Exercises in Critical Thinking

Problems

The following excerpts from the dental literature are intended to provide further illustrations of some of the concepts introduced in chapter 22 of Critical Thinking, Second Edition. The examples have been extracted from papers, and much detail has been omitted. In some instances, the authors discuss the weaknesses or strengths of the particular approach they employed in their article (which is not included here). The intent in presenting these examples is not to criticize or commend the articles in question, but rather to show how the arguments, strategies, and ideas discussed in the book appear in the dental (or popular) literature. To provide a wide range of examples in a reasonable amount of space, only select material was extracted from the papers. Often the problems contain a conclusion drawn from the abstract or summary of the paper and select material from other sections of the paper, such as Materials and Methods and Results, relevant to the conclusion. In approaching these problems, you should assume that the aspects of the conclusions that are not concerned with the information presented in the Materials and Methods and Results extracts are not problematic.

Comments on these Problems can be found at the end of Problem 48.

Problem 39


Results:

“Readers may notice a loss of marginal integrity between enamel and the restoration areas in several of the micrographs. This was due to the desiccation of samples necessary for preparation for SEM observation. The shrinkage was not caused by any of the materials used in the study.”

Problem 40


Summary:

“In this study was compared the mental health status of 47 multiple sclerosis patients with silver/mercury tooth fillings (amalgams) to that of 50 patients with their fillings removed. On the Beck Depression Inventory the multiple sclerosis subjects with amalgams suffered significantly more depression while their scores on the State-Trait Anger Expression Inventory indicated the former group also exhibited significantly more anger. On the SCL-90 Revised, subjects with amalgam fillings had significantly more symptoms of depression, hostility, psychotism, and were more obsessive-compulsive than the patients with such fillings removed. On a questionnaire containing 18 mental health symptoms multiple sclerosis subjects with amalgam fillings reported a history of 43% more symptoms than those without amalgam fillings over the past 12 months. These data suggested that the poorer mental health status exhibited by multiple sclerosis subjects with dental amalgam fillings may be associated with mercury toxicity from the amalgam.”

What is the design of this study? What sorts of problems in data analysis and interpretation would you expect? Do you think the study can adequately support the conclusion that “amalgam fillings may be associated with mercury toxicity from the amalgam?”
**Problem 41**


**Introduction:**

“The earlier reports did not present data to allow a detailed, direct comparison of the effects of sugared and sugar-free gums. This study was therefore designed to repeat the previous study, but using standard acidogenic challenges to allow comparison of the two types of gum. In addition, the previous work used plaque telemetry to measure acidity, in which the pH is recorded at a single intra-oral site; here we have used a sampling method which is not site-specific.”

**Comment on the rhetorical techniques used in this passage.**

**Problem 42**


**Abstract:**

“An examination is made of data on dental caries amongst 12-year-old children and sugar consumption of the total population for 90 countries. For the whole data set, DMFT score tends to rise with sugar consumption. The linear relationship between the logarithm of DMFT and sugar is estimated to have a slope of 0.021 per kg/year per head of population (P < .00001), and accounts for 28% of the variation in DMFT. In contrast, when data from 29 industrialised nations are analysed separately, there is no evidence of a sugar-caries relationship; the slope of the linear regression line is estimated to be -0.013, not significantly different from zero. This latter result is in agreement with the considerable evidence of a lack of strong relationship between the amount of sugar consumed and caries occurrence in Western countries. These results suggest that, in addition to sugar, other factors, such as other aspects of diet, exposure to fluoride and genetic effects, must be taken into account when seeking to explain variations in caries prevalence and when making recommendations for caries control.”

**Identify the study design and its particular weakness. Guess what organization funded the study.**

**Problem 43**


**Summary:**

“Using the dye penetration method, the effect on the microleakage of Class 2 resin restorations of two dentin bonding systems that use 10% citric acid–containing dentin conditioners was studied. These results were then compared to the results obtained when the manufacturer’s conditioner was replaced by a mild surface-active detergent containing 0.2% EDTA and 1% NaF. The cavities that were treated with the 0.2% EDTA-containing conditioner in place of the manufacturer’s conditioner showed similar results: Neither of the two bonding systems could totally prevent cervical gap formation.

What kind of results are found in this study? If this paper was presented in a seminar, what would you expect many of the questions to be about?”

**Problem 44**


**Abstract:**

“In 95 children aged 7-8 years, having all four first permanent molars fully erupted and caries free, a chemically initiated tinted fissure sealant was placed with the following 4 different methods in every child. (1) Tooth 16: Cotton rolls isolation and cleaning of occlusal surface using a bristle brush and non-fluoridated paste. (2) Tooth 26: Rubber dam isolation and mechanical preparation of pits and fissures using a round bur No. 0 in a slow hand-piece. (3) Tooth 36: Rubber dam isolation and cleaning of occlusal surface using a bristle brush and non-fluoridated paste. (4) Tooth 46: Isolation with cotton rolls and mechanical preparation of pits and fissures using a round bur No. 0 in a slow hand-piece.”

**What is the design of this experiment? Can you identify a possible flaw in the design, and is the flaw important?**

**Problem 45**


**From the Summary:**

“Statistical analysis by repeated measure ANOVA for univariate tests of hypothesis for within subject effects showed the sodium chloride solution was more effective in reducing dentin sensitivity than the potassium oxalate solution. Scanning electron micrographic analysis revealed a mean dentin tubule aperture size of 1.720 square µm following EDTA treatment alone, 0.564 square µm following potassium oxalate treatment, and 0.386 square µm following sodium chloride treatment.”

**From the Introduction:**

“Several substances have been evaluated in vitro for their ability to occlude dentin tubules or decrease tubule diameter. Therapeutic tubule occlusion in vivo has been attempted by resin bonding, topical application of Ca(OH)2, NaF, or oxalates. Nevertheless, to date, no single clinical treatment for dentin hypersensitivity has gained universal acceptance.”

**Identify the controls in this paper and why they were selected. Do you think the authors expected the result that they obtained?**
**Problem 46**


a) From the Abstract:

“This article discusses a test conducted to evaluate the clinical effectiveness of a transparent visible light-polymerized pit and fissure sealant (Visio-Seal®). Three operators in Shelbyville, Tennessee, applied the sealant to the occlusal surfaces of 383 fully erupted posterior permanent teeth in 103 children. Only teeth without visibly detectable caries or restorations were chosen for the test. The 24-month examination results showed an overall sealant retention rate of 85.7%. The retention rates ranged from 70.5% for operator 3 to 90.7% for operator 1, demonstrating that the use of multiple operators can adversely affect the overall retention rate reported in pit and fissure sealant evaluation projects.”

Comment on the adequacy of the statistics reported in this summary.

b) From the Materials and Methods:

“Two dentists and a dental hygienist applied the sealant in accordance with the manufacturer’s recommendation for application. A special effort was made to ensure an adequate etch and to avoid moisture contamination.”

This paper was reviewed by a dental student who stated the following: “NB, Operator #3 with the lowest retentive rate was probably the hygienist.” What assumption would the student have to make to make his reasoning deductively sound?

c) From the Discussion:

“Because the effectiveness of pit and fissure sealants has been demonstrated, studies of homologous pairs of teeth in which some teeth are treated while others are used as controls are unnecessary. Instead, research should evaluate new or improved materials, application procedures, and the rate of sealant retention.”

Comment on the logic.

**Problem 47**


From the Abstract:

“An investigative study was performed to evaluate changes in gingival health with the application of a 10% carbamide peroxide bleaching gel using exposure times of 2 and 7 hours (overnight). The presence or absence of gingival inflammation was recorded using the Löe and Silness Gingival Index at intervals over a 28-day period. The results showed no statistical significance between the preoperative gingival index scores and those recorded at any point during the study regardless of exposure time.

From the Conclusion:

“Although the GI has been used to assess other products intended for intraoral use, it may not be a sensitive measure for such a study. The GI does not examine and identify cellular changes; it is limited to identifying qualitative changes in the gingival soft tissue.”

What is likely to be the most effective approach in criticizing this paper? In light of the statement made in the conclusion, comment on the design of this experiment.

**Problem 48**


From the Abstract:

“The effect of a pre-brush rinse (Colgate Plax, Colgate UK) containing 0.03% triclosan (Irgacare MP, Ciba-Geigy Corp.) and 0.125% of a copolymer of methoxyethylene and maleic acid (Gantrez, ISP Corp.) on existing plaque and gingivitis over a 6-month period was compared to a matching placebo pre-brush rinse. The study was a double-blind, parallel design utilizing 125 subjects, 117 of whom completed the 6-month period. Subjects rinsed twice daily for 60 seconds with 15 ml of their assigned pre-brush rinse. Immediately after rinsing, subjects brushed their teeth for 30 seconds with a fluoride dentifrice and a soft-bristled toothbrush. After 3 and 6 months, the levels of plaque and gingivitis were significantly lower in the triclosan/copolymer rinse group when compared with the placebo rinse group. The beneficial effects of the active rinse were particularly evident on the surfaces of teeth which are poorly cleaned by mechanical procedures. No side effects, such as staining, were observed or reported. The results indicate that the twice daily use of a pre-brush rinse containing triclosan and copolymer can provide significant adjunctive benefits to mechanical oral hygiene procedures.”
Comment on problem 40

We could consider this study a static group comparison (see page 203). It is not an experiment because there was no randomization to determine which individuals had their amalgam fillings removed.

The potential analysis problems lie with selection and interaction. For example, individuals who elect to undergo the expense and discomfort associated with amalgam filling replacement may well differ in some psychologic aspects from those who adopt the more usual decision of retaining amalgam fillings until they break down and need replacement. In addition, the authors did not postulate which particular parameters would be changed as a result of amalgam removal. Looking for correlations in a large data set is sometimes called *data dredging*, and spurious correlations can arise. Thus, we follow the dictum that there should be a well-stipulated research hypothesis (see page 215).

Considering this study in the terms of Hume’s three criteria for causation (see page 71), this study does not provide convincing evidence for any sort of relationship and, thus, does not meet the criterion for repeated conjuction (i.e., a history of regularity). Moreover, the extended conclusion that amalgam fillings may be associated with mercury toxicity is unsupported in terms of showing that the levels of mercury in the blood are at toxic levels. Thus, the argument fails to meet the criterion of contiguity. Finally, there is no well-defined time sequence; the patients with amalgam fillings may have had the same psychologic profile before and after replacement of amalgam fillings, so the criterion of temporality is also not met.

Comment on problem 41

The authors used the rhetorical technique of directing thoughts (see pages 33 and 34). To deal with the problem of distinguishing their study from previous work, the authors tried to sell the advantage of approaching a standard challenge with a different sampling method. Therefore, the authors emphasize the benefits of the new sampling method. However, it is certain that, in previous studies, investigators who used the telemetry technique would have emphasized its advantages as well, which are not mentioned here.

Comment on problem 42

This is an ecologic study (see pages 210 and 211), and it is problematic that the data compares populations, not individuals in the population. This design has been known to generate spurious relationships (see the example of hatted cats vs black cats [Fig 17-1], page 211). Because sugar was not found to be a culprit (and most studies suggest that it is), we might wonder whether the sugar industry or a research organization funded by the sugar industry supported the study.

From the Results:

Figure legend for Fig CP-1: “Mean Gingival Index scores for the two study groups at baseline, 3 and 6 months. The shaded area represents the placebo rinse group (n = 57), the cross-hatched represents the triclosan/copolymer rinse group (n = 60). The 95% confidence intervals for the mean are indicated. "P < 0.001."

What information is missing from the abstract that would be considered essential in assessing the importance of the effect produced by a treatment? Who do you think provided financial support for the study? Why do you think a large number of subjects was used?
Comment on problem 43

This is a negative results (ie, no differences) paper (see page 79). Questions would arise about the sensitivity of their techniques, including statistical considerations such as power of their tests.

Comment on problem 44

This study could be considered a factorial design (see pages 237 to 240) with two factors: isolation (ie, cotton roll vs rubber dam) and mechanical preparation (ie, brush and paste vs bur). However, it is not clear that the factors could in fact interact. It could also be considered a split-mouth design (see page 241) if the analysis were done in such a way that data (eg, order of effectiveness of treatments) were analyzed on each patient.

One possible flaw is that the treatment is confounded with location. In other words, if some sites were more susceptible to removal of the sealant (eg, because of tendencies of individuals to eat more on one side of the mouth than the other), then the results would not fairly represent the effect of treatments.

Comment on problem 45

It is probable that the authors originally included the NaCl treatment as a negative control (see page 220), because there would be no a priori reason for NaCl to work. They were likely surprised when it turned out to be better than the oxalate. Given the result, however, the oxalate treatment would probably be considered an active control (see pages 220 and 221).

Comment on problem 46

a) Note that the sample number is 3 (ie, the number of operators) as it is a conclusion about operators that appears to be the main point of the study. A sample of three does not normally constitute a very firm basis on which to draw inferences.

b) The assumption is that: All dental students are better sealant-placers than dental hygienists. (It is a very dubious premise indeed.)

c) This statement assumes that once an effect has been demonstrated in one study, an investigator can assume that it is operative in all studies. This assumption is highly suspect given that various aspects would differ between the current study and the previous studies. For example, the data in the current study indicated that operators differ in their effectiveness in placing sealant, and it is certain that the operators placing the sealants in this study differ from those of previous studies. So, the authors need to provide negative controls to show that their application of sealants is effective.

Comment on problem 47

A negative results (see page 79) paper calls for the examination of how sensitive the techniques were. However, in this paper, the Conclusion tells us that the authors chose an index that is not sensitive. This study was thus doomed from the start.

Comment on problem 48

The missing information includes estimates of variation (see page 153), whether randomization was employed, and—which most importantly for an abstract—the size of the effect (see page 252, appendix 7). Examination of the figure indicates that the decrease is around 25%. Calculation of the D statistic and use of appropriate tables could be used to find the percentage overlap of the gingival index levels of populations who did or did not use the rinse. In any case, it can be seen that the effect is relatively small, and whether it is a clinically significant difference would be arguable. It is noteworthy that a large number of subjects was used, which is a good, but expensive, way of reducing variance and increasing the likelihood of getting significant results (see pages 117 to 119 and 234). This kind of expensive study would not normally be undertaken by an investigator pursuing curiosity-based research. It is more likely that the study was sponsored by a commercial concern that stood to gain if their product was found to be effective.

Click here for more information about the book Critical Thinking: Understanding and Evaluating Dental Research by Donald Maxwell Brunette