



The Orthopaedic Forum



ORTHOPAEDIC INFORMATION MASTERY: APPLYING EVIDENCE-BASED INFORMATION TOOLS TO IMPROVE PATIENT OUTCOMES WHILE SAVING ORTHOPAEDISTS' TIME*

What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention, and a need to allocate that attention efficiently among the overabundance of information sources that might consume it.

—Herbert Simon,
Nobel Laureate Economist, 1971

Knowledge is power.

—Sir Francis Bacon, 1597

Some books are to be tasted, others to be swallowed, and some few to be chewed and digested.

—Sir Francis Bacon

Medical information that is relevant to orthopaedic surgeons is continuously expanding and changing, while older information is expiring^{24,25}. The speed at which new information is generated and disseminated challenges us to adopt new strategies for acquiring useful knowledge and leaving unusable information aside. Reading faster or spending more time reading does not ensure that one is gaining more relevant orthopaedic knowledge. In addition to the challenge of processing ever-increasing amounts of orthopaedic information, there exists the timeless problem of discriminating “the truth” from that which is “not-truth” (incorrect or not clinically useful). The ability to sift through large amounts of written material to uncover a few useful truths that will improve one’s practice is a skill that busy orthopaedists and current residents should learn^{19,21}.

We live in an electronic information age in which

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patients often have more citations at their command than do practitioners^{15,16}. Our present dilemma is that a large quantity of information is quickly available, yet more and faster information services have not translated into better care for patients^{15,20,21}. The management or application of information related to orthopaedic care, combined with the skill of treating musculoskeletal disease, is what will set the orthopaedic surgeon apart from the educated lay public and from physicians who are not trained in managing orthopaedic disorders. As we enter the third millennium, we must add constantly to our knowledge base and skills repertoire while paring away unused or obsolete information that clutters the mind and memory.

Orthopaedic practitioners gather information for four basic reasons²⁶: (1) to keep up with new developments in clinical medicine, (2) to answer a question related to a specific patient, (3) to review and reinforce previously learned information, and (4) for fun or to keep up with a subspecialty of interest. Depending on why the information is needed and how it is to be used, different information sources (such as journals, videos, lectures, and textbooks) will provide the solution to the quest for practical knowledge^{11,17}. The acquisition of knowledge and the acquisition of the wisdom to use or apply this knowledge are the ultimate goals of orthopaedic research and education (Fig. 1). This paper introduces concepts that should help orthopaedic surgeons to manage their information^{18,19} and time while ultimately improving musculoskeletal patient care²⁰.

The Information Challenge

In the past two decades, we have had to learn and apply new diagnostic and treatment technologies, such as computerized tomography, ultrasound, mag-

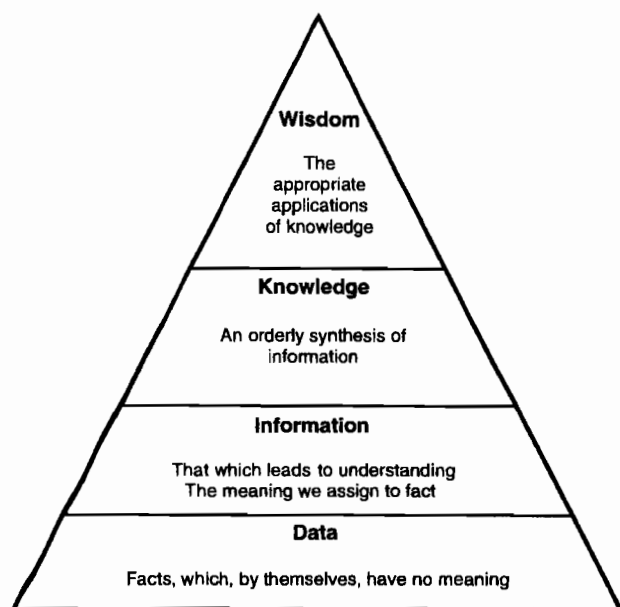


FIG. 1

Pyramidal representation of the ascendancy from gathering data to form information and knowledge to the application of knowledge as wisdom. There is an element of clinical experience and judgment (not represented in this pictorial) within the wisdom domain.

netic resonance imaging, arthroscopy, complex external fixation, bone transport and callotasis, intramedullary fixation, complex spinal instrumentation, and replacement arthroplasty. There were false starts and blind alleys. Remember polyester ligament substitutes, hip and patellar resurfacing prostheses, laser meniscectomies, and direct-current bone stimulators? An orthopaedist may embrace an innovation or a new technique on the basis of little evidence and much advertising. At other times a good idea, such as the use of an endoprosthesis for the treatment of femoral head avascular necrosis, does not prove itself over time. The fundamental knowledge of anatomy, surgical approach, and physical assessment, learned in residency, will probably serve for the lifetime of an orthopaedist without drastic revision or change. Progress in basic science, on the other hand, will change some of what orthopaedists need to know for recertification and will gradually find application as new technology in patient care. In the future, what will change markedly is the reporting of outcomes based on clinical evidence. Rather than examining how many knee implants survived for fifteen years, we will examine how many quality-adjusted life-years a cemented implant provided to the average osteoarthritic or rheumatoid patient compared with those provided by an uncemented implant. We will also examine what additional productivity an arthroscopic partial meniscectomy provided to the average person in his or her prime working years compared with that

provided by another reasonable treatment. In other words, orthopaedic surgeons will be judged by the evidence that their interventions are doing the most good for the most people at a price that the country can afford.

For those who practice general orthopaedics, it remains relatively easy to keep up with patient-evaluation methods and technologies. There are few new diagnoses or new pathological conditions; there are some improvements in confirming diagnoses. The greater challenge, and frustration, is keeping up with current aspects of patient management: new medications (for example, cyclooxygenase-2 inhibitors and quinolone antimicrobial agents), new applications of technology (for example, computer-assisted surgery and cloning of human tissue), and refinements in techniques (for example, arthroscopic procedures compared with open procedures). Even with common problems that have relatively simple treatments, the increasing constraints of a busy practice minimize the time available to critically evaluate new treatments. Lack of time limits the ability to do extensive literature searches and to use scientific measures of outcomes in one's practice.

Guilt accumulates in direct proportion to the growing pile of unread journals and the mounting stack of invitations to desirable courses that promise hands-on learning experience²². This problem is compounded when a patient arrives with an article from the Internet that describes the outstanding results from the latest technique, which combines laser arthroscopy with genetically engineered clones of autologous chondrocytes. In addition, the generalist must cope with a dizzying array of new classes of medications that improve pain control, bone density, or fracture-healing. One has a hard time keeping abreast of all areas of orthopaedic interest.

As this river of information flows by, it is difficult to identify which information, knowledge, and wisdom we really need and then incorporate it into practice^{14,18,27}. Should you be the first, or the second, or the last orthopaedist in your community to perform a thermal reduction of the shoulder capsule with use of an arthroscope? The old adage "Never be the first or last orthopaedic surgeon to learn a new technique" should be tempered by the credo "First of all, do no harm (*primum non nocere*)."²⁸ Both sayings are relevant if we are to achieve balance in this setting.

Translating Information into Knowledge

A number of studies in the medical literature have shown that there is an unacceptable lag between



the time of publication of credible scientific information that should change medical practice and the time of the adoption of this change by practitioners^{3,22,26}. Fineberg¹¹ identified the impact that twenty-eight so-called landmark papers had on the practice of medicine and discovered that only two had an effect within two years of publication. Clearly, the concept of a landmark article must be reconsidered^{11,17}.

Superficially, the solution to the information problem is easy. Find a way to get the information to orthopaedists, and they will change their way of doing things. However, the evidence suggests that, even with appropriate information, clinicians are reluctant to change their management and treatment behavior⁴. Evans et al.¹⁰ found that the strongest predictor of a physician's knowledge and management of hypertension was the clinician's year of graduation from medical school.

Two additional problems remain. The first is that the knowledge needed to make certain management decisions does not exist. A new surgical procedure has a waiting period before a meaningful comparison can be made with established procedures. We do not know if patients will be better ten years from now if they have their shoulder instability treated with an arthroscopic laser or diathermy capsular reduction rather than with more conventional open surgical plication of capsular tissue. The choice of a new surgical procedure should be based on its benefits compared with those of the existing treatment and on the hope that it will achieve at least equal success. Once an innovation demonstrates comparable or improved outcomes, it becomes popular because of reduced cost, reduced morbidity, or ease of performance compared with those of the previous technique. The long period between the development of an innovation and the acquisition of results underlies the conservatism of most orthopaedic surgeons and increases the difficulty of evidence-based persuasion to improve surgical practice.

The second problem with information management is that once we are aware of evidential knowledge we are hesitant to put this knowledge into practice^{3,14}. Researchers who have studied the diffusion of information in medicine have reported that innovations in surgical and medical practice are widely adopted only after they are first adopted by a so-called opinion leader^{2,12,14}, an influential member who is trusted by others in the community. These researchers also indicated that physicians obtain information from many sources and place greater credibility on some than on others. No matter where or from whom

the information is obtained, for the most part its roots can be traced to one source: medical journals^{2,5,22,25,28}.

Journals are the major sources of new information for both researchers and practitioners^{6,23,26}. However, these two groups approach this information quite differently. When researchers evaluate articles in their area of expertise, they usually are familiar with all of the research that has been published previously^{23,28}. Clinicians may not be so well read in the dialogue generated by previous publications and, in a sense, are listening to the middle of a conversation. Reading a journal article is similar to listening to only part of a conversation or hearing only one person's half of a conversation^{24,25}.

Following this analogy further, much of what is written in journals can be considered "chatter" among researchers with the practitioner listening in^{23,25}. Just as bits and pieces of chatter overheard in a public arena can be dangerous if taken out of context, medical research chatter can be misapplied to clinical situations and can become as harmful and inappropriate as gossip. Most people, orthopaedists included, enjoy listening to chatter and gossip and argue that it is useful to keep abreast of the lay public and to recognize future trends. But consider some of the false starts in clinical practice when medical gossip was translated into action: carbon-fiber polyethylene, fluoride treatment of osteoporosis, and the injection of chymopapain into the lumbar intervertebral disc. In these examples, clinical practice was changed on the basis of preliminary or intermediate evidence that was not subsequently supported by ongoing scientific clinical evaluation.

On the other hand, orthopaedists chastened by their experiences of changing their treatment (going along with the fad) might justifiably develop a cynical mistrust of journals. Our journals remain the primary medium for communicating new information but, unfortunately, not necessarily for providing knowledge. In the above examples of intermediate outcomes leading to treatments that did not prove successful, the facts were laid out on the table for all to see but they were left up to the individual reader to interpret. The array of medical facts (disease-oriented evidence) is often an intermediary for knowledge, and many times the facts alone do not yield a successful treatment.

The acquisition of knowledge from information is a daunting task for which few clinicians are adequately prepared. Most general orthopaedists refer to many sources for quick, reliable knowledge: textbooks, discussions with colleagues, newsletters, review articles, consultations with subspecialists, equipment-company



representatives or brochures, and instructional meetings. The benefit of these knowledge sources is apparent: they are quick and easy to use, and the knowledge is often immediately applicable. However, each source of orthopaedic knowledge has limitations. Colleagues who are no better informed than you may feel pressured to give an answer or may be biased by their experience or self-interest^{17,18,21}. A textbook may be outdated by the time that it is published. Industry representatives are obviously biased by profit interests. Newsletters and review articles may give only one side of an argument or may fail to put new information in context with the old⁷. How, then, do we find a compromise between relying on other sources and converting information into knowledge for ourselves? There is a need for a reliable approach to the practical and time-efficient management of information.

The Usefulness Equation

When a busy orthopaedist picks up a journal, calls a colleague, or attends a conference, the goal is to spend the least amount of time and effort to find the best information. Some but not most of what is acquired in this process is knowledge. Information that is useful has three attributes^{7,8,13,23}: (1) it must be relevant to the practitioner's needs, (2) it must be valid, and (3) it must require little work to obtain. These three factors can be expressed in the following usefulness equation²³: usefulness of orthopaedic information = (relevance × validity)/work.

The relevance component of the equation starts with the notion of applicability to one's practice and extends into the domain of patient outcomes. We need patient-oriented evidence with which we can evaluate the efficacy of interventions in terms of results that patients care about and that we as clinicians want for our patients. This has been designated Patient-Oriented Evidence that Matters (POEM)²³ as opposed to Patient-Oriented Evidence (POE) that does not have a relevance measure or Disease-Oriented Evidence (DOE). POEMs are rare and are scattered among the huge number of DOEs.

DOEs consist of information aimed at increasing our understanding of a disease: its etiology, pathophysiology, prevalence, prognosis, and so on. These studies are important in all of medicine and in orthopaedics in particular. We must understand how a disease works before we can routinely diagnose, treat, or prevent it with any certainty.

A study that reports the prevalence of redislocation, wound infection, and adhesions in a consecutive series of patients treated with arthroscopic thermal

plication is a DOE. In contrast, a randomized trial that compares arthroscopic thermal plication with arthrotomy by using a valid instrument to measure the quality of life of throwing athletes with a dislocating shoulder is a POEM. For the most part, POEMs consist of ready-to-use knowledge and DOEs consist of available information of uncertain clinical utility. More importantly, a POEM tells us what our patients want to know and would like us to fulfill as a diagnostic or treatment goal. A physician will change his or her practice to incorporate the evidence (the POEM) in order to improve patient outcomes.

Until recently, DOEs were the only sources of information that we had about many illnesses and treatments. We knew, for example, that sodium fluoride increased the apparent density of bone. Yet when it was used to prevent vertebral fractures due to postmenopausal osteoporosis, the rate of vertebral fracture actually increased. This paradoxical finding is explained by the brittle quality of the new bone that forms with sodium fluoride treatment. This is an example of how a surrogate outcome (increased bone density) did not predict the clinical outcome (prevention of vertebral compression fractures). The application of DOEs to orthopaedic practice requires assumptions that translate information about a general phenomenon to your patient. (For example, joint laxity produces pain; therefore, if lax joints are surgically tightened, the pain will resolve.) The application of POEMs requires only that the condition of your patient matches that of the patients in the study. (For example, my patient has a ruptured anterior cruciate ligament, and if it is properly repaired she will most likely be able to return to athletic activities.)

POEMs exist for diagnosis and prevention as well as treatment. Diagnostic POEMs are particularly helpful in applications of new technology, such as polymerase chain-reaction evaluation of joint fluid for suspected staphylococcal infection.

POEMs involving highly prevalent conditions have the greatest impact on our patients and therefore the greatest relevance^{8,23,24}. In contrast, DOEs involving rare or unusual disorders have the least relevance. Evidence that a medication can prevent progression of stage-I avascular necrosis of the femoral head is a POEM for a common condition, while a chemical assay for p53 messenger RNA expression in the diagnosis of clear-cell sarcoma is a DOE for a very rare condition (Fig. 2).

The validity of information defines to what extent the knowledge gained as a result represents "the truth." Well designed clinical trials based on statistical



	Common Problem	Uncommon Problem
Patient-Oriented Evidence	<p>Best</p> <p>Best source of POEMs</p> <p>Relevance: I</p>	<p>POEMs</p> <p>Only if Time</p> <p>May not be relevant to everyday practice</p> <p>Relevance: II</p>
Disease-Oriented Evidence	<p>Danger</p> <p>Can be misleading (Harmful medical gossip)</p> <p>Relevance: III</p>	<p>Worst</p> <p>Read only if extremely interested</p> <p>Relevance: IV</p>

FIG. 2

Cartesian grid illustrating the relationship of the four types of evidence and their clinical relevance, ranked from I (high) to IV (low). POEM = Patient-Oriented Evidence that Matters.

and experimental plans minimize bias and are most likely to provide valid conclusions²⁰. Such clinical trials are lengthy, expensive, and fraught with potential weaknesses. The assessment of validity is also difficult and time-consuming for clinicians with inadequate training in statistics or epidemiology. Validity assessment can be done individually, can be done with other orthopaedists, or can be delegated, with great care, to a nonorthopaedist who has the appropriate training (such as a biomedical statistician) and the available time. It is not enough to ask a respected subspecialist or academic orthopaedist whether an article is good.

There is no evidence that subspecialty surgeons are better at validating new information than are general orthopaedists. The best strategy is to consult a colleague with expertise in statistics, attend orthopaedic journal clubs that spread the burden of finding and evaluating new information, or search for published rigorous evaluations^{4,7,21,25} such as those presented in the new Evidence-Based Orthopaedics section in this issue of *The Journal* (see page 873). Review articles, even in highly respected orthopaedic journals, do not provide rapid critical evaluation of evidence-oriented publications.

The effort that it takes to obtain and validate useful information is the work that is the denominator in the usefulness equation. Work consists of factors such as the time and expense necessary to obtain information and the mental effort required to ensure its rele-

vance and validity. Too much time, energy, or expense will increase the work factor and decrease the usefulness of the information. In some instances, the information is essential and the investment in time and other resources is mandated by the need for an answer. For the busy orthopaedist, a high usefulness score should fulfill most information needs. The best sources of information are those that provide highly relevant and valid information with minimal work.

Studies evaluating the impact of medical research have shown that well designed clinical trials that should influence medical care fail to do so because the results are diminished by the surplus of clinically unimportant information^{8,22}. Clinicians, frequently overwhelmed by the volume of DOE literature, fail to identify the high-quality POEM information that is available^{8,12}. Incorporating POEM information into clinical practice is in the best interest of patients because POEMs provide the relevant answers to patient problems.

Information Mastery

Understanding the relationship between relevance, validity, and work helps us to master the management of medical information. Distinguishing between POEMs and DOEs will minimize the potential for misapplying harmful medical gossip^{22,23}. In addition, focusing on the identification of POEMs will reduce the time necessary to remain up to date within



all areas of orthopaedics. Allowing oneself the luxury to skim over DOE information does wonders for improving self-esteem and increasing free time without creating a guilty conscience. One major caution: this approach to medical information management creates a double-edged sword^{23,24,27}. One edge empowers clinicians to skim most of the published literature. The other edge gives clinicians the responsibility to seek, evaluate, and, most importantly, implement the new knowledge that improves patient care (POEMs).

Now, what do you tell a tournament tennis player who asks for cloned cartilage resurfacing of a defect in the humeral head of her dominant shoulder? There is no published patient-oriented evidence that supports this approach in the shoulders of athletes, and this treatment is considered experimental. Preliminary experience by some pioneering surgeons may exist, but there is no published data. A less radical treatment would be to temporize until better POEM information becomes available. Alternatively, if the patient is insistent after both of you weigh the available (DOE) evidence, she can become your first patient to receive a cartilage implant in the humeral head and she can be part of a collaborative effort to generate POEM data for this treatment. Whatever the decision, you should remain open to the necessity of changing directions if POEM information becomes available.

Deciding to implement a new procedure has a significant impact not only on the quality of medical care but also on its cost. General orthopaedists on the front lines and in the trenches of the battle against musculoskeletal disease recognize the power derived from the appropriate management of information. As summarized by Eddy⁹: "In a field filled with uncertainty and doubt, the difference between 'when in doubt, do it' and 'when in doubt, stop' could easily swing \$100 billion a year."

The goal of orthopaedic information mastery is to complement an evidence-based practice of orthopaedics: musculoskeletal evaluation and management, operative and nonoperative treatment, and hospital and community-based treatment. We support a paradigm shift toward a more scientific, modern, and (hopefully) cost-effective approach to improving patient outcomes based on useful knowledge from reputable sources in orthopaedic journals. Funding for lengthy and expensive clinical trials that generate POEMs is more likely if the orthopaedic community demonstrates the need for POEMs to those funding sources. The "quality" orthopaedic journals will demonstrate the need for POEMs by publishing more

evidence-based material. The "quality time" that we spend "digesting" POEMs, as suggested by Sir Francis Bacon, will improve orthopaedic outcomes²⁰ and save us valuable time.

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