SPECIAL SECTION: EVIDENCE-BASED MEDICINE IN LOW BACK PAIN—PART 1

Evidence-Based Medicine and the Challenge of Low Back Pain: Where Are We Now?

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■ **Abstract:** Low back pain has long been described as a challenge for both primary care physicians and specialists. Management of low back pain has also been criticized as frequently arbitrary, inappropriate, or ineffective. Contributing factors have been an inadequate evidence base and a need for more rigorous appraisals of the available literature.

Evidence-based medicine, an approach to clinical problem solving, is predicated on the premise that high-quality health care will result from practices consistent with the best evidence. In contrast to the traditional medical paradigm that placed a heavy reliance on expert opinion, authority, and unsystematic clinical observations, evidence-based medicine emphasizes the need for rigorous critical appraisals of the scientific literature to inform medical decision making. Evidence-based medicine places strong weight on the requirement for valid studies, particularly randomized controlled trials, to appropriately evaluate the effectiveness of health care interventions. Because of the rapidly increasing volume of medical literature, however, most clinicians are unable to keep up-to-date with all the new data. Two types of preprocessed evidence that can aid busy clinicians in medical decision making are systematic reviews and evidence-based clinical practice guidelines. Like primary studies, systematic reviews and clinical practice guidelines must adhere to high methodologic standards to reduce error and bias.

As in other areas of medicine, the approach to the management of low back pain has been positively affected by the availability of more clinical trials and better use of critical appraisal techniques to evaluate and apply research findings. In addition to more rigorous primary studies, an increasing number of high-quality systematic reviews and evidence-based clinical practice guidelines for low back pain are also available. Although some research gaps and methodologic shortcomings persist, the richer evidence base has greatly improved our understanding of what does and does not work for low back pain. Despite these advances, the best available evidence often does not inform everyday clinical decisions for low back pain. Nonetheless, there is widespread agreement that adherence to evidence-based practice will help improve low back pain patient outcomes and reduce arbitrary variations in care. This article reviews basic principles of evidence-based medicine, discusses evidence-based medicine in the context of low back pain management, and summarizes some useful evidence-based medicine resources. ■

Key Words: low back pain, evidence-based medicine, meta-analysis, practice guidelines

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Pain Practice, Volume 5, Issue 3, 2005 153–178

INTRODUCTION

Consider a clinical scenario in which a 40-year-old man without other medical problems presents to you, his primary care physician, for evaluation of low back pain of 2-day duration. The patient reports intense bilateral

paralumbar pain without radiation, no lower extremity weakness or numbness, and no bowel or bladder changes. He denies constitutional symptoms (such as fevers, night sweats, weight loss, or anorexia) or significant trauma (the pain started after doing some heavy lifting), and reports no history of cancer. Physical examination shows no neurologic deficits.

Despite the ordinariness of the situation, complex medical decision making will take place during this visit. The patient is likely to have questions about what is causing his low back pain, the expected course of this painful episode, and what he should do to get better.[1] You will need to decide whether to recommend activity limitations, therapeutic interventions, diagnostic testing, or specialist referrals.

Several decades ago, the approach to this patient would typically be based primarily on expert opinions, unsystematic clinical observations, local practice patterns, and "authoritative," nonsystematic review articles. Few randomized controlled trials on low back pain were available, and many published studies of interventions were not controlled or had other study design flaws.[2,3] Most physicians did not receive formal training in assessing the validity or applicability of research findings. Assessments of the literature were heavily influenced by the authors' own conclusions and the prestige of the journal, the authors, or their institutions.[4] Most review articles did not perform comprehensive literature searches and lacked clearly defined methods for identifying, appraising, and synthesizing data.[5] Clinicians could not refer to evidence-based guidelines on the management of low back pain, because none had been published.

In that setting, you might order X-rays of the lumbar spine and recommend bed rest for a week.[6] A hospital admission and surgical consultation might even seem reasonable.[7] If the patient requested your opinion about physical therapy, spinal manipulation, or acupuncture, you might recommend physical therapy—not because you are aware of evidence regarding its superior effectiveness, but simply because you are more familiar with that modality. If the back pain does not resolve within a few weeks, you might recommend a popular low back pain treatment such as laser treatment, oral colchicine, or coccygectomy—even if the treatment had not been evaluated in rigorous controlled studies.[8]

Over the last few decades, there has been a significant shift in the approach to evaluating and managing low back pain. This shift has led to a greater emphasis on the need for a stronger evidence base and more rigorous critical appraisals of the literature to optimally inform clinical decisions. Such an approach to medical decision making is referred to as "evidence-based medicine."[9] Today, researchers studying low back pain apply evidence-based medicine principles when designing and evaluating primary studies,[10] clinicians routinely receive training in evidence-based medicine,[11] methodologically rigorous systematic reviews of low back pain topics are increasingly common,[12] and evidence-based guidelines for management of low back pain are widely available.[13] This article reviews basic principles of evidence-based medicine, discusses evidence-based medicine principles specifically in the context of low back pain management, and summarizes some useful evidence-based medicine resources.

WHAT IS EVIDENCE-BASED MEDICINE?

> *Evidence based medicine is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients.*
>
> *David Sackett, 1996*[14]

Evidence-based medicine is predicated on the assumption that high-quality health care will result from practices consistent with the best evidence.[15] Although the term "evidence-based medicine" initially appeared in print in 1991,[9] clinicians and researchers stressed the need to more rigorously evaluate the effectiveness of medical interventions well before that.[16] Many principles of evidence-based medicine, for example, were presented in a series of journal articles on critical appraisal published in the early 1980s that were based on the residency training program taught at McMaster Medical School in Canada.[17] Acceptance of evidence-based medicine principles rapidly accelerated in the 1990s.[18] Factors that contributed to the receptiveness of the medical community to evidence-based medicine included an enormous increase in the number of clinical studies (in particular randomized controlled trials), the increased accessibility of the medical literature, the adaptation of techniques developed for the field of clinical epidemiology to the needs of clinicians,[19] and the increasing recognition that a substantial gap existed between evidence and practice.[20] Nowadays, the term "evidence-based" is omnipresent, and it is often used indiscriminately or to convey a measure of credibility, even when it is not clear that rigorous evidence-based principles have been followed.[21]

The term "evidence-based medicine" also refers to an approach to clinical problem solving. The first compre-

hensive publication of the tenets of evidence-based medicine described a paradigm shift in medical practice toward the use of the rigorous examination of evidence from clinical research to inform medical decision making, and away from the "traditional" approach that considered anecdotal experience, case reports, pathophysiologic rationales, clinical impressions, and a dependence on authority as sufficient.[22] Although evidence-based medicine acknowledges the importance of clinical expertise, it emphasizes that in order to use that expertise for optimal medical decision making, clinicians must also understand certain rules of evidence to correctly interpret and apply literature on causation, prognosis, diagnostic tests, and medical interventions. An evidence-based approach to a clinical decision requires the practitioner to formulate a clear clinical question, identify relevant clinical articles from the literature, critically appraise the evidence for its validity and usefulness, and apply useful findings to clinical practice.[23] When applying evidence, clinicians also need to consider the particular circumstances and values of patients—a point often overlooked in discussions about the merits of evidence-based medicine.[24–26]

Evidence-based medicine has traditionally placed a heavy emphasis on the evaluation of randomized controlled trials to determine the effectiveness of medical interventions, because such studies are the least susceptible to bias when designed and executed properly.[27] In some cases, however, such as when evaluating studies of natural history, prognosis, diagnostic test characteristics, or when randomized controlled trials are not ethical or feasible, well-designed observational studies may fill in gaps in the literature or help provide a more comprehensive or real-life picture of benefits and harms.[28–30]

The term "observational studies" actually encompasses a broad range of study designs, including case reports or series; retrospective analyses of large claims databases; population-based, longitudinal cohort studies; uncontrolled series of patients receiving an intervention; and other design types. All of these study designs are subject to confounding and biases that are encountered less commonly in well-designed and executed randomized controlled trials. Uncontrolled studies (such as a study consisting of results from a series of patients undergoing a specific surgical procedure) are a particularly unreliable source of evidence.[31] On the other hand, the traditional controlled observational designs used in epidemiology—case–control and population-based cohort studies—take stronger precautions against bias than other observational designs, and their strengths and weaknesses are well understood.[32] For example, confounding by indication is usually not an issue when evaluating unexpected adverse drug events in these studies, because such unpredictable outcomes are usually not associated with the indication for treatment.[33] Several studies have shown that well-designed case–control and cohort studies often reach similar conclusions compared with randomized trials.[34–37] However, there are also several recent, highly publicized examples where randomized trial results contradicted earlier observational data.[38,39] Because they lack randomization and are more susceptible to bias, it is always important to remember that observational studies should adhere to methodologic standards at least as high as randomized controlled trials to be valid.[38,40,41]

Critical appraisal involves judging features of individual studies related to quality (defined as "the confidence that the trial design, conduct, and analysis has minimized or avoided biases in its treatment comparisons"[42]), and considering their place on a study design-based evidence hierarchy.[27,43] Generally speaking, good-quality studies from higher levels in the evidence hierarchy should have a greater impact on clinical decisions than poorer-quality evidence or evidence from lower levels. Several sample evidence level classification schemes are shown in Table 1. The scheme proposed by the Scottish Intercollegiate Guidelines Network Grading Review Group, for example, explicitly incorporates assessments of study quality into its evidence classification system.[44]

Although empirically validated quality rating scales for randomized trials[45–47] and other studies[48] are available, associations between quality measures and estimates of treatment effect are not always straightforward.[49–51] Nonetheless, controlled trials with adequate randomization techniques, allocation concealment, blinding, and complete follow-up would typically be considered higher quality than randomized trials lacking one or more of these characteristics.[52] A separate but equally important component of quality assessment involves evaluations of external validity, or the applicability of the results of a study to other settings and populations.[53]

Although evidence-based medicine has received its share of criticism[54,55] and continues to evolve,[56] it is now nearly universally considered an integral part of medical training and an important means for improving the quality of health care.[57] Most of the focus today lies in developing more effective methods for its teaching[58,59] and implementation,[60,61] although there is also a need for continued research, particularly with regard to the

Table 1. Sample Evidence Level Classification Schemes

I	II	III
I: Evidence obtained from at least one properly randomized controlled trial	N of 1 randomized trials	1++: High-quality meta-analyses, systematic reviews of randomized controlled trials (RCTs), or RCTs with a very low risk of bias
II-1: Evidence obtained from well-designed controlled trials without randomization	Systematic reviews of randomized trials	1+: Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias
II-2: Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group	Single randomized trial	1–: Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
II-3: Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence	Systematic reviews of observational studies addressing patient-important outcomes	2++: High-quality systematic reviews of case–control or cohort studies or high-quality case–control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal
III: Opinions of respected authorities, based on clinical experience; descriptive studies and case reports; or reports of expert committees	Single observational study addressing patient-important outcomes	2+: Well-conducted case–control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal
	Physiologic studies	2–: Case–control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal
	Unsystematic clinical observations	3: Nonanalytic studies, for example, case reports, case series
		4: Expert opinion
Source: Canadian Task Force on the Periodic Health Examination. The periodic health examination. *CMAJ.* 1979;121:1193–1254.	*Source:* Guyatt GH, Haynes RB, Jaeschke RZ, et al. Users' guides to the medical literature, XXV. Evidence-based medicine: principles for applying the users' guides to patient care. *JAMA.* 2000;284:1290–1296.	*Source:* Harbour R, Miller J, for the Scottish Intercollegiate Guidelines Network Grading Review Group. A new system for grading recommendations in evidence based guidelines. *BMJ.* 2001;323:334–336.

impact of evidence-based medicine on clinical practice and patient outcomes.[62]

For readers interested in further reading on evidence-based medicine, resources include several classic journal article series on critical appraisal, literature retrieval, and applying evidence.[17,63–66] Numerous preprocessed evidence resources are readily available to aid busy clinicians.[43] Publications such as *ACP Journal Club* and *Evidence-Based Medicine*, for example, identify the best recently published articles and provide concise summaries and critical appraisals.[67–69] Two specific types of preprocessed evidence—systematic reviews and clinical practice guidelines—are discussed below. Many other evidence-based medicine resources, including several well-known textbooks, are also available; many are listed on websites such as those maintained by the University of Toronto (http://www.cebm.utoronto.ca/resources/websites.htm), McMaster University (http://hsl.mcmaster.ca/ebm/), and the University of Hertfordshire (http://www.herts.ac.uk/lis/subjects/health/ebm.htm#protocol).

SYSTEMATIC REVIEWS IN EVIDENCE-BASED MEDICINE

It is surely a great criticism of our profession that we have not organized a critical summary, by specialty or subspecialty, of all relevant randomized controlled trials.

Archie Cochrane, 1979[70]

Since the first modern randomized controlled trial was published in 1948,[71] the number of published randomized clinical trials has increased exponentially. In 1997 alone, more than 29,000 new randomized controlled trials were published.[52] In fact, more randomized trials were published in the single year 2000 than in the decade 1965 to 1975.[72] It has been estimated that primary care physicians who want to keep up with relevant journals would need to review 19 articles every day—an impossibility for most practitioners.[68] Many clinicians overwhelmed by the volume of the medical literature depend on review articles to keep them up to date.[73]

Review articles that assemble and examine all of the available high-quality evidence relevant for the clinical question at hand are invaluable for clinicians.[74] Traditional or narrative review articles, however, do not use systematic literature searches or report search methods, describe how studies were chosen for inclusion, or assess their validity.[5] The evidence included in such narrative reviews is often incomplete and could be highly influenced by the conscious or unconscious biases or opinions of the authors. Perhaps most concerning, narrative reviews frequently recommend treatments

long after they have been shown to be useless or even harmful.[75]

Systematic reviews, on the other hand, are distinguished by the use of techniques for maximizing comprehensiveness and minimizing bias, such as explicit methods for identifying all relevant studies, including or excluding studies, rating the validity of studies, and synthesizing the evidence, either qualitatively or quantitatively ("meta-analysis").[73] Systematic reviews have become a common and prominent evidence-based practice resource. In addition to summarizing the existing data, systematic reviews are also useful for detecting small but clinically meaningful treatment effects, identifying research gaps, developing hypotheses to explain differential outcomes between studies, and identifying and mapping areas of uncertainty.[76]

Like primary studies, conclusions of systematic reviews should not be taken at face value. A systematic review of meta-analyses of analgesic interventions, for example, found that low-quality meta-analyses produced significantly more positive conclusions.[77] Critical appraisal of the methods that systematic reviews used to minimize error and bias is therefore necessary to judge the validity of their conclusions.[78] Important areas to consider include the comprehensiveness of search strategies[79] and sources, how recently the searches were performed, the use of standardized quality appraisal of included studies, the use of appropriate data synthesis techniques, and how well the conclusions are supported by the analyses.[80–82] Systematic reviews should also evaluate the effects of quality assessments of primary studies on results,[83,84] thoroughly investigate areas of heterogeneity, and consider potential effects of publication bias[85,86] and conflicts of interest.[87–89] Areas of uncertainty include whether it is necessary to routinely include unpublished reports, gray literature, or non-English language articles.[90–92] Although inclusion of well-designed observational studies can be helpful to fill in gaps or complement data from randomized controlled trials,[93] methods for performing systematic reviews of observational studies are still in relatively early stages of development.[40,76,94] A further challenge for systematic reviewers is developing methods for integrating evidence from both randomized and nonrandomized studies.[95–97]

Conclusions of systematic reviews can rapidly become obsolete if provisions are not made for incorporating new trials. One method for updating systematic reviews is to periodically repeat the analysis. The effects that individual new studies have on changing conclusions from earlier analyses, however, are not readily apparent with this method. In contrast, an alternative technique known as cumulative meta-analysis helps readers quantify changes in beliefs about treatment effects as data accumulate.[98] Cumulative meta-analysis involves the performance of an updated meta-analysis every time a new trial appears. Such analyses provide additional information about the benefits or safety of interventions in the context of what is already known, as soon as new data become available.[99] Cumulative meta-analysis can be understood most easily in terms of a Bayesian conceptual framework of how beliefs are altered by data.[100] For example, when evaluating the effectiveness of an intervention, a cumulative meta-analysis updates the estimate of effectiveness based on earlier trials (the prior probability distribution) with data from the new trial, to generate a posterior probability distribution. This posterior probability distribution then becomes the new prior probability distribution of estimated effect when more new data become available.

It should be noted that Bayesian approaches to meta-analysis go well beyond the basic conceptual framework described here for cumulative meta-analysis.[101] Bayesian techniques, for example, allow investigators to explicitly incorporate all prior objective or subjective (a priori) estimates of model uncertainty, such as prior estimates that a treatment is effective before new data are included, or even before an initial meta-analysis has been performed.[102] On the other hand, what Bayesian proponents see as an advantage—the ability to incorporate subjective prior beliefs—has been criticized by others for lacking objectivity.[103] Although Bayesian and classical meta-analytic methods can give rise to different results, circumstances in which it is preferable to use one approach over the other are not completely understood.[104] A full discussion of advantages and disadvantages of Bayesian vs. classical meta-analytic approaches is beyond the scope of this article, but has been reviewed elsewhere.[103,105]

The largest worldwide source for systematic reviews is the Cochrane Collaboration, an international collaborative review group.[106] The Cochrane Collaboration is named after Archie Cochrane, a Scottish physician-epidemiologist who is known for his writings on how to make health care more rational and equitable.[107] He placed a strong emphasis on the need to use evidence from randomized controlled trials, and recognized that practitioners frequently did not have ready access to reliable evidence.[108] The Cochrane Collaboration goals

are to produce high-quality systematic reviews,[109] to ensure that they are subjected to rigorous peer review, to update the reviews when necessary, and to make the reviews widely available. In addition to performing systematic reviews, the Cochrane Collaboration also maintains a register of clinical trials and systematic reviews, promotes research on improving the quality of systematic reviews, and organizes workshops and seminars on performing high-quality reviews.[110]

The long-term goal of the Cochrane Collaboration is to synthesize the clinical literature on all clinical interventions. This enormous task has been characterized as equal in importance to the human genome project.[111] Although there are over 1600 completed Cochrane reviews,[112] it has been estimated that at least 10,000 reviews will be needed to cover the existing evidence on the effects of health care interventions.[113]

In North America, the largest source of rigorous systematic reviews is the Evidence-based Practice Centers program.[114] This program was launched by what is now known as the Agency for Healthcare Research and Quality (AHRQ) in 1997. There are currently 13 institutions in the United States and Canada designated as Evidence-based Practice Centers. In addition to producing over 120 evidence reports for AHRQ, the Evidence-based Practice Centers conduct systematic reviews for other public and private sector organizations. At the Oregon Evidence-based Practice Center, for example, ongoing projects include systematic evidence reviews for the U.S. Preventive Services Task Force to inform screening guideline recommendations[115] and systematic reviews commissioned by the Drug Effectiveness Review Project (DERP) on the comparative safety and efficacy of drugs in different classes to guide pharmaceutical coverage decisions.[116] For interested readers, additional information about the Cochrane Collaboration and the Evidence-based Practice Center program are available at http://www.cochrane.org/index0.htm and http://www.ahrq.gov/clinic/epc/.

EVIDENCE-BASED CLINICAL PRACTICE GUIDELINES

Systematic reviews are a useful tool for summarizing evidence. Unfortunately, even well-designed systematic reviews may not provide information about benefits and harms in a way that easily facilitates clinical decision making.[117] Systematic reviews may be too narrow in focus, not answer the exact clinical question of interest, or provide inconclusive results. In fact, a "stainless steel" law of systematic reviews may be in effect—that is, the more rigorous the review, the more likely that there will be less evidence showing that an intervention is effective.[76] This can occur if there is a lack of high-quality primary evidence, there is heterogeneity between studies, or because primary studies do not assess clinically relevant outcomes.

Clinical practice guidelines have been defined as "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances."[118] An increasingly common resource, it was estimated that over 2500 clinical practice guidelines were available in 1997.[119] Clinical practice guidelines can address issues of prevention, diagnosis, or treatment. Their purpose is to encourage the use of practices shown to be effective, to reduce the use of unproven or ineffective therapies, and to support the introduction of new knowledge into clinical practice. Like systematic reviews, clinical practice guidelines gather, critically appraise, and synthesize evidence. In fact, systematic reviews are a valuable aid for developing evidence-based guidelines.[120,121] Guidelines, however, go beyond most systematic reviews by explicitly seeking to influence clinical practice.[122] They attempt to incorporate all of the issues and values relevant to a clinical question in order to generate actionable recommendations. Developers of clinical practice guidelines often struggle with the need to provide clear, concise recommendations in order to be useful for clinicians,[123] while remaining flexible enough to promote individualization of care.[124]

Clinical practice guidelines are more likely to avoid biased or incorrect recommendations if they adhere to a rigorous evidence basis.[124] In fact, the term "evidence-based clinical practice guidelines" is used to refer to guidelines based more on scientific evidence than on subjective judgments or consensus.[118,125] This distinction is important because recommendations from evidence-based guidelines often differ substantially from recommendations based on expert consensus.[126]

Because even guidelines labeled as "evidence-based" may not meet standards for high methodologic quality,[127–129] clinicians should subject all clinical practice guidelines to critical appraisals before using them.[122,130] In addition to gathering and appraising the evidence, evidence-based guidelines should follow reproducible and transparent methods for ranking the evidence, evaluating the balance between benefits and harms, and grading the strength of recommendations.[44,115,122,131–135] Grading the strength of recommendations is particularly important because it helps users of guidelines judge how

much confidence they can place in them. Just as systematic reviews can become rapidly outdated, so can guideline recommendations,[136] and it is essential to consider the potential effects of new information on the validity of guidelines, particularly for rapidly evolving areas.[137] The composition of the expert panel can also have an important influence on clinical practice guidelines. Multispecialty panels, for example, may generate more balanced recommendations than single-specialty panels.[138] Conflicts of interest can affect recommendations and should be fully and clearly disclosed, but were only reported in 17.5% (7/40) of guidelines published in major medical journals in 1999.[139]

Clinical practice guidelines continue to assume an expanding role in clinical practice. Despite widespread optimism for clinical practice guidelines, however, knowledge of guideline recommendations and their use in everyday practice has often been suboptimal.[140] Factors that increase the use of guidelines include strong professional support, clear and concise recommendations, a stable and convincing evidence base, no increased costs associated with compliance, and organizational supports to track and aid implementation.[140–143] In addition, the case for using clinical practice guidelines would be further strengthened by more data showing beneficial effects of evidence-based clinical practice guidelines on patient outcomes.[119]

A useful web-based resource for clinical practice guidelines is the National Guidelines Clearinghouse, an initiative of the U.S. AHRQ (http://www.guidelines.gov). Designed to promote widespread access to evidence-based clinical practice guidelines, this site includes structured abstracts of guidelines and links or other access information to English language guidelines meeting minimum methodologic standards.

CHALLENGES IN THE MANAGEMENT OF LOW BACK PAIN

Those of us involved in back pain research are not making the scientific progress that we could and should, partly because of outmoded concepts of clinical research design. In some cases, the paucity of a strong research base has led not only to slow progress but in some cases probably to worse, not better, quality of care.

Richard Deyo, 1993[2]

Low back pain has long been a challenge for both primary care physicians[144] and specialists.[145] Management of low back pain has often been criticized as being arbitrary, inappropriate, or effective,[2,146] in part because patients are frequently desperate for a cure, physicians are eager to provide relief, and both are confronted by a wide array of treatment options—each with its own often vocal group of advocates.[147] Consequently, there has been little consensus, either within or between specialties, on appropriate uses of diagnostic tests[148] and interventions[149] for low back pain. This is demonstrated by numerous studies showing marked unexplained variations in diagnosis and treatment. In international comparisons, for example, the rate of back surgery in the United States is over five times higher than the rate in England.[150] Even within smaller areas in the United States, rates of back surgery vary up to 15-fold.[151] Despite wide variations in practice, patients managed by physicians from different specialties appear to have similar outcomes, although the cost of care often differs substantially both between and within specialities.[152,153] Among primary care physicians, a practice style consistent with back pain self-care was associated with similar long-term outcomes at lower cost than a practice style associated with more frequent prescribing of medications and bed rest.[154]

In addition to unexplained practice variations, another troubling feature of low back pain management has been the frequent enthusiastic uptake of successive back treatment "fads"—interventions widely popularized on the basis of expert recommendations or initial flawed studies, only to be abandoned later, after their ineffectiveness had been proven.[8] One factor explaining the tendency for clinicians to adopt these fads is the natural history of back pain.[2,145] Because the majority of patients with acute low back pain get better within the first month without any specific treatment,[155,156] uncontrolled studies often misleadingly suggest substantial efficacy. Furthermore, because patients with low back pain frequently present when their symptoms are at their worst, regression to the mean is often significant and can lead to inflated estimates of beneficial effects.[157]

Even when studies are randomized and controlled, inadequate blinding of subjects can lead to substantial placebo effects favoring a particular intervention.[158] Adequate blinding of patients and assessors to treatment assignment is particularly important in trials that assess subjective outcomes such as pain relief. For low back pain, this issue may be critical for interpretation of trials evaluating manipulations, injections, acupuncture, surgery, or other interventions that are difficult to adequately blind, because patient expectations of benefit can have a substantial effect on outcomes.[159] In a ran-

domized trial of patients undergoing massage or acupuncture for chronic low back pain, for example, patients who expected greater benefit from massage than acupuncture were significantly more likely to experience better outcomes with massage than with acupuncture, and vice versa.[160] Similarly, in a prospective cohort study of patients undergoing surgery for sciatica, more patients with favorable expectations about surgery had good outcomes than patients with unfavorable expectations.[161]

Another challenge of low back pain management is that in most cases, precise anatomic diagnosis is not possible.[162,163] Because many anatomic abnormalities in the spine are quite common in healthy persons,[164] diagnostic imaging often identifies radiographic abnormalities that are only loosely associated with symptoms.[165,166] Nonetheless, patients and clinicians often seek a precise diagnosis for low back symptoms.[167] Advances in diagnostic imaging such as magnetic resonance imaging often lead to the identification of more and smaller radiographic abnormalities—and subsequently to the enthusiastic uptake of new technologies.[168] Even though many of the findings on these studies are incidental or irrelevant, they can result in unnecessary, invasive, and costly tests and treatments.[169]

The lack of a sufficient evidence base for low back pain management has clearly contributed to unexplained practice variations, treatment "fads," and use of inappropriate or unnecessary tests and procedures. A MEDLINE search of articles published in 1985 found that only 8 of 757 articles on low back pain were randomized controlled trials.[3] Even when randomized trials were available, they frequently did not meet high methodologic standards. A literature review of studies published through 1982 found only 33 randomized controlled trials on a wide range of nonsurgical therapies for low back pain—none of which met rigorous quality criteria.[170] Similarly, a review of clinical trials of spinal manipulation published in 1984 found that all had at least one important methodologic flaw.[171] Over half of the spinal manipulation randomized trials in this review, for example, lacked adequate blinding. Even in a more recent systematic review, median scores of randomized controlled trials of low back pain through 1992 ranged from 35 to 40 on a 100-point quality scale, depending on the intervention being evaluated.[172] In addition to lack of or inadequate blinding, other important shortcomings included small sample sizes, no description of randomization procedures, no description of dropouts, and no placebo control group. Further complicating matters, studies of low back pain management have frequently used a wide range of often unvalidated outcome measurements and unstandardized methods for reporting results, and often have failed to measure important aspects of patient outcomes.[173]

LOW BACK PAIN AND EVIDENCE-BASED MEDICINE

Today, most clinicians are familiar with the concepts of evidence-based medicine and recognize its usefulness for better informing low back pain practice.[2,174] Guides to critical appraisal aimed at practitioners managing low back pain have been published in several journals.[175–179] In addition, although more research is needed, there is a better empiric basis for understanding which methodologic features are associated with valid findings in studies specifically of low back pain. In one study of acupuncture trials for chronic back or neck pain, for example, studies that scored lower on a 16-point validity scale were associated with a higher likelihood to report positive results.[180] Another recent study found that spine studies supported by industry were more likely to report positive results than studies funded by other sources.[181]

Perhaps most importantly, the evidence base for low back pain management has become considerably richer.[182] For example, for a single intervention—acupuncture for low back pain—systematic reviews identified 33 randomized controlled trials published through 2004,[183] compared with 12 published through 1996.[184] For spinal manipulation, the number of randomized controlled trials included in systematic reviews increased from 7 in 1985[185] to 39 in 2003.[186]

In addition to a greater quantity of randomized controlled trials of low back pain, the quality of the trials also appears to be improving. In a systematic review of acupuncture, 13 of the 16 included trials that received a score of 3 or higher on the five-point Jadad scale were published in or after 1999.[183] Similarly, in a systematic review of bed rest vs. advice to stay active, one of the four trials that was rated good quality was published in 1995; the other three were published in or after 1999.[187] A survey of the physical therapy literature found that the quality of randomized controlled trials has steadily improved, with the most recent mean Physiotherapy Evidence Database (PEDro) quality score of 5.7 (range 0 to 8) for studies published in 2000 or 2001, compared with 5.0 for studies published between 1995 and 1999, and less than 4.0 for studies published between 1975 and 1979.[188] Updated recommendations for low back

pain studies to measure at least five core sets of domains (back specific function, generic health status, pain, work disability, and patient satisfaction) and use standard validated outcomes scales (such as the Medical Outcomes Short Form-36 Health Status Survey [SF-36], Roland–Morris Disability Questionnaire, and the Oswestry Disability Index) have helped facilitate interpretation and comparison of important patient outcomes across studies.[189]

Appropriate blinding in trials of low back pain continues to pose a challenge, particularly for studies of manipulative therapy, exercise, acupuncture, injections, and surgery.[190] However, adequate or at least partially effective as well as safe blinding can often be achieved, although creative methods may be required. One case in point is a randomized controlled trial using a sham transcutaneous electrical nerve stimulation (TENS) instrument that used a visually identical unit, excluded subjects with previous TENS experience, avoided a crossover design, and used identical electrode placements and adjustments.[191] About 84% of the patients receiving sham units believed that they had functioning units. This trial found TENS no more effective than exercise or sham treatment for chronic low back pain.[163] A trial of low-level laser therapy for chronic low back pain used a modified device with a switch that toggled between actual laser and placebo treatment.[192] For each application, the toggle switch was set according to a computer-generated randomization table, with physicians, therapists, and patients all unaware of treatment assignment. In another study, simulated acupuncture using toothpick insertions were thought to be "real" acupuncture by 52% of subjects, compared with 65% receiving real acupuncture.[193]

The results of high-quality randomized controlled trials have helped us to better understand what does and does not work for low back pain. In some cases, randomized trial results challenged long-used or widely used practices for low back pain management. One trial published in 1986, for example, found that acute low back pain patients randomized to advice for bed rest for 2 days had significantly fewer days of work absence than those randomized to 7 days.[194] On critical appraisal, this trial met criteria for adequate randomization, allocation concealment, blinding of outcomes assessment, intention-to-treat analysis, and low loss to follow-up.[195] Randomized trials have also been helpful in reducing the use of "fad" interventions. One well-designed, placebo-controlled trial, for example, found that corticosteroid injections into facet joints for chronic low back pain was of little value.[196] Another randomized trial of low-energy laser treatment plus exercise for chronic low back pain found that laser had no advantage over exercise alone.[192]

Recent randomized trials of low back pain management have addressed topics as varied as the use of a clinical prediction rule to identify patients most likely to benefit from spinal manipulation,[197] epidural steroid injections for nerve root compression,[198] effects of coordination of primary health care for back pain,[199] effects of community-based education on surgery rates,[200] outcomes associated with magnetic resonance imaging vs. plain radiographs for patients with low back pain,[201] and the effects of exercise vs. spinal manipulation or their combination for back pain.[202,203] The last study also included a cost analysis, and is an example of how such economic analyses can be incorporated into the design of relevant, large clinical trials.[204,205]

In some areas of low back pain management, randomized trials are still lacking. Trials data are particularly scarce for the areas of devices, surgeries, and other invasive procedures. For example, the primary evidence directly comparing surgery and conservative management of sciatica due to lumbar disc prolapse comes from a single, randomized, nonblinded trial of 126 patients at one hospital in Norway.[206] This study found that 1-year outcomes were significantly better in the surgical group, but 4- and 10-year outcomes were similar. As the first randomized trial of back surgery, this study has been highly influential, even though it only included patients with unclear indications for surgery, and other potentially significant methodologic shortcomings include a large number of crossovers, small sample size, and use of insensitive outcome measurements.[207] There is also only one small (31 subjects) long-term randomized controlled trial of surgery vs. conservative management for spinal stenosis.[208] Rigorously designed randomized trials of surgery vs. conservative management for spinal stenosis and sciatica due to lumbar disc herniation, however, are currently underway.[209]

Even when randomized trials are available, it should be remembered that nearly all trials are designed to evaluate clinical *efficacy* in ideal settings and populations. Patients who enroll in low back pain clinical trials, for example, tend to be better educated, more frequently employed, and differ in other prognostically important ways from patients in everyday practice.[210] Trials also employ methods to maximize compliance, minimize the incidence of adverse events, and reduce dropout rates. In contrast, observational studies that are

designed to evaluate the clinical *effectiveness* of interventions in everyday practice can be very valuable for learning the outcomes of interventions when physicians and patients apply their own perceptions and biases to the decision-making process.[211]

Interpretation of low back pain observational studies, however, must be done with caution. For observational studies to be valid, researchers must understand and be able to measure all of the important variables that could affect who receives different interventions. In the case of low back pain, these factors have often not been clearly defined, or may not be easily measured. Furthermore, many observational studies of low back pain interventions remain poorly designed and reported. A review of observational studies of spinal fusions and chemonucleolysis, for example, found that many were uncontrolled case series, lacked adequate description of patients, did not assess confounders, and had high rates of loss to follow-up.[212] Even for areas of low back pain research where the quality of observational studies seems to be improving, progress has often been marginal. One systematic review of spinal cord stimulation for chronic back pain found that the median quality score had only improved from 1 (0 to 7 scale) for observational studies published between 1975 and 1984, to 2 for studies published from 1995 onwards.[213] Even if high-quality observational studies for an intervention were available, there are few empiric data assessing how frequently results from observational studies of low back pain agree with subsequent randomized controlled trials, although examples where randomized controlled trials and observational studies were discordant are numerous.[2] Because of the substantial risk of bias in studies of low back pain, observational studies are probably most helpful for evaluating clinical effectiveness only when efficacy has already been established with randomized trials.[211]

Outcomes research is a relatively new concept that builds on existing research methodologies, often using observational study designs and large databases, in order to better understand the end results of health care practices and interventions.[214] Although outcomes research for low back pain spans a wide range of issues including variations in medical practice,[215] etiology and prognosis,[216] effectiveness of medical or surgical interventions,[10] and natural history of disease,[217] it is distinguished from traditional clinical research by its emphasis on measuring outcomes that matter the most to patients (including functional outcomes and quality of life), and a broad view that encompasses all aspects of health care delivery, from the initial clinical encounter to issues of organization, financing, and regulation of the health care system.[218]

One of the best-known low back pain outcomes studies is the Maine Lumbar Spine Study.[219] One goal of this study is to evaluate long-term outcomes from surgical compared with nonsurgical management of lumbar spinal stenosis and lumbar disc herniation in community health care settings. As noted above, the randomized trial evidence base is slim for both of these interventions.[206,208] Recently published 10-year results of the Maine Lumbar Spine Study found that for both conditions, 10-year outcomes slightly favored surgically treated patients for some outcomes, although the effects generally appeared small.[220,221] This study was prospective, had a clear inception cohort, collected baseline data, measured outcomes yearly using standardized scales, and analyzed baseline characteristics and other known confounders for their effects on results. Nonetheless, residual confounding or selection bias could have influenced the results because of unmeasured or unknown factors. Additional randomized trial data will help confirm these findings, although results from such well-designed observational studies provide some reassurance that outcomes among patients managed operatively and nonoperatively for these conditions are unlikely to be markedly different.

The evidence basis for low back pain management has clearly come a long way over the last several decades. Clinicians also have a better understanding of how to identify methodologic shortcomings in low back pain studies. For readers interested in further reading on this topic, Table 2 lists articles providing low back pain-specific guidance on critical appraisal and research methods. These articles address a wide range of studies including studies of therapeutic interventions, natural history, prognosis, diagnostic tests, geographic variation, economic evaluations, decision analyses, systematic reviews, and clinical practice guidelines.

Systematic Reviews of Low Back Pain

Given the rapid expansion of the low back pain evidence base, the usefulness of high-quality systematic reviews is obvious.[222] In fact, systematic reviews of low back pain research have become quite common (Table 3). For example, at least 16 systematic reviews of spinal manipulation for low back pain have been published since 1985, although several are updated versions of previously published studies.[185,186,223–236] A prominent leader in the development of systematic

Table 2. Selected Articles to Aid in the Critical Appraisal of the Low Back Pain Literature

Andersson GB, Deyo RA. History and physical examination in patients with herniated lumbar discs. *Spine.* 1996;21(24 suppl):10S–18S.
Bloch R. Methodology in clinical back pain trials. *Spine.* 1987;12:430–432.
Bombardier C. Outcome assessments in the evaluation of treatment of spinal disorders: summary and general recommendations. *Spine.* 2000;25:2100–3103.
Bombardier C, Kerr MS, Shannon HS, Frank JW. A guide to interpreting epidemiologic studies on the etiology of back pain. *Spine.* 1994;19:2047S–2056S.
Busse JW, Guyatt GH, Bhandari M, Cassidy JD. Users' guide to the chiropractic literature-IA: how to use an article about therapy. *J Manipulative Physiol Ther.* 2003;26:330–337.
Busse JW, Guyatt GH, Bhandari M, Cassidy JD. Users' guide to the chiropractic literature-IB: how to use an article about therapy. *J Manipulative Physiol Ther.* 2003;26:525–532.
Conrad DA, Deyo RA. Economic decision analysis in the diagnosis and treatment of low back pain: a methodologic primer. *Spine.* 1994;19:2101S–2106S.
Deyo RA. Conservative therapy for low back pain. Distinguishing useful from useless therapy. *JAMA.* 1983;250:1057–1062.
Deyo RA, Haselkorn JK, Hoffman RM, Kent DL. Designing studies of diagnostic tests for low back pain or radiculopathy. *Spine.* 2001;19:2057S–2065S.
Furlan AD, Clarke J, Esmail R, et al. A critical review of reviews on the treatment of chronic low back pain. *Spine.* 2001;26:1.
Haselkorn JK, Turner JA, Diehr PA, Ciol MA, Deyo RA. Meta-analysis: a useful tool for the spine researcher. *Spine.* 1994;19:2076S–2082S.
Hoffman RM, Turner JA, Cherkin DC, Deyo RA, Herron LD. Therapeutic trials for low back pain. *Spine.* 1994;19(18S):2068S–2075S.
Koes BW, Bouter LM, van der Heijden GJ. Methodological quality of randomized clinical trials on treatment efficacy in low back pain. *Spine.* 1995;20:228–235.
Korthals-de Bos I, van Tulder M, van Dieten H, Bouter L. Economic evaluations and randomized trials in spinal disorders: principles and methods. *Spine.* 2004;29:442–448.
Liang MH, Andersson G, Bombardier C, et al. Strategies for outcome research in spinal disorders: an introduction. *Spine.* 1994;19:2037S–2040S.
Maher CG, Sherrington C, Elkins M, Herbert RD, Moseley AM. Challenges for evidence-based physical therapy: accessing and interpreting high-quality evidence on therapy. *Phys Ther.* 2004;84:644–654.
Saal JS. General principles of diagnostic testing as related to painful lumbar spine disorders. *Spine.* 2002;27:2538–2545.
Scalzitti DA. Evidence-based guidelines: application to clinical practice. *Phys Ther.* 2001;81:1622–1628.
Shah RV, Albert TJ, Buegel-Sanchez V, Vaccaro AR, Hilibrand AS, Gauer JN. Industry support and correlation to study outcome for papers published in Spine. *Spine.* 2005;30:1099–1104.
Shekelle PG, Andersson G, Bombardier C, et al. A brief introduction to the critical reading of the clinical literature. *Spine.* 1994;19:2028S–2031S.
van Tulder M, Furlan AD, Bombardier C, Bouter L, the Editorial Board of the Cochrane Collaboration Back Review Group. Updated method guidelines for systematic reviews in the Cochrane Collaboration Back Review Group. *Spine.* 2003;28:1290–1299.
van Tulder MW, Tuut MK, Pennick V, Bombardier C, Assendelft WJJ. Quality of primary care guidelines for acute low back pain. *Spine.* 2004;29:E357–E362.
Volinn E, Diehr P, Ciol MA, Loeser JD. Why does geographic variation in health care practices matter? (And seven questions to ask in evaluating studies on geographic variation). *Spine.* 1994;19:2092S–2100S.
Von Korff M. Studying the natural history of back pain. *Spine.* 1994;19:2041S–2046S.

reviews of low back pain is the Cochrane Back Review Group, a subgroup of the Cochrane Musculoskeletal Review Group that has been active since 1992.[237] As of 2003, the Cochrane Back Review Group had published 18 completed reviews of low back pain, and an additional five protocols for reviews that had not yet been completed.[238]

The number of systematic reviews of low back pain from outside the Cochrane Collaboration is also increasing. In fact, Cochrane[239] and non-Cochrane[183] reviews of acupuncture for low back pain were recently published in different journals during the same week! In addition to numerous systematic reviews of low back pain therapies, systematic reviews have also been published on patient expectations of management,[167] prognosis,[156,240] diagnostic imaging,[165,166,241,242] and physical examination.[243] There is even a systematic review of systematic reviews of low back pain,[244] and a systematic review of low back pain guidelines.[245]

Although the rapid expansion in the number of low back pain systematic reviews has been helpful for summarizing the existing literature, the reviews have often been hampered by the poor quality of primary (particular older) studies. In a review of diagnostic imaging tests for spinal stenosis, for example, all of the 14 included studies had significant methodologic problems.[242] Similarly, a systematic review of traction for back and neck pain found that only 3 of 17 randomized controlled trials scored more than 50 points on a 100-point quality rating scale.[246] A systematic review of surgery for lumbar spinal stenosis was unable to conduct a planned meta-analysis because of major deficits in study design, analysis, and reporting.[247] Overall, about two-thirds of systematic reviews of low back pain emphasize the need for more high-quality trials.[244]

When the primary literature is poor in quality, systematic reviews may be unable to reach strong conclusions, but remain helpful for pointing out evidence gaps and areas that primary researchers should consider when designing and conducting studies. Authors of the systematic review on diagnosis of spinal stenosis, for example, suggested that future studies should include sufficiently large sample sizes, insure independent readings of diagnostic tests and reference standards, and assess the contribution of imaging diagnoses on clinical outcomes.[242] A more recent systematic review of spinal

Table 3. Selected Systematic Reviews on Low Back Pain Topics

Assendelft WJ, Morton SC, Yu EI, Suttorp MJ, Shekelle PG. Spinal manipulative therapy for low back pain. A meta-analysis of effectiveness relative to other therapies. *Ann Intern Med*. 2003;138:871–881.

Bronfort G, Haas M, Evans RL, Bouter LM. Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. *Spine J.* 2004;4:335–356.

Brosseau L, Milne S, Robinson V, et al. Efficacy of the transcutaneous electrical nerve stimulation for the treatment of chronic low back pain: a meta-analysis. *Spine*. 2002;27:596–603.

Cherkin DC, Sherman KJ, Deyo RA, Shekelle PG. A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain. *Ann Intern Med.* 2003;138:898–906.

Cohen JE, Goel V, Frank JW, Bombardier C, Peloso P, Guillemin F. Group education interventions for people with low back pain: an overview of the literature. *Spine*. 1994;19:1214–1222.

Deyo RA, Rainville J, Kent DL. What can the history and physical examination tell us about low back pain? *JAMA*. 1992;268:760–765.

Di Fabio RP. Efficacy of comprehensive rehabilitation programs and back school for patients with low back pain: a meta-analysis. *Phys Ther*. 1995;75:865–878.

Ernst E, White AR. Prospective studies of the safety of acupuncture: a systematic review. *Am J Med.* 2001;110:481–485.

Ferreira ML, Ferreira PH, Latimer J, Herbert R, Maher CG. Does spinal manipulative therapy help people with chronic low back pain? *Aust J Physiother*. 2002;48:277–284.

Furlan AD, Brosseau L, Imamura M, Irvin E. Massage for low-back pain [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2;2005.

Furlan AD, van Tulder MW, Cherkin DC, et al. Acupuncture and dry-needling for low back pain [Systematic Review]. *Cochrane Database of Systematic Reviews*. Search on 04-21-05 Issue 2;2005.

Gibson JNA, Grant IC, Waddell G. Surgery for lumbar disc prolapse [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2;2005.

Gibson JNA, Waddell G, Grant IC. Surgery for degenerative lumbar spondylosis [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2;2005.

Guzman J, Esmail R, Karjalainen K, Malmivaara A, Irvin E, Bombardier C. Multidisciplinary bio-psycho-social rehabilitation for chronic low-back pain [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2;2005.

Hagen KB, Hilde G, Jamtvedt G, Winnem MF. The Cochrane review of bed rest for acute low back pain and sciatica. *Spine*. 2000;25:2932–2939.

Hagen KB, Jamtvedt G, Hilde G, Winnem M. The updated Cochrane review of bed rest for low back pain and sciatica. *Spine*. 2005;30:542–546.

Hayden JA, van Tulder MW, Malmivaara AV, Koes BW. Meta-analysis: exercise therapy for nonspecific low back pain. *Ann Intern Med.* 2005;142:765–775.

Hayden JA, van Tulder MW, Tomlinson G. Systematic review: strategies for using exercise therapy to improve outcomes in chronic low back pain. *Ann Intern Med.* 2005;142:776–785.

van der Heijden GJ, Beurskens AJ, Koes BW, Assendelft WJ, de Vet HC, Bouter LM. The efficacy of traction for back and neck pain: a systematic, blinded review of randomized clinical trial methods. *Phys Ther*. 1995;75:93–104.

Heymans MW, van Tulder MW, Esmail R, Bombardier C, Koes BW. Back schools for non-specific low-back pain [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2; 2005.

Hoffman RM, Kent DL, Deyo RA. Diagnostic accuracy and clinical utility of thermography for lumbar radiculopathy. A meta-analysis. [see comment]. *Spine*. 1991;16:623–628.

van den Hoogen HM, Koes BW, van Eijk JT, Bouter LM. On the accuracy of history, physical examination, and erythrocyte sedimentation rate in diagnosing low back pain in general practice. A criteria-based review of the literature. [see comment]. *Spine*. 1995;20:318–327.

Hoogendoorn W, van Poppel MNM, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine*. 2000;25:2114–2125.

van der Hulst M, Vollenbroek-Hutten MMR, Ijzerman MJ. A systematic review of sociodemographic, physical, and psychological predictors of multidisciplinary rehabilitation—or, back school treatment outcome in patients with chronic low back pain. *Spine*. 2005;30:813–825.

Jarvik JG, Deyo RA. Diagnostic evaluation of low back pain with emphasis on imaging. *Ann Intern Med*. 2002;137:586–597.

Jellema P, van Tulder M, van Poppel MNM, Nachemson AL, Bouter LM. Lumbar supports for prevention and treatment of low back pain. *Spine*. 2001;26:377–386.

Karjalainen K, Malmivaara A, van Tulder M, et al. Multidisciplinary biopsychosocial rehabilitation for subacute low-back pain among working age adults [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2;2005.

Kent DL, Haynor DR, Larson EB, Deyo RA. Diagnosis of lumbar spinal stenosis in adults: a meta-analysis of the accuracy of CT, MR, and myelography. *Am J Roentgenol*. 1992;158:1135–1144.

Koes BW, Scholten RJPM, Mens JMA, Bouter LM. Efficacy of non-steroidal anti-inflammatory drugs for low back pain: a systematic review of randomized clinical trials. *Ann Rheum Dis.* 1997;56:514–523.

Kool J, de Bie R, Oesch P, Knusel O, van den Brandt P, Bachmann S. Exercise reduces sick leave in patients with non-acute non-specific low back pain: a meta-analysis. *J Rehabil Med*. 2004;36:49–62.

Littenberg B, Siegel A, Tosteson AN, Mead T. Clinical efficacy of SPECT bone imaging for low back pain. *J Nucl Med.* 1995;36:1707–1713.

Maier-Riehle B, Harter M. The effects of back schools—a meta-analysis. *Int J Rehabil Res.* 2001;24:199–206.

Manheimer E, White A, Berman B, Forys K, Ernst E. Meta-analysis: acupuncture for low back pain. *Ann Intern Med.* 2005;142:651–663.

Mardjetko SM, Connolly PJ, Shott S. Degenerative lumbar spondylolisthesis. *Spine*. 1994;19(20S):2256S–2265S.

McIntosh G, Frank J, Hogg-Johnson S, Hall H, Bombardier C. Low back pain prognosis: structured review of the literature. *J Occup Rehabil*. 2000;10:101–115.

Nelemans PJ, de Bie RA, de Vet HCW, Sturmans F. Injection therapy for subacute and chronic benign low-back pain [Systematic Review]. *Cochrane Database of Systematic Reviews.* Issue 2;2005.

Niemisto L, Kalso E, Malmivaara A, Seitsalo S, Hurri H. Radio frequency denervation for neck and back pain: a systematic review within the framework of the Cochrane Collaboration Back Review Group. *Spine*. 2003;28:1877–1888.

Pengel LHM, Herbert RD, Maher CG, Refshauge KM. Acute low back pain: systematic review of its prognosis. *BMJ*. 2003;327:323.

Pincus T, Burton AK, Vogel S, Field AP. A systematic review of psychological factors as predictors of chronicity/disability in prospective cohorts of low back pain. *Spine*. 2002;27:E109–E120.

Salerno SM, Browning R, Jackson JL. The effect of antidepressant treatment on chronic back pain: a meta-analysis. *Arch Intern Med*. 2002;162:19–24.

Schnitzer TJ, Ferraro A, Hunsche E, Kong SX. A comprehensive review of clinical trials on the efficacy and safety of drugs for the treatment of low back pain. *J Pain Symptom Manage*. 2004;28:72–95.

Schonstein E, Kenny D, Keating J, Koes B, Herbert RD. Physical conditioning programs for workers with back and neck pain: a Cochrane systematic review. *Spine*. 2003;28:E391–E395.

Staiger TO, Gaster B, Sullivan MD, Deyo RA. Systematic review of antidepressants in the treatment of chronic low back pain. *Spine*. 2003;28:2540–2545.

Table 3. ***Cont.***

Taylor RS, Van Buyten J, Buscher E. Spinal cord stimulation for chronic back pain and leg pain and failed back surgery syndrome: a systematic review and analysis of progressive factors. *Spine*. 2004;30:152–160.
van Tulder MW, Assendelft WJJ, Koes BW, Bouter LM. Spinal radiographic findings and nonspecific low back pain. A systematic review of observational studies. *Spine*. 1997;22:427–434.
van Tulder M, Malmivaara A, Esmail R, Koes B. Exercise therapy for low back pain: a systematic review within the framework of the Cochrane Collaboration back review group. *Spine*. 2000;25:2784–2796.
van Tulder MW, Osteleo R, Vlaeyen JWS, Linton SJ, Morely SJ, Assendelft WJJ. Behavioral treatment for chronic low back pain: a systematic review within the framework of the Cochrane back review group. *Spine*. 2000;26:270–281.
van Tulder MW, Schotten RJPM, Koes BW, Deyo RA. Non-steroidal anti-inflammatory drugs for low back pain: a systematic review within the framework of the Cochrane Collaboration back review group. *Spine*. 2000;25:2501–2513.
van Tulder MW, Touray T, Furlan AD, Solway S, Bouter LM, Cochrane Back Review Group. Muscle relaxants for nonspecific low back pain: a systematic review within the framework of the Cochrane collaboration. [see comment]. *Spine*. 1978;28:1978–1992.
Turner JA, Ersek M, Herron L, Deyo R. Surgery for lumbar spinal stenosis: attempted meta-analysis of the literature. *Spine*. 1992;17:1–8.
Turner JA, Ersek M, Herron L, et al. Patient outcomes after lumbar spinal fusions. *JAMA*. 1992;268:907–911.
Turner JA, Herron L, Deyo RA. Meta-analysis of the results of lumbar spine fusion. *Acta Orthop Scand Suppl*. 1993;251:120–122.
Turner JA, Loeser JD, Bell KG. Spinal cord stimulation for chronic low back pain: a systematic literature synthesis. *Neurosurgery*. 1088;37:1088–1095.
Urrutia G, Burton AK, Morral A, Bonfill X, Zanoli G. Neuroreflexotherapy for non-specific low-back pain [Systematic Review]. *Cochrane Database of Systematic Reviews*. Issue 2;2005.
Verbeek J, Sengers M-J, Riemens L, Haafkens J. Patient expectations of treatment for back pain: a systematic review of qualitative and quantitative studies. *Spine*. 2004;29:2309–2318.
Yelland MJ, Del Mar C, Pirozzo S, Schoene ML, Vercoe P. Prolotherapy injections for chronic low-back pain [Systematic Review]. *Cochrane Database of Systematic Reviews*. Issue 2;2005.

cord stimulation for failed back surgery syndrome provided a separate table of detailed recommendations for future studies, including the use of a control group and sham treatments if possible, follow-up assessment of all patients including those no longer using stimulators, and more detailed reporting of adverse events and study characteristics related to external validity.[248] To be effective in improving the evidence base, however, such guidance needs to be acted on by researchers. Even though the same authors also provided a list of recommendations for future studies of spinal cord stimulation 10 years earlier,[249] only two controlled studies (one cohort study and one randomized trial) have become available in the last decade, compared with over a dozen uncontrolled case series.[213]

One recent systematic review of exercise therapy for low back pain used an innovative method for addressing limitations in the primary studies.[250] The review found that the literature was characterized by low-quality studies with heterogeneous outcome measures, inconsistent and poor reporting, and possibly publication bias, and concluded that there is only limited evidence (mean improvement of 7.3 points for pain and 2.5 points for function on 100-point scales with 20 and 10 points considered clinically important, respectively) that exercise therapy was effective. The review also found significant heterogeneity between results of trials according to the particular exercise intervention evaluated. Analyses using Bayesian meta-regression techniques were used to identify features of exercise therapy associated with better outcomes, such as individually designed programs, use of stretching and strengthening, high-dose or high-intervention therapy, and supervision.[251] Additional modeling found that exercise therapy consisting of all of these favorable features would be expected to result in better outcomes than seen in the pooled analysis of trials (improved mean score of 18.1 points for pain and 5.5 points for function compared with no treatment), although no trial evaluating such an intervention currently exists. This type of analysis has the potential to provide additional guidance for clinicians recommending exercise therapy for low back pain until the randomized trials are available, and also can help researchers decide which intervention to evaluate when designing future studies.

Even when the primary literature is adequate, systematic reviews are only valid if they use methods to minimize error and bias and insure comprehensiveness.[77] In general, the methodologic quality of systematic reviews on low back pain has been moderate. A systematic review of 36 systematic reviews on low back pain treatments found that the average quality score was 4.1 on a scale of 1 to 7.[244] The most common flaws were noncomprehensive literature searches, bias in selection of studies, inadequate assessment of validity of primary studies, inappropriate combination of findings, or conclusions not supported or only partially supported by the results. In this study, systematic reviews that were more rigorous tended to be more cautious in drawing conclusions about the effectiveness of interventions, and

reported more negative or uncertain results. However, the relationship between methodologic quality of reviews of back pain and results may not always follow this pattern. A study of reviews of spinal manipulation, for example, found that higher-quality reviews were more likely to conclude that manipulation is effective.[252]

The Cochrane Back Review Group has published guidelines for conducting systematic reviews.[12] They include recommendations on literature searches, inclusion criteria, quality assessment of primary studies, data extraction, and data analysis. For example, the guidelines suggest minimum literature searches that include multiple electronic databases (MEDLINE, EMBASE, and the Cochrane Central Register of Controlled Trials); reviewing reference lists of relevant systematic review and randomized controlled trials; and contacting content experts for additional references. In addition, searching additional databases (such as the Physiotherapy Evidence Database, or PEDro[253]) is recommended for specific topics. Although the majority of Cochrane reviews already follow the minimum criteria suggested in the guidelines, adherence to additional suggestions (referred to as "expanded guidance") could help further improve the quality of both Cochrane and non-Cochrane systematic reviews.[12]

An important goal of Cochrane systematic reviews is to regularly update results, although time and resource limitations often makes this difficult to achieve in practice. There are several examples where incorporation of new research into low back pain systematic reviews has changed or altered the strength of previous conclusions. For instance, a Cochrane review of studies of bed rest for low back pain and sciatica through 1999 reported somewhat inconclusive results—specifically that bed rest had no effect at best, and at worst might have slightly harmful effects, compared with advice to stay active.[254] In contrast, an updated review of studies published through 2003, which included two new good-quality trials, concluded that there is high-quality evidence that advice to stay in bed is less effective than advice to stay active.[187] Inclusion of recent clinical trials of spinal manipulation for acute low back pain in recent systematic reviews has also reduced uncertainty about the effectiveness of this intervention. Although earlier systematic reviews reached mixed conclusions, recent Cochrane and non-Cochrane reviews with the new trials[186,226,229,232] reported similar findings—namely, that spinal manipulation has modest efficacy similar in magnitude to other conventional treatments (Table 4). Likewise, earlier systematic reviews of acupuncture for low back pain were somewhat discordant,[180,184,229,255] but two recent reviews[183,239] both found that acupuncture appears effective for chronic (but not acute) low back pain.

When high-quality systematic reviews of a topic reach similar conclusions, they can be very helpful for reducing clinical uncertainty and guiding medical decisions. A more challenging scenario for clinicians is when well-conducted reviews of the same topic disagree.[256] This situation appears quite common for low back pain topics. In fact, for 13 different low back pain interventions that were evaluated in two or more systematic reviews, conclusions conflicted for 11 interventions.[244] Reasons include different methods for identifying, including, and rating studies, as well as different methods for analyzing, combining, and synthesizing data. Among 37 systematic review of chronic low back pain, for example, 27 used qualitative pooling methods, and 10 used quantitative methods.[244]

Different methods of data synthesis—quantitative pooling vs. vote counting—help explain why two systematic reviews of epidural steroid injections for sciatica came to different conclusions.[257] In one study, results of individual studies were combined to find a pooled odds ratio of 2.61 favoring epidural steroids.[258] In contrast, the other study concluded that the efficacy of epidural steroids was inconclusive because equal numbers of studies found "positive" and "negative" (no benefit) effects.[259] Different methods for ranking the evidence may also affect the conclusions of systematic reviews. One study found that application of different "levels of evidence" criteria to studies included in Cochrane reviews of low back pain would have substantially changed conclusions in 17% of cases.[260] For studies on the efficacy of back school, using four different sets of levels of evidence criteria would have produced four different conclusions: "strong evidence that back schools are effective," "weak evidence," "limited evidence," and "no evidence."

These observations highlight the fact that the optimal methods for grading and pooling evidence are not completely understood, and could vary for different back pain topics. The best approach may be for systematic reviews to perform sensitivity analyses assessing the effects of different synthesis methods on conclusions. One recent systematic review of spinal manipulation, for example, found that using the Jadad scale and modified Jadad scales to determine which studies were included in the analysis resulted in similar conclusions.[186] Another systematic review of spinal manipula-

Table 4. Summary of Selected Narrative and Systematic Reviews on Spinal Manipulation for Acute Low Back Pain*

Reviews	Year	Conclusions
Narrative reviews (or not clearly systematic)		
Greenland S, Reisbord L, Haldeman S, Buerger A. Controlled clinical trials of manipulation: a review and a proposal. *J Occup Med.* 1980;22:670–676.	1980	". . . manipulation is probably superior to certain control or sham treatments."
Brunarski DJ. Clinical trials of spinal manipulation: a critical appraisal and review of the literature. *J Manipulative Physiol Ther.* 1984;7:243–249.	1984	"Overall, it would seem that there is sufficient evidence to suggest that spinal manipulative therapy may be more effective than standard medical care in the management of painful neuromusculoskeletal conditions, most notably that of low back pain."
Di Fabio R. Clinical assessment of manipulation and mobilization of the lumbar spine. A critical review of the literature. *Phys Ther.* 1986;66:51–54.	1986	"The literature reviewed indicates highly equivocal results . . ."
Systematic reviews		
Ottenbacher K, DiFabio RP. Efficacy of spinal manipulation/mobilization therapy. A meta-analysis. *Spine.* 1985;10:833–837.	1985	"The results provided only limited empiric support for spinal mobilization and manipulation . . ."
Koes BW, Assendelft WJ, van der Heijden GJ, Bouter LM, Knipschild PG. Spinal manipulation and mobilization for back and neck pain: a blinded review. *BMJ.* 1991;303:1298–1303.	1991	"Although some results are promising, the efficacy of manipulation has not been convincingly shown."
Abenhaim L, Bergeron AM. Twenty years of randomized clinical trials of manipulative therapy for back pain: a review. *Clin Invest Med.* 1992;15:527–535.	1992	"The 21 randomized clinical trials reviewed here provide some indication that manipulative therapy offers some positive short-term results . . ."
Anderson R, Meeker WC, Wirick BE, Mootz RD, Kirk DH, Adams A. A meta-analysis of clinical trials of spinal manipulation. *J Manipulative Physiol Ther.* 1992;15:181–194.	1992	"(Spinal manipulative therapy) proved to be consistently more effective in the treatment of low back pain than were any of the array of comparison treatments."
Di Fabio RP. Efficacy of manual therapy. *Phys Ther.* 1992;72:853–864.	1992	"The analysis of valid trials provided clear evidence that manual therapy, particularly manipulation, can be an effective modality when used to treat patients who have low back pain."
Shekelle PG, Adams AH, Chassin MR, Hurwitz EL, Brook RH. Spinal manipulation for low-back pain. *Ann Intern Med.* 1992;117:590–598.	1992	"Spinal manipulation is of short-term benefit in some patients, particularly those with uncomplicated, acute low-back pain."
Koes BW, Assendelft WJJ, van der Heijden GJMG, Bouter LM. Spinal manipulation for low back pain. *Spine.* 1996;21:2860–2873.	1996	"The efficacy of spinal manipulation for patients with acute or chronic low back pain has not been demonstrated with sound randomized clinical trials."
Assendelft WJ, Morton SC, Yu EI, Suttorp MJ, Shekelle PG. Spinal manipulative therapy for low back pain. A meta-analysis of effectiveness relative to other therapies. *Ann Intern Med.* 2003;138:871–881.	2003	". . . spinal manipulative therapy was superior only to sham therapy . . . or therapies judged to be ineffective or even harmful."
Cherkin DC, Sherman KJ, Deyo RA, Shekelle PG. A review of the evidence for the effectiveness, safety, and cost of acupuncture, massage therapy, and spinal manipulation for back pain. *Ann Intern Med.* 2003;138:898–906.	2003	"Spinal manipulation has small clinical benefits that are equivalent to those of other commonly used therapies." *Note: This systematic review evaluated a subset of trials included in Assendelft, 2003 (above).*
Ferreira ML, Ferreira PH, Latimer J, Herbert R, Maher CG. Efficacy of spinal manipulative therapy for low back pain of less than three months' duration. *J Manipulative Physiol Ther.* 2003;26:593–601.	2003	"Spinal manipulative therapy produces slightly better outcomes than placebo therapy, no treatment, massage, and short wave therapy for nonspecific low back pain of less than 3 months duration. Spinal manipulative therapy, exercise, usual physiotherapy, and medical care appear to produce similar outcomes in the first 4 weeks of treatment."
Bronfort G, Haas M, Evans RL, Bouter LM. Efficacy of spinal manipulation and mobilization for low back pain and neck pain: a systematic review and best evidence synthesis. *Spine J.* 2004;4:335–356	2004	"There is moderate evidence that spinal manipulative therapy provides more short-term pain relief than mobilization and detuned diathermy, and limited evidence of faster recovery than a commonly used physical therapy treatment strategy."

*Shown in chronological order.

tion found that changing the quality score thresholds for grading evidence had little impact.[226]

Even when systematic reviews agree, clinicians must decide whether the conclusions apply to their practice. In the case of acupuncture for low back pain, even though two recent systematic reviews came to similar conclusions,[183,239] the results may not be generalizable to all settings. This is in part due to the fact that acupuncture (as well as spinal manipulation, massage, and physical therapy) techniques vary substantially and are often "tailored" to the individual patient.[261] The effectiveness of such interventions may also depend on the skill or training of the practitioner. In addition, several trials of acupuncture included in the systematic reviews were performed in Asia, where results of clinical trials may have favored acupuncture because of higher patient

expectations for benefit.[160] Acupuncture could prove to be less effective in western settings because of lower expectations of benefit.[147] Based on these considerations, clinicians practicing in the United States might consider recommending the specific acupuncture techniques found effective in the primary studies only for patients who express strong conviction that it will help and only if skilled providers are available in the area, and suggest alternative interventions for other patients.

These examples help call attention to the fact that conducting and applying even high-quality systematic reviews involves the use of judgment and subjective decisions. In addition, it is important to remember that systematic reviews may not always yield conclusions that are more informative or valid than a single, well-conducted trial. A recent systematic review of epidural steroids,[262] for example, pooled results of the highest quality trial[263] with trials of significantly inferior quality. In such cases, the best evidence to guide clinical decisions could be from the single large, rigorous trial.[264] That is not to say that systematic reviews should not be performed in these situations. Even when pooling of study results is inappropriate or does not provide helpful information, systematic reviews of low back pain remain valuable when they identify all of the relevant research, assess the methodologic quality of the primary literature, and thoroughly explore areas of heterogeneity.[265]

Guidelines for Management of Low Back Pain

The Quebec Task Force on Spinal Disorders published one of the first evidence-based clinical practice guidelines for management of low back pain in 1987.[266] This early attempt at using an explicit scientific basis for issuing management recommendations found that there was insufficient evidence in the vast majority of cases to support the use of the most common diagnostic procedures and treatment modalities. In 1994, a multidisciplinary expert panel convened by the U.S. Agency for Health Care and Policy Research (AHCPR) issued its recommendations on management of acute low back pain.[267] These guidelines emphasized history taking and physical examination to exclude "red flag" symptoms suggestive of serious underlying pathology; physical examination for neurologic screening; diagnostic triage into broad categories including nonspecific low back pain, radicular syndrome, or specific pathology; judicious use of diagnostic imaging; and consideration of psychosocial factors when there is no improvement. Despite an exhaustive literature search and review, none of the 40 recommendations made for clinical care methods was viewed as supported by strong research-based evidence, and only six were judged as having at least a moderate evidence base.[268] The AHCPR guidelines were subject to intense criticism and scrutiny, in part because they recommended more conservative approaches to most acute back problems.[269] Nonetheless, nearly all international guidelines published since 1994 follow an approach similar to the AHCPR guidelines.[13]

There are now at least 11 international guidelines for management of low back pain. Despite differences in health care systems and cultures, most diagnostic and therapeutic recommendations between guidelines are similar. This suggests that the scientific evidence is sufficient to enable groups in very different settings to reach similar conclusions for most areas of low back pain management. However, there are also some discrepancies among recommendations, particularly with regard to those for exercise therapy, spinal manipulation, muscle relaxants, and provision of patient information.[13] Such discrepancies may reflect areas in which the evidence is lacking or unclear. For example, guidelines published in three different countries between 1994 and 1996 recommended spinal manipulation as a treatment option (U.S.A.), recommended against spinal manipulation (Holland), or did not make a recommendation (Israel).[226] At the time that these guidelines were being developed, evidence on the benefits of spinal manipulation was mixed.[234,235] In such cases, specific circumstances within a country could affect interpretations about the evidence and about acceptable side-effects, benefits, and costs. Such contextual differences can and often should impact how evidence is incorporated into guideline recommendations.[270] In the United States, there was a perceived overuse of surgical therapies and aggressive interventions at the time that the AHCPR guidelines were being developed.[2] This could have swayed recommendations toward conservative interventions such as spinal manipulation if some data, even if not conclusive, suggested a benefit with little evidence of harm.

Practitioners in everyday practice are more likely to use guidelines that have been developed using transparent and rigorous evidence-based methods.[123] Unfortunately, the general quality of low back pain clinical practice guidelines appears suboptimal. A systematic review of 17 primary care guidelines for acute low back pain found that many did not include explicit descriptions of how the available evidence was identified, selected, and summarized.[245] Other frequent shortcom-

ings include not taking patient preferences into account,[271] not including recommendations for implementation, not including external review, and not adequately recording editorial independence or conflicts of interest.

Most clinicians believe that the development and implementation of rigorous clinical guidelines will lead to improved patient outcomes and reduce unnecessarily costly care.[142] To date, however, there are only limited data showing positive effects from adhering to evidence-based low back pain guidelines. One trial found that randomization of communities to an educational intervention regarding an evidence-based approach to low back pain as recommended in national guidelines resulted in a decline in the rate of surgery by about 9% compared with usual care.[200] An observational study found that evidence-based back care was associated with clinically and statistically significantly improved long-term results, as well as marginally better short-term results.[272] In this study, evidence-based care was associated with lower cost of care, greater reduction in pain, reduced requirement for continuing care, and greater patient satisfaction.

Despite the wide availability of evidence-based clinical practice guidelines, many clinicians do not follow or have knowledge of even basic low back pain guideline recommendations.[273,274] In addition, even if clinicians are aware of guidelines, recommendations that challenge traditional practices and beliefs may be difficult to implement. For example, recommendations to advise avoidance or minimization of bed rest for most acute low back pain patients are frequently met with significant reservations by both patients and physicians.[275] Research indicates that passive methods of guidelines dissemination (such as simply distributing the guidelines or making them electronically available) are unlikely to change physician practice.[60] Active strategies combining multiple approaches (such as auditing individual providers' practices and providing constructive feedback, providing manual or computerized reminders, and interactive educational meetings) are likely to be more effective, although additional research on effective implementation techniques is needed.[276]

CONCLUSIONS

Evidence-based medicine is an explicit approach to medical decision making that emphasizes the rigorous examination of evidence from clinical research. The last part of the 20th century saw a strong international shift toward evidence-based medicine and away from medical decision making based on authority, tradition, and unsystematic clinical observations. Like other areas of medicine, the approach to the management of low back pain has been positively affected by the availability of a richer evidence base and the application of evidence-based medicine principles. This has led to significant advances in our understanding of what does and does not work for low back pain. However, the ever-increasing volume of low back pain research threatens to overwhelm clinicians with too much data. Preprocessed evidence resources such as systematic reviews and clinical practice guidelines are widely available to aid in decision making. Nonetheless, it is important to remember that such syntheses of evidence should be subject to the same level of critical scrutiny as primary studies.

Although physicians now routinely receive residency training or continuing medical education in evidence-based medicine, everyday medical decisions, including those involving low back pain management, frequently remain uninformed by the best available evidence. Barriers to using evidence-based medicine in clinical practice include lack of time to identify and appraise primary studies of syntheses of evidence, insufficient development of evidence-based medicine skills, uncertainty about beneficial effects of evidence-based medicine on patient outcomes, and resistance to findings that challenge traditional practices.[123,141] To improve patient acceptance of evidence-based recommendations, practitioners need to better understand and incorporate individual patient circumstances and preferences into medical decisions.[277] In addition, the case for evidence-based management of low back pain would be strengthened by more research showing beneficial effects on low back pain practice, patient outcomes, patient satisfaction, and cost of care. Further research is also needed on effective strategies for implementing evidence-based low back pain recommendations.

Consider again the clinical scenario of a healthy 40-year-old patient with 2 days of low back pain, no radicular symptoms, and no "red flags." Today, a primary care provider can easily access high-quality evidence-based clinical practice guidelines on management of acute low back pain. Although the 1994 AHCPR guidelines on management of acute low back pain are now outdated, more recent guidelines issued by the Veterans Health Administration[278] and updated U.K. guidelines[279] are available. Based on these clinical practice guidelines and the patient's presentation, you would not be likely to recommend bed rest, diagnostic imaging, early surgical referral, or hospitalization. If the patient

inquired about acupuncture, you could take advantage of recently published high-quality systematic reviews of acupuncture—not yet incorporated into any guidelines—that found that this intervention is not beneficial for acute low back pain.[183,239] For some areas of low back pain management, systematic reviews and clinical practice guidelines are not yet available to guide clinical decision making, and you may need to identify and critically appraise primary studies. If the patient was interested in spinal manipulation, for example, you could critically appraise a study evaluating a clinical prediction rule to assess the likelihood that he would benefit from this intervention, and apply the prediction rule to guide your decision-making process if the findings appear valid.[197]

Although better evidence is available to guide most low back pain management decisions, research gaps and methodologic shortcomings remain, and low back pain is still a clinical challenge. However, practitioners have a better understanding of how to appraise and apply the scientific evidence, and there is widespread optimism that evidence-based practice will improve patient outcomes. To achieve this goal, low back pain researchers need to continue designing and conducting rigorous studies, and health care leaders must develop better ways to disseminate and increase the use of high-quality evidence-based clinical practice guidelines. In everyday practice, however, it remains up to front-line clinicians managing low back pain to use the evidence-based medicine training and resources already at their disposal in order to further the goal of providing optimal patient care.

ACKNOWLEDGMENTS

The author would like to acknowledge Jayne Schablaske for administrative support with this manuscript.

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