CHAPTER 10

Evidence-Based Medicine Applied to Fixed Prosthodontics

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People who seek help from professionals have a right to expect that formal measures have been taken to assess the relative merits of the various forms of health care on offer, be these, for example, radical surgery or fixed prosthodontics.[1] There is increasingly wide support for the principle of reliable assessment of the effects of health and social interventions on outcomes that matter to the people to whom they are offered. Debate continues, however, about the methods of assessment that should be used in implementing this principle in practice. Different strategies for improving treatment effectiveness and quality have been proposed under different names. "Outcome research", "technology assessment methodology", "quality management and assurance", "clinical guidelines", "parameters of care", "health economy analyses", etc. are familiar terms. Which strategy is selected and, perhaps more important, funded, is influenced by current beliefs and priorities in society. However, a common denominator of the different strategies is the concern about the appropriateness of care, whether on an individual or on a population level. It is in this context that a new strategy for teaching the practice of medicine, named **evidence-based medicine** (EBM), was introduced in 1991 at the McMaster University in Canada.[2]

The rationale for changing the teaching strategy was the assumption that although traditional medical training resulted in a more-or-less thorough understanding of basic mechanisms of disease and pathophysiological principles, this combined with common sense and unsystematic observations from one's own clinical experience did not prepare the physician for assessing and evaluating the new diagnostic tests, treat-

ments and guidelines for clinical practice continuously presented in the scientific literature. Thus, it was assumed that teaching the medical students instead how to critically appraise medical information for its validity and usefulness and incorporate this evidence into one's clinical practice would produce physicians capable of life-long self-directed learning resulting in superior patient care.[5]

Since its introduction, the principles of EBM have been applied in other biomedical areas, and named thereafter. We have journals named evidence-based nursing and evidence-based mental health, textbooks entitled evidence-based health care and evidence-based health promotion, and disciplines termed evidence-based physiotherapy and evidence-based dentistry, etc. Although the proliferation of different terms can be questioned, the main aims remain the same, to identify and apply the current best evidence in making decisions about the care of our patients. This should also be applied to fixed prosthodontics.

Characteristics of Fixed Prosthodontics

Prosthodontics can be defined as: "*The discipline of dentistry concerned with the consequences of congenital absence or acquired loss of oral tissues for appearance, stomatognathic function, comfort, and local and general health of the patient, and with the assessment of whether more good than harm is done by inserting artificial devices made from alloplastic materials to change these conditions*".[3] In fixed prosthodontics, precise and clinically accurate operative techniques based on sound biological and mechanical principles are used to achieve this goal with fixed artificial devices. Advances in the discipline rely on research in multiple technical sciences such as chemistry, physics, biomaterial research etc, since critical decisions made to achieve aesthetic and functional goals must be within the limitations of available restorative materials. The practice of fixed prosthodontics, however, lies in the borderline zone between health, illness and disease, and therefore needs to draw on theories not only from biomedical research, but also from the humanities (psychology, philosophy and ethics), the social sciences (sociology, anthropology) and the organisational sciences. Knowledge is needed about help-seeking behaviour, doctor-patient interaction and clinical decision-making, and the process of quality development, implementation of new skills and technology, cost effective audit and continuing education. Dentists engaged in prosthodontics benefit from training in key theoretical and practical concepts, e.g. communication theories, health beliefs, coping, stress, somatisation, empowerment, health technology assessment, quality development, health economy and priority-setting.

The dentist relies more or less consciously on the knowledge from these disciplines and key concepts when faced with daily obligations to: *1.* identify the individual patient's problems, needs and preferences, *2.* make a thorough examination and correct diagnosis and advocate an optimal therapy based on the treatment outcome and prognosis of the different possibilities, and *3.* discuss the treatment options, of which fixed prosthodontics may be one of several, with the patient, keeping the focus on patient-relevant factors.

We would probably all agree that, if placing ourselves in the patient's place, we whould like to be treated according to the best available scientific evidence on the accuracy and precision of diagnostic tests, the power of prognostic markers and the efficacy and safety of therapeutic, rehabilitative and preventive measures. In addition, we would prefer a clinician who integrates this with thoughtful identification and compassionate consideration of our predicament, rights and preferences in making clinical decisions about our care.[4] Although this has always been the aim of conscientious clinicians, practice according to these principles is hampered by several difficulties. The most fundamental problem is perhaps the lack of training in critical appraisal of new, primarily scientific information among the front-line (bio)medical professions. However, more disturbing is the lack of sound scientific evidence relevant to diagnosis, prognosis and treatment of patients in all areas of medicine[5], including the multidimensional perspectives relevant to fixed prosthodontics .

What is the Basis of Our Knowledge of Fixed Prosthodontics ?

Dental School Training

The production of new medical information has never before been as high, and there is no reason to suppose that it will diminish. An anecdote refers to the dean of a medical school who proclaimed to the new students that 50 per cent of everything they would learn in the next few years would be outdated and wrong by the time they started practising – unfortunately nobody knew which 50 per cent.

In spite of this, most dentists have their greatest theoretical knowledge at the time of graduation. From then on, time to acquire more theoretical knowledge becomes scarce. During dental school training the teaching is focussed on how to execute basic, "safe" clinical procedures, which are not necessarily the most modern ones. Students learn to place conventional dental materials in a variety of situations instead of more lengthy and technique-sensitive procedures for ceramic restorations.[6] Furthermore, many treatment procedures carried out in general practice have not been given

any room in the tightly packed curricula in many dental schools, for various reasons. Examples are membrane augmentation and implant-supported partial dentures. Thus, right from their graduation day, dentists need to improve their technical and theoretical clinical skills. The problem is where to go and how to proceed to obtain the necessary knowledge, and how to allocate limited and precious time to do it.

The Scientific Literature

The scientific literature comprises 20 000 biomedical journals with 2 million papers per year, including 500 dental journals with 50 000 articles per year. Since it is obviously impossible to read, or even scan the abstract of, 140 papers every day, we need to focus on the quality of the information we receive rather than the quantity. Another strategy is to focus on reading the journals that include secondary papers, e.g. Evidence-Based Dentistry, which limits its contents to studies in oral medicine satisfying generally accepted criteria for good scientific quality.

Review papers are by many regarded as helpful guides for their own practice. However, many review papers are heavily author-biased. A review paper must satisfy two basic requirements: the clinical topic being reviewed must be clearly stated and there must be a description of how the evidence on this topic was obtained, from what sources and with which inclusion and exclusion criteria. A check-list for critically assessing a review paper is presented in Table 1. Systematic reviews are reviews carried out and presented according to specific criteria, e.g. described by the international Cochrane Collaboration (http://www.cochrane.dk). At present, very few systematic reviews have been carried out in oral medicine, but this will change in the near future.

Some reviews include data accumulated data from individual studies, which is termed carrying out a meta-analysis. Meta-analyses can be helpful when properly made, but are worthless if inappropriately applied.

Clinical Experience

The fallacy of using an approach to treat patients based on previous clinical experience is summed up by Charles S Greene: "*The expression "it works in my hands" seems to serve as a standard of validity for some people, despite the fact that a positive clinical response may be obtained either because of, in spite of, or irrespective of the treatment rendered*".[7] Apparent success must be evaluated relative to factors such as spontaneous remission, placebo response and multiple variables of treatment: radical versus conservative treatment, over-treatment, long-term failure and side effects and sequelae of treatment. On the other hand, failure can be related to incorrect diagnosis, incorrect cause-effect correlation, multifactorial problems, lack of co-operation, improper

Table 1. Checklist for critical appraisal of review articles (adapted from Sackett et al.[4])

Are the results of the review valid?			
1. Did the review address a clearly focussed issue? *An issue can be focussed in terms of* *- the population studied* *- the intervention given* *- the outcomes considered*	Yes	Can't tell	No
2. Did the authors select the right sort of studies for review? *The right sort of studies would* *- address the review's question* *- have an adequate study design*	Yes	Can't tell	No
3. Do you think the important, relevant studies were included? *look for* *- which bibliographic databases were used* *- check from reference lists* *- personal contact with experts* *- search for unpublished as well as published studies* *- search for non-English language studies*	Yes	Can't tell	No
4. Did the review's authors do enough to assess the quality of the studies included?	Yes	Can't tell	No
5. Were the results similar from study to study? *Consider whether* *- the results of all the studies included are clearly displayed* *- the results of the different studies are similar* *- the reasons for any variations in results are discussed*	Yes	Can't tell	No
What are the results?			
6. What is the overall result of the review? *Consider* *- if you are clear about the review's bottom line results* *what these are (numerically if appropriate)* *what units these results are expressed in*			
7. How precise are the results ? *Are there confidence limits? What are they?*			
Will the results help my patients?			
8. Can the results be applied to my patients? *Do you think that the patients covered by the trial are similar enough to your population?*	Yes	Can't tell	No
9. Were all clinically important outcomes considered? *If not, does this affect the decision?*	Yes	Can't tell,	No
10. Are the benefits worth the harms and costs? *This is unlikely to be addressed by the trial.* *But what do you think?*	Yes	Can't tell	No

execution of treatment, premature evaluation of treatment, limited success of treatment and psychological barriers to success. Unsystematic observations from clinical experience are not a valid way of building and maintaining one's knowledge about patient prognosis, the value of diagnostic tests, and the efficacy of treatment.[5]

Clinical Guidelines, Standard Operating Procedures, Parameters of Care, etc.

Although the development and use of practice-related guidelines as educational aids have a long history in the health professions, scientific assessments indicate that they have limited success in changing daily practice. A major reason is the lack of knowledge needed to develop guidelines that have to be accepted by the profession.[8] A check-list for critically assessing guidelines is presented in Table 2.

Guidelines developed by professional dental organisations specific to oral health are rare, and almost non-existent in the field of prosthodontics. The few existing guidelines have mostly been developed using a consensus approach. A problem when using a consensus approach is that it does not guarantee clinical applicability, reliability and validity.

The Canadian Dental Association's Ad Hoc Committee on Clinical Practice Guidelines is currently developing guidelines in dentistry, but has encountered many setbacks during the work. The British Society for Restorative Dentistry has developed "Guidelines for Crowns and Bridgework" and "A Strategy For Planning Restorative Dental Care" (http://www.derweb.ac.uk/bsrd/index.html). In the USA, the American College of Prosthodontics has formulated the "principles, concepts and practices in prosthodontics", but the speciality does not formally recognise these as guidelines.

Appraisal of the Scientific Basis for Decision-Making in Fixed Prosthodontics

The following elements are involved in the treatment of patients with fixed prosthodontics (Table 3) and can serve as a framework for a critical appraisal of the scientific foundation of the treatment:

I. The patient's problem versus identification of need

- *Patient differences and reasons for variations in perceived problems caused by missing oral tissue*

The everyday-working situation of the dentist is complex, especially when treating patients seeking professional help due to the physical, psychological or social manifes-

tations of missing hard and soft oral tissues. Missing oral tissue per se is not, and seldom leads to, a pathophysiological process. As a consequence, prosthodontics should be regarded as elective and the patient's values and preferences must influence all treatment decisions. Also, because prosthodontics is associated with high costs, economic constraints often influence the treatment decisions. Different aims and study designs can be used to clarify these questions.

The preferred study design is cross-sectional survey or cohort studies. The perceived need for treatment varies among both patients and dentists. Some interesting high-quality studies from Sweden have focussed on the marked variation among

Table 2. Checklist for critical appraisal of clinical practice guidelines (adapted from Sackett et al.[4]).

Are the clinical practice guidelines valid?			
1. Were all important options and issues clearly specified?	Yes	Can't tell	No
2. Was an explicit and sensible process used to identify, select and combine evidence?	Yes	Can't tell	No
3. Was an explicit and sensible process used to consider the relative value of different outcomes?	Yes	Can't tell	No
4. Is the guideline likely to account for important recent developments?	Yes	Can't tell	No
5. Has the guideline been subject to peer review and testing?	Yes	Can't tell	No
What are the recommendations?			
6. Are practical, clinically important recommendations made?	Yes	Can't tell	No
7. How strong are the recommendations ?			
8. What is the impact of uncertainty associated with the evidence and values used in the guidelines?			
Will the recommendations help my patients?			
9. Is the primary objective of the guideline consistent with your objective?	Yes	Can't tell	No
10. Can the recommendations be applied to my patients?	Yes	Can't tell	No

patients'[9], as well as dentists'[10] expectations, values and priorities that definitely influence treatment decisions, therapy, patient compliance, costs, the risk of malpractice suits, etc.

- *Patient education*

The effectiveness of various methods of motivating and educating patients should be addressed, using appropriate study designs. The preferred study design is randomised controlled trials. A disturbing conclusion reported recently is that many strategies for prophylactic activity may perhaps be of limited value for motivating patients to adopt and maintain good oral health.[11]

Table 3. Elements involved in fixed prosthodontics

I. The patient's problem versus identification of need
• Patient differences and reasons for variations in perceived problems caused by missing oral tissue
• Patient education
II. Therapeutic aims
• Criteria used to define need vs. outcome
Morphological, functional, esthetic, psychometric, subjective
How valid and reproducible are these criteria?
Who should define "minimum satisfactorily" outcome criteria?
• Cost-efficiency and -utility versus other treatment alternatives
III. Procedures for producing fixed prostheses
• Diagnostics of the occlusion and quality of abutment teeth
• Technical procedures, and risk for technical and biological complications
The clinic / The laboratory
1. choice of preprosthetic endodontics
2. choice of posts and cores
3. choice of biomaterials
4. adequate tooth preparation (technique)
5. choice of impression (material/technique)
6. choice of die material
7. choice of investment
8. choice of casting
9. choice of interim solution
10. choice of cementation (material/technique)
11. choice of adequate maintenance
IV. Identification of outcome
• To what extent are treatment aims reached
• Adverse reactions, longevity and risk for technical and biological complications

II. Therapeutic aims

• *Criteria used to define need vs. outcome*

The key determinants of need for, as well as assessment of the outcomes of, fixed prosthodontics reflect both patients' – and dentists' concerns:

1. **Physiological impact:** Satisfactory and comfortable mastication, i.e. efficiency, bite force, maintenance of remaining tissues, effect on diet, etc.
2. **Psychological impact:** orofacial body image, perceived quality of life, perceived satisfaction with prostheses, self-esteem and interpersonal relations, etc.
3. **Longevity/survival:** minimal risk of morbidity, provisions for easy and routine patient and dentist maintenance, provisions for planned and unplanned design modifications, time-dependent wear-and-tear concerns in varying and variable intraoral environments that may become increasingly unpredictable in the context of an individual patient's biological and chronological aging, etc.
4. **Economic impact:** Direct cost of treatment, maintenance costs, indirect costs.

Several questions can be raised, and best answered using cross-sectional surveys. The literature describes criteria for evaluating both need for treatment and treatment outcome that can be categorised as morphological, functional, aesthetic, psychometric or patient-subjective criteria. Major questions in this context are how valid and reproducible these criteria are and who should define the "minimum satisfactory" outcome criteria of fixed prosthodontics? Is it the patient, the clinician, society or the insurance companies? As in other areas of medicine, much attention is addressed to patient-selected criteria for treatment success as an adjunct to, or even in contrast to, the professionals' criteria. However, many problems arise because of the previously identified variations in patients' values and priorities. Also, patient satisfaction is the result of many other factors besides the actual care that is given[12], which confounds the interpretation of patient-selected criteria for treatment success. This is partly the reason why there are many objections to the increased emphasis on so-called quality-of-life analyses in medicine and to a limited extent in dentistry.[13]

• *Cost-efficiency and utility versus other health care alternatives*

The preferred study design is randomised controlled trials. Some studies have compared the prognoses of conventional versus other variants of fixed partial dentures, for example, resin-bonded[14] or implant-supported.[15] Problems with such comparisons are differences in study design, the selection of patients and the criteria of treatment success and outcome. On top of this, differences in patients' values and prefer-

Table 4. Specific criteria needed to be completed for studies to be considered as good evidence.

1. Clinical findings 2. Diagnostic tests 3. Differential diagnosis	• clearly identified comparison groups, at least one of which is free from the target disorder or derangement; either an objective diagnostic standard (e.g. machine-produced laboratory result) or a contemporary clinical diagnostic standard with demonstrably reproducible criteria for any objectively interpreted component (e.g. report of better-than-chance agreement among interpreters); • interpretation of the test without knowledge of the diagnostic standard result; • interpretation of the diagnostic standard without knowledge of the test result; • an analysis consistent with the study design; • for pre-test probabilities, also a consecutive series or random sample of patients from a clearly defined setting.
4. Etiology	• clearly identified comparison group for those at risk for, or having, the outcome of interest (whether from randomised, quasi-randomised or non-randomised); • controlled trials; cohort-analytic studies with case-by-case matching or statistical adjustment to create comparable groups; or case-control studies; • masking of observers of outcomes to exposures (this criterion is assumed to be met if the outcome is objective [e.g. all-cause mortality or an objective test]); • observers of exposures masked to outcomes for case-control studies and subjects masked to exposure for all other study designs; • interpretation of the diagnostic standard without knowledge of the test result; • an analysis consistent with the study design.
5. Therapy 7. Prevention 8. Education	• random allocation of the participants to the different interventions; • outcome measures of known or probable clinical importance for at least 80 per cent of participants who entered the investigation; • an analysis consistent with the study design.
6. Prognosis	• an inception cohort of persons, all initially free of the outcome of interest; • follow-up of at least 80 per cent of patients until the occurrence of either a major study endpoint or the end of the study; • an analysis consistent with the study design.

ences confound such analyses, since they will indirectly influence both the choice of treatment and the patient's satisfaction with the treatment.[16]

III. Procedures for producing fixed partial dentures

- *Diagnosis of the occlusion and quality of abutment teeth*

The preferred study design is a cross-sectional study where potential new concepts and procedures for diagnosis must be validated as described in Table 4.

- *Technical procedures, and the risk of technical and biological complications during the treatment process*

The preferred study design is randomised-controlled trials. During the last 15 years numerous new concepts using different dental materials and and/or procedures have been developed and disappeared. It is remarkable that, except for a few products, scientific grounds for advocating these concepts are lacking. Some thirty alternatives to conventional metal-ceramic crowns have been described but very few are supported by sound clinical data. Similar tables can be made for impression materials and procedures, bite registration techniques, gingival retraction management, cements and cementation methods, interim materials, etc., with even fewer references to sound clinical studies. Other reports that embrace other disciplines of dentistry show that even though traditional solutions often work better, many dentists still prefer to use modern and unproven solutions for their patients, e.g. a post and core.[17] The reason for this situation remains uncertain but many have speculated that the lack of training in critical appraisal of information in the dental school curriculum may explain the phenomenon.

IV. Judging the outcome

- *To what extent are treatment objectives achieved?*

The determinants of success of fixed prosthodontic treatment are identical to the determinants of treatment needs, including the validity, reliability and relevance to the patient, the clinician and society. Again, the patient's values and preferences are of prime importance when addressing these issues.[18] The preferred study design is randomised controlled trials or longitudinal cohort studies, but some problems may also best be elucidated using cross-sectional data. Several meta-analyses show marked variations of prognosis due to differences in patients, materials and operators for conventional tooth-supported fixed partial dentures[19,20], veneers[21] and implant-tooth-based FPDs or implant-based single crowns.[22]

- *Adverse reactions, longevity and risk of technical and biological complications*

The preferred study design is randomised controlled trials or longitudinal cohort studies, but hypotheses can also be developed from data recorded in cohort and case-series and case-controlled studies.

EBM Applied to Fixed Prosthodontics

Application of EBM to fixed prosthodontics is done by conscientiously asking oneself the following questions in actual clinical situations when a need for information arises before making a clinical decision:[2]

1. How can I convert information needs into answerable questions?
2. How can I track down, with maximum efficiency, the best evidence with which to answer them (whether from the clinical examination, the diagnostic results, the published literature, or other sources)?
3. How can I critically appraise the evidence for its validity (closeness to the truth) and usefulness (clinical applicability)?
4. How can I apply the results of this appraisal in this particular clinical situation?

Integration of these questions with the individual elements that form treatment decisions for individual patients is one way of describing the practice of EBM (Fig. 1). It is apparent that EBM is not a type of cookbook medicine, but rather a strategy for integrating the best available external evidence from systematic research with individual clinical expertise. EBM is a strategy for coping with new information; it is not about knowing all the answers. Thus, it is not so much about what you have read in the past, but about how you go about identifying and meeting your ongoing learning needs and applying your new knowledge appropriately and consistently in new clinical situations.

Consider the following patient situation:

> *Eva Karlsson is a 45-year-old woman who has had all her amalgam restorations removed and replaced these with non-metal materials. She now wants a fixed partial denture to close a space and would like your opinion on the benefits and disadvantages of choosing a non-metal appliance (which she intuitively would prefer, but knows nothing about).*

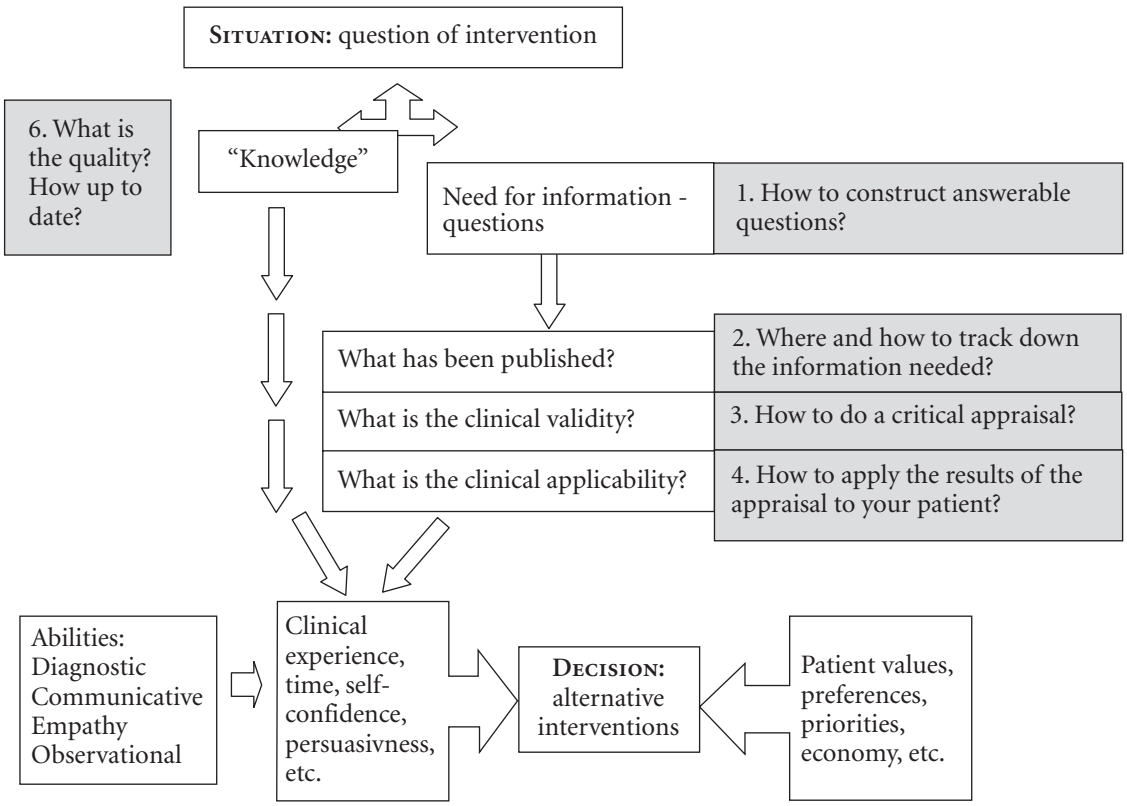

Fig 1. The elements of EBM applied to the daily work situation as clinicians.

1. Posing answerable questions

Well-formulated clinical questions should be directly relevant to the problem at hand and phrased to facilitate searching the literature for a precise answer. To achieve these aims, the questions must be focused and well articulated and cover the following issues:

1. **The patient or problem being addressed:** How would I describe a group of patients similar to mine?
2. **The intervention or exposure being considered:** Which main intervention, prognostic factor or exposure am I considering?
3. **Comparison of the intervention or exposure with alternatives,** when relevant: What is the main alternative to compare with the intervention?
4. **The clinical outcome:** What can I hope to accomplish, measure, improve or affect?

Applying these questions to our example needs perhaps some clarification from the patient regarding her values and priorities – does she emphasise concern about, for example, the aesthetics, prognosis or potential adverse effects of metal-ceramic fixed dentures? Let us assume that the primary concern for this particular patient is the longevity. Thus, our clinical questions could be formulated as follows: In adult patients, what is the longevity of full-ceramic fixed partial dentures compared to metal-ceramic appliances?

Two further questions can be posed, which will apply directly to **the type of research being most relevant:** what type of clinical problem am I faced with and what would be the best study design in order to obtain the information needed (Table 4)?
Since this is a question of the outcome of a therapy, the best evidence for effectiveness is observations made in randomised controlled trials.

2. Tracking down evidence

Advances in computer technology have improved the possibility of effectively tracking down the evidence from the rapidly growing body of medical information. Due to ease of access, Internet has become the highway to information abou just about anything, including oral health. Internet search robots, e.g. Altavista, Excite, Infoseek, Lycos, Medcrawler, Netscape, Snap, etc., facilitate the search and can produce large numbers of references. Unfortunately, it takes time and energy to sort out important information, time which most people don't have. Another strategy is therefore to link up to medical search engines or large dental sites, which presumably have such information sorted out by the use of different "quality criteria".

The greatest value of using the Internet is the possibility to gain direct access to

large encyclopaedias and databases of scientific literature, material properties, toxicology etc. Perhaps the most important information can be located in Medline; the bibliographic database administrated by the US National Library of Medicine, NLM. (http://www.nlm.nih.gov/databases/freemedl.html). Use of the Medline is free, and can easily be done without much prior experience by using the two searching softwares offered by NLM, Pubmed and Internet Grateful Med.

Our search in the Medline database resulted in finding 5865 papers focussed on fixed partial dentures and 7778 on ceramics. Combining these two search terms and limiting the search to randomised controlled trials reduced the number of papers to 3, of which only one was relevant for us. By also including controlled trials, the number of studies increased to 12. In addition, a search for potentially interesting reviews on the topic resulted in 17 papers. In this particular search, the software Ovid was used (http://gateway.ovid.com). However, about identical numbers would be located if Pubmed or Internet Grateful Med had been used.

3. Critical appraisal of information

Most dentists are aware that progress is based upon scientific research. Even "instants of perception" must be backed up by tedious research in order to persuade colleagues, third party payers and patients of hypothetical relationships. There are no laws against constructing hypotheses, even when unscientifically founded, which signifies that a hypothesis is worth just as much as the relevance and validity of the science upon which it is based. The difficult part is to validate a hypothesis, which in modern medicine is preferably done by carrying out research using accepted scientific standards. Unless these standards are adhered to, studies may mislead instead of elucidating improved health care.[23]

Research studies focused on fixed prosthodontics can be categorised as laboratory (or in-vitro) studies or as clinical (or in-vivo) studies. Clinical studies can be subdivided using different criteria, e.g. using the time aspect, i.e. retrospective or prospective, the data collection process, i.e. cross-sectional or longitudinal, or the characteristics of the study, i.e. observational or experimental.

The clinical relevance of any type of study is only one of the factors to be considered. The other crucial question is how sure can we be that the study describes the truth? Scientific standards set rigorous rules for how the study is carried out – the internal validity – as well as to what extent conclusions can be drawn from the findings, depending on the study design – the external validity. Certain minimum criteria need

Table 5. Type and strength of evidence of treatment effects

US Agency of Health Care Policy & Research 1992	EBM Working Group, McMaster University 1993	Richards & Lawrence, Br Dent J 1995;175:270	Sackett et al., Editorial. EBM 1995;1:4	CEBM Oxford, 1998 http://cebm.jr2.ox.ac.uk/docs/levels.html
Ia. Meta-analysis of randomised controlled trials Ib. At least one randomised controlled trial	Systematic reviews and meta-analyses	At least one published systematic review of multiple well designed randomised controlled trials	(I-1) Based on 2 or better designed randomised controlled trials (RCT), meta-analyses, or systematic reviews. (I-2) Based on a RCT	1a. Systematic review (with homogeneity of RCTs 1b. Individual RCT (with narrow confidence interval) 1c. All or none
IIa. At least one well-designed controlled study without randomisation IIb. At least one other quasi-experimental study	RCT with definite results (i.e. result with CI that do not overlap the threshold clinically significant effect)	At least one published properly designed randomised controlled trial of appropriate size and in an appropriate clinical setting	(II-1) Based on a cohort study. (II-2) Based on a case controlled study. (II-3) Based on a dramatic uncontrolled experiment.	2a. Systematic review (with homogeneity) of cohort studies 2b. Individual cohort study (including low quality RCT; e.g., <80% follow-up) 2c. "Outcome" research
III. Well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case-control studies.	RCT with non-definite results (i.e. a point estimate that suggests a clinically significant effect, but with CI overlapping the threshold for this effect)	Published well-designed trials without randomisation, single group pre-post, cohort, time series or matched case controlled studies	(III) respected authorities, expert committees (consensus)etc.	3a. Systematic review (with homogeneity) of case-control studies 3b. Individual case-control study
IV. Expert committee reports or opinions and/or clinical experience of respected authorities	Cohort studies	Well-designed experimental studies from more than one centre or research group		4. Case-series (and poor quality cohort and case-control studies)
	Case-control studies			
	Cross sectional studies	Opinions of respected authorities based on clinical evidence, descriptive studies or reports of expert consensus committees	(IV) ...someone once told me	5. Expert opinion without explicit critical appraisal, or based on physiology, bench research or "first principles"
	Case reports			

Table 6. Checklist for critical appraisal of papers reporting interventions – e.g. therapy, prevention or aetiology. (adapted from Sackett et al.[4])

Are the results of the trial valid?			
1. Did the trial address a clearly focussed issue? *An issue can be focused in terms of* *- the population studied* *-the intervention* *-the outcome considered*	Yes	Can't tell	No
2. Was the assignment of patients to the intervention randomised?	Yes	Can't tell	No
3. Were all the patients who entered the trial properly accounted for at its conclusion? *- was follow-up complete?* *- were patients analysed in the groups to which they were randomised?*	Yes	Can't tell	No
4. Were patients, health workers and study study personnel blind to the intervention? *patients? health workers? study personnel?*	Yes	Can't tell	No
5. Were the groups similar at the start of the trial? *In terms of other factors that might affect the outcome such as age, sex and social class*	Yes	Can't tell	No
6. Aside from the experimental intervention were the groups treated equally?	Yes	Can't tell	No
What are the results?			
7. How large was the effect of the intervention? *Which outcome was measured?*			
8. How precise was the estimate of the effect of intervention? *What were the confidence limits?*			
Will the results help my patients?			
9. Can the results he applied to my patients? *Do you think that the patients covered by the trial are similar enough to your population?*	Yes	Can't tell	No
10. Were all clinically important outcomes considered? *If not, does this affect the decision?*	Yes	Can't tell	No
11. Are the benefits worth the harms and costs? *This is unlikely to be addressed by the trial but what do you think?*	Yes	Can't tell	No

to be met in order that study findings can be regarded as good evidence of effectiveness. Some types of clinical questions are best answered by using specific study designs and vice versa (http://cebm.jr2.ox.ac.uk/docs/levels.html). Although there is no exact consensus on what constitutes good and bad evidence, the grading of evidence from different types of studies is almost identical, e.g. for therapy (Table 5).

Critical appraisal of scientific papers can be carried out using different strategies. One common method is to use check-lists when reading papers. Check-lists with varying degrees of details can be found in various textbooks. An example of a condensed check-list for assessing papers focussed on therapy, prevention and aetiology is shown in Table 6. Similar check-lists have been made for studies on diagnostic tests, decision analyses, economic analyses, harm, etc. Textbooks in statistics and in analytical epidemiology should be consulted to learn critical appraisal[2,24] or correct reporting[25] of findings from one's own clinical practice.

Our search resulted in no clinical studies where the patients had been randomised with regard to choice of metal-ceramic versus full-ceramic constructions. We therefore proceeded to appraise the controlled clinical studies in accordance with the list in Table 6. Thus, in this particular search we need to extrapolate findings from other studies, which should meet the criteria listed in Tables 4 and 6. The fewer criteria the studies satisfy, the poorer the chances are that the findings in the study will be valid and reliable. Furthermore, no systematic reviews were identified. Among the review papers, two looked interesting enough to read, and were appraised according to the criteria in Table 1. The studies identified described 1, 3 and 5 years of observation of fixed partial dentures made from In-Ceram, Procera and Empress.

4. Applying the new information in treatment

After describing your findings to the patient and discussing the limitations of the findings due to the study design, you agree that a metal-ceramic restoration is the best solution for her. Alternatively, you and the patient agree to find the latest information about metal intolerance, risk of material-related adverse effects, etc. using other criteria for selection of valid and reliable studies with optimal study designs.

Concluding Remarks

Our clinical practice should be evidence-based in order to give the best and most up-to-date care possible. This can be accomplished by routinely asking ourselves the following questions, and conscientiously applying the answers: Do I usually

1 identify and give priority to the clinical, psychological, social and other problem(s), taking into account the patient's perspective?
2 perform sufficiently competent and complete examinations to establish the likelihood of competing diagnoses?
3 consider additional problems and risk factors that may need opportunistic attention?
4 when necessary, seek evidence (from systematic reviews, guidelines, clinical trials, and other sources) pertaining to problems?
5 assess and take into account the completeness, quality, and strength of the evidence?
6 apply valid and relevant evidence to a particular set of problems in a way that is both scientifically justified and intuitively sensible?
7 present the pros and cons of different options to the patient in a way he can understand and incorporate the patient's priorities and values into the final recommendation?

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