



Evidence Based Medicine and the Rural Emergency Physician

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What Is EBM (And What Is It Not)

The term “evidence based medicine” was coined in 1992 by Gordon Guyatt and the Evidence Based Medicine Working Group as the overlap between clinician expertise, patient’s unique situation and personal values, and research evidence (Figure 1).¹ Although graduate education, resident training, and post-residency practice improvement (continuing medical education) espoused the virtues of research evidence since the Flexner report of the early 20th Century, this concept of EBM provided a new approach to incorporating clinical research into bedside practice. For example, the process of EBM provided a template to seek, find, appraise, and apply research findings to individual patients as opposed to the passive dissemination of research that had been relied upon by investigators, journals, and educators in the decades following the Flexner medical revolution. Through a series of peer reviewed “How to use and appraise” manuscripts published in the Journal of the American Medical Association (JAMA),² EBM proponents provided a toolbox for learners at all levels of training to use research evidence appropriate for their unique practice settings. This JAMA series is now available as a textbook entitled “User’s Guide to the Medical Literature”.³

FIGURE 1: The EBM Triad



Unfortunately, a growing body of evidence suggests that clinical experience alone is insufficient to ensure that patients receive contemporary, guideline-based medical care.⁴ In fact, half of the patients in the United States do not receive evidence-based management in primary care.⁵ Since there are over 5000 biomedical publications that appear every day in PUBMED and since an emergency medicine provider needs to read 26 articles in Annals of Emergency Medicine to find one manuscript that changes their practice,⁶ it is not surprising that new innovations and updated guidelines are often overlooked by busy clinicians. EBM is one approach to help busy clinicians to find, evaluate, and use clinical research in their practice, but it is not a panacea.⁷ In Malcolm Gladwell’s novel “Outliers”, he provides examples of multiple talented individuals in a variety of professions noting that each shared one key exposure: 10,000 hours of mentored

training to master their domain.⁸ Most clinicians lacked a high-quality exposure to EBM during their medical training^{9, 10} and there is ample evidence that traditional CME is ineffective.¹¹ Since it is unlikely that clinicians working long hours with increasing patient volumes and paperwork burdens will have the luxury of Gladwell’s 10,000-hour exposure, EBM critics therefore portray the EBM construct of finding, appraising, and using clinical evidence as an unreal expectation.¹²⁻¹⁴ Some of the arguments of EBM opponents are noted in Table 1.¹² However, these same critics offer no viable alternatives (authoritarian dictate? conscious ignorance?),^{15, 16} while a fiscally fragile, increasingly strained healthcare system demands adaptation from the status quo. This chapter provides a roadmap for rural physicians to assimilate EBM principles into their practice.

Table 1: Problems Inherent to the Philosophy of EBM

EBM Grading is Detached from Scientific Reality
EBM Proceeds Where Logical Positivism Failed
EBM Reduces Scientific Methodology to a Single Step
EBM Confuses Statistics with Science
EBM Lacks Evidence of Efficacy, Hence It Is Internally Inconsistent

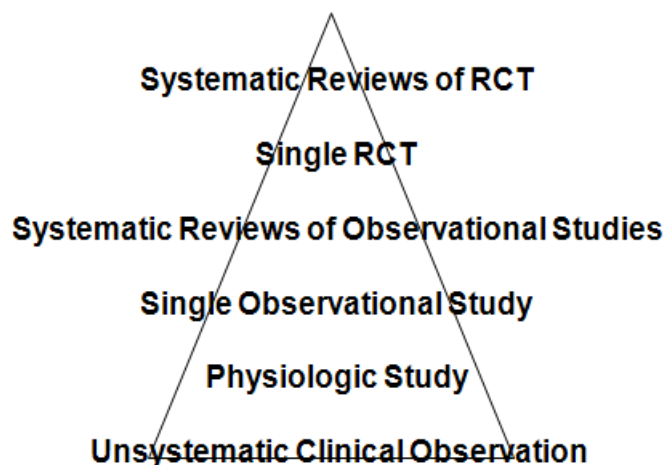
The Evidence Based Clinical Practitioner

Two key components of EBM are that:

- (1) Evidence alone is never enough.
- (2) Not all evidence is equally valid.

The first precept contends that there is an important and indispensable role for clinical expertise. Each clinician spends thousands of hours evaluating and contemplating myriad patient presentations and approach to care. No textbook or journal manuscript will supplant the knowledge base, which informs clinical intuition. In addition, patient priorities and values often trump clinical intuition and research evidence. The second component refers to a hierarchy of research evidence.

FIGURE 2: The EBM Hierarchy of Evidence



The hierarchy of evidence proposed by EBM leaders is depicted in Figure 2. In this hierarchical structure, systematic reviews/meta-analyses are considered the most accurate form of research evidence, followed by randomized controlled trials, meta-analyses of observational research, individual observational studies, case reports/case series, and bench research (i.e. physiologic studies), in order of highest to lowest forms of clinical research evidence. The rationale for this hierarchy is that the highest forms of evidence are least likely to provide biased estimates of effect

size, whether the research question is a therapy, diagnostic test, or prognostic factor. EBM proponents recognize that not every research question is amenable to a randomized controlled trial so their emphasis is on ensuring the least biased estimate of effect size, hence the evidence hierarchy.

EBM: Experts Versus Practitioners

Some have stratified clinicians into EBM experts or evidence based practitioners.¹⁷ EBM experts seek to understand existing EBM principles, develop innovative EBM teaching modules or measurement instruments, and disseminate these ideas within and around the House of Medicine. On the other hand, evidence-based practitioners are less interested in EBM as a teachable concept and more invested in applying research evidence at the bedside using EBM. Many resources exist for individuals seeking to become EBM experts.^{18,19} The focus of this chapter is on *evidence-based practitioners*.

The stepwise approach for evidence based practitioners is depicted in Figure 3.²⁰ The first step is to understand what information is required by asking an answerable question. The question is formulated using the PICO format²¹

P = patient population

I = intervention (therapy, diagnostic test, prognostic factor)

C = control group (if applicable)

O = outcomes of interest

The PICO question is used to direct the search strategy that will acquire research evidence. Specific resources to find applicable evidence are discussed in the next section. Evidence based practitioners prioritize evidence via the hierarchy of evidence (Figure 2). The next step is to appraise the evidence. The User's Guide provides key questions for each type of research, including therapy, diagnosis, differential diagnosis, prognosis, cost-effectiveness... which are available in the appendix. Figure 3 provides a real-life example of how evidence based practitioners would use these principles to find the highest quality research and then assess the risk of bias based upon the clinician's unique experience, patient population, and practice setting.

Figure 3: An Example of the EBM Process

STEP 1: Derive the PICO question

Population: Adult patients with pulmonary embolism
Intervention: Outpatient management (heparin/LMWH anticoagulation)
Comparison: Inpatient management (heparin/LMWH anticoagulation)
Outcome: Morbidity, mortality, ED recidivism, cost, side effects

STEP 2: Devise a search strategy and find the evidence

You use PUBMED to conduct a “broad” therapy study Clinical Query using the search term “pulmonary embolism” yielding 16242 citations which you subsequently combine with the search terms “emergency*” and “outpatient management” (27 citations – see <http://tinyurl.com/m8nq8yg>)

STEP 3: Select the least biased clinical research using the evidence hierarchy (Fig. 2)

Can selected patients with newly diagnosed pulmonary embolism be safely treated without hospitalization? A systematic review, **Ann Emerg Med** 2012; 60(5):651-662. (<http://pmid.us/22944455>).

STEP 4: Appraise the evidence using the appropriate critical appraisal worksheet—in this case the meta-analysis critical appraisal form from the User’s Guide to the Medical Literature

I.	Are the results valid?	
1.	Did the review explicitly address a sensible question?	Yes, can a subset of newly diagnosed PE patients be safely and effectively treated at home?
2.	Was the search for relevant studies detailed and exhaustive?	Yes, the authors followed PRISMA guidelines and searched multiple electronic database and conference proceedings.
3.	Were the primary studies of high methodological quality?	As noted in Table 2 (p. 656) only one RCT was identified. It was moderate quality using GRADE criteria with potential bias from lack of allocation concealment and lack of blinding. Seven observational trials were “very low” quality of evidence with concerns for failure to develop and apply appropriate eligibility criteria, failure to measure all known prognostic variables and control for confounders, and imprecision (wide CI’s).
4.	Were the assessments of the included studies reproducible?	Yes, the authors used the GRADE criteria that are reproducible.
II.	What are the results?	
1.	What are the overall results of the study?	<ul style="list-style-type: none"> Original search identified 2286 titles from which 24 prospective studies were identified, but 17 excluded (1 because hotel used, 16 because PE and DVT outcomes were reported separately), although the SR authors were able to obtain the PE data from one study from the original investigators

STEP 4: Appraise the evidence (cont'd)

		<ul style="list-style-type: none"> • Kappa = 1 (95% CI 0.85-1.0) for study selection • 8 studies (1 RCT, 7 observational studies), including 777 adult patients, were included, all but one in academic settings and only four initiated from the ED. Only one study included U.S. patients. Mean ages varied from 47-69 across studies • Three studies used risk stratification instruments <ul style="list-style-type: none"> • Beer used 6-variable Geneva score • Agterof used NT-pro BNP < 500 pg/mL to define “low-risk” • Aujesky used the 11-variable Pulmonary Embolism Severity Index • All 3 of the studies that used risk-stratification instruments also used social or medical conditions to preclude outpatient treatment, including PE characteristics (massive, received lysis, or diagnosed > 23° prior), patient symptoms requiring parenteral opioids, vital sign abnormalities (hypotension, tachycardia, hypoxemia), contraindications to anticoagulation (active bleeding, acute anemia, thrombocytopenia renal insufficiency, severe liver disease, stroke within 10 days-4 weeks, GI bleed or operation within 2 weeks, heparin intolerance, comorbidities (heart failure, arrhythmia, pregnancy, extreme obesity, life expectancy < 3 months), and barriers to adherence/follow-up (lack of telephone or transport support, lack of around-the-clock caregiver, substance abuse, psychosis, dementia, homelessness, imprisonment, or patient preference) • Treatment consisted of LMWH for 5 days + warfarin with arranged clinic follow-up within 7-10 days, preceded by researcher-initiated telephone calls • All studies included patient/caregiver education on medication usage and signs/symptoms requiring medical attention • Four studies used adjudication committee to define outcomes • No patients in any study were lost to follow-up • Seven studies with 90-day follow-up on 741 patients found zero cases of thromboembolic or hemorrhage-related death (95% CI 0-0.62%) • One study with 180-day follow-up reported two deaths. If these had occurred within 90 days, the event rate would have been 0.26% (95% CI 0-1%) • 90 day non-fatal recurrent venous thromboembolic rates ranged from 0 to 6.2% and non-fatal hemorrhage 0-1.2% • In the RCT patient satisfaction did not differ between groups (92% outpatient vs. 95% inpatients, p=0.39) were satisfied or very satisfied with the medical care received
2.	How precise are the results?	See 95% CI above.
3.	Were the results similar from study to study?	No. “The significant heterogeneity between the study population precluded outcome-level assessments” (p. 654). These studies were conducted in different settings on variable PE risk strata with variable methods of following up patients.
III.	<i>Will the results help me in caring for my patients?</i>	
1.	How can I best interpret the results to apply them to the care of my patients?	In select and agreeable non-geriatric adult patients with newly-diagnosed PE, transportation access to outpatient anticoagulation care, and a reliable caregiver at home, outpatient management of PE is safe with PE or hemorrhage-related deaths <1%.
2.	Were all patient important outcomes considered?	Yes, including patient acceptability.
3.	Are the benefits worth the costs and potential risks?	Yes, if appropriately low-risk patients with access to care can be reliably identified real-time in the ED. This will require an algorithm/protocol agreed upon by EM, PCP’s, Hospitalists, and anti-coagulation services.
4.	How will you communicate the findings of this study with your patients to facilitate shared decision-making?	Multiple studies have demonstrated that treating your pulmonary embolism (blood clot) at home with shots and pills is as safe and effective as treating you with the same medications in the hospital, if you meet certain low-risk criteria, have the ability to follow-up within 7-10 days as scheduled and have somebody at home to help you monitor your care.

STEP 5: Summarize the limitations of this research and the take-home message

Limitations:

1. Heterogenous, poor-quality study with only 4 ED-based settings and limited external validity for community ED’s
2. Failure to assess publication bias
3. No assessment of how many rural ED patients in the U.S. would be eligible for this protocol given stringent criteria

Bottom Line:

In select and agreeable non-geriatric adult patients with newly-diagnosed PE, transportation access to outpatient anticoagulation care, and a reliable caregiver at home, outpatient management of PE is safe with PE or hemorrhage-related deaths <1%.

Multiple uncertainties remain. Can and will EP’s reliability risk stratify PE patients? Which risk-stratification instrument should be used? Is LMWH available to destitute ED patients 24/7? Who will provide LMWH teaching and is this instruction reliable? How will follow-up be assured and what QI process will close the loop?

STEP 6: Determine whether this evidence is sufficient to incorporate into your practice

The EBM Resources for the Rural Physician

A variety of free online resources already exist to help emergency physicians keep up-to-date on practice-changing or practice-enhancing research. Some of these websites are listed in Table 2. These products include synopses of journal club events across a variety of academic institutions that often include reproducible PICO-based queries, critically appraised topics, associated podcasts, and social media feeds like Twitter

and Facebook. Other resources like “TheNNT.com” provide quantitative EBM reviews that may or may not be relevant to EM, but they are searchable. Some of these online resources are also discoverable by some of the electronic search engines described below (such as the Washington University in St. Louis Journal Club via the Translating Research into Practice [TRIP] database). The content archived on these websites can be used as ready for primetime, pre-canned educational sessions for physicians to conduct their own journal club-like events locally or as sources of pre-analyzed, secondary peer-reviewed research news.

TABLE 2: Free EBM Resources for Rural Emergency Medicine Physicians

Resources	Website
<i>Search Engines</i>	
PUBMED	http://www.ncbi.nlm.nih.gov/pubmed
TRIP	http://www.tripdatabase.com/
<i>Journal Club Reviews</i>	
Eastern Virginia	http://emjournalclub.com/
Indiana University	http://emergency.medicine.iu.edu/research/journal-club/
Washington University	http://emed.wustl.edu/content/journalclub/em_journal_club.html
<i>Quantitative Reviews</i>	
TheNNT.com	http://www.thennt.com/
<i>Statistical Calculators</i>	
2x2 Contingency Table	http://statpages.org/ctab2x2.html
Post-Test Probability	http://www.dokterrutten.nl/collega/LRcalcul.html
Sample Size Calculator	http://homepage.divms.uiowa.edu/~rlenth/Power/

Free search engines exist for rural physicians with internet access. PUBMED (<http://www.ncbi.nlm.nih.gov/pubmed>) is commonly used and represents a medical librarian archived resource made available by the National Library of Medicine. The PUBMED website includes online tutorials (circled in red) to show novice users how to optimize the search capability of this resource. As illustrated in Figure 4, PUBMED Clinical Queries are an extremely useful resource for clinicians to focus a search on therapy, prognosis, diagnostics, or clinical prediction guides.^{22, 23} Rural emergency physicians can use Clinical Queries to quickly identify all of the research for a clinical question and then combine these findings with a search term like “rural*” to

isolate the most relevant studies for their setting (see Figure 4d through 4g). Note that the asterisk tells PUBMED to search for all terms beginning with “rural” (including rural health, rural communities, rural disparities, etc.). PUBMED also provides users with the capability to save search strategies and re-run them later. Some research indicates that physicians lack expertise in using PUBMED and other search engines so medical librarians are often quite helpful to enhance clinicians’ capability to use these resources.^{17, 24} MEDLINE is another name for PUBMED, while OVID is a fee-based platform intended to add more user-friendly features to the PUBMED search engine.

FIGURE 4: Free PUBMED Resources

Figure 4a: Note Quick Start Guide and online tutorials, mobile applications, and clinical queries. Also, users can sign up for NCBI account to save searches and receive email updates when relevant research is published based upon established search strategies.

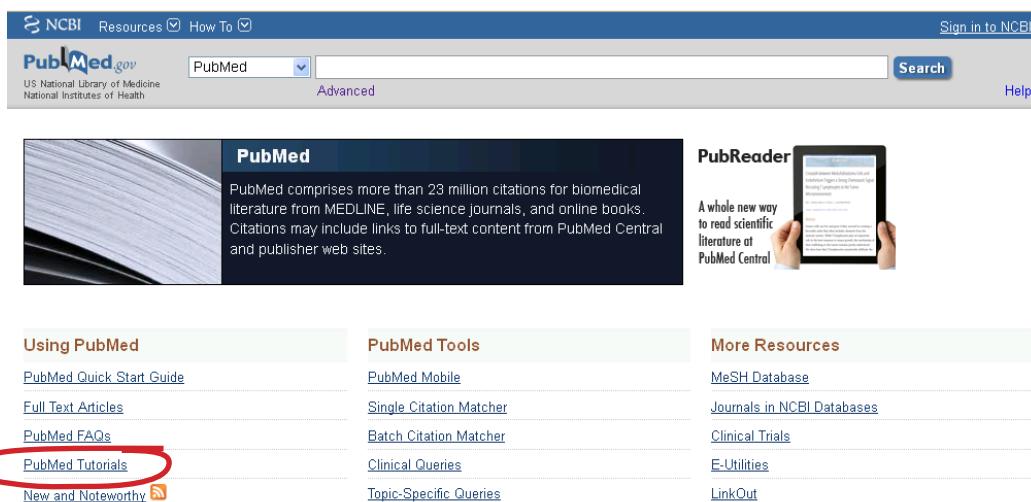


Figure 4b: Clinical Queries tab allows users to conduct broad or narrow searches for specific types of research.

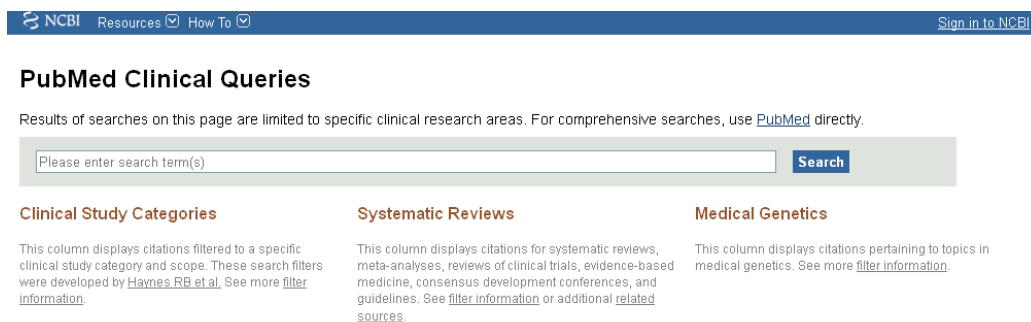


Figure 4c: Simple Clinical Query of “acute coronary syndrome” using category “Therapy” and “broad” scope. Note that other categories include etiology, prognosis, diagnosis, and clinical prediction guides. Also, note that PUBMED stratifies search results into clinical studies, systematic reviews, and medical genetics.

PubMed Clinical Queries

Results of searches on this page are limited to specific clinical research areas. For comprehensive searches, use PubMed directly.

acute coronary syndrome

Clinical Study Categories
 Category:
 Scope:

Systematic Reviews
 Results: 5 of 768
 Meta-analysis of stroke after transradial versus transfemoral artery catheterization.
 Patel VG, Brayton KM, Kumbhani DJ, Banerjee S, Brilakis ES. Int J Cardiol. 2013 Aug 14; . Epub 2013 Aug 14.
 Slick euthyroid syndrome is associated with poor prognosis in patients with STEMI undergoing primary

Medical Genetics
 Topic:
 Results: 5 of 650
 Cardiovascular Genomics: Implications for Acute and Critical Care Nurses.
 Quinn Griffin MT, Klein D, Winkelman C. Dimens Crit Care Nurs. 2013 September/October; 32(5):213-221.
 Serotonin Phenolamine 2,3,4,5-Tetrahydro

Figure 4d: All of the PUBMED citations under the Clinical Study category.

NCBI Resources How To Sign in to NCBI

PubMed.gov (Therapy/Broad[filter]) AND (acute coronary syndrome)

US National Library of Medicine National Institutes of Health

Display Settings: Summary, 20 per page, Sorted by Recently Added

Results: 1 to 20 of 7248

1. [Hospital-based versus community-based shared care cardiac rehabilitation after acute coronary syndrome: protocol for a randomized clinical trial.](#)
 Bertelsen JB, Refsgaard J, Kanstrup H, Johnsen SP, Qvist I, Christensen B, Christensen KL.
 Dan Med J. 2013 Sep;60(9):A4699.
 PMID: 24001464 [PubMed - in process]

2. [Cardiac computed tomography guided treatment strategy in patients with recent acute-onset chest pain: Results from the randomised, controlled trial: CArdiac cT in the treatment of acute Chest pain \(CATCH\).](#)
 Linde JJ, Kofoed KF, Sørgaard M, Kelbæk H, Jensen GB, Nielsen WB, Hove JD.
 Int J Cardiol. 2013 Aug 14. doi:pii: S0167-5273(13)01545-3. 10.1016/j.ijcard.2013.08.020. [Epub ahead of print]
 PMID: 23998546 [PubMed - as supplied by publisher]

505 free full-text articles in PubMed Central

Variation in the Sodium-Dependent Vitamin C Transporter 2 [PLoS One. 2013]
 Routine pretreatment with abciximab versus standard p [Exp Clin Cardiol. 2013]
 Combination of Chinese Herbal Medicines d Based Complement Alternat Med. 2013]

Figure 4e: Conduct separate search for “rural*” with 114,495 citations on this date. Select the “Advanced” tab at the upper-right, mid-screen to get to the next screen.

NCBI Resources How To

PubMed.gov
US National Library of Medicine
National Institutes of Health

PubMed rural* RSS Save search Advanced

Show additional filters Display Settings: Summary, 20 per page, Sorted by Recently Added Send to:

Article types
Clinical Trial
Review
More ...

Text availability
Abstract available
Free full text available
Full text available

Publication dates
5 years
10 years
Custom range...

Species
Humans

Results: 1 to 20 of 114495 << First < Prev Page 1 of 5725 Next > Last >>

- [Changing prevalence of allergic diseases in the Asia-pacific region.](#)
1. Wong GW, Leung TF, Ko FW. Allergy Asthma Immunol Res. 2013 Sep;5(5):251-7. doi: 10.4168/aa.2013.5.5.251. Epub 2013 Mar 18. Review. PMID: 24003381 [PubMed]
- [The Moderating Effects of Impulsivity on Chinese Rural Young Suicide.](#)
2. Zhang J, Lin L. J Clin Psychol. 2013 Sep 3. doi: 10.1002/jclp.22039. [Epub ahead of print] PMID: 24002993 [PubMed - as supplied by publisher]
- [National disparities in laparoscopic colorectal procedures for colon cancer.](#)
3. Alnasser M, Schneider EB, Gearhart SL, Wick EC, Fang SH, Haider AH, Efron JE. Surg Endosc. 2013 Sep 4. [Epub ahead of print] PMID: 24002916 [PubMed - as supplied by publisher]

Figure 4f: Combine the Clinical Queries search with the “rural*” search by entering “#3 and #4” in the “Builder box” in the middle of the screen.

PubMed Advanced Search Builder YouTube Tutorial

(#3 and #4) [Edit](#) [Clear](#)

Builder

Recent Query #3 and #4

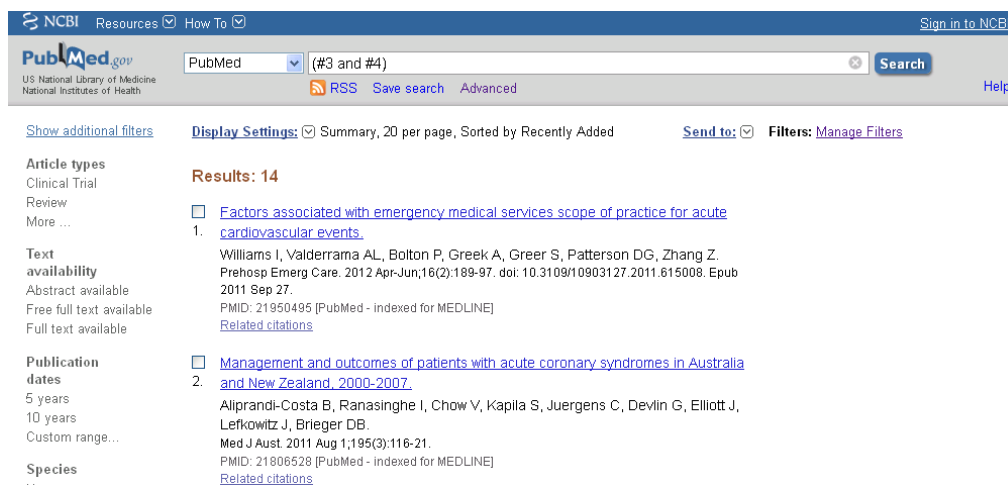
AND All Fields [Show index list](#)

Search or [Add to history](#)

History [Download history](#) [Clear history](#)

Search	Add to builder	Query	Items found	Time
#4	Add	Search rural*	114495	09:47:50
#3	Add	Search (Therapy/Broad[filter]) AND (acute coronary syndrome)	7248	09:47:43

Figure 4g: The result of your combined search, which you can also save to rerun at a later date or email to others for their awareness.



Meta-search engines are electronic search products that simultaneously use medical terms to search PUBMED, guidelines, textbooks, and other web-based resources. The TRIP database (<http://www.tripdatabase.com/>) is one prominent and free meta-engine.²⁵ As demonstrated in Figure 5, TRIP

provides the findings for a search by listing the citations in the EBM hierarchy (Figure 2). TRIP also allows users to save search strategies and can email users each month when new citations become available for a given search strategy or topic of interest.

FIGURE 5: Free TRIP Database Resources

Figure 5a: Enter search term. Note on the right that advanced search options are available, in addition to ability to construct a PICO question upon which to base search.

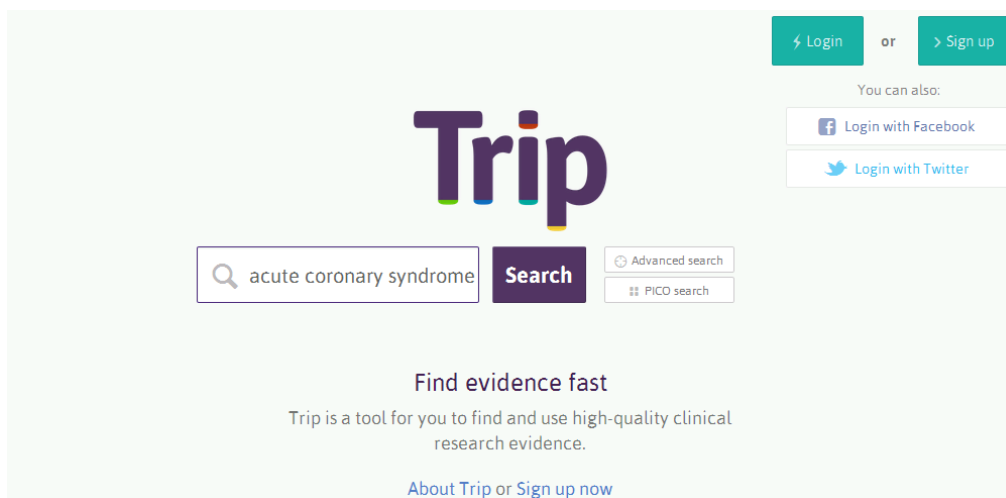


Figure 5b: TRIP search results for term “acute coronary syndrome.” Note on the right that the results can be stratified by level of evidence using the hierarchy from Figure 2: Synopses, Systematic Reviews, Guidelines, Clinical Questions/Answers, primary research, etc. Also, note that textbook chapters are included and that findings most applicable to developing world settings can be identified with sensitive or specific filters.

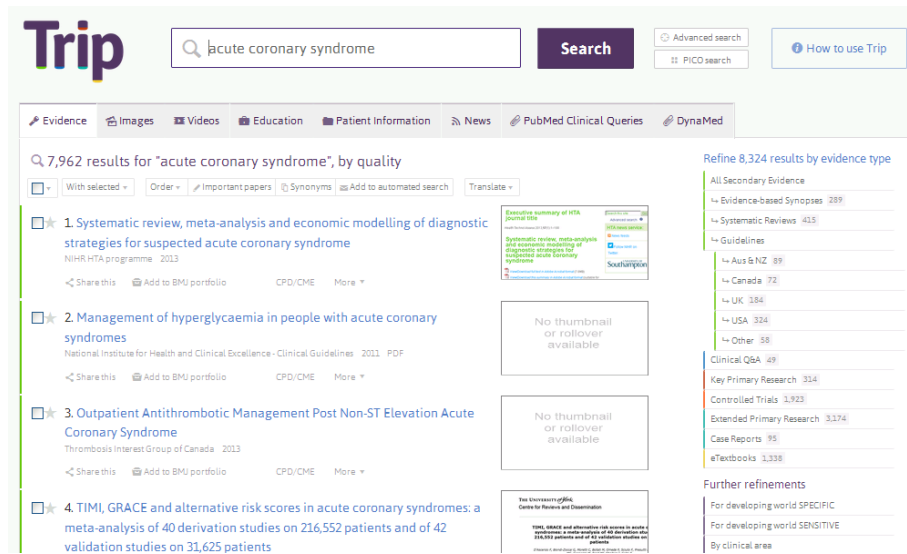


Figure 5c: TRIP search results can also be stratified by “clinical area” as noted to the right of this screenshot.

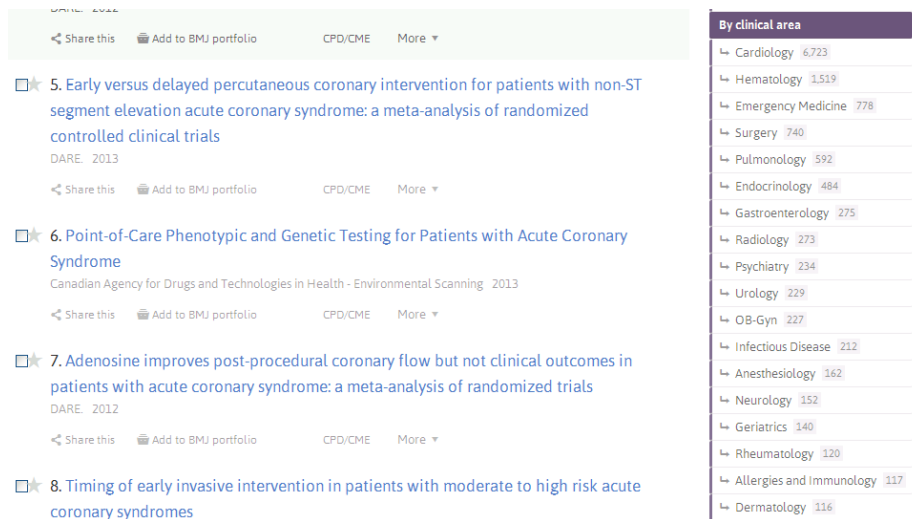


Figure 5d: Using the PICO function to refine the search.

Trip **Search**

PICO Search
PICO is a novel approach of allowing users to conduct a focussed search based on a structured clinical question [Learn more at cebm.net](#)

Population:	<input type="text" value="rural adults"/>	Intervention:	<input type="text" value="acute revascularization and standard care"/>
Comparison:	<input type="text" value="standard care"/>	Outcome:	<input type="text" value="cardiac mortality, cardiac morbidity"/>

Figure 5e: PICO-refined search results.

Trip **Search**

Evidence **Images** **Videos** **Education** **Patient Info.** **News** **PubMed CQs** **DynaMed**

20 results for "(rural adults)(acute revascularization and standard care)(standard care)(cardiac mortality, cardiac morbidity)", by quality

1. **Outpatient Case Management for Adults With Medical Illness and Complex Care Needs**
AHRQ - Comparative Effectiveness Review 2013
[Share this](#) [Add to BMJ portfolio](#) [CPD/CME](#) [More](#)

20 results

- All Secondary Evidence
- Evidence-based Synopses 5
- Systematic Reviews 0
- Guidelines
 - Aus & NZ 4
 - Canada 5
 - UK 1

Residency leaders indicate that EBM instructors' primary skill set ought to be the ability to identify secondary peer reviewed resources for resident learners.¹⁰ Secondary peer reviewed literature is a snapshot synopsis of high-yield, practice-changing research with critical appraisal already performed by a colleague in the field to which the research applies. Examples of secondary peer-reviewed resources include the journals ACP Journal Club and Evidence Based Medicine.²⁶ The research that secondary peer reviewed journals summarize undergo a complicated process before reaching the end-user bedside clinicians. In the case of ACP Journal Club, the McMaster Health Information Research Unit reviews two hundred journals every month seeking higher quality, minimally biased research methods. Once identified, these manuscripts are sent via email to at least three specialists in the applicable medical field(s) who rate the evidence for newsworthiness and likelihood of changing practice. The evidence that is rated by applicable medical specialties as both

highly newsworthy and practice-changing is then critically appraised with commentary by an EBM expert in that field. Secondary peer-reviewed journals are not free, but many offer complimentary services to "push" the most compelling evidence to the medical specialists affected by the new research. For example, KT-Plus (<http://plus.mcmaster.ca/kt/Default.aspx>) can be accessed by anybody who signs up for this service.²⁷

Although most textbooks represent authoritarian dictate, narrative review, or unsubstantiated opinion, several EM textbooks exist that use the EBM approach described above.²⁸ In addition, EM journals such as Annals of Emergency Medicine,³⁰ Academic Emergency Medicine,³¹ the Canadian Journal of Emergency Medicine, and the Journal of Emergency Medicine³² now publish EBM series regularly. The disadvantage of these textbooks and academic journals' EBM series is that a large proportion of contemporary medical practice has little evidentiary basis, or the evidence is contradictory.³³

Another resource for healthcare providers are clinical guidelines, but these are often viewed with skepticism for a variety of reasons.³⁴ Guidelines are often outdated, too. In addition, guidelines do not exist for many of the clinical situations faced on a daily basis. In the future, guidelines should become more applicable and transparent as the Grading of Recommendations Assessment Development and Recommendation (GRADE) criteria are used to develop them.³⁵ However, rural physicians will need to be part of the guideline development process to ensure that the recommendations are pragmatic and attainable for this environment.³⁶

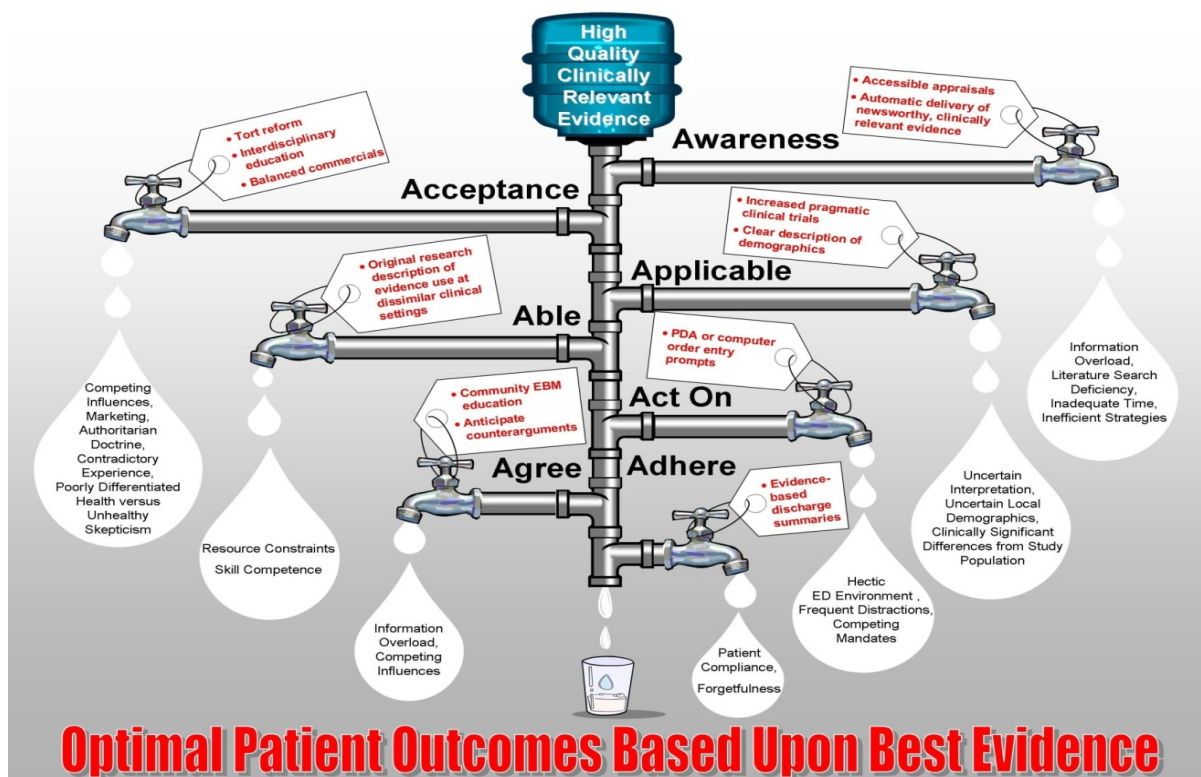
Moving Beyond EBM: What is Knowledge Translation?

Once clinicians find and appraise the evidence, application of the new information at the bedside is necessary. The original descriptors of EBM acknowledged this portion of the process, but the complexities were oversimplified. Over the last 10-years, a new science has been developed to explore and promote the process of applying the evidence. In the United States this process is called “Dissemination and Implementation” (D&I) science and in Canada the term to describe this process is Knowledge Translation (KT).^{37, 38}

Why is there the need for D&I research? In the past investigators assumed that publication of new discoveries was a sufficient dissemination strategy to promote practice change

in applicable clinical settings, but the diffusion of innovations is more complex in medicine, public health, and policy making.³⁹ In fact, the delay between biomedical scientific discovery and widespread implementation usually extends over 10-years.⁴¹⁻⁴⁴ The 2001 Institute of Medicine report “Crossing the Quality Chasm: A New Health System for the 21st Century” noted a “chasm” between medical advances and current medical care.⁴⁵ For example, McGlynn et al. examined 439 quality indicators in adult primary care patients from 12 United States cities and reported that only 55% routinely received recommended medical management.⁶ A decade ago the National Institute of Health (NIH) recognized that effective translational science would require a paradigm shift.⁴⁶ Many barriers exist between scientific discovery and clinical application at the levels of the individual clinician and the healthcare system, including clinical awareness in an era of information overload, balancing healthy skepticism with sufficient evidence of effectiveness, misaligned incentives for evidence uptake and care delivery and an evolving understanding of dissemination and implementation (D&I) research methods. These physician-level conceptual leaks at the clinical bedside are depicted in Figure 6, along with specific examples driving each leak and solutions to slow the relative leak of clinically useful information.⁴⁷ D&I principles have been used in rural ED settings to facilitate efficient update of best-evidence practice.⁴⁸ By understanding these factors, evidence-based practitioners can more efficiently introduce high quality, practice-worthy research evidence into bedside practice.

FIGURE 6: The Knowledge Translation Pipeline (from Reference 47)



The complexity of D&I is in the questions that remain unanswered by the EBM process, including:

- How is the “best evidence” defined against the spectrum of research findings, particularly when conflicting evidence exists?
- How is this “best evidence” disseminated (publication, opinion leader)?
- What is the effective component of the intervention?
- Can this effective component be replicated with fidelity in your setting? If adaptation is necessary, when is the modified intervention sufficiently dissimilar from the published intervention that it is a different intervention?
- What is organizational culture is essential to facilitate local adoption?
- Is the intervention sustainable?
- What are the unintended consequences of this intervention?
- What are the financial and personnel costs to implement this intervention?

D&I/KT science is distinct from the traditional understanding of scientific discovery. D&I researchers often engage in systems engineering and behavioral modification, a process that usually engages stakeholders beyond the clinical setting and includes administrative leadership, social services, case managers, home healthcare services, and policy-makers. In addition, most professions have been developing D&I methods, but the disparate nomenclature across non-medical and medical fields is confusing and limits penetration of similar concepts.⁴⁹

The Future of EBM and KT in Rural Emergency Medicine

Since 1992, the process of EBM has continued to evolve and improve.⁸ More recently, D&I developed as a necessary and distinct byproduct of EBM. Both EBM and D&I depend upon the other to be most useful for clinicians, as well as patients and society. EBM and D&I will continue to evolve in the future. One important advance is the development of a reliable and accurate instrument to identify practice-changing or practice-enhancing research pertinent to EM: the BEEM Rater Tool.⁵⁰ ⁵¹ This instrument provides a validated tool to filter the signal from the noise from amongst the 5000+ biomedical publications that appear on PUBMED every day, yet busy clinicians lack the time to find, appraise, and assimilate all of this data. In fact, most published research is not ready for bedside application.⁵² Even in the leading peer-review journal in EM, *Annals of Emergency Medicine*, a busy clinician needs to read 26 articles to find one that alters their clinical practice.⁷ The BEEM Rater tool narrows that 26-to-1 ratio to something closer to 1-to-1. Figure 7 provides

an example of how the BEEM Rater tool could be used as a filter for rural clinicians to find high quality (i.e. minimally biased), practice-worthy evidence applicable to their healthcare setting. These methods could be modified to identify rural-ready EM research evidence primed for widespread bedside application by developing a network of rural emergency physician raters.

Adult learning theory emphasizes the process of learning that is problem based and collaborative rather than didactic. A substantial body of evidence implies that traditional conference-based didactic instructor-to-learner one-way information exchange is ineffective to ensure quality improvement in medicine.^{11, 53} Another ongoing development in the EBM/KT world is the use of social media to promote a “bottoms up” approach to disseminating high-quality research evidence. For example, the podcast “Skeptics Guide to Emergency Medicine” provides brief synopses of BEEM Rater Tool filtered evidence targeting junior learners in an entertaining delivery mode using adult learning theory with the millennial audience in mind.⁵⁴ Other high-quality podcasts also exist.⁵⁵⁻⁵⁷

Definitions

Bias – deviation from the “truth” in the universe (i.e. the correct effect size) as a result of the research study design, conduct, or reporting.

Critical appraisal – refers to the process of assessing the risk of bias and applicability to one’s patient population and clinical setting when evaluating medical research manuscripts.

D&I/KT – dissemination implementation/knowledge translation science which is the approach of applying evidence in the clinical environment with consideration of pragmatic challenges, reproducibility, sustainability, unintended consequences, and costs.

EBM – the philosophical approach of seeking the overlap of patient circumstances/values, clinical expertise, and research evidence to yield optimal outcomes.

Effect size – the quantifiable impact that an intervention has upon an intended outcome or measure. In the case of a therapy, effect size is commonly expressed in terms of relative risk, absolute risk reduction, or number needed to treat and number needed to harm. On the other hand, in assessing a diagnostic test effect size is quantified using sensitivity, specificity, likelihood ratios, and receiver operator curve area under the curve. Understanding effect size empowers critical clinicians to (a) directly compare one intervention or test to another AND (b) communicate risk/benefit decisions with patients to facilitate shared decision making.

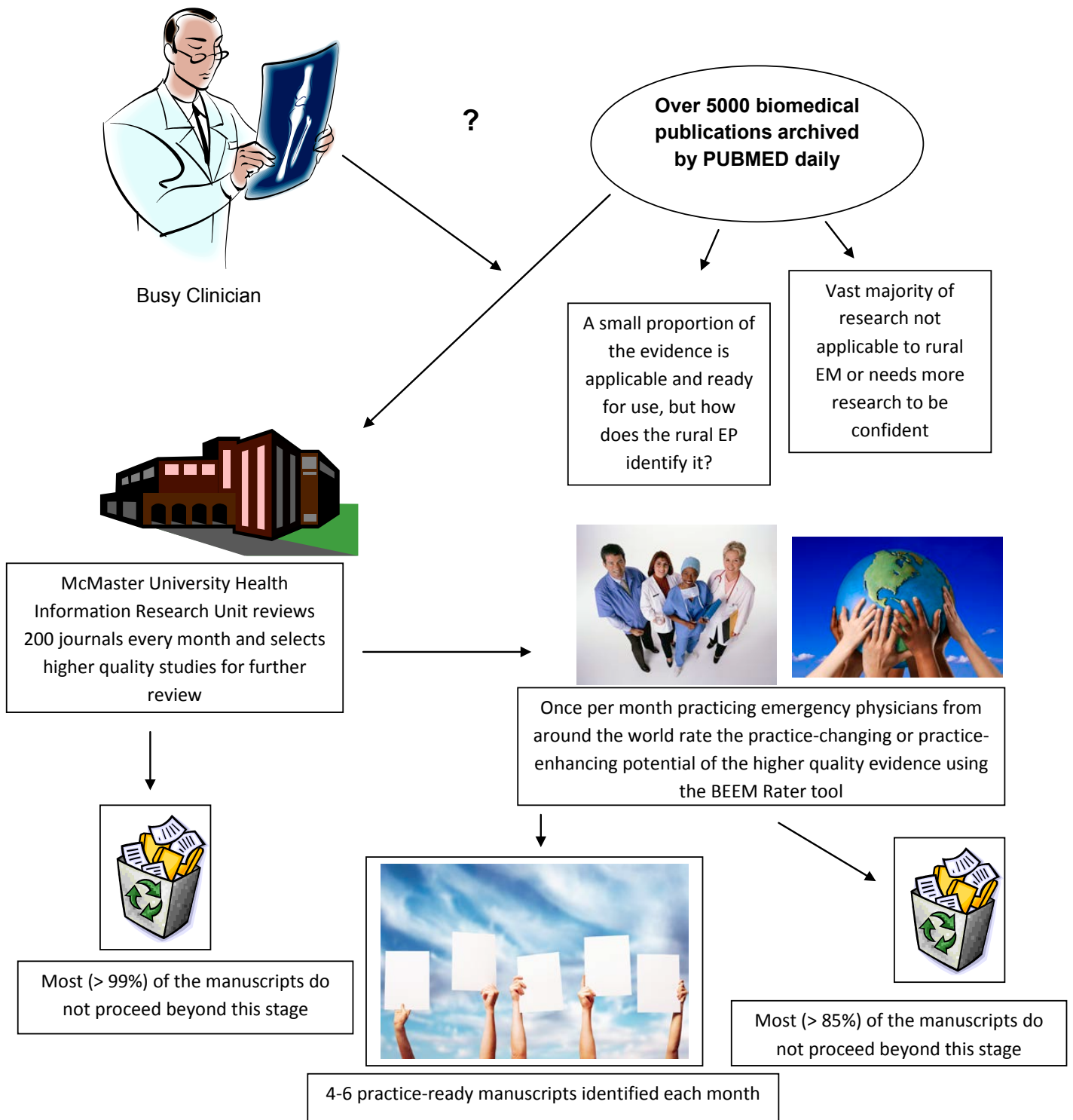
Meta-Search Engine – a software system that uses sends queries to several search engines or databases simultaneously.

Search engine – software system used to find evidence on the world wide web.

Secondary peer reviewed literature – journals or resources that provide critical appraisal and expert commentary of original research for other healthcare providers.

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Figure 7: Application of the BEEM Rater Instrument



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