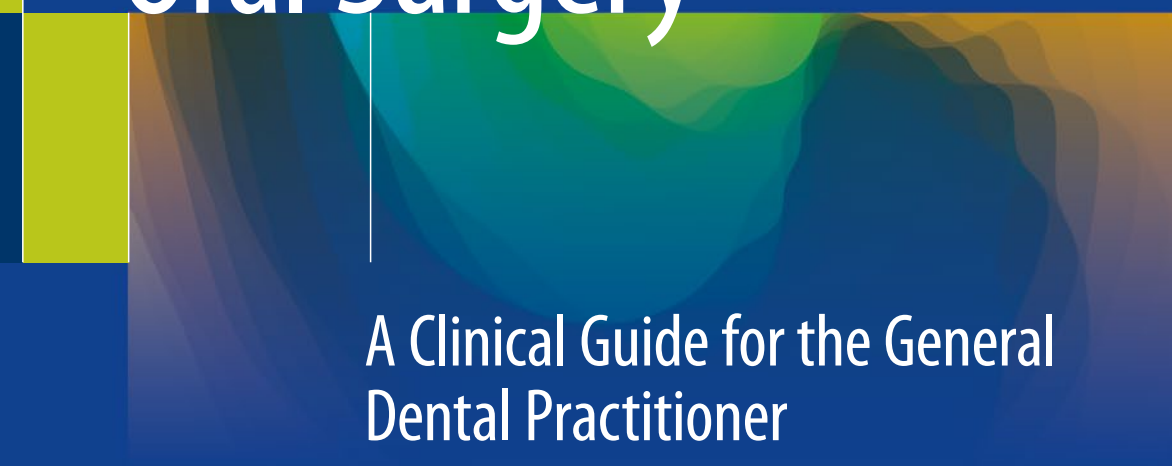
# Evidence-Based Oral Surgery



## A Clinical Guide for the General Dental Practitioner

Elie M. Ferneini
Michael T. Goupil
*Editors*

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# Foreword

Evidence-based dentistry integrates a practitioner's clinical expertise and judgment, the needs, desires, and preferences of the patient, and current, clinically relevant evidence. The intersection of these domains is a critical component of an effective, patient-centered approach to care. The American Dental Association defines evidence-based dentistry (EBD) as "an approach to oral healthcare that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history, with the dentist's clinical expertise and the patient's treatment needs and preferences." Since introduced at McMaster University in the 1980s to improve the quality of healthcare delivery by closing the gap between scientific-based knowledge and commonly found practice patterns, evidence-based dentistry has continued to advance and is now widely accepted as a best practice.

This text is intended to provide the general dentistry community with clear, concise, focused guidance on the delivery of evidence-based, patient-centered surgical management and care. Drs. Goupil and Ferneini are leaders in the practice of evidence-based oral and maxillofacial surgery, with extensive experience in academic, military, and private practice settings. The text covers a spectrum of topics pertaining to oral and maxillofacial surgery, including patient assessment, exodontia, pain management, oral pathology, trauma, temporomandibular joint dysfunction, and implant therapy—all of which are discussed using the principles and parameters of evidence-based healthcare. Collaborating with over twenty authors, they have developed the quintessential guide for general dentists to apply translational science and knowledge into everyday clinical practice. All general dentists will find information in *Evidence-Based Oral Surgery: A Clinical Guide for the General Dental Practitioner* to be of great value and relevance to their practice.

Farmington, CT, USA — Steven M. Lepowsky

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# Part I

# Patient Assessment

# Evidence Based Dentistry: What, Why, How

1

Michael T. Goupil and Linda Elder

*"Now we will take another line of reasoning. When you follow two separate chains of thought, you will find some point of intersection which should approximate the truth."*
Sherlock Holmes in—The Disappearance of Lady Frances Carfax

**Abstract**

The concept of evidence-based medicine {EBM} and evidence-based dentistry (EBD) is not new. EBM traces its origins back to the 1980s when the evidence-based process was developed at McMaster University, Ontario, Canada. This concept should be commonplace with the current generation of graduating dentists. Yet there continues to be barriers to fully implement EBD. This chapter focuses on the what, why, and how of EBD.

## 1.1 Introduction: What Is EBD

The American Dental Association defines evidence-based dentistry as "an approach to oral health care that requires the judicious integration of systemic assessments of clinically relevant scientific evidence, relating to the patient's oral and medical condition and history with the dentist's clinical expertise and the patient's treatment needs and preference" (Sakaguchi 2010). In other words dentists are expected to provide the best possible health care for their patients as possible.

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The concept of EBD can best be demonstrated through a Venn diagram consisting of three intersecting circles of equal value (Fig. 1.1). The circles represent (1) the current clinical situation of the patient and the patient's values, (2) current and relevant scientific evidence, and (3) the clinical experience and judgment of the dental provider. The area where all three of the circles intersect represents evidence-based dentistry or more aptly labeled evidence-based practice. There is a misconception that evidence-based dentistry is based solely on the dental or medical literature. Rather all three areas need to be considered, and depending on the circumstance of a specific situation or patient, each of these areas may take on more or less importance. There are a number of factors that need to be considered in each of these domains.

## 1.2 The Patient

First consider the clinical patient circumstances. Obviously this includes an appropriate hard and soft tissue examination of the head and neck region. But one also needs to consider the patient's past dental history including past and current oral hygiene practices and opportunities. Equally important is the past and current medical health history including past and current medications. Several questions need to be addressed. How might the medical history have contributed to the patient's oral health? Will the patient's medical status have an impact on any planned treatment? Does the patient have any physical impairment that might affect the delivery of the proposed treatment, and equally important, are there impairments in the patient's ability to maintain her or his oral health? (See Chap. 3.) Once the physical data have

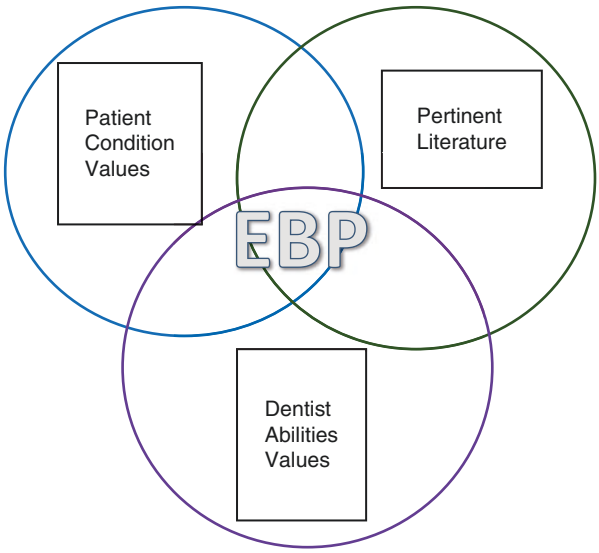



**Fig. 1.1** Venn diagram demonstrating the components of evidence-based dentistry [EBD]

been obtained, treatment plan options can be formulated for the patient, which addresses their oral health in context with their more general medical health.

Next consider the patient's preferences and their values. What is the patient's overall perception of oral health and its impact on general, overall health? Does he or she eat to live or live to eat? What kind of esthetic concerns does the patient have? Is a bright, white smile with straight teeth necessary? What is the patient's financial situation, and what time and financial investments do they want to make toward their oral health?

There needs to be a recognition and acknowledgment that the patient's value system and the dental practitioner value system may be worlds apart. This does not mean that the provider shouldn't try to influence the patient's value system through education, but in the final analysis, it is the patient's preferences that should drive the final treatment choices. These preferences and values may change over time and need be reassessed periodically. How patients view the world when they are young and on the dating scene may be very different than when they are in their later years and enjoying a few final pleasures like eating. From an ethical point of view, the dental provider is not required to provide treatment that is not in the best interest of the patient just because the patient wants a certain treatment plan, for example, the young adult patient with a reasonable healthy and easily restored dentition that wants a full-mouth extraction and complete dentures to avoid going to the dentist in the future. This is really not a justifiable and ethical option despite the patient's preference.

## 1.3 Scientific Evidence

As treatment plans are developed, it is paramount to consider what the literature states about current materials and methods. Technology continues to advance rapidly, providing ever-expanding options for providing health care. The literature must be evaluated both critically and carefully, and especially for applicability, before changing tried and true methods.

The notion of a "universally true" concept in dentistry is myth. Depending on when an individual has graduated from dental school, some of the concepts that were taught and "written in stone" have not survived the test of time. These "universally true" concepts should be reassessed periodically in light of advanced and advancing understandings of disease and the human condition.

The clinician should look for the best scientific literature available that represents the clinical situation as closely as possible. This literature then needs to be evaluated in a systematic fashion to assess both its value and applicability to the patient.

## 1.4 The Dental Provider

Lastly but equally important is the clinician's experience and judgment. The scientific literature is frequently based on looking at the results of an intervention on a reasonably homogenous population. The results of a study must be assessed in the

context of how closely a specific patient matches the population studied. As a clinician gains more experience she/he is better able to make predictions on how successful the treatment might be in a given situation.

Not all clinicians have an equal ability to perform certain specific tasks, although there usually is an acceptable minimum standard that needs to be met. Frequently one hears and perhaps even says "in my hands this works in such and such a way." That is a very important concept in assessing both the results in the literature and the formulated treatment plan. Dental providers should accurately assess and honestly face the results of their skills on a periodic basis. Treatment outcome assessments should be part of every practice to ensure oral health care is provided at the highest level. These outcome assessments can then be compared to current literature results.

In summary there are at least three components to evidence-based dentistry: (1) the patient's needs and desires, (2) what good current scientific literature states, and (3) what the clinician knows that works well in her/his hands. Each of these components is important and must be considered if one wants to deliver evidence-based care. The relative importance of each of these components may change based on circumstances for a specific patient. The influence of each of these components may change and must be adjusted for each individual patient. The influence of the literature may vary based on what is available and how applicable the literature is to a specific patient. The clinician's influence should improve over time, based on experience and continuing education. Evidence-based dentistry entails using the current literature within the context of one's own expertise and applying this knowledge to provide the best possible health care to dental patients.

## 1.5 Why Do EBD?

Evidence-based decision-making is the best approach to dentistry because it offers the best chance at successfully helping our patients achieve reasonable goals in terms of their dental care. The practitioner should continually ask the questions—"What would I want if I were facing these dental issues?" "What would I want for my family member?" One does need to be cautious though when applying this dictum to specific patients. As mentioned, part of the evidence-based dentistry model entails respecting the desires and values of the patient.

Oral health values are based on education and previous clinical experience and modified by the practitioner's own personal value system. This may lead the practitioner to believe that a certain treatment plan is the "best" or the "ideal treatment plan" and, indeed, the proposed plan may be the best for the provider, but it may not be the best for the patient. The practitioner needs to again consider the patient's value system. As mentioned above the best procedure may be able to modify the patient's choice through education. In any case, the provider needs to be mindful that current ethical philosophy focuses on patient autonomy, as opposed to the "doctor knows best" paternalism of the past.

Another way of looking at evidence-based dentistry is that it represents or is part of the informed consent process. Informed consent is a process that evolves over

time through an open dialogue with the patient. Components of the informed consent process include the patient's condition as well as potential methods for how this condition may best be addressed. What are the best treatment options, including possibly no treatment at all? What risks and benefits of each of the reasonable treatment options exist—including no treatment? How competent is the provider ability to deliver these options?

In today's litigiousness society, a recurrent theme is lack of informed consent. Probably one of the best ways to avoid these legal consequences is to apply the evidence-based dentistry model, incorporate EBD into the informed consent process, and then, of course, document the process.

## 1.6 How Can EBD Be Accomplished?

In certain regards, evidence-based decision-making within dentistry can be implemented relatively easily. In most cases the patient's condition can be assessed through the clinical examination and a review of the medical history that has been captured earlier through questionnaires and verified through patient dialogue. Directed questions to the patient to determine what he or she is looking for in terms of health in general, and oral health more specifically, will help assess the patient's desires and personal values. Initial evaluation inferences may change, when various treatment options are discussed with the patient as part of the informed consent process. Individual practitioners are aware of their own experiences and expectations, and they should realize, as mentioned previously, that these experiences and outcomes must be evaluated objectively. Given the inherent problem of intellectual arrogance in all human thought, it must be remembered that a provider's success rate may not be as high as one perceives it to be. Ideally, expectations change over the course of time based on further experience, developed skills, and continuing education. Periodic objective clinical practice outcome assessments should be part of any EBD-based practice.

Incorporation of the scientific literature can be a little more complicated, but, hopefully, with practice this need not be overly time-consuming. The scientific evidence is limited to given research in reputable journals. But other essential information is relevant to evidence-based dentistry. To name a few information sources relevant to EBD (in addition to those already mentioned):

- Formal as well as informal learning and training through dental programs and dental degree programs
- Discussions with colleagues
- Given Standards of Dental Societies
- Community Standards
- Professional Meetings

None of these sources, in and of themselves, should be considered to offer definitive "facts" and instead must be evaluated using a systematic critical thinking approach.

To some, evaluation of the scientific evidence may be the most intimidating; but there are ways to make the process less daunting. First and foremost, one should already be taking an active approach to keep abreast of the current, as well as classic, scientific literature. Most states and hospital organizations already require mandatory continuing education hours, to encourage this process (ADA n.d.). There are hundreds of medical/dental journals available, and in fact it is impossible to keep abreast of all of them. For general dentists in the United States, the journal considered by most scholars in the field to be required reading is the *Journal of the American Dental Association*. This journal contains frequent updates on important changes in the standards of the dental profession. We also recommend *Dental Abstracts*, a journal that supplies easy-to-read summaries of potentially relevant articles from a wide variety of journals that, in all likelihood, are not part of one's routine reading. Accordingly *Dental Abstracts* may offer exciting, new, and innovative ways of thinking about dentistry and therefore can help keep you on the cutting edge of our field.

In reviewing a patient's medical history, the odds are that several disease entities and/or medications will crop up where one's knowledge base may be weak. A quick *Google Scholar* search and a few minutes time in all likely will answer the question—"Will this disease or medication have a modifying effect on the treatment I am contemplating?" It would be beneficial to make a quick note in the patient's chart on the conclusions. An annotation of the information source and date is also advisable. Again, remember that your conclusions may change with the development of further information, given that, considered from one point of view, dentistry is still in its infancy in terms of its potential.

As one considers an individual patient, certain key questions should also come to mind:

- Is this the best treatment option?
- Is there another way?
- Is there a better way?
- How long will this last?
- Why didn't that treatment work?
- Is there a more efficient way?
- Is there a more cost-effective way?

To effectively and efficiently address these questions, one needs to consider the type of answer desired. Are we looking for generalities and opinion or, more likely, specific, concrete information that will answer our questions and help direct the patient's care?

One method that is widely proposed is the use of the acronym **PICO** or more commonly called the PICO statement. This method narrows the question and

therefore should guide you to a more precise search of the literature, hopefully resulting in the most relevant and significant articles, focused on the specific information you are seeking.

**"P"** stands for the patient, problem, and the population with whom we are concerned. Rather than looking for "What is the success rate of dental implants?", the search needs to be narrowed and focused on a specific relevant population, articulated in a specific question, such as: "What is the success rate of dental implants in a young, healthy male population?" "What is the success rate of dental implants in a geriatric partially edentulous patient, with Type II diabetes, who is being treated for osteoporosis?" You should be able to appreciate the differences in the responses of search engines to each of these questions. The generalized question potentially will return hundreds of responses, whereas the other two questions may only return very few, but more relevant, articles.

**"I"** stands for intervention. What treatment options are you contemplating?

**"C"** stands for comparison. This is an optional component to the PICO statement. Are reasonable alternative treatment options available?

**"O"** stands for outcomes, which refers to anticipated results for treatment option options.

**Example of a PICO Statement**
**P**: For patients undergoing the removal of impacted third molars,
**I**: does the use of prophylactic antibiotics,
**C**: as opposed to no antibiotics,
**O**: help prevent postoperative complications, i.e. infection, alveolar osteitis

A variety of scientific sources are available for beginning to find answers. Primary sources, such as research articles in scientific literature, are usually considered to have the best answers for EBD. A hierarchy exists in terms of value of the literature; meta-analysis of randomized controlled trials (RCTs) is considered to be at the top of the pyramid. Other significant and relevant sources of information should be also considered. Textbooks, lectures, and input from colleagues may also be utilized, providing a critical analysis and assessment of the information are performed.

The more specific the question, the better the literature search is likely to answer the question at the heart of the clinical process. The downside of an overly specific question is that search engines might not find any literature that can answer the question.

The type of question and the kind of information required will determine the best place to start the search. When dealing with questions concerning the medical history of a client, a drug app on a smartphone may be all that is needed. A simple Internet search, entering only the drug name or medical condition, will frequently provide sufficient information. Even Wikipedia may provide the relevant answer, but of course one must always use caution in using this source.

The University of Texas at San Antonio has championed evidence-based practice in a real practice environment for a number of years, and consequently they developed the medical literature search engine SUMSearch [sumsearch.uthscsa.edu]. SUMSearch 2 {http://sumsearch.org/} is now hosted by the University of Kansas. The University of South Carolina hosts an evidence-based dentistry search engine [http://musc.libguides.com/EBD/searching] that is designed to readily accept your PICO question.

If the question at issue doesn't readily adapt to using the PICO method, another way of formulating questions is the use of WIN-, WIS-, and WIR-type questions that are used in problem-based learning pedagogy. These stand for "What is the nature of_____? What is the significance of_____? What is the relation of_____? Using this process entails selecting the most applicable question and filling in the blank with the information relevant to the clinical case. These questions can be easily used with other search engines.

PubMed is a frequently used and readily available search tool. Another search engine to be considered is the Trip database [www.tripdatabase.com]. This database will provide you with established practice guidelines which can help in the decision-making process.

Part of the acquisition of the evidence is ensuring that the source of the information is reliable. It must be clear that any information acted upon will be in the best interest of the patient. If the information is outdated or not from a trusted source, there is significant potential that the information is no longer valid.

There are a couple of choices though that need to be made as part of the search process. Some of the search engines noted previously should accommodate these choices. One of the choices is "Do you want to select a specific journal?" Some ranking systems attempt to assign a score to indicate the potential value of an article found in a specific journal. One method commonly used is the "impact factor." The impact factor (IF) is calculated on the number of times each article in a journal is cited by authors for other articles. The impact factor is based on this calculation over a 2-year period and obviously may change from year to year. One implication is that the higher the IF, the more important is the value of an article published in that journal. Thus, one would expect a journal like *Cancer* to have a higher IF value than a throw away journal like *Dental Economics*. Remember though this is a guideline and should be used with caution. Depending on the information you are seeking, an obscure information source with a lower IF value may be more relevant to a specific patient condition. The top five dental journals with consistently high impact factors are the *Journal of Dental Research*, *Journal of Clinical Periodontology*, *Clinical Oral Implants Research*, *Dental Materials*, and *Periodontology 2000* (Sillet et al. 2012).

A more recent method for ranking scientific journals is the Eigenfactor. In this method the journal is still evaluated by the number of citations for each article, but now the citations are weighted based on the relative importance of where the citation is being used. The top five journals in this ranking system have now changed to the *Journal of Dental Research*; *Journal of Periodontology*;

*Journal of Oral and Maxillofacial Surgery*; *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology (quad O and E)*; and *Dental Materials*. The *Journal of the American Dental Association*, which has an impact factor of 1.9 and ranks #24 now moves to #14 using the Eigenfactor (Sillet et al. 2012).

Just as journals may differ in relative value or significance, so may individual articles within a specific journal. As mentioned previously a hierarchy exists of study design or clinical evidence which is commonly described as "levels of evidence," ranking from Level 1 studies which contain the strongest evidence to Level 5 which contain the weakest (Fig. 1.2). Level 5 entails editorials or opinions, and Level 4 contains case reports; Level 3, case-controlled studies; Level 2, cohort studies; and Level 1, randomized controlled trial and/or meta-analysis systematic reviews. Several of the previously mentioned search engines can be judged according to the level of evidence required. Obviously, one would prefer to have Level 1 evidence answer the question; but in many, if not most instances, this type of evidence may not be available to answer the question. In most situations the provider will have to settle for the best information currently available, at whatever level this exists.

Cochrane reviews are an excellent source of high-level, comprehensive, clinical-based literature. Their evaluations are designed to provide both the practitioner and the patient relevant information for making informed health-care decisions (Sandhu 2012).

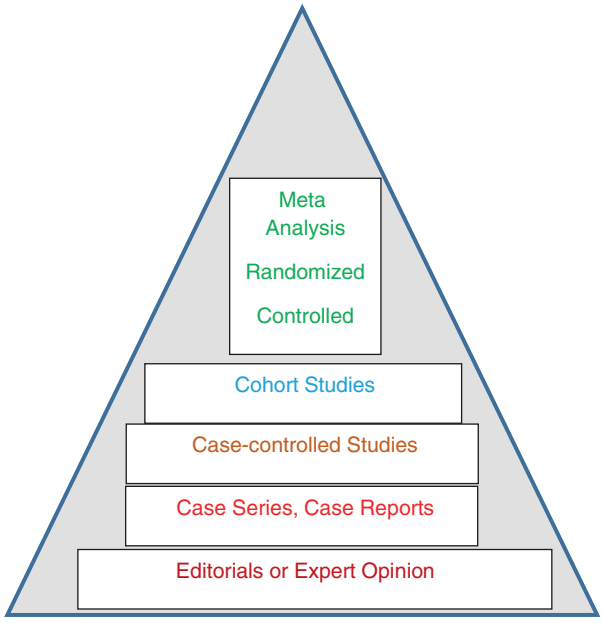



**Fig. 1.2** Hierarchy of levels of evidence

Another choice that must be decided upon is how far back in the literature to go. In most cases probably no more than 5 years would be appropriate. Decisions should be made on the best and most current literature that is available.

Just because something is in print doesn't necessarily make it true. A statistic to keep in mind is that studies that have a significant difference are more likely to be published than studies that don't have a significant difference (Smyth et al. 2011). Thus when reviewing the literature, be mindful that what is being read already contains some form of bias. A critical evaluation of the information is of paramount importance.

When reading a scientific article, there are a couple of things need to be checked in the method section. Is the sample size large enough to truly indicate whether the statistical difference is truly valid? Was a power analysis conducted to ensure that the sample size is appropriate? Unfortunately, this is frequently missing in the dental literature. Also note, if the test groups are compared over time, was the time interval long enough? A difference noted may initially be found to be "statistically significant," but when followed for a longer more appropriate period of time, this difference may in fact disappear, with the end result that indeed there was no difference in the intervention being studied.

The *p*-value or statistical significance should be assigned before the study is conducted. In most dental literature, a *p*-value of 0.05 is used to indicate significance. A term creeping into the literature is "the results are approaching significant." An outcome is either significant or not. Significant results may also be indicated by a confidence level (CL) that implies the probability that the true result falls within a defined interval.

A large and varied body of literature is available, dealing with critical thinking. Critical thinking is now required in the curriculum in all US dental schools. In the field of dentistry, the concepts critical thinking and evidence-based dentistry are essentially being used synonymously. However, while evidence is a significant part of critical thinking, it represents only one part.

Further, some people believe that critical thinking is confined to given subjects such as literature and the humanities. However this would be incorrect. Critical thinking is in fact relevant to all subjects and disciplines in which people reason, including dentistry; critical thinking can and should be applied to all facets of life where best decisions need to be made and issues need to be reasoned through.

There isn't a single definition capturing all components and complexities of critical thinking. According to Dr. Richard Paul, a world-renowned authority on this subject, "critical thinking is thinking about your thinking while you are thinking in order to improve your thinking." This offers just one simple way into the concept. In the remainder of this chapter, we will attempt to provide the basic format of the Paul-Elder Critical Thinking Model™ (Fig. 1.3). It is up to dental professionals to apply this method to our continuing education seminars and professional meetings and even to other interpersonal interactions.

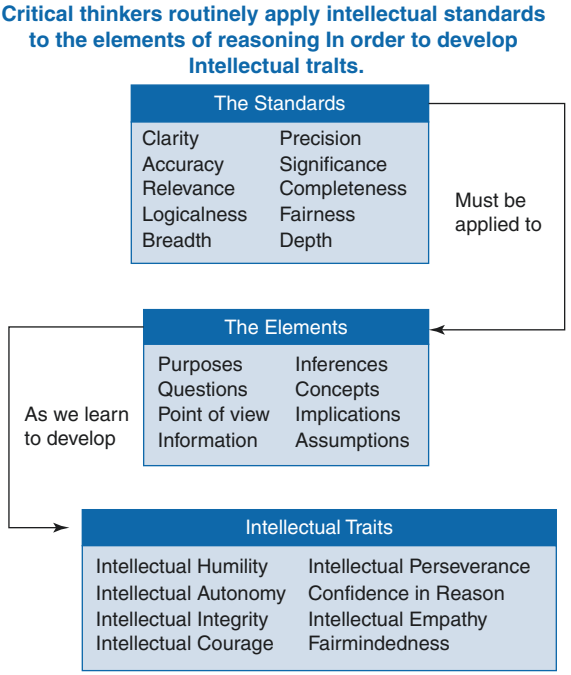



**Fig. 1.3** The Paul-Elder Critical Thinking Model™ (Paul and Elder 2015)

## 1.7 Paul-Elder Approach to Critical Thinking

*The Paul-Elder Framework for Critical Thinking*™ offers a unique approach to analyzing an article, lecture, case study, patient interaction, etc. into eight component parts. The eight component parts are based on *reasoning* and are as follows: purpose, key question, point of view, assumptions, information, concepts, inferences, and implications (Fig. 1.4).

It is important to realize that there is no hierarchy to the eight parts of reasoning; they all are open to analysis; and they function in a dynamic relationship with one another in the mind of all humans. Therefore the provider need not analyze reasoning (either one's own or a patient's) in a specific order. From a practical point of view though, it may be easier to conduct the analysis in the order given above. Consistent use in this order will ensure that all eight components have been considered when reasoning through a given issue. An advantage of using this mode of analysis for most peer-reviewed literature is that at least half of the components can usually be identified in the article's abstract.

This analysis is useful in analyzing any form of reasoning in any context—a lecture, an article, a book, and a conversation. The use of the *Checklist for Clinical Reasoning* taken from *The Thinker's Guide to Clinical Reasoning* (Hawkins et al. 2010) simplifies the process (Fig. 1.5). The following helpful diagrams from this guide illustrate the analysis and assessment process in clinical practice.

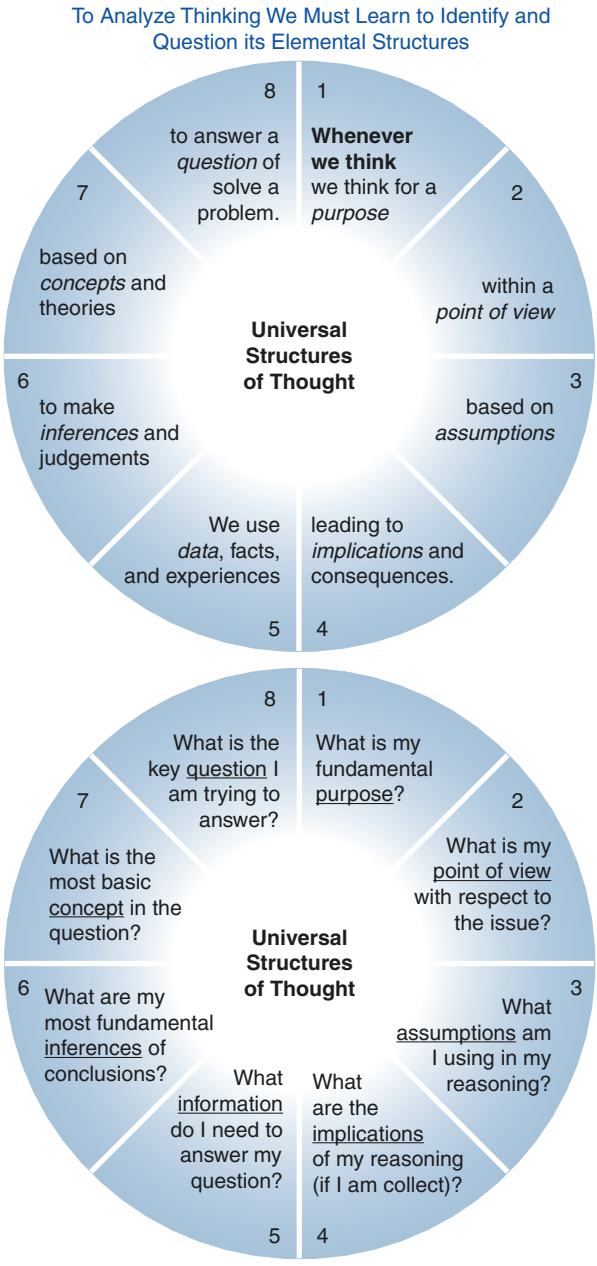
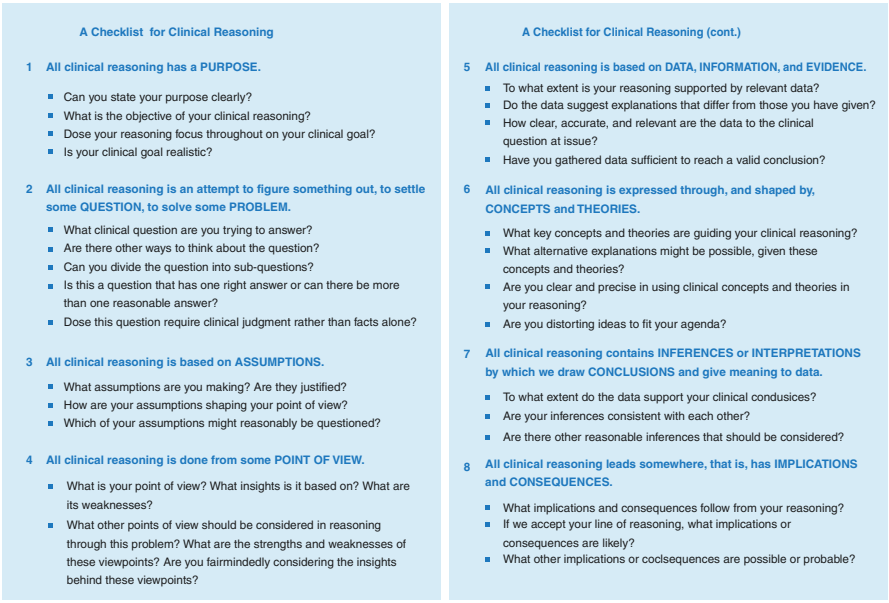



**Fig. 1.4** Elements of critical thinking (Elder and Paul 2010)



**A Checklist for Clinical Reasoning**

**1 All clinical reasoning has a PURPOSE.**

- Can you state your purpose clearly?
- What is the objective of your clinical reasoning?
- Dose your reasoning focus throughout on your clinical goal?
- Is your clinical goal realistic?

**2 All clinical reasoning is an attempt to figure something out, to settle some QUESTION, to solve some PROBLEM.**

- What clinical question are you trying to answer?
- Are there other ways to think about the question?
- Can you divide the question into sub-questions?
- Is this a question that has one right answer or can there be more than one reasonable answer?
- Dose this question require clinical judgment rather than facts alone?

**3 All clinical reasoning is based on ASSUMPTIONS.**

- What assumptions are you making? Are they justified?
- How are your assumptions shaping your point of view?
- Which of your assumptions might reasonably be questioned?

**4 All clinical reasoning is done from some POINT OF VIEW.**

- What is your point of view? What insights is it based on? What are its weaknesses?
- What other points of view should be considered in reasoning through this problem? What are the strengths and weaknesses of these viewpoints? Are you fairmindedly considering the insights behind these viewpoints?

**A Checklist for Clinical Reasoning (cont.)**

**5 All clinical reasoning is based on DATA, INFORMATION, and EVIDENCE.**

- To what extent is your reasoning supported by relevant data?
- Do the data suggest explanations that differ from those you have given?
- How clear, accurate, and relevant are the data to the clinical question at issue?
- Have you gathered data sufficient to reach a valid conclusion?

**6 All clinical reasoning is expressed through, and shaped by, CONCEPTS and THEORIES.**

- What key concepts and theories are guiding your clinical reasoning?
- What alternative explanations might be possible, given these concepts and theories?
- Are you clear and precise in using clinical concepts and theories in your reasoning?
- Are you distorting ideas to fit your agenda?

**7 All clinical reasoning contains INFERENCES or INTERPRETATIONS by which we draw CONCLUSIONS and give meaning to data.**

- To what extent do the data support your clinical condusices?
- Are your inferences consistent with each other?
- Are there other reasonable inferences that should be considered?

**8 All clinical reasoning leads somewhere, that is, has IMPLICATIONS and CONSEQUENCES.**

- What implications and consequences follow from your reasoning?
- If we accept your line of reasoning, what implications or consequences are likely?
- What other implications or coclsequences are possible or probable?

**Fig. 1.5** Checklist for clinical reasoning (Hawkins et al. 2010)

## 1.8 Reasoning Through the Logic of This Chapter

We can take the eight elements of reasoning and use them to figure out the logic of this chapter we are writing for this book, as follows:

**Purpose**—*What is the author trying to accomplish?* For instance, the purpose of this chapter is to give the dental practitioner a reasonable and defensible rationale behind evidence-based dentistry and suggested ways to easily accomplish this goal.

**Key Question**—*What essential question does this chapter, article, or lecture address?* For instance, a key question in writing this chapter was: What is a feasible approach to addressing implementation of EBD?

**Point of View**—*From what direction is the question being viewed and answered? What are you looking at and how are you seeing it?* Focusing on point of view can help define potential bias when one is evaluating a piece of research, lecture, or interaction. One of the authors [MG] has been a dentist for the past 40 plus years and in this capacity has provided direct patient care as an oral and maxillofacial surgeon; for the past 15 years, he has been involved in teaching critical thinking skills to dental students. The other author [LE] has made

teaching of critical thinking her life's work and is the one of the developers of Paul-Elder Framework for Critical Thinking™. Each author therefore brings a different point of view to this chapter, and both viewpoints enhance the other. To take a different example, when considering the point of view in the context of EBD, one must consider not only how a dental provider is looking at an issue but very importantly how the patient may view the same issue; in many situations, there also must be a consideration of how a third-party payer may be looking at the same issue.

**Assumptions**—*What is being, or should be, taken for granted in the clinical context?* One assumption being made by the authors of this chapter is that the readers want to be more facile in applying evidence-based dentistry to their practice and therefore would see this chapter as useful and valuable. The readers, in turn, should assume that the authors have been vetted and are therefore sufficiently expert in their fields to write intelligently about the issues in this chapter.

**Information**—*What data is being used in the article or chapter?* The information used in this chapter offers the basics of what, why, when, and how of EBD. It also offers a rich conception of critical thinking for the reader, through which EBD can be best implemented.

**Concepts**—*Concepts are the rules, laws, and principles used to interpret the information in order to ultimately derive a conclusion.* The primary concepts used in this chapter include our idea of what constitutes EBD and how it may be reasonably understood in the dental field. This chapter also introduces the Paul-Elder Framework for Critical Thinking™, as a primary conceptual tool for engaging in EBD.

**Conclusions**—*What primary conclusions do the authors of this chapter want the reader to accept?* At the end of this chapter, our expectation is that the reader will conclude that evidence-based dentistry has value and that there are powerful conceptual tools available for engaging in effective EBD.

**Consequences**—*What happens if one acts or fails to act on the conclusions offered in this chapter?* A desired consequence of this chapter is that the reader will incorporate critical thinking, not only throughout their practice in client care but also in their daily life. If EBD is considered valuable, then as a result of using EBD, one will be in a better position to make reasonable and sound decisions—based on fact and not myth. If the concepts of EBD and critical thinking are not accepted by the reader, the reader may not see the value of progressing as a thinker in dental care and hence keep doing the same thing year after year, never advancing as a dental provider.

## 1.9 Analyzing and Assessing Clinical Research Using the Tools of Critical Thinking

The essence of this textbook entails the idea that the best treatment option for a patient should be supported by the best available scientific data. The eight parts of reasoning are very useful in analyzing and assessing research in the field of dentistry (Fig. 1.6).

## Analyzing & Assessing Clinical Research

**Use this template to assess the quality of any clinical research project or paper.**

1) All clinical research has a fundamental PURPOSE and goal.

- Research purposes and goals should be clearly stated.
- Related purposes should be explicitly distinguished.
- All segments of the research should be relevant to the purpose.
- All research purposes should be realistic and significant.

2) All clinical research addresses a fundamental QUESTION, problem or issue.

- The fundamental question at issue should be clearly and precisely stated.
- Related questions should be articulated and distinguished.
- All segments of the research should be relevant to the central question.
- All research questions should be realistic and significant.
- All research questions should define clearly stated intellectual tasks that, being fulfilled, settle the questions.

3) All clinical research identifies data, INFORMATION, and evidence relevant to its fundamental question and purpose.

- All information used should be clear, accurate, and relevant to the fundamental question at issue.
- Information gathered must be sufficient to settle the question at issue.
- Information contrary to the main conclusions of the research should be explained.

4) All clinical research contains INFERENCES or interpretations by which conclusions are drawn.

- All conclusion should be clear, accurate, and relevant to the key question at issue.
- Conclusions drawn should not go beyond what the data imply.
- Conclusions should be consistent and reconcile discrepancies in the data.
- Conclusions should explain how the key questions at issue have been settled.

5) All clinical research is conducted from some POINT OF VIEW or frame of reference.

- All points of view in the research should be identified
- Objections from competing points of view should be identified and fairly addressed.

6) All clinical research is based on ASSUMPTIONS.

- Clearly identify and assess major assumption in the research.
- Explain how the assumptions shape the research point of view.

7) All clinical research is expressed through, and shaped by, CONCEPTS and ideas.

- Assess for clarity the key concepts in the research.
- Assess the significance of the key concepts in the research.

8) All clinical research leads somewhere (i.e., have IMPLICATIONS and consequences).

- Trace the implications and consequences that follow from the research.
- Search for negative as well as positive implication.
- Consider all significant implications and consequences.

**Fig. 1.6** Analyzing and assessing clinical research (Hawkins et al. 2010)

## 1.10 The Importance of Universal Intellectual Standards in Evidence-Based Dentistry

Once the eight parts have been analyzed, then a critical assessment of the article, lecture, event, etc. can be accomplished. For this, we must understand, internalize, and adhere to *universal intellectual standards* on a daily basis. Essential intellectual

standards include *clarity*, *accuracy*, *precision*, *relevance*, *significance*, *depth*, *breadth*, *logic*, and *fairness* (Fig. 1.7). From a practical standpoint, certain parts of the analysis and assessment can be accomplished at the same time. Using only a few of the analysis and assessment items, a quick determination as to the potential value of a given piece of research can often be accomplished.

### Universal Intellectual Standards Essential to Sound Clinical Reasoning

Universal intellectual standards are standards which must be applied to thinking Whenever one is evaluating the quality of reasoning about a problem, issue, or situation. To think cirtically one must have a command of these standards. While there are a number of universal standards, we focus here on some of the most significant:

**Clarity**

Could you elaborate further on that point? Could you express that point in another way? Could you give me an illustration? Could you give me an example?

Clarity is a gateway standard. if a statements is unclear, we cannot determine whether it is accurate or relevant. infact. In fact, we cannot tell anything about it (except that it is unclear) because we don't yet know what it is saying.

**Accuracy**

Is that really true? How could we check that? How could we find out if that is true? What evidence is there to support the validity of your clinical thinking?

A statement can be clear but not accurate, as in "Most creatures with a spine weigh more than 300 pounds."

**Precision**

Could you give me more details? Could you be more specific?

A statement can be both clear and accurate, but not precise, as in "The solution in the beaker is hot." (We don't know how hot it is.)

**Relevance**

How is that connected to the question? How dose that bear on the issue?

A statement can be clear, accurate, and precise, but not relevant to the question at issue. If a person who believed in astrology defended his/her view by saying "Many intelligent people believe in astrology." their defense would be clear, accurate, and sufficiently precise, but irrelevant to clinical reasoning.

**Depth**

How dose your answer address the complexities in the question? How are you talking into account the problems in the question? Are you dealing with the most significant factors?

A statement can be clear, accurate, precise, and relevant, but superficial (that is, lacks depth). For example, the statement "Just Say No" which is often used to discourage children and teen from using drugs, is clear, accurate, precise, and relevant. Nevertheless, it lacks depth because it treats an extremely complex issue, the pervasive problem of drug use among young people, superficially. It fails to deal with the complexities of the issue.

**Fig. 1.7** Analyzing and assessing clinical research (Hawkins et al. 2010)

**Breadth**

Do we need to consider another point of view? Is there another way to look at this question? What would this look like from the point of view of a conflicting theory, hypothesis or conceptual scheme?

A line of reasoning may be clear, accurate, precise, relevant and deep, but lack breadth (as in a well-reasoned argument from either of two conflicting theories which ignores insights into the conflicting theory).

**Logic**

Does this really make sense? Is this consistent with what we know about this issue or problem?

When we think, we bring a variety of thoughts together into some order. When the combination of thoughts is mutually supporting and makes sense in combination, the thinking is "logical." When the combination is not mutually supporting, is contradictory in some sense, or does not "make sense" the combination is "not logical." In clinical reasoning, new conceptual schemes become working hypotheses when we deduce from them logical consequences which can be tested by experiment. If many of such consequences are shown to be true, the theory (hypothesis) which implied them may itself be accepted as true.

**Significance**

Is the most important problem to consider? Is this the central idea to focus on? Which of these facts are most important?

When dealing with a complex issue it is essential to consider relevant variables but some are more significant than others. The most significant variables should be considered first. Secondary relevant variables come next in order of importance.

**Fairness**

Do we nhave a vested interest in this issue? Am I represnting the viewpoints of others in a way that is fair and balanced?

We naturally think from our own perspective, from a point of view which tends to privilege our position. Fairness implies the treating of all relevant viewpoints alike without reference to one's own feelings or interests. Because we tent to be biased in favor of our own viewpoint, it is important to keep the standard of fairness at the forefront of our thinking. This is especially important when the situation may call on us to see things we don't want to see, or give something up that we want to hold onto.

**Fig. 1.7** (continued)

In assessing the quality of this chapter, using essential intellectual standards, the reader should find the following to be true:

**Clarity**—Hopefully the reader has found this chapter relatively straightforward and easy to read. Diagrams and charts were included to illustrate the material to help the reader better understand the text. The chapter itself has been used to provide an example on how to use the Paul-Elder Framework for Critical Thinking™ in EBD.

**Accuracy and Precision**—Terms were defined, and figures were taken from published materials. Appropriate literature was cited.

**Depth and Breadth**—The depth of the chapter is appropriate for the stated purpose (see above). Should the reader desire more depth, there are numerous articles

and texts devoted to the topic of evidence-based practice available through the sources indicated in this chapter. Similarly the breadth of the chapter was limited to only one literature review technique—the Paul-Elder Approach to Thinking™. This is also in keeping with the stated purpose.

**Relevance**—The concept of evidence-based practice is now an established part of contemporary dental practice. The Paul-Elder Critical Thinking Model provides a structured method for analyzing and assessing the scientific literature.

**Significance**—EBD is essential for reasonable dental practice in today's complex information society.

**Logic**—The chapter starts with defining EBD and flows from why to how. EBD is logically connected with the richer concept of critical thinking.

**Fairness**—Evidence and ideas in this chapter have been presented objectively and without bias.

## 1.11 Conclusion

To sum up this chapter, we may return to our question: *What is evidence-based dentistry?* First and foremost, it does not entail simply "doing an intervention" just because some given piece of research may offer "correct" course of action. Rather, evidence-based dentistry involves a *critical appraisal* of appropriate research and other information that addresses a patient's specific circumstances, as well as her or his value system, interpreted through the clinician's knowledge, experience, and expertise.

Why do it? Because it takes into account the worldview of the dental patient as well as the best knowledge available at a given time, in the field of dentistry.

How can EBD be reasonably accomplished?

1. Listen to patients to determine what they want.
2. Make an honest assessment of the dental situation in context.
3. Critically review the literature most relevant to the specific situation.
4. Then using personal experience, determine the best options to address the specific situation. There is usually more than one way to reach a satisfactory result. Conduct a cost-benefit, risk-benefit discussion with the patient. This is the informed consent process; make sure it is documented.

This chapter encourages the use of Paul-Elder's Framework for Critical Thinking™. It is one of the many ways to select and critically assess the literature. But it has been chosen for inclusion here because it provides an excellent method for reasoning through specific decisions, using the richest tools of criticality extant. And we have recommended that the reader apply this approach to all aspects of life. In starting this critical thinking process, consider beginning with assumptions. What assumptions have you or others made about others that resulted in a course of action detrimental or not in the best interest of your client?

The tools of critical thinking can be easily documented in the best thinking in dental practice. But dentists have yet to embrace, as a profession, a robust conception of fair-minded critical thinking. This will be required if the best evidence-based dental practices are to be achieved.

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# Office Environment

# 2

Melissa E. Ing and Peter Arsenault

*"I fear that if the matter is beyond humanity it is certainly beyond me."*

—The Adventure of the Devil's Foot

**Abstract**

The dental profession is predisposed to various occupational hazards including blood-borne pathogens, chemical agents, and particulate projectiles which can cause skin and eye safety issues and musculoskeletal disorders. Oral surgery procedures can cultivate these occupational hazards. This chapter discusses these problems, their implications, and subsequent approaches to create a safe and functional work environment. In addition, this chapter focuses on how to incorporate proper ergonomics to prevent musculoskeletal disorders, thereby helping dentists maintain a healthy, long-term career.

## 2.1 Office Environment/Office Design

A dental office environment with thoughtful attention to details allows for patient comfort as well as employer and employee satisfaction. The practice should look professional and organized, with up-to-date technology, as superior office design can be an excellent marketing tool. The workplace is an expression of the dentist's personality and should make a positive impression on the patient. Particular attention should be given to make the waiting area appealing and reassuring to anxious patients. Furthermore, treatment areas should have soundproof walls to drown out loud noises such as those from turbine-driven handpieces.

Dentists will always have their personal vision of what the office space should consist of. However, an office's clinical function will dictate its layout and ergonomic considerations.

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The floor plan should have good traffic flow. There should be areas that are accessible to patients and private areas designated only for the staff.

Dental professionals can be exposed to numerous occupational hazards including exposure to blood-borne pathogens, chemical agents, and musculoskeletal disorders due to ergonomic setups. The office environment should provide protective mechanisms and a systematic approach to safe practices.

## 2.2 Blood-Borne Pathogens

Dental offices must vigilantly follow the Centers for Disease Control and Prevention (CDC) and the Occupational Safety and Health Administration (OSHA) guidelines for proper infection control and safe work practices. While the CDC is a government agency within the US Public Health Service, it is not a regulatory authority (Cuny and Collins 2013). However, creating infection control recommendations according to evidence-based research is one of the CDC's many tasks. OSHA is part of the US Department of Labor, and their duty is to protect the health and safety of workers within the USA. OSHA creates regulations such as the Bloodborne Pathogens standard to reduce the risk of occupational exposure to blood-borne pathogens (Cuny and Collins 2013).

The blood-borne pathogens that are of concern to dental health-care personnel (DHCP) are hepatitis B (HBV), hepatitis C (HCV), and human immunodeficiency virus (HIV). HBV vaccinations became routine in 1982 and universal precautions have been recommended since 1987.

Due to hepatitis B vaccinations and universal precaution recommendations, transmission of blood-borne pathogens in the dental setting has rarely been reported during the last decade. In the 1990s, there was one case where a dentist with autoimmune deficiency disease (AIDS) was found to have transmitted HIV to five of his patients after invasive procedures (Ciesielski and Marianos 1992). At this time, there are no known patient to patient reports of HIV transmission.

Yet, a 2016 review of the literature cites three reports of blood-borne pathogen transmissions of hepatitis B and hepatitis C from 2003 through 2015 (Cleveland 2016). The article described an incident from 2002 as a single HBV transmission from one patient to another patient that occurred in an oral surgery office. The article described a 2009 occurrence as the first documented patient to patient HBV transmission which occurred in a large portable free dental clinic setting. The third reported incident occurred in 2013 at an oral surgery office and is considered the first documented case of patient to patient transmission of HCV in an American dental setting. In the 2002 case, investigators speculated that there was a breach in cleaning the environmental surfaces that resulted in cross contamination of blood with the source patient who had chronic HBV with a high viral load at the time of the surgery (Cleveland 2016). In the 2009 documented case, five HBV transmissions occurred from a portable free dental clinic that was held in a gymnasium. Multiple failures in infection control were cited retrospectively as the cause of the transmission of HBV to three other patients as well as to two DHCP. It was reported that the

utilized handpieces were not heat sterilized; unwrapped sterilized instruments were utilized, and patients were allowed to transport partially used anesthetic cartridges in metal syringes to another station for later reuse (Cleveland 2016). Investigators speculate that the 2013 patient to patient transmission of HCV occurred due to the failure to administer IV sedation by licensed, trained dental personnel, due to the use of improperly sterilized equipment, and due to the reusing of contaminated medication vials, needles, and syringes (Cleveland 2016).

Lesson gleaned from the above reporting is that even though blood-borne pathogen transmissions are infrequent, they can happen from routine restorative and oral surgery procedures. There are several potential routes for the spread of infection in the dental clinic. These include (1) direct contact with bodily fluids of an infective patient, (2) contact with contaminated instruments or environmental surfaces, and (3) contact with infectious airborne particles from an infective patient (Harrel and Molinari 2004).

HBV and HCV can survive on blood-contaminated environmental surfaces for long periods of time. Bond et al. demonstrated that the HBV virus can survive in dried blood at room temperature on environmental surfaces for at least 1 week (Bond et al. 1981). Furthermore, Paintsil et al. demonstrated that HCV infectivity can remain on dry surfaces for up to 6 weeks (Paintsil et al. 2014). HIV can survive in dried blood at room temperature for 5–6 days if placed in an ideal pH level. For long-term survival, HIV cannot have a pH below 7 nor a pH above 8 (Tjotta 1991).

In 2003 the CDC published the Guidelines for Infection Control in Dental Health Care Settings. To this day, this remains the standard for offices and institutions to follow (CDC 2003). More recently, the CDC also published the Summary of Infection Prevention Practices in Dental Settings: Basic Expectations for Safe Care. This includes a handy infection prevention checklist that DHCP can use to evaluate infection control compliance (CDC n.d.-a). Offices should designate an infection control officer to be in charge of assessing annual safe practice policies and updating a written manual. Dental offices should ensure each DHCP hire and current employees have yearly OSHA training.

Clinicians should always keep in mind that all patients could be carriers of an infectious disease. Therefore, universal precautions should always be followed. Since oral surgical procedures can increase the risks of local or systemic infection, it would be prudent to have an extra vigilant infection prevention routine in place.

## 2.3 Spatter and Aerosols

In the dental operatory, a visible spray is created each time high-speed rotary handpieces, ultrasonic scalers, or air-water syringes are utilized. Water is often used as coolant with handpieces and ultrasonics to prevent overheating of tooth structure. Studies show that when high-speed rotary handpieces are used, the air can be contaminated for a period of time until the particles settle (Harrel and Molinari 2004). In oral surgery, Hall drills, Stryker drills, and high-speed and low-speed drills are often used to section teeth for easier extraction and for implant placement.

The water spray alone that is generated from the rotary equipment may not be harmful, but once mixed with the patient's oral fluids such as saliva, blood, bone fragments, human tissue, bacteria, and debris, it can turn into a potential health hazard.

This visible spray contains larger and smaller particles. The larger particles, in the size of 50 μm or more, are called "spatter" (Harrel and Molinari 2004; Micik et al. 1969). Since spatter particles are large and heavy, they traverse short distances, landing fairly quickly on operatory surfaces, equipment, the clinician, and the patient.

In contrast, aerosols are defined as a collection of solid or liquid particles which are less than 50 μm in size (Harrel and Molinari 2004; Micik et al. 1969). Since aerosols are much smaller particles, they remain suspended in air much longer than spatter before finally contacting surfaces (Harrel and Molinari 2004). In fact, aerosols can stay suspended in the operatory air for up to 30 min (Harrel and Molinari 2004). Some of the smaller aerosols that range in size from 0.5 to 10 μm can potentially travel to and penetrate into the pulmonary passages (Harrel and Molinari 2004). Harrel and Molinari noted that if DHCP remove face shields upon completing the procedure to talk with the patient, there is potential contact with aerosol contaminants which are floating in the environment (Harrel and Molinari 2004).

Studies have demonstrated that the ultrasonic scaler produces the greatest amount of airborne contamination followed by the high-speed handpiece. The air-water syringe also produces a great deal of aerosols (Harrel and Molinari 2004).

Investigators have demonstrated that during scaling and root planing, blood is always present in the ultrasonic scaler aerosols (Harrel and Molinari 2004). Harrel and Molinari deduced that blood is most likely present in aerosols where any rotary instrumentation was used within an operating field containing blood. This would include any subgingival, periodontal, and oral surgery procedures (Harrel and Molinari 2004).

## 2.4 Infection Control Measures

The most logical and first precautionary measure to reduce spatter and aerosols is to ensure that DHCP wear OSHA-approved personal protection equipment (PPE) while treating patients as well as when preparing and breaking down the operatory.

PPE consists of and should be donned in the following sequence: (1) fluid resistant clinic gowns, (2) face masks, (3) safety eyewear, and (4) gloves.

Clinic gowns should have high necks and long sleeves, with ribbed cuffs at the neck and at the wrists. The gowns should at least cover the operator's knees when seated. Rutala et al. studied the cost differences between disposable and reusable gowns and found that reusable gowns did not always save money due to the fact that the gowns would be damaged during the handling and laundering process thus rendering them useless (Rutala et al. 2001). Rutala also demonstrated that some

reusable gown materials proved more superior than others. Gowns with a laminated coating of polypropylene provided the most superior resistance to blood and other liquids seeping through. A single-layered non-woven fabric was found to be the next best performing reusable gown fabric. 50 cotton/50 polyester was not very effective in preventing blood strike through, and 100% cotton offered the least amount of protection (Rutala et al. 2001).

If masks become soiled or wet during the procedure, they should be replaced. Clinicians should always avoid touching masks during the course of treatment to prevent cross contamination. All dental mask styles provide protection of covered facial areas (nose, mouth, and portions of the cheeks) against splash and projectiles.

Dental masks are available in a variety of designs and profiles. Pleated-type dental masks are preferred by dental practitioners since they are easy to wear and have low resistance to breathing. Most pleated masks contain an inner layer of melt-blown filtration material (Arsenault and Tayebi 2016). However, since there is no effective seal between the perimeter of the mask and the wearer's face, air leakage occurs through the perimeter of the mask, and hence, the mask fails to provide effective respiratory system protection. The National Institute for Occupational Safety and Health (NIOSH), which is part of the CDC, utilizes research to promote safer recommendations for workers. In comparison to NIOSH-approved respirators, most pleated masks lack the seal between their perimeter and the wearer's face and hence would not meet NIOSH approval requirements (Arsenault and Tayebi 2016). Masks that are fitted with a full-face transparent shield such as an up visor or a full down visor may be particularly desirable when an oral surgery procedure generates excessive blood splashes, fluids, or particulates.

The CDC recommends that prior to oral surgical procedures, a fast-acting antimicrobial soap with a broad spectrum of bactericidal activity is utilized for handwashing. For oral surgery procedures in the operating room, sterile gloves should be used. If gloves become wet and torn or are deemed defective, they should be promptly replaced. Scrupulous handwashing after the procedure is completed must take place.

In 2006, Rautemaa et al. studied how far aerosols travel from a patient after the use of high-speed rotary instrumentation is utilized in the operatory. Investigators placed agar plates in distances varying from 0.5 to 2 m from the patient. The agar plates were samples before and after dental procedures. At the same time, they also sampled the facial masks of the DHCP before and after the procedure. The most commonly found bacteria in the agar plates were *Viridans streptococci* and staphylococci. Significant contamination was found from agar plates at all distances. Face masks were found to be equally contaminated when high-speed rotary instruments were used. Rautemaa's study substantiates how aerosols spread beyond the area and equipment used for the procedure (Rautemaa et al. 2006). Thus, all PPE needs to be removed as soon as the DHCP leave the operating area to prevent cross contamination. This study also substantiates the need to wear PPE when cleaning, preparing, and breaking down operatory surfaces and equipment (Rautemaa et al. 2006).

In addition, Rautemaa's work demonstrates that all environmental surfaces, even if not used for the procedure, must be thoroughly disinfected at the beginning of the workday, in between each patient, and at the end of the workday. Rautemaa's study also suggests that only necessary equipment items needed for the procedure at hand be placed within the operatory work surfaces to minimize contamination and that all other items be placed within a closed cupboard (Rautemaa et al. 2006). Furthermore, Rautemaa et al. (2006) suggest protection of the exposed skin and hair to prevent bacterial spread.

As a second precautionary measure, having patients use an antiseptic preoperative rinse such as 0.01% chlorhexidine for 1 min prior to the procedure can lower overall bacterial counts in the operating environment (Harrel and Molinari 2004).

A third essential method in reducing airborne aerosols is to use an efficient high-volume evacuator (HVE) to prevent aerosols and bacteria from escaping the immediate operating site. An HVE suction system is defined as one that removes a large volume of air within a short period of time. Most HVE used in dentistry are attached to an evacuation system and will have an 8 mm or greater opening and are able to remove up to 100 cubic feet of air per minute. Since a saliva ejector has a very small opening, it cannot remove enough volume of air to be classified as an HVE. Studies demonstrated that an HVE with a good suction system can reduce up to 90% of operatory area contamination (Harrel and Molinari 2004; Micik et al. 1969). A study done by Noro et al. in Japan demonstrated that the use of a high-speed vacuum aspirator effectively reduced the spread of streptococci bacteria (Micik et al. 1969; Noro et al. 1995).

It is important that each dental unit suction hose be flushed twice daily with disinfecting agent and routinely cleaned according to manufacturer's instructions. The water in each unit should be flushed for any utilized handpieces, ultrasonic scalers, and air-water syringes for 30 s after each patient.

Whenever possible, single-use devices such as aspirator tips and drill burs should be used. Disposable instruments and equipment eliminate the risk of patient to patient contamination once it is discarded after one-time use. Items such as patient bib clip chains are sources of cross contamination. The University of North Carolina cultured bib chains in a study and found strains of *Pseudomonas*, *E. coli*, and *Staphylococcus aureus*. These bacteria can put immunocompromised populations at even greater risk for respiratory disease transmission. Disinfecting the napkin holders does not eradicate the bacteria completely, so disposable holders should be considered instead (Molinari 2010). The CDC recommends that one-time-use gauze, irrigating syringes, syringe needles, and scalpel blades used for oral surgery procedures be sterile (CDC n.d.-b).

At the end of the appointment, the CDC recommends the following sequential order for instrument processing (Cuny and Collins 2013; CDC 2003). Sharps, including syringe needles, burs, and scalpel blades, need to be carefully discarded into specially marked puncture-resistant sharps containers. Next, single-use disposable materials and waste should be discarded. Biohazard waste must be disposed of in specially marked biohazard containers in accordance with state

regulations. The equipment and instrument cassettes should be transported to a centrally located cleaning and sterilization area that fosters one-directional work flow which will prevent cross contamination (Cuny and Collins 2013). There should be separate areas for receiving dirty instruments and cassettes as well as areas for decontamination, packaging for sterilization, and sterilization. There should be a separate storage area to place sterile packaged instruments until ready for the next procedures.

The CDC has made three categories of criteria to determine how instruments should be sterilized. These categories are (1) critical, (2) semi-critical, and (3) non-critical. Critical instruments are those that penetrate soft tissue, contact the bone, or have entered the bloodstream. Critical instruments used in oral surgery procedures would include dental burs, elevators, forceps, and scalpel blades. Semi-critical instruments are those that contact mucous membranes but have not penetrated soft tissue or bone and have not entered the bloodstream. These instruments would include dental mouth mirrors and dental handpieces. Noncritical instruments are those that contact intact skin, and this equipment would include blood pressure cuffs, pulse oximeters, and radiographic tube heads. The CDC stipulates that all critical instruments be heat sterilized as well as all dental handpieces even though they are considered semi-critical (Cuny and Collins 2013; CDC 2003).

Utilized handpieces should be lubricated after use to prolong the life of the equipment prior to sterilization. Hand instruments should be cleaned thoroughly with either a washing disinfecting machine or an ultrasonic soak. The pre-cleaning helps to remove blood or debris that could potentially harm the DHCP that is packaging the cassettes for sterilization. Used handpieces and hand instruments must be inspected thoroughly for any left on particles of blood, tooth, and bone debris. Debris must be removed so as not to compromise the sterilization process. A metal cleaning brush can be used to clean off caked on debris. Equipment should then always be prepared for sterilization by wrapping and sealing in special pouches or bound in sterilization appropriate sheeting that are labeled to show the date of sterilization, which sterilizer was used, and the load or cycle.

Quality assurance of the instrument sterilization process must be upheld for patient safety. It is crucial that sterilization machines are not improperly loaded. Overloading is a common reason for sterilization failure. Utilizing a combination of biological and chemical indicator methods ensures that adequate sterilization conditions have been achieved (Cuny and Collins 2013).

The biological indicator method is also commonly referred to as “spore testing.” Spore testing is recommended at least once a week for private practice offices and institutions. Spore testing is the most widely accepted method of testing sterilization efficacy since it can kill highly resistant microorganisms such as *Geobacillus* and *Bacillus* (Cuny and Collins 2013; CDC 2003).

Since spore testing might only be done once a week and takes some time to obtain the results, it is prudent to also utilize a chemical indicator method. Chemical indicators can provide more timely indications if sterilization equipment malfunction were to occur (Cuny and Collins 2013; CDC 2003).

Peel and seal sterilization pouches specially marked with sensitive chemical indicators will change color if the contents have been sterilized to correct temperature and time. It is also possible to place chemical indicating tape over wrapped instruments. If a color change does not occur after the sterilization process, this indicates that the sterilization process has been compromised, so the instruments should be repackaged and sent through sterilization again (Cuny and Collins 2013; CDC 2003).

Furthermore, chemical indicating devices, called "multiparameter integrators," are highly suggested to be placed within the instrument pouches to determine optimal sterilization conditions. The integrators verify that the sterilization process has penetrated the instruments within the packaging (Cuny and Collins 2013; CDC 2003). Multiparameter integrators indicate if the contents of the peel and seal pouch have been exposed to the correct time, temperature, and pressure during autoclaving procedures (see Photo 2.1).

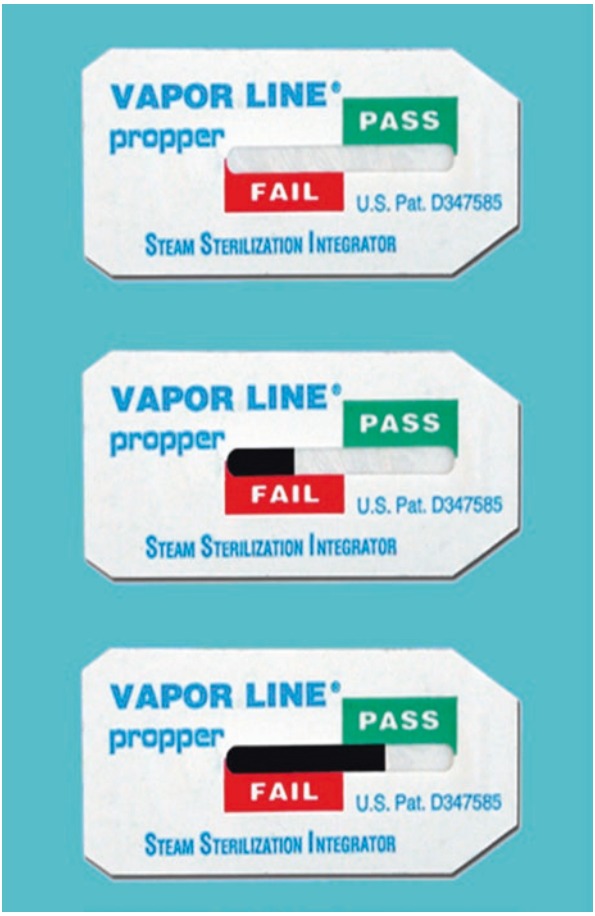



**Photo 2.1** Example of a chemical multiparameter integrator (courtesy of Vapor Line)

## 2.5 Eyewear Safety Considerations

OSHA Standard 1910.133(a) (1) states:

> "The **employer** shall ensure that each affected employee uses **appropriate** eye or face protection when exposed to **eye** or face hazards from **flying particles**, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation."

By their nature, dental procedures involving drilling at very high speeds (180,000–500,000 rpm) generate debris that can travel at speeds of up to 50 mph (Arsenault and Tayebi 2016). Such debris could include pieces of amalgam, tooth enamel, calculus, pumice, and broken dental burs. In the absence of a protective means, such debris may find its way to the eyes of the practitioner, the staff, or the patient.

CDC and OSHA mandate that dentists wear protective eyewear (either glasses or loupes, prescription or nonprescription) while performing dental procedures. Most often, dental assistants wear either prescription or nonprescription safety eyewear.

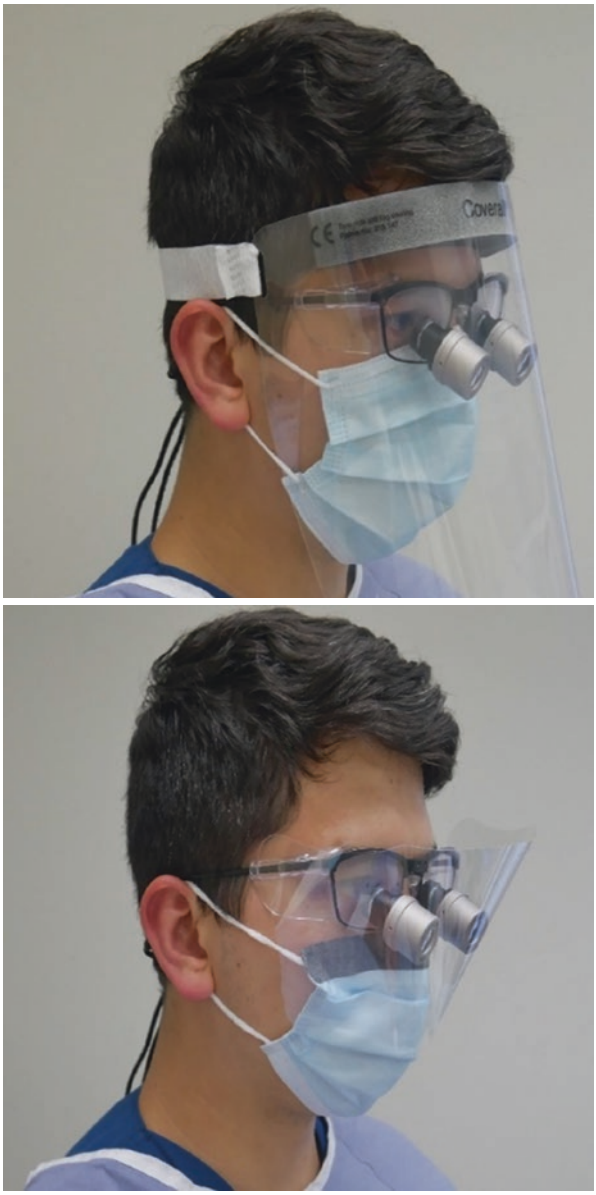
Masks with full-face shield or a mask and visor combination provide the most effective facial and eye protection to date against projectile and spatter hazards (see Photos 2.2 and 2.3). However, their use by dental practitioners is limited due to their higher cost, reflective glare, fogging, and optical distortion caused by the unavoidable curvature of the face shield when the mask is worn and hotness of the air in the zone between the face shield and the wearer's face. This results in discomfort and inconvenience.

There are three possible routes dental debris may follow in order to reach the eye of a practitioner not wearing a full-face shield mask or mask and visor combination.

(a) Frontal entry route by debris traveling perpendicular to the dental professional's face. Glasses provide the necessary protection against such debris. Not only do the glasses need to meet OSHA Standard 1910.133(a) (1), but they also must meet ANSI Standard (Z87.1) (Arsenault and Tayebi 2016). ANSI is the American National Standards Institute which supervises the development of safety standards from products, systems, and services in the USA. By choosing eyewear that meets both OSHA and ANSI, fewer eye injuries are caused by flying debris.
(b) Sideway (right to left or left to right) entry routes by debris traveling tangential to the face. Side shields provide effective protection against such debris and are specifically required by OSHA Standard 1910.133(a) (2), which states:

> "The **employer** shall ensure that each affected employee uses **eye protection** that provides **side protection** when there is a hazard from **flying objects**. Detachable side protectors (e.g. clip-on or slide-on side shields) meeting the pertinent requirements of this section are acceptable."

**Photos 2.2 and 2.3**
Up visor and down visor prevent bottom gap space breach



(c) Bottom gap entry routes (see Photo 2.4) by debris traveling vertically and tangential to the face. Such debris may reach a practitioner's eye through the open gaps (bottom gaps) between the lower rims of the lenses of the protective eyewear and the upper edge of the mask worn by the practitioner (Arsenault and Tayebi 2016).

Since frontal entry route and sideway entry routes are effectively blocked by the use of OSHA-required protective eyewear (OSHA Standard 1910.133(a) (1)) and side shields (OSHA Standard 1910.133(a) (2)), the bottom gap entry routes are the most frequent, yet unaddressed, routes of eye-injury-causing debris.