>Positive</td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td>Negative</td>
<td>c</td>
<td>d</td>
<td>c+d</td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>a+c</td>
<td>b+d</td>
<td>a+b+c+d</td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity = a/(a+c)  Positive predictive value = a/(a+b)  LR (+) = [a/(a+c)]/[b/(b+d)]
Specificity= d/(b+d)  Negative predictive value = d/(c+d)  LR (-) = [c/(a+c)]/[d/(b+d)]

For a discussion of Likelihood Ratios (LR), including an LR nomogram, visit www.cebm.net/index.aspx?o=1043

<table>
<thead>
<tr>
<th>Are the results applicable to my patient?</th>
<th>Is the diagnostic test available, affordable, accurate, and precise in our setting?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Are the study patients similar to our own patient?</td>
</tr>
<tr>
<td></td>
<td>Can we generate a clinically sensible estimate of our patient’s pre-test probability?</td>
</tr>
<tr>
<td></td>
<td>• Did the study provide a reasonable estimate of the pre-test probability, or are there other, independent studies or resources that provide such an estimate?</td>
</tr>
<tr>
<td></td>
<td>Will the resulting post-test probability affect our management and help our patient?</td>
</tr>
</tbody>
</table>
Overview/Systematic Review/Meta-analysis
Adapted from Straus SE, Glasziou P, Richardson WS, Haynes RB.
Evidence Based Medicine, How to Practice and Teach It, Fourth Edition.

For a more detailed discussion from the Evidence Based Medicine Working Group, visit
www.cche.net/text/usersguides/overview.asp

| Are the results likely to be valid? | Is this a systematic review of randomized controlled trials?  
Does it describe a comprehensive and detailed search for relevant articles?  
- Is it unlikely that important, relevant studies were missed?  
Were the individual studies included assessed for validity?  
- Were the criteria used to assess validity explained?  
Were assessments of the studies reproducible?  
- Did the study have more than one assessor, and if so, how were disagreements resolved? |
|-----------------------------------|--------------------------------------------------------------------------------------------------|
| Are the results important?        | Are the results consistent from study to study?  
What is the magnitude of the treatment effect?  
- Is there an explanation of the effect size of the individual and pooled studies?  
How precise is the treatment effect?  
- Is the confidence interval around the effect size reasonable? |
| Are the results applicable to my patient? | Is our patient so different from those in the study that the results cannot apply?  
Is the treatment feasible in our setting?  
What are our patient’s potential benefits and harms from the therapy?  
What are our patient’s values and expectations for both the outcome we are trying to prevent and the adverse effects we may cause? |
## Prognosis


*For a more detailed discussion from the Evidence Based Medicine Working Group, visit [www.cche.net/text/usersguides/prognosis.asp](http://www.cche.net/text/usersguides/prognosis.asp)*

| Are the results likely to be valid? | Was there a representative and well-defined sample of patients assembled at a similar point in the course of their disease?  
| | Was follow-up sufficiently long and complete?  
| | Were objective and unbiased outcome criteria used?  
| | Was there adjustment for important prognostic factors? |
| Are the results important? | How large is the likelihood of the outcome event(s) in a specified time period?  
| | How precise are the estimates of likelihood? |
| Are the results applicable to my patient? | Is our patient so different from those in the study that its results cannot apply?  
| | Will the results lead directly to selecting or avoiding therapy?  
| | Are the results useful for reassuring or counseling patients? |
B. The Epidemiology Approach

Below is a summary of the different study design types and how they evolve.

Figure 1: Algorithm for classification of types of clinical research
Below are the different measurements used to assess outcomes.

AN OVERVIEW OF MEASUREMENTS IN EPIEMIOLOGY

Epidemiology is about identifying associations between exposures and outcomes. To identify any association, exposures and outcomes must first be measured in a quantitative manner. Then rates of occurrence of events are computed. These measures are called “measures of disease frequency.” Other measures, the association between exposures and outcomes, are then evaluated by calculating “measures of association or effect.” Finally, the impact of removal of an exposure or the outcome is evaluated by computing “measures of potential impact.” In general, measures of disease frequency are needed to generate measures of association, and both are needed to get measures of impact. There is some overlap between these measures, and terminology is poorly standardized.

The superscript numbers refer to the formulas used to compute these measures (formulas shown separately in the following pages).

Mallherie Ph, UC Berkeley, May 2003 (mallherie@public.berkeley.edu)
Randomized Controlled Trials

- **Relevance** – Do you care about this subject? Who is the target?

- **Quality of the research (Validity)**
  
  - **Question** – Is the research question clear? Who is being studied, what is the intervention, and how will success be measured? Is the question supported by literature?
  
  - **Design** – Was the best study design used for this question?
  
  - **Randomization** – Was randomization done appropriately? *(Hint: look at Table 1.)*
  
  - **Blinding** – Who was blinded? Was this the best they could do? What bias is introduced?
  
  - **Recruitment/Inclusion/Exclusion Criteria** – What errors or sources of bias? Who was studied?
  
  - **Outcome measurement** – Did they use objective or subjective measures? How much error is in these measures?
  
  - **Analysis** – Is there a CONSORT diagram or clear explanation of how people moved through the trial? Was intent-to-treat analysis used? How did they deal with missing data?
  
  - **Power** – Did they have enough participants to answer their question with minimal chance of error?

- **Results**

  - **Reporting** – Are the questions asked in the introduction answered by the results presented?
  
  - **Size and precision of outcome** – *Did they produce a clinically significant effect size?* What is your confidence in outcomes? *(p values, confidence intervals, etc)*

- **Implications**

  - **Interpretation** – Are the conclusions made appropriate? Are important sources of bias and limitations discussed?
  
  - **Clinical significance** – Does this matter to you in your clinical practice?
  
  - **Benefits verses costs/harm** – Is it worth it?
  
  - **Generalizability** – Can it be applied to others?
Cohort Studies

- **Relevance** – Do you care about this subject? Who is the target?

- **Quality of the research (Validity)**
  - **Question** – Is the research question clear? Who is being studied and how will the outcomes be determined? Is the question supported by literature?
  - **Design** – Is the prospective or retrospective? Was the best study design used for this question?
  - **Recruitment/Inclusion/Exclusion Criteria** – What errors or sources of bias? Who was studied? Think about selection bias and generalizability.
  - **Exposure and outcome measurement** – What are the specific exposures and outcomes? Did they use objective or subjective measures? How much error is in these measures?
  - **Confounders** – Are known confounders listed and addressed?
  - **Follow-up** – How long were people followed for? Is this appropriate?
  - **Analysis** – Are the analyses appropriate?

- **Results**
  - **Reporting** – Are the questions asked in the introduction answered by the results presented?
  - **Size and precision of outcome** – What is your confidence in outcomes? (p values, confidence intervals, etc)

- **Implications**
  - **Interpretation** – Are the conclusions made appropriate? Are important sources of bias and limitations discussed?
  - **Clinical significance** – Does this matter to you in your clinical practice?
  - **Benefits verses costs/harm** – Is it worth it?
  - **Generalizability** – Can it be applied to others?
Case Control Studies

- **Relevance** – Do you care about this subject? Who is the target?
- **Quality of the research (Validity)**
  - **Question** – Is the research question clear? Who is being studied and how will the outcomes be determined? Is the question supported by literature?
  - **Design** – Was the best study design used for this question?
  - **Cases** – Were the cases recruited in an appropriate way? What errors or sources of bias? 
  - **Controls** – Were the controls recruited in an appropriate way? What errors or sources of bias? Was matching used? Any issues with non-response? Are there enough controls?
  - **Exposure and outcome measurement** – What are the specific exposures and outcomes? Did they use objective or subjective measures? How much error is in these measures? Most importantly, how accurate is the exposure measure?
  - **Confounders** – Are known confounders listed and addressed?
  - **Analysis** – Are the analyses appropriate?

- **Results**
  - **Reporting** – Are the questions asked in the introduction answered by the results presented?
  - **Size and precision of outcome** – What is your confidence in outcomes? (p values, confidence intervals, etc)

- **Implications**
  - **Interpretation** – Are the conclusions made appropriate? Are important sources of bias and limitations discussed?
  - **Clinical significance** – Does this matter to you in your clinical practice?
  - **Benefits verses costs/harm** – Is it worth it?
  - **Generalizability** – Can it be applied to others?
Section 4: Communicating the Evidence

The following are useful articles for helping instructors and students understand how to use EMB.


