Evidence-Based Dentistry—It Subdivided: Accepted Truths, Once Divided, May Lack Validity

The evidence-based approach to dental practice (EBD) provides a coherent strategy for the information needs of clinicians. It is valid, reliable, and appropriate to the populations and contexts in which they are taken and it is "practice that integrates evidence, clinical experience, and patient preference." As science progresses, there is no doubt that scientific evidence considered satisfactory 20 years ago may no longer be appropriate today. This is why it is so important to understand what is happening with the Cochrane Collaboration and EBD journals. EBD is not the Cochrane Collaboration, since high levels of evidence are still lacking in some traditional areas of dentistry; but this does not mean that we can discount these interventions.

It is also equally important to recognize that EBD has the capacity to be remarkably flexible in its use. It is estimated that only 7% to 8% of all dental treatment is evidence based and that greater than 60% of general dental practitioners in their study turn to friends and colleagues for evidence rather than looking in a textbook or an electronic database.[1] We must be aware that just because a statement is repeated frequently, stated with passion and conviction, or delivered by a remarkable person, does not make it science. Science embraces prediction.

Prophets and Vendors

I would like to introduce the concept of prophets and vendors. A prophet is one who espouses the merits and virtues of new materials, techniques, or interventions. In their hands it "always works" and "never has a complication." Many hear what prophets have to say and hear the truth. Prophets often enhance the truth with case series that report outstanding outcomes (no control group, no randomization, small population size, and lacking defined outcome measures). Prophets assume many disguises. A dental prophet can include persons ranging from university lecturers, remarkably skilled clinicians, entrepreneurial craftsmen and inventors, clinical researchers, to political and commercial dental leaders.

Dental vendors, on the other hand, frequently quote a dental prophet from within the community who uses the product they are promoting and infers that outstanding results can also be achieved by others who choose to use this product. Vendors frequently refer to selected journal articles that reflect favorably on their product, thus further enhancing the "truth."

EBD in Clinical Practice

How does one use an EBD approach to intervention in clinical practice? Simply, one must first and foremost seek the patient's views and wishes regarding treatment. Sometimes this can be a simple question such as "How can I help you?" After all relevant information is collected and a diagnosis formed, it is critical for the clinician to articulate his/her experience and views including a risk/benefit summary and present this in language appropriate for the patient to fully understand. In doing this, it is also important to refer to the best available scientific evidence regarding the intervention(s) being considered, survival data, and the likelihood of failure or complication. If this process is followed, patients are in a better position to make an informed decision regarding the best intervention to meet their needs. While overseeing this process, the practitioner is continuously mindful of the basic underlying tenant to do no harm. Just as it is not appropriate for patients to prescribe their own treatment and have a compliant practitioner deliver such interventions, it is also inappropriate for a practitioner to recommend interventions that are popular or commercially attractive but do not meet the true needs or risk profile of a fully informed patient.

Seeking Truth in the Literature

In assessing the scientific literature, seeking "truth" to support prescribed interventions and thus in some way being responsible for providing a level of predictability for patients to consider, it is important to be mindful of the popularly accepted hierarchy of scientific evidence:

- Systematic review of the literature
- Randomized controlled clinical trials
- Non-randomized controlled clinical trials
- Prospective clinical trials
- Retrospective clinical trials
- Cohort studies
- Case studies

In light of these facts and mindful of the previously stated assertion that few general dentists seek evidence from literature and the reality that best evidence rarely exists, it might be appropriate to define what is understood by the term *best evidence*. Best evidence refers to information obtained from this hierarchy of research evidence and, in the absence of scientific evidence, the consensus opinion of experts in the appropriate fields of research or clinical practice. The strength of the evidence follows the hierarchical order of the studies or opinions mentioned and listed.

Best evidence, a systematic review of retrospective clinical trials, frequently does not exist for us to compare the level of predictability for many interventions both traditional and recent. In the absence of this level of science, predictability for these interventions begins to rely on the valuable role that prophets and vendors play in an informed and scientifically challenging dental community.

In evaluating the scientific literature, it is also important to develop a strategy of critical appraisal to avoid an interpretation that might at times reveal false truths. For example, a recently published survival and complication study[2] concluded that despite high survival rates, 38.7% of the patients with implant-supported fixed dental prostheses had some complications after the 5-year observation period. Does this then translate into a "truth" that almost 40% of implant prostheses encounter complications? Reading beyond the abstract and conclusions, the text can frequently reveal something closer to the truth. Pjetursson et al[2] noted that compared with tooth-supported fixed dental prostheses, the incidence of technical complications was significantly higher for the implant-supported reconstructions. The most frequent technical complications were fractures of the veneer material (ceramic fractures or chipping), abutment or screw loosening, and loss of retention (cement failure). Once analyzed, the "truth" now reveals that so-called complications are largely inconvenience or maintenance requirements.

This brings into sharper focus the concept of maintenance for our prosthetic devices. Do we fabricate maintenance-free prosthetic devices with an expectation of eternal longevity? Do patients have an expectation of maintenance for their prosthesis? Do we inform patients of the need for regular programmed maintenance and replacement? The truth regarding maintenance of prosthetic devices resides in the literature if we read and interpret the data from the perspective of an altered paradigm. We could begin by not reporting an incident of maintenance as a complication.

At times, the introduction of new prosthodontic interventions progresses at such a rate that adequate scientific scrutiny and controlled studies lag behind the clinical evolution. The necessary scientific validation in these circumstances is reduced by necessity to the level of expert opinion. When uncertainty regarding such interventions enters the research community, a scientific convention known as a consensus statement, from recognized experts, is often implemented regarding the issue or intervention. The McGill Consensus Statement on Overdentures is a recent example.[3] Released in May 2002, it stated: "The evidence currently available suggests that the restoration of the edentulous mandible with a conventional denture is no longer the most appropriate first choice prosthodontic treatment. There is now overwhelming evidence that a 2-implant overdenture should become the first choice of treatment for the edentulous mandible." The McGill Consensus Statement on Overdentures was rapidly adapted by prophets into the standard of care for the treatment of the edentulous mandible. Does this mean that:

- The patient who is satisfied with his/her complete denture reconstruction is wrong?
- The patient who receives a complete denture reconstruction is being provided with less than adequate treatment?
- A fixed implant-supported and retained prosthesis is overtreatment even though the patient requested a non-removable prosthesis?

Since the release of this consensus statement it has been widely referenced in the literature and quoted by a great many prophets at dental forums around the world. To the full-time clinician, this statement has caused confusion at best and harm at worst. Confusion amongst clinicians has resulted from the fact that this statement does not reconcile universally with patient needs and wishes and harm from the manner in which third parties have used the statement to question alternative interventions recommended by practitioners.

Another recent systematic review of the literature sought evidence for a superior intervention for the treatment of the edentulous mandible.[4] The purpose of this study was to test the null hypothesis that there is no single standard of care for the edentulous mandible as defined by a specific treatment modality. The literature demonstrates that the functional demands of edentulous patients are highly variable and that patient treatment responses are individual, vary significantly, and are influenced by psychosocial forces. The literature further demonstrates that patient acceptance of specific treatment modalities is modified by social and cultural influences, financial means, and adaptive capacity. Additionally, patient acceptance of a particular

treatment modality is influenced by the educational background, knowledge, and experience of the dental healthcare provider, as well as by a host of other socioeconomic, regional, cultural, age, and gender influences. Within the limits of this review, there was no evidence for a single, universally superior treatment modality for the edentulous mandible. These findings have been supported recently in a publication including several authors of the original McGill Consensus Statement on Overdentures.[5] These outcomes are consistent with the basic principles of an evidence-based approach to seeking an intervention for a specific individual with an edentulous mandible. A consensus statement is a critical direction indicator when confusion surrounds a particular intervention. Any consensus statement requires regular review at defined intervals to maintain relevance with current literature and science.

Standard of Care

This brings into focus the concept of "Standard of Care" that has crept into our scientific literature and common-use professional language with little challenge. The definition for standard of care is twofold: *(1)* a diagnostic and treatment process that a clinician should follow for a certain type of patient, illness, or clinical circumstance, and *(2)* in legal terms, the level at which the average, prudent provider in a given community would practice. It is how similarly qualified practitioners would have managed the patient's care under the same or similar circumstances. The medical malpractice plaintiff must establish the appropriate standard of care and demonstrate that the standard of care has been breached.

Attorneys have been provided with considerable evidence from our own scientific community by publishing a standard of care statement that prescribes a specific intervention for a patient with an edentulous mandible. Attorneys can use the literature as a tool to challenge alternative interventions that have less than desirable patient outcomes. The McGill Consensus Statement failed the primary EBD principle to adequately consider patient choice. Any standard of care statement has the potential to be a hazard to the healthcare profession if it does not fully embrace the basic 3 principles of EBD: patient choice, professional experience, and best evidence.

Searching Further for the Truth

It is possible that a series of assembled micro-truths might achieve something that is not true when challenged. A collection of good scientific articles can collectively come to erroneous conclusions regarding interventions for entire populations. Many authors carefully point out that their deductions apply only to the population studied. The best evidence at the time was assembled and the series of truths once assembled was found when tested not to be necessarily true for the general population. Clinical research outcomes are valid only for the population being studied. A cohort of patients experiencing difficulty wearing conventional complete dentures does not represent an entire population. Quality of life outcomes and patient satisfaction studies are valid only for the interventions compared. Control and study groups rarely represent a random sample of the entire population.

Posts in Endodontically Treated Teeth

The use of posts in the restoration of teeth following endodontic intervention is a topic that is extensively studied yet remains both controversial and confusing from many perspectives. Our teachers and other prophets have propagated many perceived truths regarding the use of posts. Among commonly held beliefs are the notions that posts reinforce teeth, all endodontically treated teeth must be restored with a cemented post, and cast posts are superior to wrought or pre-formed posts. A good starting position would be to scan the literature for evidence of whether a root-filled tooth does require a post. In any search, critical clinical considerations need to be measured regarding the restoration of endodontically treated teeth. It would generally be considered prudent for a clinician to assess the size and position of the defect, assess the likelihood of obtaining a ferrule, and then consider whether the tooth requires a post. Due to pressure from educators, prophets, and vendors, clinicians frequently assume that an endodontically treated tooth must be restored with a post rather than assessing whether it is necessary that a tooth be restored with a post.

Seeking evidence from the literature to resolve whether all endodontically treated teeth require restoration with a post and other related issues can further add to this confusion once critically analyzed:

Heydecke and Peters, in a systematic review of the literature, compared the clinical and in vitro performance of cast posts and cores to that of direct cores with prefabricated posts in single-rooted teeth.[6] The search yielded a total of 1,773 references and after these references were subjected to strict inclusion criteria, 10 in vitro and 6 in vivo studies remained and were critically reviewed. A comparison of fracture loads in the in vitro studies revealed no significant difference between cast and direct posts and cores. An overall survival analysis was not possible for the in vivo studies, but the survival for cast posts and cores in 2 studies ranged from 87.2% to 88.1% and in a third study

reached 86.4% for direct cores after 72 months. Randomized clinical trials on this topic were not available, and since this low-level scientific evidence suggested no difference, are we any closer to knowing what is the truth?

Schwartz and Robbins, in a systematic review of the literature with an emphasis on major decision-making elements in post placement and restoration of endodontically treated teeth, found mounting good evidence that posts are increasingly not required.[7] They found evidence that endodontically treated molar teeth should receive cuspal coverage but in most cases do not require a post provided there is adequate retention for a core buildup. What about the "truth" that all endodontically treated teeth require posts? Once challenged, our "truths" might lack validity.

In an effort to further search for the truth regarding post systems for the restoration of endodontically treated teeth, it is necessary to investigate where new materials fit into the overall post landscape. With all of the claims that are made regarding the relative merits of each post material, what is the truth about which post material is best? The gold standard is claimed to be a cast gold post and core. However, increasingly popular is the wrought post with cast core, wrought post with composite core, titanium post with composite core, zirconia post with cast ceramic core, and zirconia post with direct composite core. So what is the truth?

Fokkinga et al sought to aggregate literature data on in vitro failure loads and failure modes of prefabricated fiber-reinforced composite (FRC) post systems and to compare them to those of prefabricated metal, custom-cast, and ceramic post systems.[8] The literature search revealed 1,984 abstracts. Included were 244, 42, and 12 articles in the first, second, and third selection steps, respectively. Their final conclusion was that FRC post systems more frequently showed favorable failure modes than did metal post systems, so readers hear "truth" that FRC are superior. Once analyzed, FRC posts fail more often and at lower failure loads than conventional cast post cores. Butz et al investigated various post and core material combinations and concluded that survival rates and fracture strengths for zirconia posts with composite cores are significantly lower, so this combination cannot be recommended for clinical use.[9] Heydecke et al published a similar investigation of various post and core materials and concluded that within the limitations of this study, the results suggest that zirconia posts with ceramic cores can be recommended as an alternative to cast posts and cores.[10] If a chairside procedure is preferred, zirconia or titanium posts with composite cores can be used. These 2 studies included 3 common authors and were published a year apart. What is the truth and what is the avid literature follower to believe?

Pontius and Hutter conducted an interesting in vitro study that evaluated the survival rate and fracture resistance of maxillary central incisors restored with different post and core systems.[11] The post and core systems investigated were a prefabricated high precious metal post with cast core (group A), zirconia post with a prefabricated bonded ceramic core (group B), and a resin-ceramic interpenetrating phase composite post (experimental) with a prefabricated bonded ceramic core (group C), as well as an effective control group without coronoradicular reinforcement in which the access cavity was closed with a light-cured composite in combination with a dentin-bonding agent (group D). The results were most interesting, with the reported survival rates after 1,200,000 cycles in the artificial mouth being 90% (group A), 80% (group B), 60% (group C), and 100% (group D). They concluded that the preservation of both internal and external tooth structure is of utmost importance when restoring endodontically treated teeth. Could it also be concluded that there is evidence that posts do not reinforce teeth? Is it further possible from these data to conclude that introducing posts into teeth increases the risk of root fracture? What is the truth? Is it possible that the truth is often buried deep in the detail of the literature?

If we were to review the literature in the context of the evidence-based dentistry model and apply it to a search for the truth regarding the use of posts to restore endodontically treated teeth, it might be possible to summarize the following facts: Posts do not reinforce or strengthen teeth, but rather increase the risk of root fracture. Posts should retain core material and the ferrule (1 to 2 mm) effect is a vital ingredient for long-term survival of any post-retained restoration. Further observations and advice regarding the selection and use of post systems might be: beware of vendors selling new post systems, remember that clinical experience is very important, and read the literature with critical appraisal. The sheer volume of literature easily facilitates selective referencing to support a product or techniques, so don't be the first kid on the block with the new post system.

Guided Bone Regeneration

Guided bone regeneration (GBR) is another intervention that is supported by considerable prophet and vendor opinion and also with a significant volume of scientific publications with conflicting conclusions. There are many prophets within our community who promote techniques, conduct clinics and CE courses, make claims of bone regeneration and retention of autologous graft bone, and also publish case studies that appear to be supportive of their views. Concurrently, vendors are promoting a range of mate-

rials and membranes including such impressive choices as resorbable, non-resorbable, titanium ribs, composite nano-fibers (PCL/$CaCO_3$) and platelet-rich fibrin (PRF). Again clinicians are left with a search for the truth of the best level of evidence in the current literature. It is therefore interesting to note that the recent systematic review by Gielkens et al concluded: "Based on a systematic review of the literature, further evidence is needed to determine whether barrier membranes prevent bone resorption in autologous onlay bone grafts."[12]

Computer-Guided Implant Surgery

Computer guided implant surgery has been promoted by the implant device industry and enthusiastically embraced by the profession. The presumed benefits to patients range from less invasive surgical delivery modes and lower morbidity, to more rapid patient recovery resulting in less disruption to quality of life and more accurate and predictable prosthodontic solutions. A few publications assert that guided surgical options are superior to manual or hand-guided placement of implants.[13] This intervention has its genesis in technological possibilities derived from digital advances in radiology and industrial manufacturing protocols. The profession's leap of faith in embracing this technology has largely been driven by promotion and support by prophets endorsing and showing the beneficial possibilities from computer-guided implant surgery and supporting the claims by vendors. The inevitable question increasingly being asked by discerning surgeons and prosthodontists concerns the accuracy of the various guide systems commercially available. Increasing reliability is placed in these systems where vital anatomical structures and minimum bone volume are involved. A search of the literature has failed to find evidence of validation studies. The "truth" regarding the accuracy, reproducibility, and predictability of this guided surgical protocol currently remains within the scientific hierarchy of prophet and vendor opinion.

Compromise in Pursuit of Truth

In the pursuit of truth for clinical decision-making in practice, it is frequently necessary to adopt a compromise between acceptance of the lowest level of evidence, resulting in the largest body of published material, and the highest level, which for some interventions produces little evidence. Acceptance of this fact does not represent endorsement of lower levels of scientific evidence per se. Rather, it is the practical application of the principles of EBD to permit clinical decisions to be made within the existing knowledge base.

Several definitions have been proposed for evidence-based dentistry. The American Dental Association's remains a practical and workable directive since it describes both what EBD is and what it is not:

Evidence-based dentistry (EBD) is an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences. In adopting this definition for EBD, the American Dental Association recognizes that treatment recommendations should be determined for each patient by his or her dentist, and that patient preferences should be considered in all decisions. Dentist experience and other circumstances, such as patients' characteristics, should also be considered in treatment planning. EBD does not provide a "cookbook" that dentists must follow, nor does it establish a standard of care. The EBD process must not be used to interfere in the dentist/patient relationship, nor is it to be used solely as a cost-containment tool by third-party payers.

The increase in alternative treatment interventions resulting from commercial initiatives has already led to a wide range of choices for clinicians and patients. The volume of literature keeps on increasing while EBD continues to gain impressive traction. The term is certainly in common usage, but consensus on its true value is essential if it is to become the routine tool to assist with clinical judgment, minimize errors in diagnosis, and ensure optimal treatment decisions.

References

1. Richards D (ed). Evidence for up-to-date clinical practice. A review of 10 years of the Cochrane Oral Health Group. Evid Based Dent 2006;7:60–61.
2. Pjetursson BE, Brägger U, Lang NP, Zwahlen M. Comparison of survival and complication rates of tooth-supported fixed dental prostheses (FDPs) and implant-supported FDPs and single crowns (SCs). Clin Oral Implants Res 2007;18 (suppl 3):97–113.
3. Feine JS, Carlsson GE, Awad MA, et al. The McGill consensus statement on overdentures. Int J Prosthodont 2002;15:413–414.
4. Fitzpatrick B. Standard of care for the edentulous mandible: A systematic review. J Prosthet Dent 2006;95:71–78.
5. Thomason JM, Heydecke G, Feine JS, Ellis JS. How do patients perceive the benefit of reconstructive dentistry with regard to oral health-related quality of life and patient satisfaction? A systematic review. Clin Oral Implants Res 2007;18(suppl 3):168188.
6. Heydecke G, Peters MC. The restoration of endodontically treated, single-rooted teeth with cast or direct posts and cores: A systematic review. J Prosthet Dent 2002;87:380–386.
7. Schwartz R, Robbins JW. Post placement and restoration of endodontically treated teeth: A literature review. J Endod 2004;30: 289–301.
8. Fokkinga WA, Kreulen CM, Vallittu PK, Creugers NH. A structured analysis of in vitro failure loads and failure modes of fiber, metal, and ceramic post-and-core systems. Int J Prosthodont 2004;17: 476–482.

9. Butz F, Lennon AM, Heydecke G, Strub JR. Survival rate and fracture strength of endodontically treated maxillary incisors with moderate defects restored with different post-and-core systems: An in vitro study. Int J Prosthodont 2001;14: 58–64.
10. Heydecke G, Butz F, Hussein A, Strub JR. Fracture strength after dynamic loading of endodontically treated teeth restored with different post-and-core systems. J Prosthet Dent 2002;87: 438–445.
11. Pontius O, Hutter JW. Survival rate and fracture strength of incisors restored with different post and core systems and endodontically treated incisors without coronoradicular reinforcement. J Endod 2002;28:710–715.
12. Gielkens PF, Bos RR, Raghoebar GM, Stegenga B. Is there evidence that barrier membranes prevent bone resorption in autologous bone grafts during the healing period? A systematic review. Int J Oral Maxillofac Implants 2007;22:390–398.
13. Brief J, Edinger D, Hassfeld S, Eggers G. Accuracy of image-guided implantology. Clin Oral Implants Res 2005;16:495501.

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