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Evidence-Based Treatment Planning: Assessment of Risk, Prognosis, and Expected Treatment Outcomes

CHAPTER OUTLINE

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The intent of this chapter is to frame the context for decision making in dentistry. We begin with a perspective on how dental treatment planning decisions have typically been made in the past and a discussion of the apparent limitations of that process. Recognizing that there is often inadequate knowledge at both the professional level and the patient-specific level upon which to base our treatment decisions, there is a call for sound clinical investigations to support clinical decision making. The emergence of **evidence-based dentistry** has significant implications for both the dental treatment planning process for individual patients and the design of parameters for decision making in the profession of dentistry. The importance of evidence-based dentistry is reinforced throughout this book in the *What's the Evidence?* boxes.

Health promotion and disease prevention have become a focus of all the health sciences. Programs and practices put into place to promote these goals should be evidence based and should also include a careful assessment of **disease risk** and **treatment outcomes**. An analysis of both disease prognosis and treatment **prognosis** is also integral to this process. These three concepts—risk assessment, outcomes assessment, and prognosis determination—will all be defined and described, and their relevance to dental treatment planning will be discussed. The findings from research in these areas can be expected to both improve future dental treatment planning and have a positive impact on the oral health of

patients. In the meantime, however, the concepts themselves offer the practicing dentist a systematic way to organize the process of assessing clinical problems and solutions. In addition, these concepts will provide a useful framework for presenting and discussing treatment options with the patient. In summary then, the purposes of this chapter are: to discuss the kinds of information necessary to help patients make informed decisions, to review some related areas of dentistry in which progress has been made, and to provide a template for dentist and patient decision making as more information becomes available. This chapter provides the foundation for the detailed process of treatment planning, which is delineated in Chapter 3 and then applied repeatedly throughout the subsequent chapters of this textbook.

TRADITIONAL MODEL FOR DENTAL TREATMENT PLANNING

Traditionally, dental students have been taught that creating a treatment plan for a patient incorporates a stepwise process: first, a thorough evaluation of the patient is conducted; then a diagnosis or problem list is developed; and finally, a plan for a series of treatments is constructed. Certainly this model has merit. Its rationale and virtues are discussed at length in other chapters, and it is the basis for the treatment planning process described throughout this text. But the model has shortcomings. One fundamental problem is how little the model has been implemented by practicing dentists. A second concern relates to the realization that the model is too simple and must be broadened to meet the diverse needs of patients and the profession.

As the dentist plans treatment for his or her patients, the traditional stepwise model may not be followed. Instead, a tooth condition or problem is evaluated and the dentist makes an immediate recommendation to the patient about what should be done to solve the problem.¹ This is certainly an efficient way for the practitioner to gain a measure of consent from the patient to begin treatment. In this scenario, however, a clearly articulated diagnosis is often *not* made, and even in those cases in which the dentist makes a mental judgment about the rationale for treatment, the diagnosis may not be explicitly *stated* to the patient. Thus the patient remains relatively uninformed about the nature of the problem and the rationale for a particular treatment.

It is also unlikely in this situation that the patient will be presented with *options* from which the best treatment (for the patient) can be selected. Even when options are presented, the offerings tend to be perfunctory, with the patient given minimal information from which to

make a well-reasoned, thoughtful decision. Given the time pressures of a daily dental practice, these omissions can evolve to become the routine rather than the exception. The patient, who remains uninformed about diagnoses and treatment options, however, is ill prepared to provide **informed consent** for treatment. Obviously, this can be both unwise and hazardous from a risk management perspective (see Chapter 4). The need to achieve fully informed consent is a central theme of this chapter and this text.

The second significant problem points to a deficiency not of application, but rather with the *scope* of the traditional stepwise model. Although when used to its fullest, the model helps ensure that the dentist considers—and the patient is informed about—all diagnoses and treatment options, the model does not include the potential or capability for any *weighting* of the relative benefits of the various treatment options. To accomplish this weighting and to provide a rational comparison of the options, more information is needed by the dentist.

Few dentists have difficulty making treatment recommendations for their patients. Typically, those recommendations are based on what the dentist learned in dental school and what he or she has gleaned from continuing education activities, reading dental journals, and discussions with peers. In addition, the dentist may be exposed to other, less objective, and often empirical sources of information. For instance, product salespersons or dental supply representatives who are selling products or promoting techniques may not have valid supporting evidence for the rationale and efficacy of their products. For many dentists, the most important basis on which they make their treatment planning recommendations is their own personal experience with a specific approach or technique.² The wise dentist will recognize the limitations and hazards of this approach. In the absence of scientific scrutiny, old, sometimes misguided, approaches have been perpetuated, while new and untried (by the practitioner) approaches are rejected out of hand. When the dentist fails to offer and make available a complete range of treatment options to patients, or to accurately characterize the viability of each option, the quality of care provided to patients is diminished.

The reality at this time is that many treatment decisions in dentistry must be made in an environment of uncertainty. Our ability to make an accurate diagnosis, realistically predict outcomes of treatment, and delineate with precision the course of the disease in the presence or the absence of treatment is in many cases limited. That being the case, it behooves the dentist to place the ethical principle of nonmaleficence, or “do no harm,” in a position of preeminence. Stated another way, when the

reasons for intervening are not conclusive or compelling or when the risks of “no treatment” do not have clear and demonstrable significance, then conservative therapy or no therapy should usually be recommended over aggressive therapy. The nature of the disease process certainly has a bearing on this analysis. Where there is diagnostic and/or treatment uncertainty but the disease has significant morbidity or mortality, as with oral cancer, aggressive intervention is generally warranted. On the other hand, when there is similar diagnostic uncertainty (as with incipient dental caries in a patient at low risk for new caries), and the short-term probability of negative sequelae (fracture, pulpal disease, or periapical disease) is low, then intervening slowly and conservatively is more professionally reasonable.

PROFESSIONAL DIVERSITY AND DISAGREEMENT IN TREATMENT PLANNING

It has been well established that dentists frequently differ with one another on plans for treatment.^{2,3} When several dentists examine the same patient under the same conditions, they often disagree about the substance of the plan and on which teeth and surfaces need to be restored. Arguably, this is not *necessarily* a problem. If different practitioners could demonstrate with comparable positive outcomes measures that their individual plans were equally effective, there would be no reason for concern. But this optimistic scenario is unlikely. Presumably, one treatment plan would be found to have a better outcome than the others if all could be followed over an extended period of time. In reality, several plans may yield acceptable results, while a few plans would definitely be inferior or incorrect. The appropriate goal then should be to identify the *inappropriate* plans. Before discussing ways to achieve this goal, the reader should have a clear understanding of why clinicians disagree.

Why Dentists Disagree in Treatment Planning

Disagreement Over the Diagnosis Dentists may disagree about diagnoses for a patient. These differences sometimes exist at the professional level. For example, historically, there has been significant disagreement among dentists as to how temporomandibular disorders (TMDs) should be assessed, diagnosed, and managed. Differences can exist on a patient level. Unfortunately, some dentists have underdiagnosed the occurrence of periodontal disease in their patients—which has in some instances become the cause for malpractice litigation. Differences can also exist at a patient-, tooth-, or surface-

specific level.^{2,4} Different practitioners examining the same patients frequently differ in their diagnoses regarding caries and restoration defects. There are multiple reasons for these differences—the information base collected by each dentist may differ; the interpretations may differ; and the diagnostic options considered by each dentist also may differ.

Even with conditions as pervasive as dental caries, our diagnostic tests are imperfect. Bader and Shugars in their systematic review of dental caries detection methods found a mean sensitivity of 59 and a mean specificity of 72 for visual detection of occlusal carious lesions irrespective of lesion size; a mean sensitivity of 39 and a mean specificity of 94 for visual-tactile detection of occlusal carious lesions irrespective of lesion size; and a mean sensitivity of 50 and a mean specificity of 87 for radiographic detection of proximal carious lesions irrespective of lesion size.⁵ Newer diagnostic techniques can improve those numbers, but may still have notable error rates. In one study of the detection of occlusal carious lesions, the laser fluorescent measuring device (Diagnodent) yielded improved sensitivity (94%) but lower specificity (82%) when compared with expert examiners using conventional diagnostic techniques.⁶ Statistical measures of diagnostic accuracy (e.g., sensitivity/specificity ratio; percent of false positives) are also not ideal for commonly used clinical and radiographic caries detection methods. False-positive diagnoses for caries are particularly troubling as they may lead to unnecessary treatment of the patient.

Regardless of the reasons, however, if dentists cannot agree on the diagnosis for a patient, then inevitably consensus concerning the best treatment option or recommendation will not be possible.

Lack of Risk Assessment If accurate disease- and patient-specific risk assessment either is not available or is not used by the dentist, treatment plans that take risk factors or indicators into account will not be developed and as a result may vary widely among dentists. Failure to properly assess a patient’s risk for caries, for example, can lead to improper treatment recommendations, restorative overtreatment, or failure to control the *Streptococcus mutans* infection.

Uncertainty About Prognosis Prognosis is the forecast of the probable course or outcome of a disease; or a prediction of the probability of success of a treatment. In the absence of accurate patient-, disease-, tooth-, and treatment-specific prognoses, treatment planning depends on individual clinical experience, and the benchmark for success becomes “what works in my hands.” Unfortunately, this is an unstable base on which to

attempt to build consensus on treatment planning. The lack of evidence-based prognosis determination leads to errors in planning for the individual patient and impairs professionwide attempts to establish treatment parameters.

Limited Use of Outcomes Measures Outcomes measures provide a quantifiable and standardized method for comparing treatments. This is especially helpful in relation to oral conditions, such as TMDs for which there have historically been many different and sometimes conflicting treatment modalities. Unfortunately, for many dental procedures, outcomes data are not available. Even when available, however, many practitioners do not choose to make use of them. In either case, dentists have no dependable method of predicting which treatment is most reliable and likely to function the longest. Attempts to develop professionwide treatment parameters have been slow to emerge. As a result, the individual dentist is placed in the uncomfortable position of making judgments based primarily on empirical wisdom drawn from what has worked best in the past in his or her own practice.

Dentists' Varying Interpretations of Patient Expectations It has been confirmed that when several dentists each independently examine the same patient under controlled conditions, each may interpret findings and the patient's wishes regarding treatment differently.⁷ There are probably several plausible explanations for why this variability occurs. The dentist may be making assumptions about the patient's desires and listening selectively, or the dentist may have a preconceived idea about what the ideal treatment should be and then may present that plan in a more favorable light.

The Need for More and Better Information on Which to Base Decisions

If the reader accepts the premise that more and better evidence will assist the dentist and patient in making sound treatment decisions, achieving more completely informed consent, and delivering and receiving higher quality care, then the question becomes, "What information is needed to achieve these ends?" A series of parallel questions can be developed that, when addressed, will meet the needs of patients and practitioners. They are framed here from the patient's perspective, but each can also be asked from the perspective of the dentist as the care provider for a specific patient. Each patient then

has the right to ask and deserves to receive answers to questions such as:

- What specific problems do I have? What ill effects can they cause?
- Can the problems be controlled or eliminated?
- What treatment options are available to address these problems?
- What results can I expect from the various possible treatment options?
- What might happen if no treatment is performed?
- What are the advantages and disadvantages of carrying out treatment X? Treatment Y? No treatment?
- Am I at risk for ongoing or new disease?

To answer these questions, information is needed on several levels: the profession, the individual provider, and the patient. In other words, it would be useful to know:

- On a professional level—what is the general success rate for a particular procedure; the populationwide expected longevity of a particular type of treatment or restoration?
- On a provider level—what level of success has the individual dentist experienced with the procedure?
- On a patient level—what is the likely outcome for this procedure when it is implemented on this particular patient?

Unfortunately, these pieces of information are rarely available for any particular treatment option—not to mention for all possible options in a given clinical situation. Thus in many instances, the dentist must recommend treatment based on empirical information and personal experience, and the patient must make a corresponding decision based on that information.

EVIDENCE-BASED DECISION MAKING

The concept of evidence-based decision making is now well established in all of the health sciences. It has been defined as "the integration of best research evidence with clinical expertise and patient values."⁸ In essence, it entails the view that clinical decisions should be based on scientific principles and that treatment regimens must be tried, tested, and proven worthy by accurate, substantiated, and reproducible studies. Ideally, any treatment method, whether in dentistry or medicine, should be supported by controlled, blinded, prospective longitudinal studies. The adjoining *What's the Evidence?* box discusses in some detail how the dental practitioner can locate, evaluate, and derive clinically relevant information from the literature upon which to base appropriate treatment recommendations and plans.

What's the Evidence?

How Do I Find the Best Quality Evidence for Treatment Planning Decisions?

Although the formal concept of evidence-based dentistry and medicine has only appeared in the literature in the past 15 years, an understanding of the importance of basing the practice of clinical medicine and dentistry on research findings dates from at least the early twentieth century.¹ More recently, the concept has been formalized and reemphasized in the work of David Sackett, who has defined evidence-based practice as "... integrating individual clinical expertise with the best available external clinical evidence from systematic research."² Sackett is writing about the practice of medicine, but his views apply equally well to dentistry. In other words, the practice of evidence-based dentistry or medicine means making treatment planning decisions based on a combination of the clinician's expertise, the patient's particular needs, and the best and most relevant published research.

As part of this concept, the importance of systematic reviews as best quality evidence for clinicians has evolved. The authors of such reports critically review the literature on a particular topic. Going beyond the traditional literature review, which often only identifies, describes, and summarizes the literature on a particular topic, the systematic review involves a formal process of assessing the *quality* of research reported in a set of articles; analyzing and synthesizing findings according to specifically defined, predetermined criteria; and then, finally, drawing conclusions for clinical practice based on that careful and systematic assessment.³

Currently, many of the best examples of systematic reviews in dentistry can be found in the Cochrane Library, an on-line catalog of systematic reviews.⁴ Most Cochrane reviews are current and topics are often updated as additional research on the topic becomes available. Although in many countries access to the Cochrane Library is free of charge,⁵ in the United States, complete access to full reviews requires a paid subscription. Free access to detailed abstracts of Cochrane reviews, however, is available at www.cochrane.org/reviews. Cochrane reviews can also be accessed on the website of the American Dental Association (www.ada.org), but ADA membership is required. The ADA website does include useful related resources for which membership is not required, including a detailed definition and discussion of evidence-based dentistry, alerts to recent relevant studies, and links to additional related resources.

(Find evidence-based dentistry at the ADA website under Dental Professionals, click on Professional A-Z Topics.)

Although the number of systematic reviews available on subjects relevant to clinical dentistry can certainly be expected to increase in the coming years, currently such reviews are not available for every clinical question that

may arise. Developing a regular routine for journal reading will be important to the clinician who wishes to provide the best possible care to his or her patients.

Scientific journals are the most important source of current information about clinical care. The judicious reader will select peer-reviewed journals, recognizing that the manuscripts selected for publication in such journals have been reviewed by several experts in the subject area. Although reports of controlled randomized clinical trials provide the most clinically relevant information, such studies are not always available on a topic of interest and less-global reports must be used. Once the desired literature is obtained, it is up to the clinician to critically evaluate the report. It is not always easy to distinguish good from poor research, but given time and experience, practitioners will gain skill in evaluating the evidence.

For the dentist in clinical practice, the most efficient method for finding articles on a specific topic is through PubMed, a free database produced by the National Library of Medicine (NLM).⁶ PubMed draws on the resources of the MEDLINE database, an online index to the world's health sciences journal literature since 1966. Many dental journals, in addition to traditional paper versions, are now also available as online subscriptions. Two relatively new English-language journals focus specifically on evidence-based dentistry—*Evidence-Based Dentistry*, published in Britain,⁷ and the *Journal of Evidence-Based Dental Practice*, published in the U.S.⁸ In the future, such journals may prove to be the most efficient method for the busy practitioner to obtain evidence-based information in dentistry.

Throughout this text you will find *What's the Evidence?* threads. For each question posed, a selected body of literature is listed and discussed briefly. At the time of publication of this text, no systematic reviews had yet been published for most of these topics. Therefore we have critically evaluated the current research to identify the most recent perspectives in response to the *What's The Evidence?* questions. Conclusions drawn from these segments should be regarded as suggestive rather than definitive. Because health care options evolve rapidly, the responsible clinician will recognize the importance of staying informed and will learn how to efficiently access new research information, including systematic reviews, as he or she gains skill in critically evaluating the literature of dental research.

1. Flexner A: Medical education in the United States and Canada; a report to the Carnegie Foundation for the Advancement of Teaching, New York, 1910; and Gies WJ: Dental education in the United States and Canada: a report to the Carnegie Foundation for the Advancement of Teaching, New York, 1926.
2. Sackett DL: Editorial. Evidence based medicine: what it is and what it isn't, Br Med J 312:71-72, 1996. See also

What's the Evidence?

How Do I Find the Best Quality Evidence for Treatment Planning Decisions?—cont'd

- Sackett DL, Straus SE, Richardson WS and others: Evidence-based medicine: how to practice and teach EBM, ed 2, New York, 2000, Churchill Livingstone.
3. Klassen TP, Jadad AR, Moher D: Guides for reading and interpreting systematic reviews: I. Getting started. Arch Pediatr Adolesc Med 152:700-704, 1998. See also Moher D, Cook DJ, Eastwood S and others: Improving the quality of reports of meta-analyses of randomized controlled trials: The QUOROM statement, Lancet 354:1896-1900, 1999.
 4. <http://www.cochrane.org/index0.htm> (accessed 11/12/05).
 5. <http://www.cochrane.org/reviews/index.htm> (accessed 11/12/05).
 6. <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi> (accessed 11/15/05).
 7. <http://www.nature.com/ebd/index.html> (accessed 11/12/05).
 8. <http://www.elsevier.com> (click on the word "Journals" in left margin) (accessed 11/12/05).

The importance of evidence-based decision making is a recurring theme throughout this chapter. Evidence-based dentistry (EBD) has application to treatment planning on several levels. At the most basic level, research can sometimes provide compelling guidance to the patient and practitioner on the treat versus not to treat question. In other situations, for example, when several different viable alternatives are being weighed, it can provide the basis for moving to a specific decision. The application of EBD must be also be tempered by an understanding of its limitations, however. The strength of the evidence needs to be considered as it is factored into the decision making. The stronger the evidence, the more seriously it should be weighed and conversely, the weaker the evidence, the more other factors should drive the decision making.⁹

The growing importance of EBD in contemporary dental treatment planning cannot be overemphasized. Indeed, it can be anticipated that, in the future, all treatment planning will be based on such sound scientific principles and the body of knowledge that emerges to affirm or disavow the efficacy of various dental treatments.

RISK ASSESSMENT

Not all patients are equally likely to develop a particular disease. Some patients, because of heredity, environment, diet, personal habits, systemic health, medications, and other factors, are more likely than others to develop and continue to suffer from certain conditions. Those patients who have that innate predisposition or who engage in behaviors known to promote a particular disease or condition are described as **at risk**. This differs from the epidemiologic definition of "at risk." In epidemiology, anyone who could potentially get the condition is "at risk." Individuals who could not get the condition are

"not at risk." Edentulous patients, for example, would not be at risk for caries development; but everyone who has at least one natural tooth is at risk for caries development. This distinction is important in determining the denominator for incidence and prevalence estimates. But in both realms, clinical and epidemiologic, someone who is more likely to get the condition is "at high risk."

Identifiable conditions that, if present, are known to be associated with a higher probability of the occurrence of the disease are designated as **risk indicators**. **Risk factors** are a subset of risk indicators for which there is a demonstrable causal biologic link between the factor and the disease. Risk factors are best confirmed by **longitudinal studies** during which patients with the hypothesized risk factor are evaluated over sufficient time to determine whether they (the patients) do or do not develop the specific disease or problem in question. Risk indicators may be identified by taking a cross section, or sample, of individuals and looking for instances of the risk indicator and the disease occurring together.¹⁰ Many risk indicators, although not yet confirmed by longitudinal study as risk factors, are useful in dental treatment planning.

Although risk and causality may be linked, they are not the same. Some risk indicators do have a causal relationship with the disease. For example, a diet that is heavily weighted with refined sugars constitutes a risk factor and is also a direct cause of dental caries. Other risk indicators can help identify individuals at risk, but do not themselves *cause* the disease process. For example, adolescents and the elderly are known to be at greater risk than other age groups for developing dental caries, but age *per se* is not a direct cause of the decay in an individual. Similarly, although growing up in an area that does not have fluoridated water represents a risk indicator for dental caries, the lack of fluoridation is not itself a cause of caries. Instead, the lack of exposure to systemic fluorides makes the individual more vulnerable to the com-

bination of multifactorial issues that lead to the caries infection and subsequent demineralization process.

Another categorization that is particularly useful in a dental setting is the differentiation between **mutable** and **immutable risk factors** or risk indicators. Mutable risk indicators (such as diet, oral self care, smoking, poorly contoured restorations) are those that can be changed, and immutable risk indicators (such as age, socioeconomic status, and fluoride history) are those that cannot. The dental team can and should employ any and all reasonable interventions that have the potential to mitigate or eliminate mutable risk indicators. In the case of immutable risk indicators, however, the value of their identification may be limited to risk assessment and prescribing preventive therapy—which can in themselves be useful tools in health promotion and oral disease prevention.

Assessing risk helps the dentist identify which patients are more likely to develop a particular disease or condition or to have recurrence of the disease. Once that identification has been made, the patient can be informed about these risks and, when possible, efforts can be made to eliminate the specific cause or causes of the disease. When successful, such efforts may prevent the disease from occurring or recurring. Elimination of a specific cause or causes of an oral disease early in the progression of the condition can, in some cases, reduce the severity and the duration of the disease. Once the disease is initiated, however, removal of a risk indicator or indicators that are not known causes of the disease may not have any effect on the duration or course of the disease.

To describe the strength of the relationship between risk and disease occurrence, it is often helpful to specify the *degree* of risk with terms like “high,” “moderate,” or “low.” Defining the degree of risk varies with the clinical context or with the parameters of the individual study or protocol. In any setting, it can be assumed that the higher the risk, the more likely the occurrence or recurrence of the disease. It is also noteworthy that the more risk indicators that are present and/or the more serious the risk indicator, the higher the likelihood both that the disease will occur and that it will be severe. For example, in general, the patient who has multiple risk indicators for dental caries (e.g., lack of current fluoride exposure and a cariogenic diet) is more likely to be afflicted by dental caries than a patient with only one or no known risk indicators. Also, as is discussed later in this text, the patient with severe **xerostomia** (dry mouth) is more likely to develop serious dental caries than a patient with a less strong risk indicator, such as a lack of fluoride exposure as a child.

Fully accurate risk assessment in dentistry is still at an elementary stage. To date, some risk indicators have

been identified for caries, periodontal disease, TMDs, tooth loss, oral cancer, and a few other conditions (see Suggested Readings). Even for these conditions, however, agreement on the relative importance of the risk indicators and the impact they should have on dental treatment and dental treatment planning is still limited. More research is needed in this area.

A related topic that also needs more investigation is a better understanding of the natural history of specific oral diseases. The term **natural history** refers to the predictable progression of the disease from its inception; through its maturation, including periods of exacerbation and remission; and culminating in various possible outcomes in the absence of treatment. Such an understanding would help us to go beyond our ability to assess whether a condition is likely to occur and (to a lesser extent) predict the severity of occurrence, and help us to better understand the risk, or probability and magnitude of negative sequelae if the disease is left *untreated*. This information can be useful not only in determining the relative value of various treatment interventions to an individual patient (compared with no treatment), but also in developing public health policy when there are limited resources and those resources need to be used where the interventions will be most useful and effective.

Risk Assessment and Dental Treatment Planning

Five categories of conditions or behaviors that may be risk indicators for oral disease can be described and are discussed in the following sections. It must be noted that, although the categories and their relevance to treatment planning are presented here as distinct entities, many potential risk indicators do not fit neatly into only one category, but may appropriately be placed in two or more.

Heritable Conditions Heritable conditions include the genetic predisposition for specific tooth abnormalities, such as amelogenesis imperfecta; dentinogenesis imperfecta; dentinal dysplasia; or extradental abnormalities, such as epidermolysis bullosa, a palatal cleft, or a skeletal malocclusion (Figure 2-1). The presence of a genetic marker for any hereditary or developmental oral abnormality would certainly be an indicator of risk. Knowledge of such risk indicators can be useful to the dentist and patient in the following ways:

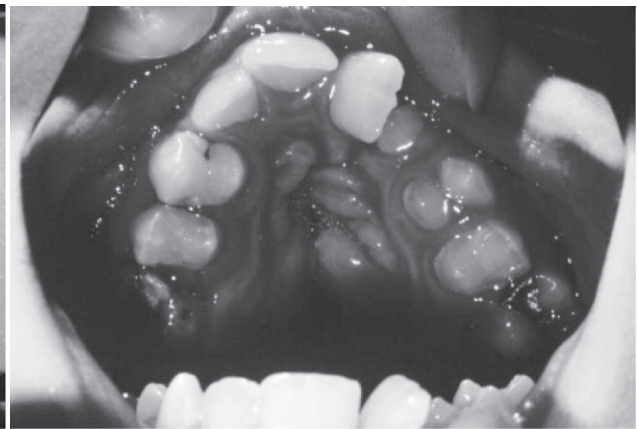
- **Genetic counseling:** The dentist plays a role in identifying oral conditions and anomalies that may be heritable. When such conditions are recognized, the patient as a potential parent can be encouraged to seek genetic counseling. Also, parents who have had one child with a genetic disorder will be very



A



B



C

Figure 2-1 A-C, Cleft palate: An example of an oral developmental abnormality. (Courtesy Dr. R. Strauss.)

interested in the probability that other progeny will be similarly affected.

- **Patient education:** With awareness that a patient is at risk for developing an oral disease, it becomes part of the dentist's role to educate the patient about the true cause of that process. Some patients may mistakenly think that the heritable condition is caused by factors that *are* in their control, and they will go to unusual lengths in a misguided and sometimes harmful effort to control the disease. Taking antibiotics to control the "infection" associated with a normally erupting tooth is one such example. Conversely, some patients assume that some conditions like "soft teeth" are totally controlled by "genes" and that they can do nothing to prevent caries. Educating patients about the true causes of caries infection can be helpful in leading to effective means of controlling the disease and in giving the patient a clear sense that his or her condition is not hopeless.
- **Disease prevention:** If a family history of a heritable oral condition is known, it may be possible for measures to be taken to prevent or at least mitigate the occurrence of the disease in susceptible individuals. Eliminating other risk factors and/or known causes of the disease would be one such strategy.
- **Early recognition:** With awareness that a patient is at risk for a heritable oral condition, the dentist and patient can carefully monitor for any early signs or symptoms of change. Through such efforts, laboratory tests or other confirmatory information can be obtained at an early point and a timely diagnosis made.
- **Early intervention:** Early intervention by the dentist may be effective in preventing full manifestation of the inherited condition and in reducing morbidity. Intensity and/or the longevity of the outbreak may be decreased and recurrence prevented. Aggressive (early onset) periodontitis is an example of a

sometimes heritable oral disease that, if treated early, has a much improved prognosis.

Systemic Disease as a Risk Indicator for Oral or General Health Problems

Systemic diseases such as diabetes can be risk factors, predisposing the patient to significant oral problems—such as oral ulceration, stomatitis, infection, and poor wound healing. Certainly the poorly controlled diabetic patient is more likely to have periodontitis. Patients with gastroesophageal reflux disease (GERD) or those who are afflicted with bulimia are much more likely to have dental erosion. There is significant evidence that suggests that periodontal disease and atherosclerotic vascular disease are interrelated.¹¹ The medications or treatments used to control systemic disease (e.g., radiation therapy for head and neck cancer) can have a devastating impact on the oral cavity. In addition, the systemic disease or its treatment may leave the patient at increased risk for a medical emergency while undergoing dental treatment. If the patient has a systemic disease, the dentist needs to be aware of any related risks for oral disorders, the possible need for antibiotic premedication, the advisability of modifying or postponing dental treatment, and the need to be prepared for an emergency in the dental office.

Dietary and Other Behavioral Risk Indicators

If the patient's diet, behavior, or habits contribute to an increased risk for the development of oral disease, then it is appropriate for the dentist to educate the patient and to encourage modification or elimination of that behavior. Use of tobacco products, excessive alcohol consumption, oral use of cocaine or methamphetamines, or frequent ingestion of cariogenic foods and beverages are examples. On occasion, seemingly beneficial habits, such as frequent use of mouthrinses, can be detrimental—especially if the mouthrinse has a low pH and/or contains a high percentage of alcohol. As a health care professional, the dentist has the responsibility to inform the patient of the possible negative consequences of continuance and to remain vigilant for the occurrence of signs suggestive of pathologic developments, such as oral cancer or dental erosion. An example of a behavioral problem that is linked to an oral pathologic condition is the patient with obsessive compulsive disorder who is prone to develop severe dental abrasion and other traumatic or factitious injuries.

Risk Indicators Related to Stress, Anxiety, and the Environment

Patients can be at risk for many forms of oral pathologic conditions because of severe life stresses or other environmental influences. Erosive lichen planus is an example of an oral condition for which stress

is a strong risk factor. Food service workers, who have constant and unlimited access to sweetened and carbonated beverages, are at increased risk for dental caries and dental erosion. Frequent swimming in pools with poorly regulated chlorine levels can cause significant dental erosion in susceptible individuals.¹² An all too common problem is the patient whose anxiety about going to the dentist leads to avoidance of needed treatment. As discussed in Chapter 13, the implications for the anxious patient of the development of oral problems and the potential impact on the way dental treatment will be planned and carried out can be enormous. The dentist has the obligation to identify these risk indicators, to inform the patient of their deleterious potential, and to mitigate them whenever possible.

Functional or Trauma-Related Conditions

Functional or trauma-related conditions also incur risk. For example, the patient who bruxes and who has fractured teeth in the past should be assessed for current and future risk of the problem's recurrence. If the patient continues to be at risk, then appropriate reconstructive and/or preventive measures should be considered. For the patient with severe attrition, large existing amalgam restorations, and a history of fractured teeth, sound recommendations may be crowns and an occlusal guard. If new restorations are warranted, but the patient cannot afford crowns, using a protective cusp design rather than a conventional preparation design for **direct fill restorations** may be a reasonable alternative.

Previous Disease Experience

Previous disease experience can be a strong predictor of future disease. For many oral conditions—including dental caries, periodontal disease, oral cancer, and tooth fracture—if the patient has experienced the problem in the past, the probability is greater that the same problem will arise again in the future.^{13,14}

To summarize, risk assessment can be a useful adjunct to the dental treatment planning process in the following ways:

- By identifying the need for counseling the patient, spouse, or offspring about heritable oral conditions and diseases
- By eliminating recognized causes of oral disease when the patient is known to be at risk
- By initiating preventive measures to forestall the occurrence of oral disease when potential causes of oral disease cannot be eliminated
- By providing prophylactic behavioral, chemotherapeutic, and restorative intervention to prevent an undesirable outcome

- By providing early restorative intervention in situations in which delayed treatment would put the patient at risk for requiring more comprehensive treatment in the future

In theory, with a complete understanding of the patient's risk for oral disease, any oral abnormality for any patient could be prevented or managed more effectively. In clinical practice, this is not feasible or practical. Time would not permit so exhaustive a review for each patient, and our present scientific base is insufficient to support such an undertaking. Nevertheless, assessing risk provides a valuable resource in treatment planning. Table 2-1 lists risk indicators for selected oral conditions in which risk assessment should be critically linked to shaping the patient's plan of care. Although the list is not comprehensive, it is representative and can serve as a model for analyzing other issues.

Caries Risk Assessment

Dental caries is one oral health problem for which there has been a significant attempt to assess risk and identify risk indicators and risk factors. Progress has been made, but even so, caries risk assessment instruments have yet to be validated and generally accepted. Risk indicators have been identified and confirmed for populations, but conclusive confirmation of an individual patient's caries risk status remains problematic. Previous and current caries experience is the single most powerful indicator of caries risk.¹⁵ Other less powerful predictors of future caries include

quality of oral self care and plaque control, cariogenic diet, diminished salivary flow, and high concentrations of cariogenic microflora.¹⁶ Even though the scientific basis for caries risk assessment has not been firmly established, dental colleges, public health organizations, insurance carriers, and more recently private corporations (see PreVisor Health Information Suite) have attempted to develop risk assessment instruments. The University of Connecticut instrument (Figure 2-2) is one such example.

Occurrence of root caries has some similar features and some dissimilar characteristics when compared with pit and fissure, and smooth surface dental caries. Aside from obvious location differences, the recognition and diagnosis, the causative microbes, the natural history, and the treatment strategies may differ from those of coronal caries. Not surprisingly, the list of possible risk factors for root caries and coronal caries includes some common and some independent items. Generally accepted risk indicators for root caries include the following¹⁷:

- Exposed root surfaces
- Past caries/restorative experience
- Eight or more missing teeth
- Cariogenic diet
- Symptomatic diminished salivary flow
- Removable prosthesis
- Inadequate oral self care/high plaque scores
- Smoking
- Lack of access to dental services (low socioeconomic status/low education level)

Table 2-1 Risk Indicators for Selected Oral Conditions—Treatment Planning Implications

Conditions Associated With Risk for Oral Disorder	Oral Disorder	Possible Sequelae Without Correction	Recommendation/Intervention
Excessive alcohol consumption, tobacco use, compromised immune system	Oral cancer, periodontal disease	Pain, tooth loss, disfigurement, death	Limit alcohol intake to under two drinks/day, encourage tobacco cessation, pharmacologic management of immune deficiencies
Acute trauma, bruxism, clenching, para-functional habits	Temporomandibular disorders, tooth wear	Protracted pain, reduced ability to chew, compromised nutrition	Athletic mouth guard, occlusal appliance, behavior modification
Large existing intracoronal restoration(s)	Tooth or restoration fracture	Esthetic problems, soft tissue trauma, pathologic pulpal or periapical condition, tooth loss, need for tooth restoration or replacement	Adhesive restorations or cuspal protective restorations
Frequent exposure to refined carbohydrates, frequent exposure to dietary acids, poor oral hygiene	Dental caries	Loss of tooth structure, pain, pulpal or periapical disease, tooth loss, dysfunction, compromised esthetics, loss of self-esteem	Caries control protocol (see Chapter 7)
Poor oral hygiene, presence of specific oral microorganisms (periodontal pathogens)	Periodontal disease	Loss of function, pain, compromised esthetics, tooth loss, advanced cardiovascular disease	Improved diet and oral hygiene, pharmacotherapy, remove local factors, antibiotic treatment (local, topical, or systemic) (see Chapter 7)

CARIES RISK ASSESSMENT

RISK FACTOR	INDEX			RISK
DMFT SCORE CURRENT	≤17 yrs = 5 18 yrs = 7	20–29 yrs = 8 30–39 yrs = 10	40 + yrs = 12	
DMFT INCREASE	DMFT Today - DMFT 3 Years Ago DMFT Change Yes, if 3 or more.			
# of Active Cariious Lesions	White Spot Lesions 3 or More			
	1° Lesions 1 or More			
	2° Lesions 1 or More			
	Root Caries 1 or More			
ROOT SURFACE SUSCEPTIBILITY	Any root surface exposure			
ORAL APPLIANCE	Removable Prosthetic(s) or Orthodontic Appliance			
FREQUENCY OF REFINED CARBOHYDRATE EXPOSURE	>5 exposures/day			
FLUORIDE EXPOSURE – ADA approved dentifrice/oral rinse (occasions/day)	<2 exposures/day			
SUBJECTIVE SALIVA FLOW	1 positive response			
CARIES RISK SCORE				
FORM OVERRIDE INTO HIGH RISK CATEGORY	Reason:			

NUMERICAL RISK SCORE	RISK LEVEL ASSESSMENT
≥6 = High Risk	☐ HIGH
≤5 = Low Risk	☐ LOW

Figure 2-2 Caries risk assessment form. (Modified from “Caries risk assessment,” a system proposed by Alexander DC, Meiers JC, 1991. Courtesy Drs. J. Meiers and T. Ziemiecki of the University of Connecticut Health Science Center School of Dental Medicine.)

Continued

CARIES RISK ASSESSMENT:

On the reverse of this form is the area where the patient's risk of future dental caries is determined. This is a necessary component of the overall restorative treatment planning procedure as it helps to assess the patient's future risk of dental caries as a dynamic component to the immediate treatment plan. Being able to identify a patient's risk of dental caries has clear impact on subsequent treatment planning decisions such as the timing of when to consider cast gold restorations, crowns, or esthetic veneers. In conditions of uncontrolled disease, these treatment options may not only be inappropriate, they are potentially injurious to the patient. The instructions for the completion for the *Caries Risk Assessment* section are as follows:

1. **Determine the present DMFT (decayed, missing, and filled teeth).**
(DMFT = # of decayed teeth + # of missing teeth + # of filled teeth)
 - a. *Only count an individual tooth once*, i.e., if it is decayed and filled, or has two restorations, only score 1.
 - b. *Missing teeth*—only count teeth that you believe are missing due to caries, i.e., do not count those that are missing for orthodontic reasons, third molars removed for prophylactic reasons, and those lost due to trauma.
 - c. *Crowns & bridges*—only count when you believe caries was the cause.
2. Determine any **DMFT INCREASE** by subtracting the score from three years ago from the present score (note—if no record of past DMFT exists, ignore this section).
3. Determine the patient's current **CARIES ACTIVITY** by examining for any white spot lesions, active primary carious lesions (not arrested), caries around the margins of restorations, and root surface caries. This information is obtained from the Oral Finding section of the *Treatment Planning Worksheet*.

4. Determine if any root surfaces are exposed, especially within the last 12 months, either from recession, surgery, root planing, or prosthetic procedures.
5. Determine if there are any removable appliances currently being used, such as bite plane splints, orthodontic appliances, or removable partial dentures.
6. In consultation with the patient, establish the typical daily frequency of refined carbohydrate exposure (including beverages).
7. In consultation with the patient, establish the dentifrice and/or fluoride mouthrinses most commonly used, and the daily frequency of use. If it is a fluoride dentifrice, *it must carry the ADA Seal of Acceptance to be counted*.
8. For the Patient Perception of Salivary Flow the following questions are to be asked of the patient:
 - a) Does your mouth feel dry when eating a meal?
 - b) Do you have difficulty swallowing food?
 - c) Do you sip liquids to aid in swallowing foods?
 - d) Is the amount of saliva in your mouth, most of the time, too little, or don't you notice it?
 - e) Are you taking any medications, either prescribed or over the counter, that are drying your mouth?
 - f) Any diseases that may affect salivary flow, i.e. Sjögren's syndrome.
 - g) Have you had any medical procedures that may affect salivary flow such as surgery to salivary glands or irradiation to your head and neck?

To determine the caries risk score, sum all check marks in the **CARIES RISK SCORE** box. If six or more, check the appropriate High Risk box, or if five or less, check the Low Risk box.
9. Finally, there may be times that a single factor is so significant that it is the feeling of the examining provider that the patient needs to be placed into a High Risk category. In this case, a short description of the reason is necessary and is to be entered in the adjacent box.

Figure 2-2—cont'd

Once a determination has been made that a patient is at increased risk for future coronal or root caries, the patient needs to be informed of that fact, risk indicators need to be unveiled, and appropriate intervention put in place. The basic caries control protocol and optional interventions to manage the active caries patient are described in Chapter 7. It is also essential to continue to monitor the patient's caries activity and to reassess the patient's caries risk at periodic intervals. Caries risk may diminish, increase, or remain static over time. The dental team must be vigilant so as to recognize any increase in the caries risk status and be ready and able to intervene aggressively if it occurs.

PROGNOSIS

The term **prognosis** refers to an estimation of the likelihood of a favorable outcome for a disease and is usually expressed in such general terms as “excellent,” “good,” “favorable,” “unfavorable,” or “poor.” A prognosis can be estimated for recovery from the condition and also, in some cases, the likelihood of success of a particular treatment. The two may be related, but are not necessarily the same. For example, a patient with a moderate periodontitis may have a good prognosis for control of the disease, but a poor or guarded prognosis for a long-span, fixed partial denture that is anchored on the involved teeth.

Conversely a patient with severe periodontitis may have a poor prognosis for control of the disease, but an excellent prognosis for a related treatment, an overlay denture.

Prognosis can be related to risk. For example, if a patient is at high risk for caries, the prognosis for control of the caries may be poor unless the risk factors or indicators are modified or eliminated. Several issues that may influence the prognosis may not themselves be risk indicators. Examples of such issues are seriousness of the disease at the onset of treatment, the skill of the dentist, and the patient's level of motivation to achieve a state of oral health.

Impact of Prognosis on the Selection of Treatment Options and on the Plan of Care

It is essential for the practitioner to carefully and accurately assess the prognosis for both the disease and the treatment before a plan of care is suggested to the patient. Understanding the prognosis affords the dentist an important, if imprecise, approach to evaluating treatment alternatives. With such an assessment, the dentist is better able to discuss with the patient which plan will have the greatest likelihood of success. Less promising treatment options can be ruled out, and alternatives with a better likelihood of success can be included in the choices presented to the patient.

A thorough and accurate understanding of the prognosis can be an important tool to assist the patient in making an educated, rational choice from among several treatment alternatives. This is not to say that prognosis alone determines which alternative to choose, but along with other issues (e.g., time, degree of discomfort, financial cost, outcome relative to self-image) the concept can be very important in helping the patient decide which treatment is best. In short, this evaluation process is indispensable to both practitioner and patient to help frame the treatment choices, to help make the best treatment selection, and as part of the overall effort to establish informed consent.

Multiple variables individually or collectively may have an impact on the prognosis for an oral condition or for the treatment to be rendered. These variables may be beneficial, detrimental, or both. Table 2-2 summarizes selected oral problems and related treatments, suggesting some of the factors that may influence the prognosis in each case. This information is representative of the kind of evaluation that the practitioner should make for a treatment option before recommending it to a patient.

Establishing a prognosis can be critical to treatment planning. In developing plans for a fixed or removable partial denture, for example, the prognosis for abutment teeth is directly linked to the success or failure of the prosthodontic treatment. Determination of the prognosis for each abutment tooth will be crucial to the success

Table 2-2 Factors Influencing Prognosis

Oral Condition or Treatment	Factors That May Influence Prognosis
Marginal periodontitis	Patient age and general health, nutrition, tobacco use, alcohol or other substance abuse, ability to tolerate/manage stress, oral self care, bruxism, restorative condition of the teeth, severity, extent, and progression of periodontal disease
Posterior resin restorations	Size of the restoration required, possibility for isolating the preparation, occlusal forces, oral self care, parafunctional habits, material selection, operator skill, caries risk
Crowns and fixed partial dentures	Edentulous span length, preexisting or need for root canal therapy, crown/root ratio, adequacy of tooth reduction, fracture resistance of remaining tooth structure, operator skill, potential for recurrent caries, oral self care
Complete and partial dentures	Residual ridge form and extent, undercuts, bruxism or other deleterious habits, occlusal stability; retention, tongue position, patient-perceived level of function and esthetics; oral self care, regularity of maintenance visits, patient compliance, and motivation
Root canal treatment	Canal obturation (length, diameter, and density), presence of or potential for vertical fracture, restorability of the tooth, periodontal health, occlusal stress/load, potential for additional trauma
Orthodontic treatment	Accurate assessment/case diagnosis, operator skill, caries risk, root resorption, occlusal load and function, perceived esthetic outcome, patient cooperation, and oral self care

of the overall plan in some situations. The challenge for the treatment planner is to accurately assess the prognosis for each abutment tooth (and the related treatment options) in the context of the overall oral condition and the treatment plan as a whole. In this situation, prognosis determination is necessary to answer such questions as the following:

- Is the tooth a suitable abutment as it is?
- Does the tooth require additional treatment to prepare it for service as an abutment (e.g., root canal therapy, periodontal therapy, surgical or orthodontic crown lengthening, or a crown)?

- If the tooth has a limited or guarded prognosis as an abutment, does the patient have a realistic understanding of the chances of losing the tooth? Does the patient understand the implications to the overall oral condition if the tooth is lost?
- If the tooth is poorly suited to serve as an abutment, what are the treatment alternatives? Do those alternatives have a better or worse prognosis?

Following such an analysis, the prognosis for each of the appropriate options (as framed by the dentist) will need to be communicated to the patient. Usually this is accomplished seamlessly as a part of the larger informed consent discussion. Along with other issues, including financial cost; time and number of visits required for the treatment; and expected discomfort, inconvenience, or esthetic limitations during treatment; an understanding of the prognosis for each treatment option can be extremely helpful in assisting the patient to make a definitive treatment selection.

OUTCOMES AND OUTCOMES MEASURES

Outcomes are the specific tangible results of treatment. The results that a patient and practitioner anticipate receiving as a result of a course of treatment are **outcomes expectations**. An outcome expectation is closely linked to both risk assessment and prognosis determination. For example, if the patient remains at risk for new caries and the prognosis for control of the caries is poor, then it follows that the outcomes of treatment can be expected to be unfavorable. Based on sound clinical research, expected outcomes are usually expressed in quantifiable terms, such as the 5-year survival rate for the tooth or the average life expectancy of a restoration. Comprehensive outcome measures for the complete range of dental treatment procedures are not yet available, but some meaningful work has been published and examples of selected findings are discussed later in this chapter.

The Role of Outcomes Measures

Many treatment decisions are facilitated by knowledge of the likely outcome for each of the proposed treatment alternatives. Such predictions can help the dentist select the best options, refine the list of realistic choices, and serve as an important adjunct to the presentation of the treatment plan to the patient. This information could be even more important to the patient who attempts to weigh the pros and cons of the various treatment options. The most valuable outcomes information for the patient would be the success rate for a specific procedure when performed by the practitioner who is proposing to do the treatment. Unfortunately, these data are usually not formally tracked and therefore are not available.

Some common clinical situations for which sufficient outcomes information does exist can help shape the treatment planning discussion. The following clinical problems illustrate the ways in which the dentist can use outcomes information in the treatment planning process and how the patient can use the information to make a treatment decision.

Using Outcomes Information in the Treatment Planning Process

When Should a Defective Restoration Be Replaced?^{18,19}

Rerestoration is not an innocuous procedure. Research demonstrates that when old restorations are replaced with new ones, the new restorations tend to be larger and more expensive than their predecessors.²⁰ As intracoronar restorations become successively larger, it is increasingly likely that a protective cusp restoration (usually a crown) will be recommended and that, in a predictable percentage of the cases, undesirable sequelae will occur, such as an irreversible pulpitis and the necessity for root canal therapy. Outcomes studies provide some guidance²¹:

- Teeth with obvious recurrent caries should be restored.
- Restorations with small marginal discrepancies (ditching) and no overt caries need not be replaced.
- Teeth with isolated recurrent caries may be successfully repaired or patched.

When faced with the decision as to whether a restoration should be replaced, a review of the relevant outcomes literature provides the practitioner with additional context for the decision, an understanding of the consequences of the available options, and some broad treatment parameters. Such a review will not provide, however, answers to such diagnostic questions as whether active caries exists under an old restoration with open or stained margins. If all the information revealed by careful evaluation and inspection of the tooth fails to resolve that question, then an exploratory repair preparation may be in order.

When Should a Heavily Restored Tooth Be Crowned?

This is a common clinical scenario and it takes on particular importance in the present context because it is also, unfortunately, one of the most common opportunities for overtreatment in dentistry. To be sure, there are compelling reasons for doing a crown on an otherwise heavily restored tooth. A tooth with an obvious fracture line and pain on biting—the classic “cracked tooth syndrome” (see Chapter 6)—is one such example. But in the absence of symptoms, new or recurrent caries, restoration defect, or fracture line in the tooth, *is the mere presence of a large direct fill restoration sufficient indication to recommend a crown to a patient?*

To answer this question, the dentist will need to evaluate several parameters:

- What is the stability and viability of the current restoration? Past history of the tooth and restoration in question is most often a good predictor of longevity and future success. In other words, if the current restoration has been in the mouth for many years and there have been no negative outcomes, then it is more likely that there will be a continuing track record of success if the restoration is retained.
- Are there excessive occlusal forces on the tooth? Severe attrition, loss of vertical dimension, and heavy lateral or incline forces on the tooth all increase the probability of tooth fracture and therefore increase the probable benefit of crowning the tooth.
- What has been the patient's past experience with tooth fracture? Has it happened frequently, seldom, or not at all? Certainly a patient with a recent history of multiple tooth fractures is at greater risk for future fractures.
- If there is a high risk for fracture on the tooth in question, can the risk be mitigated by other means, such as eliminating all incline contacts on the tooth or fabricating an occlusal guard? Is placement of a crown the only or the best way to prevent future fracture?
- What is the probability that the process of fabricating the crown will necessitate additional procedures, such as a prophylactic or prosthetically required root canal therapy, forced eruption, crown lengthening procedure, or placement of a new foundation or a post and core?
- What is the probability of future negative sequelae—with either treatment option—including pulpal necrosis, recurrent caries, coronal amputation, crown debonding—and what would be the consequences of these sequelae?

- What is the prognosis for the tooth with or without the crown?

Ultimately the treat versus no treat decision must be made by the patient following the consent discussion. In most situations, when the patient presents with a disease-free and asymptomatic tooth that has a large direct fill restoration, there will not be a compelling argument for placing a crown, but the patient should nevertheless be made aware of the treatment options and the benefits and deficits of the options—including any negative sequelae that may arise with either choice—and the *probability* of those negative sequelae. Here is an instance in which good outcomes data—especially those data that reflect what occurs under similar clinical conditions—can be very helpful to the patient trying to weigh the options and decide whether or not to proceed with a crown at this time.

When Should a Missing Posterior Tooth Be Replaced?

Conventional wisdom has encouraged the replacement of missing teeth when posterior tooth loss has created a space surrounded by remaining teeth. The time-honored assumption has been that unless the space is filled, tipping or extrusion of remaining teeth leading to arch collapse will likely occur, and there will be a significantly increased potential for localized marginal bone loss and periodontal disease, pathologic temporomandibular condition, and occlusal trauma (Figure 2-3). It has been held that delaying reconstruction may necessitate more complex procedures, such as crown lengthening, root canal therapy, and/or crown placement on an opposing hypererupted tooth.²²

Studies suggest that these concerns may be inflated²³ and that the traditional alternative, the fixed partial denture, has limitations.²⁴ Replacement with an implant-retained crown has a predictably favorable outcome, but will often incur significant cost to the patient. It has been shown that although some teeth bounding an edentulous

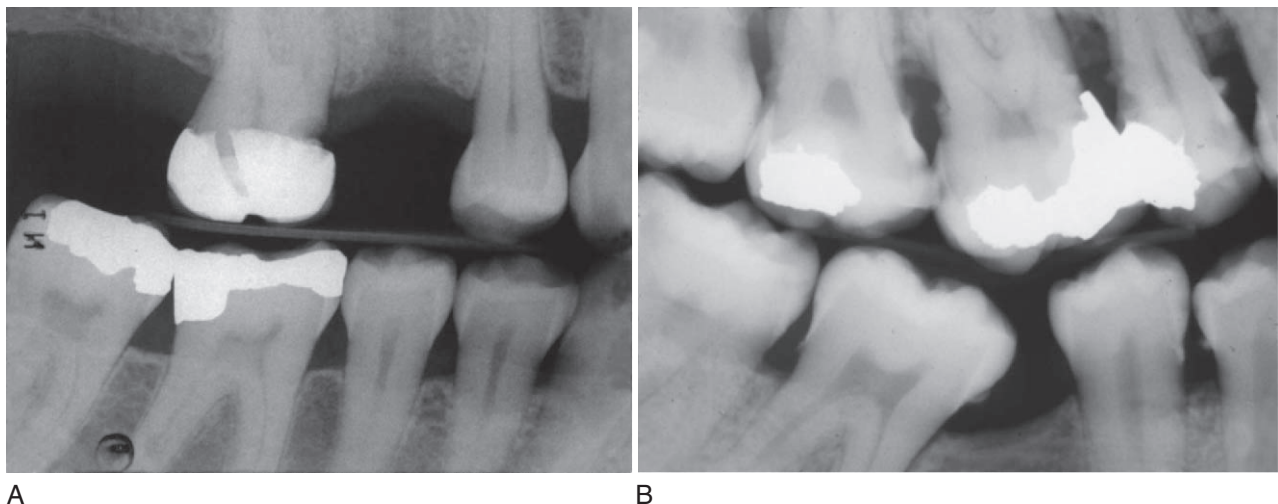


Figure 2-3 A, A stable bounded edentulous space (BES). B, A collapsed BES.

space may drift or tip, many do not. Of those that do move, most do so most dramatically within the first 2 years after the extraction. Given this information (and in the absence of a compelling esthetic or psychological concern), it is reasonable to suggest the option of closely monitoring the space with intervention only if notable change (e.g., >2 mm) begins to occur. Even if intervention becomes necessary, limited treatment, such as a fixed or removable orthodontic device or an occlusal guard, may be all that is necessary to prevent tipping and extrusion of the opposing tooth.

For this situation, outcomes studies have been instrumental in challenging the profession to reconsider conventional wisdom. Outcomes information allows patient and practitioner to define a wider and more practical range of treatment options and provides research-based information on which to evaluate treatment options. It may still be prudent for the patient to proceed with tooth replacement, but the choice can be made with more knowledge and a clearer understanding of the risks and benefits of the various options.

Should a Tooth With a Failed Root Canal Treatment Be Re-Treated?²⁵

Cumulative statistics from several studies suggest that the overall success rate for initial root canal therapy is 80% to 85% for nonvital teeth and 90% to 92% for vital teeth.²⁶⁻³⁰ The presence of a periapical lesion before treatment, obturation beyond the radiographic apex, or obturation with silver points all tend to diminish success. Failure can occur, however, and

is usually the result of root fracture, incomplete obturation, or the presence of lateral canals or other anatomic anomalies. If the root canal therapy does fail, many patients are reluctant to invest additional time, financial resources, and the potential for discomfort and prefer to consider extraction.

Nevertheless, many studies support the benefits of re-treatment. As long as the root is not overtly fractured, the success rate averages 60%. Subsequent re-treatments show diminished success, however. If re-treatment by conventional means is not feasible or has a poor prognosis, or if time constraints weigh in favor of a surgical approach, apicoectomy with retrograde fill may be another alternative. The average success rate for surgical therapy is also 60%.

In this situation, information obtained from outcomes research provides patient and provider with resources required to make a rational and informed treatment decision. Based on this information, the patient can make a reasoned choice about whether the benefit (likelihood of retaining the tooth) is worth the cost of conventional or surgical endodontic retreatment. Knowledge about the expected outcome of the common alternative treatment—extraction and placement of a single implant-retained crown—has further aided this process (see *In Clinical Practice* box). Now the patient is in the ideal position of being able to weigh options: the endodontic surgical or re-treatment at a lesser fee, but with a poorer success rate, versus the extraction, implant, and crown at a higher fee, but a higher success rate.

In Clinical Practice

A Common Dilemma—Deciding Between Extracting and Placing an Implant-Retained Crown Versus Restoration With a Root Canal Treatment, Foundation, and Crown

Before the development of the osseointegrated implant-retained crown, it was not unusual to go to extraordinary lengths to save a badly broken-down tooth. If the tooth was lost, the common replacement alternative had been a fixed or removable partial denture (see Chapter 8 for details). Dentists and patients alike generally sought to avoid those alternatives if reasonably possible. In recent years, replacement of a badly compromised tooth with an implant-retained crown has become a predictable and financially viable alternative, but there are still many situations in which it is preferable to retain a compromised tooth rather than extract it. The treatment dilemma of when to restore and when to extract a severely decayed or fractured tooth continues to be a common and relevant treatment planning question in the contemporary practice of general dentistry. It is also a good example of how the evolving body of evidence in dentistry can help both

the dentist and the patient to make sound rational treatment decisions.

For the dentist, the starting point in this analysis is to determine the prognosis if the tooth were to be restored. What treatment will be required? What is the expected survival rate? If failure occurs, what are the other possible negative outcomes? How can each of those negative outcomes be dealt with? What additional treatments could be required at that time? The patient, interestingly enough, will typically be interested in the same questions. He or she may also seek information on the prognosis, expected outcomes, and possible discomfort and inconvenience attendant on the alternative treatment of implant placement and restoration. Obviously, the patient will need to be informed about the financial costs, the time required, and the expected number of visits necessary to accomplish either alternative.

The following information summarizes many of the tooth-specific and patient-specific factors that may have a bearing on this decision making process:

In Clinical Practice

A Common Dilemma—Deciding Between Extracting and Placing an Implant-Retained Crown Versus Restoration With a Root Canal Treatment, Foundation, and Crown—cont'd

Factors that favor retention and restoration:

- Poor general health contraindicates implant surgery
- Patient aversion to oral surgical procedures
- Root canal treatment has favorable long-term prognosis
- Tooth and restoration have favorable long-term prognosis
- Sufficient biologic width exists (crown lengthening procedure or forced eruption not needed)
- Low caries risk/low risk for tooth fracture

Factors that favor extraction and implant and crown placement:

- No general health contraindications to extraction and implant placement
- Patient has no aversion to oral surgical procedures
- Adequate bone for implant fixture retention
- Inadequate biologic width (crown lengthening procedure or forced eruption needed if the tooth is to be retained)
- High caries risk/high risk for tooth fracture
- Patient exhibits significant occlusal trauma

Ultimately the treatment decision must be made as part of an extended conversation with the patient in which these

issues are covered in depth. Typically the immediate situation will have some factors that may weigh in favor of tooth retention and others that will weigh in favor of extraction and implant placement. Many other intangibles, such as a patient's previous personal experience with root canal therapy, often weigh heavily in the patient's mind and will influence the decision. Whenever possible, the dentist should share relevant information from the dental literature and should, whenever possible, augment that information with specific outcomes measures from his or her own practice. When the decision remains in the balance even after an extended options and consent discussion, the scale is usually tipped in the patient's mind as to whether additional surgical intervention (a crown lengthening procedure in the case of saving the tooth, or augmentation or sinus lift in the case of implant placement) is anticipated. If the prognosis is deemed to be favorable in both cases, the ultimate cost of the two alternatives may be the determining factor in the decision. At the present time, in most cases, it is still less expensive to restore the tooth with a root canal treatment, foundation (or post and core), and crown than to extract, place, and restore an implant. Certainly, if a crown lengthening procedure or orthodontic forced eruption is necessary to save the tooth, the total costs for the two options become more equitable.

These examples suggest the ways in which outcomes research can support clinical treatment decisions. As further research reveals quantified outcomes for additional treatments under various conditions, the practitioner has the responsibility to remain current with the scientific literature and to relate that information to the individual patient's situation. The additional missing link will be provided when dentists develop individual or practice-based treatment outcomes data for a full range of procedures in their own setting. Certainly this information will be helpful to patients as they make treatment choices, and the process should help the individual dentist to better assess his or her own practice techniques. An additional potential benefit of this process is providing the impetus for constant quality improvement in the procedures, materials, and techniques in the practice.

CHANGING THE TREATMENT PLANNING PARADIGM

Fifty years ago, the U.S. dentist was in a more authoritarian position concerning planning care for his or her patients. The limited number of treatment options available to address patient problems facilitated this stance.

In addition, many patients sought care in an episodic fashion and the chances of retaining teeth and maintaining a healthy dentition for a lifetime were believed to be far from certain. Patients often relegated treatment decisions to the dentist, expressing sentiments such as, "What would you do if I were your brother or sister?" or "Just do what you think best." The situation today is different for several reasons. A greater number of procedures are available to address common dental problems, such as tooth decay, tooth loss, and periodontal disease, and it can be difficult for the dentist to recommend one procedure over another. A larger and more diverse patient population is presenting for treatment, a population that includes the elderly and other individuals with serious systemic health problems. Not all treatment options may be appropriate for some of these patients, and the manner in which care is delivered may require the assistance of a physician or caregivers. Patients in general are asking more questions, have higher expectations about their oral appearance and function, and are often seeking answers in the popular media and on the Internet in addition to consulting with the dentist.

Today's patient is more likely to seek and accept some degree of ownership in making treatment planning decisions. With these changes, a new paradigm is emerging.

As patients become increasingly interested in becoming full participants in treatment planning, the process becomes a collegial discussion, rather than a plan devised, directed, and dispensed by the dentist to the patient. As discussed earlier in this chapter, the further development of an evidence-based body of knowledge about risk assessment, prognosis, and outcomes will support both patient and dentist as they work through the process and ultimately reach consensus regarding the optimal plan of care.

For this new paradigm to flourish and grow, it must be supported by advances at both the professional level and by the individual dentist. Significant improvement can be expected in our diagnostic methods and techniques. Technology in the form of risk calculators and new diagnostic instruments and modalities is expected to improve the accuracy of our diagnoses and reliability of and predictability of our treatment planning. The expanded use of intraoral cameras and microscopes—all integrated with the electronic patient record—can be expected to improve the quality of the information presented to the patient and significantly enrich both the treatment planning discussion and the consent process. There is, and will continue to be, the need for reliable and comprehensive research to substantiate which treatment methods are most effective in varying clinical circumstances. From the individual dentist's perspective, there will be the need to question everything—most especially conventional wisdom that lacks any evidence-based support. Only through a constant, thorough, and dedicated reassessment of procedures, techniques, and materials—with a foundation in the emerging body of evidence—can the dentist hope to guide the patient through the range of treatment options with clarity, candor, and accuracy.

Decision Pathways and Decision Trees

Several developments have already had an impact on treatment planning patterns and can help guide individual patient treatment planning. One approach has been the development of **decision pathways**. These provide direction in identifying the range of treatment options, indicating some of the key decision nodes leading to an appropriate treatment decision. Decision pathways have been developed to cover a wide array of dental situations and procedures. Hall and coauthors have written an excellent comprehensive treatment planning text using this format.³¹ By providing a template for decision making and patient presentation, decision pathways can be particularly helpful to the novice. They can be useful to the experienced practitioner as well by providing a restatement of the range of options that should be considered.

Their most significant limitation is that they tend to be somewhat cumbersome for routine daily use, especially for the experienced practitioner who has learned to intuitively sort out which issues are important for a specific patient, dismissing decision nodes that are not applicable.

Decision trees represent a more sophisticated expansion on this theme. Decision trees not only specify key decision nodes and treatment options, but also include research-based success rates for each of these options. The rates can be based on outcomes of clinical conditions (e.g., effect of tooth loss) or on outcomes of treatment (e.g., success of various therapies for tooth replacement). In theory, comprehensive decision trees would be useful for the patient treatment planning discussion, but unfortunately, to date, they do not exist for most clinical situations. Decision analysis has already been applied to several areas, including radiographic selection,^{32,33} the management of apical lesions after endodontic treatment, restorative dentistry,^{34,35} and TMDs.^{36,37}

Expert (Computer-Based) Systems for Decision Making

As use of electronic patient records becomes more ubiquitous, the development of algorithms to create risk profiles for a complete range of medical and dental diseases is a natural extension. Computer-based artificial intelligence can be developed to guide the process of selecting appropriate treatment options and to provide a framework that the dentist and patient can use to compare treatment choices and outcomes. Clinical decision support systems are computer programs designed to organize patient data into helpful information that the clinician can use to make evidence-based treatment planning decisions. There are three main types of systems.³⁸ The event monitor system gathers its data information from an institution and then alerts clinicians to updated material. An example of a system that uses the event monitor is WebCIS, used by the New York-Presbyterian Healthcare Information Systems. The application of this system occurs when a clinician orders a medication for a patient; the computer indicates any contraindications or drug to drug interaction for that particular patient.³⁹ The second type of expert system for use in treatment planning is the consultation system. A good example of this is the Oral Health Information Suite marketed by PreVisor. The dentist performs a complete oral and radiographic exam and enters the data into the computer. Based on the computer knowledge, the computer assesses the information, compares it to published literature, then recommends best treatment options.⁴⁰ The third type of

application is a clinical guidelines system. A team of experts reviews relevant data on a particular health condition and develops a set of guidelines for best treatment practices. These recommendations are then promulgated by professional organizations. An example of this is InterMed, a group effort of Harvard, Stanford, Columbia, and McGill university laboratories. This collaboration formats the guidelines into user friendly information for clinicians to apply in best evidence treatment planning. Other examples include the Cochrane Collaboration and the Forsyth Institute.⁴¹ There is evidence that the quality of the decision-making process is improved when these systems are used.⁴² Currently these expert systems are being used in a variety of dental disciplines.⁴³ Although in the beginning stages of development, the neural net has the potential to drastically redefine the treatment-planning process. Although artificial intelligence will never substitute for the provider-patient discussion, it should help to make that discussion more focused and precise.

Practice Guidelines and Parameters

Notable attempts have been made to develop **dental practice guidelines** and **parameters**. The American Dental Association's Practice Parameters represent one fledgling effort.^{44,45} Many colleges of dentistry and many military, public health, hospital, and managed care dental programs have developed formal clinical protocols for their settings. Unfortunately, many aspects of these protocols are not applicable to general dental practice and to date no concerted attempt has been made to consolidate this information although some sentinel work has been developed by specialty groups, such as the American Academy of Periodontology.^{46,47}

Dentists have traditionally resisted any intrusion into the one-on-one doctor-patient discussion of the treatment plan. Even though managed care plans, and to a lesser extent insurance carriers, have had an impact on the decision-making process, dentists can be expected to maintain autonomy in relationship to these third party agencies in assessing, diagnosing, and treatment planning for the needs of individual patients. As more research provides a knowledge base in this area, however, it will become possible to determine a controlled range of therapies that can be expected to succeed for a given clinical situation. This should be viewed as a positive development. If dentists individually and collectively accept responsibility in this area and foster the development of expert systems, the benefits will be great. Treatment planning will be performed on a more solid scientific foundation, and the patient will ultimately be able to more reliably, appropriately, and convincingly

select the treatment that is in his or her personal best interests.

As the science of decision making in dentistry improves, it will be easier for those inside and outside the profession to determine what, under some circumstances, may constitute inappropriate or unprofessional treatment. It is possible that state boards of dentistry or other oversight or governing agencies may at some point use the tools and information inherent in expert systems to identify marked deviations from the standard of care. Even in a climate in which treatment plans are carefully scrutinized and held to a more formal standard, the dentist can and should maintain the central and leading role, continuing to plan treatment with the goal of bettering the patient's oral and general health—as the dentist and the patient deem appropriate. If treatment plans that fall outside the perceived norm are fully justified and thoroughly documented (as all treatment plans should be), the dentist need not worry that less conventional approaches to a particular patient's problems will become somehow “unlawful” or “inappropriate.” The importance of treatment plan documentation is a continuing theme of this book.

Dental treatment planning is already moving from a tradition in which the norm was a limited discussion with the patient of a few treatment possibilities to today's more open format, characterized by discussion of an array of increasingly sophisticated options. What then is the goal for the future? In the best case situation, the patient will have a full and rich understanding of all the issues and will be prepared by the dentist to make an optimal treatment choice that will be in his or her short-term and long-term best interest. In the future, fully informed consent will include more than an understanding by the patient of the diagnosis, relative advantages of the various treatment options, and the costs (monetary and otherwise) of the treatment to be rendered. Consent will also include a more complete patient understanding of the prognosis for the treatment and the disease, the expected outcomes for the therapy, and the current and future risk for disease. The ultimate goal and anticipated result of these changes will be improved treatment planning and increased quality of care.

CONCLUSION

Using risk analysis, prognosis determination, and outcomes assessment in the treatment plan presentation and discussion, the profession has begun to move from empirically based to evidenced-based treatment planning. As both diagnosis and treatment planning become more evidence based, the profession can be expected to move

closer to consensus with recommendations to patients that are more thoughtful, logical, predictable, and consistent. Similarly, patients can expect to have more appropriate and accurate information, to be better able to compare and weigh treatment alternatives, and to be prepared to make more informed judgments about what is in their individual best interests. They will also be better prepared for the possibility of adverse outcomes, should they occur.

As this paradigm shift takes place, the dentist's role is changing. On one hand, some control in the decision-making process is being passed from practitioner to patient. At the same time, the dentist's role is expanding as the need to collect, filter, focus, and transmit information to the patient increases. In short, the role of the dentist in presenting the treatment plan is changing from that of final authority in all decisions to that of a content expert, educator, and advisor to the patient. This altered role will ultimately be to the betterment of patients, dentists, and the profession.

REVIEW QUESTIONS

- Describe some of the problems with the way that dental treatment plans have traditionally been formulated and presented to patients.
- How can risk assessment be a useful adjunct to the dental treatment planning process?
- How does the prognosis for a disease differ from the prognosis for treatment?
- Give examples of how the prognosis for a treatment can alter the treatment plan presentation to a patient.
- How does outcomes research support clinical treatment decision making?
- Why do dentists disagree in their treatment planning?
- How can these sources of disagreement be reduced?

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