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Combatting Dental Anxiety in Patients

Gretchen Osdoba

College of Saint Benedict/Saint John's University, gmosdoba@csbsju.edu

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COMBATTING DENTAL ANXIETY IN PATIENTS

By

GRETCHEN OSDOBA

College of Saint Benedict and St. John's University



CAPSTONE THESIS

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Abstract

Dental Anxiety is a highly debilitating condition that can keep people away from the dentist and from receiving critical care. This can lead to serious medical conditions that could have easily been prevented through proper dental care. The purpose of this paper is to describe the nature of dental fear and the different treatment options available. I will focus on helpful traits of dentists and the use of psychological treatments, nitrous oxide, anti-anxiety medications, and general anesthesia to reduce this fear. I will also discuss a comparison of a psychological treatment and an anti-anxiety medication as short-term and long-term treatment options and why dentists generally choose in-office options before reaching out to a psychologist.

Introduction

Lack of financial resources or insurance benefits are widely considered to be significant contributing factors to avoiding dental care. This, however, is not the case although many people use these explanations as an excuse for their underlying issues. “80% of adults in the United States are apprehensive about dental treatment...20% [of these adults] are highly anxious and 5% avoid dental treatment altogether” (Thom et al. 2000, p. 378). This is a startling fact considering the shocking health effects that can result from avoiding dental treatment. These consequences to health go further than what the eye can see when staring at the less-than-perfect teeth of a new acquaintance’s smile that has not been seen by a dentist for decades. Apart from the plaque, decaying teeth, and red, receding gum line caused by gingivitis, this new friend could be well on his way to developing heart disease from his mouth’s bacteria entering his bloodstream. People who fear the dentist may avoid regular visits for teeth cleanings until they have pain (Thom et al. 2000). The problems are severe by this point so more painful procedures are required which produces further future fear, avoidance, and severe problems, which leads to an entire loop of dental evasion (Armfield 2010). These procedures for advanced dental problems also cost more than simple cleanings and because of their fear, anxious individuals may elect to undergo treatment under general anesthesia, which also adds additional costs. Patient fear can also have an effect on dentists themselves. Dentists feel more discomfort when working on anxious patients, and treating them requires more time because of dentists’ decreased and slowed ability to perform and patients’ decreased cooperation (Thom et al. 2000, Beck et al. 1978).

Although there is a wide range of fears of the dentist, it is important to concentrate on individuals with the most debilitating fear. Dental fear increases with age beginning at an average age of twelve and decreasing around age 50 because an increasing need of dentures lowers the amount of work need on teeth (Thom et al. 2000). Most young children are cooperative at the dentist’s office and there is no difference in fear between sexes at these young ages so it is important to prevent initial onset of irrational fears of the dentist before adolescence, which will be discussed in more detail later. Also, statistics show that women avoid dental care more than men because of fear (Kleiman 1982). This might be misleading, however, as men are generally less likely to admit to their fears (Dr. Daniel Osdoba, D.D.S., personal interview, March 30, 2013, unreferenced).

Measuring anxiety

Evaluating dental anxiety has limitations because there are no easy ways to measure it. The most common tools used are self-reporting surveys and indexes, but these are not completely reliable because personality and views on self-confidence have a large effect on how people rate themselves, people are not always willing to be honest about their faults, questions are not posed with room for interpretation or expansion, they are aware of which answers will

place them into certain categories, and are affected by the error of central tendency (Lilienfeld et al. 2010). It is important to evaluate these fears, however, to learn more about, reduce, and prevent dental anxiety. A new Index of Dental Anxiety and Fear is in the process of being written and could potentially provide a better view of the range and effects of dental anxiety. It is comprised of a selection of questions from previous indexes that includes inquiries related to anticipated dental procedures and the fears associated such as “pain, embarrassment, lack of control, numbness, feeling sick, treatment cost, needles, gagging, not knowing what was happening, and having an unsympathetic dentist” (Armfield 2010, p. 281). This new index would be an efficient way of evaluating patients new to a dental practice so they would receive optimal dental care depending on their personal care needs (Armfield 2010).

Care in the dental office

Seeking treatment for dental anxiety is vital to preventing dental and other health complications. Before seeking external sources for treatment of dental anxiety, it is important to utilize the resources and comfort that a dentist can provide in the office (Baron et al. 1990). Dentists can use the foot-in-the door method when treating anxious patients (Lilienfeld et al. 2010). If an individual has not received dental care in a long span of time, and need a lot of work done, dentists can suggest simpler treatments to begin with such as teeth cleanings, to build trust and comfort and eventually work towards the more intensive procedures (Dr. Osdoba). Finding a dentist who makes you feel comfortable is also important, but can be a daunting task, suffering through the incompatible doctors until you reach the perfect one. There are certain traits to look for that all of these dentists have in common, though. A good dentist will have sensitivity, skills in nonverbal communication, the ability to modify treatment when it becomes aversive, the ability to provide reassurance even during stressful procedures, and the ability to detect patients’ distress. Although it is fairly easy for dentists to detect pain distress, detecting psychological distress is a much more difficult task. Pain is easier to observe because of more obvious bodily cues such as facial expressions, verbalization, and bodily response. Psychological stresses such as fear of needles, embarrassment of the state of their teeth or how they will react in situations, loss of personal control or escape from the dental chair, and potential pain are harder to spot. It is also easier to eliminate pain using local anesthesia, and the pain of the injection can be diminished with topical anesthetics but patients can still have psychological distress after this is accomplished (Baron et al. 1990, Deepika et al. 2012).

In order to assess dentists’ ability in detecting emotions of patients, Robert S. Baron, Henrietta Logan, and Chuan Feng Kao (1990) completed a study at the University of Iowa College of Dentistry using second-year dental students who had already begun working with patients. Dentists and patients were approached after an appointment in which a cavity in a tooth was filled and were both asked to rate the pain, distress, and anxiety felt by the patient during different intervals of their procedure. Neither group was aware of the experiment before the procedure, so dentists had no specific motivation for assessing fear and it was a good

measurement of the dentists' general daily assessment. The results showed that even as students, these future dentists were very accurate at assessing their patients' pain. When asked to assess anxiety and distress, however, the correlation between patient ratings and student ratings was much lower. The study also examined whether male or female dentists are more accurate in detecting stress, and it was determined (with little confidence because of a small number of female dentists) that women are slightly more accurate. It was also found that it was more difficult to assess patient emotions during high anxiety times because these times are also during most difficult part of treatment for the dentist. A follow-up experiment found that this ability increased with increasing number of years of experience and that pedodontists (dentists specializing in treatment of children) had the greatest accuracy (Baron et al. 1990). It is also helpful for offices to provide distractions for their patients. Most offices have music playing in the operatory rooms, televisions in which patients can choose the program to watch, and interesting photographs and paintings on the walls and ceiling for patients to concentrate on.

When sensitivity, skills in nonverbal communication, and the ability to modify treatment, provide reassurance, and detect patients' distress isn't enough, dentists can turn to pharmacological alternatives. These treatments can involve the use of nitrous oxide or short-term anti-anxiety medications to relax the patient, or a general anesthetic to completely put the patient to sleep. The former two options have come to be known as sedation dentistry and have become increasingly popular, especially to those requiring a lot of dental work (Baron et al. 1990). Potential problems with these treatments, however, include undesirable side effects and high cost (Beck et al. 1978).

In 1800 a British scientist determined the inhalation of nitrous oxide a way of extinguishing physical pain (Heines 1945). It was not accepted as an anesthetic until almost a half-century later, however, and was used recreationally by the wealthy during this gap. In addition to its sedative effects, it also produced a feeling of euphoria to those who experienced this luxury. After hearing of the pain-killing effects of nitrous oxide, Doctor Horace Wells, an American dentist, held a demonstration for a surgical class. After this demonstration failed, he was rather discouraged and turned his attention away from his career, but a colleague continued his efforts later and nitrous oxide was considered to be a safe anesthetic after 150,000 patients in one year successfully received the treatment and no deaths occurred (Heines 1945).

Although the anesthetic properties of nitrous oxide are not fully understood, there is some indication on how the analgesic effects occur. "It has been proposed that N_2O induces opioid peptide release in the midbrain, leading to the activation of descending noradrenergic inhibitory neurons, which modulates pain processing within the spinal cord" (Ohashi et al. 2002, p. 7). This pain processing involves inhibiting nociceptors which are nerve cell endings that promote the sensation of pain (Fujinaga and Maze 2002, Orestes et al. 2011).

Because the mechanisms of nitrous oxide that cause an anesthetic effect are not fully known, it is vital that the use of this gaseous compound is tightly regulated. Nitrous oxide is delivered in conjunction with oxygen in a constant flow that can contain no more than 70 percent nitrous oxide. This ensures that at least 30 percent of the gas delivered to the patient is oxygen,

which is nine percent more than is present in the atmosphere. It is crucial that patients are receiving enough oxygen so they do not develop hypoxia or nausea (Donaldson et al. 2012).

Benzodiazepines are a class of drugs that help relieve nervousness, tension, and other symptoms by slowing the central nervous system but do not block any senses (Anzini et al. 2011). They consist of a benzene ring fused with a seven-atom ring with two nitrogens and are commonly used to treat depression, sleep disorders, and anxiety disorders (Fletcher and Boriraj 2010). Midazolam is a short-acting benzodiazepine that is used commonly in dental practices to relieve anxiety before injection with a local anesthetic or induction of a general anesthetic (Thom et al. 2000). Benzodiazepines are positive regulators of gamma-Amino butyric acid (GABA). GABA is an inhibitory neurotransmitter that regulates neuron excitability (Shepherd and Hanson 2012). Anxiety involves overactive neural activity and because benzodiazepines activate the inhibitory neurotransmitter, benzodiazepines lower this neuron activity, therefore decreasing anxiety (Anzini et al. 2011).

As a final resort to receiving simple dental care while having a debilitating fear of the dentist, patients can elect to undergo procedures under general anesthesia, which is generally reserved for oral surgery and more invasive procedures. Under general anesthesia the patient is completely unconscious and will remain so until the intravenous medication wears off or is reversed by another drug. The patient will also need assistance with breathing and generally will experience amnesia as the medication is wearing off. Because of difficulty in breathing, during the use of general anesthetics oxygen saturation, as well as blood pressure and heart rate need to be monitored. Propofol is a common drug used to induce this unconsciousness. It is an anesthetic but not an analgesic so is often combined with a pain-relieving drug such as lidocaine (a local anesthetic) or another opioid (Helfenbein et al. 2002, Wilson 2009).

Comparison of a pharmacological and a psychological treatment

When looking at various ways of reducing dental anxiety, it is important to compare treatments that can be used in a dental office with those that must be done outside of the office to determine if any are effective, if one is more effective than others, and if any are effective for long-term improvement. A study performed by Anja Thom, Gudrum Sartory, and Peter Jöhren (2000) strove to discover if and how people could best overcome dental anxiety by comparing the use of an anti-anxiety medication in a dental office to a psychological treatment outside of the office.

Dental phobic patients were referred to the study from the Witten-Herdecke University dental clinic where they had received previous care (Thom et al. 2000). At these former appointments they completed an evaluation in which they had rated their dental anxiety on a scale from zero to 100 and reported their anxiety level as over 90. The participants were those who needed outpatient procedures and would require further dental care following the study. They were assigned to three groups by sequential allocation and restricted randomization, then a dental health assessment was performed on each patient and the total results were analyzed to

ensure that the groups were evenly distributed. The independent variable was the type of treatment each of the three groups received and the dependent variable was the anxiety level of patient before, during, and after the treatment. One group received psychological treatment one week prior to their dental treatment, another group received an anti-anxiety medication (benzodiazepine) thirty minutes before their procedure, and the final group (the control group) received no prior assistance. All groups were reassured that the dentist was specially trained in dealing with patient anxiety although the dentist was unaware of which prior treatment each patient had received (Thom et al. 2000).

Patients receiving psychological treatment were taught relaxation techniques and stress management during a single, 1.5 hour session one week before their dental treatment and were instructed to practice the techniques they learned daily. The first segment consisted of learning the components of anxiety, and how they can interact to increase anxious feelings. The next step in the treatment was anxiety management training in which patients thought about dental procedures and what scared them the most about what they thought was going to occur the following week. Patients were then guided through progressive muscle relaxation while thinking about their future dental procedure and were encouraged to notice their onset of anxiety and use the relaxation techniques to reduce these feelings. The final step in the process was exchanging negative thoughts of dental procedures with “anxiety-relieving thoughts” (Thom et al. 2000, p. 380). To conclude the session, patients were asked to practice the techniques they learned every day until their dental appointment. Patients receiving the pharmacological treatment were told to not eat five hours before their dental treatment so the medication would have a maximum effect on their cognitive processes, and were given the proper amount of anti-anxiety medicine thirty minutes before their treatment, according to their weight. The control group arrived at their dental appointment with no prior treatment (Thom et al. 2000).

To measure anxiety levels in patients, various self-reporting surveys and indexes, as well heart rate, were taken on five different occasions: before psychological treatment or pharmacological ingestion, after psychological treatment or pharmacological ingestion but before dental treatment, one day after dental treatment, one week after surgery, and two months after dental treatment. Measurement surveys included the Dental Anxiety Scale which includes four questions relating to fear of dental treatment that are rated from 4 to 20, the Dental Fear Survey which involves rating physiological and situational fears, the Dental Cognitions Questionnaire which includes negative views on dentistry and dental treatment that people rate on the similarity to their views, and the State-Trait Anxiety Inventory which involves rating general emotion states. The means of the various scores for each treatment were graphed on separate graphs for each of the surveys and indexes during the various intervals to determine the difference in anxiety improvement between the different treatments (Thom et al. 2000).

Results from this experiment showed that both psychological and pharmaceutical treatment led to less anxiety during the initial dental treatment than no prior treatment. This is important because either psychological treatment or pharmaceutical treatment showing reduced anxiety indicates that dental anxiety can be overcome with help. The important question,

however, is which is more effective in the long run (Thom et al. 2000). According to the results, psychological treatment was significantly more effective than pharmaceutical treatment in the long run. Two months after dental treatment, individuals who had received psychological help had even lower reports of anxiety than after one week while patients in the control group and those who had received the anti-anxiety medication reported higher levels of anxiety in some cases. Individuals who had received psychological treatment were also more likely to continue with dental treatments further in the future. Although pharmaceuticals are more widely used and both the pharmaceutical and psychological treatments appear cost-effective because a single drug is administered and a single session anxiety treatment is used, it is unlikely that the one-time use of an anti-anxiety medication will reduce anxiety in future dental appointments (Thom et al. 2000).

Sources of anxiety

An argument of where mental conditions arise from is the nature versus nurture debate. It has been a lengthy dispute as to if genetics play a role or if it is the environment in which an individual is raised. Most experts believe that it is a combination of nature and nurture, but the question remains of how much of each contributes to anxiety. This is a key idea because although it had been shown that people can overcome dental anxiety with assistance, it would be more difficult if it is rooted intrinsically rather than learned from life situations (Lilienfeld et al. 2010).

Twin studies have shown that anxiety is genetically linked (Vassend et al. 2011). But is this true for such a specific type of anxiety? How much of dental anxiety is inherited? A twin study was conducted to compare the correlations of dental anxiety in monozygotic (identical) twins to correlations in dizygotic (fraternal) twins. It strove to determine if shared genetic material had an effect on dental anxiety, and in turn helped researchers to understand if it is related more to general anxiety or to experiences. All of the sets of twins were chosen from the same geographic location and had been raised together. Results showed that there was a moderate connection to inheritance in dental anxious twins. This shows that genetics play a large role in the development of this specific fear and that people can be predisposed to develop dental anxiety. The results also suggest that although positive experiences in the dental office are essential, dental anxiety is more related to a presence of general anxiety than to life events. Dental anxiety is associated with a complex fear that spans across other aspects of life. So perhaps a better way to treat dental anxiety is to determine if it has comorbidity (simultaneous appearance) with other anxieties and treat all of them together to improve the overall well-being of individuals. In any case, if an individual is predisposed for anxiety, it is important to prevent these irrational fears from prevailing and taking over their lives (Lilienfeld et al. 2010, Vassend et al. 2011).

A predisposition for dental anxiety does not mean that the individual will develop the anxiety, so it is important to stop it from occurring while children are young. In order to prevent

dental anxiety, it is imperative that children have a positive experience during their early trips to the dentist. An experiment by Lawrence J. Siegel and Lizette Peterson (1980) compared simple ways of preventing stress in preschool-aged children during their first dental treatment. All of the children had visited the dentist once and required a second visit for a filling. Thirty minutes before their dental treatment, children were randomly presented with one of three treatments. The children in the first group were taught general body relaxation techniques and deep breathing paired with cue words along with calming self-talk, and imaginative pleasant imagery. Children in the second group were told everything that was going to happen while they were in the dental chair including potential sounds they would hear. The third group was held as a control group and each child was read a book. All of the children were observed by two adults who each rated the child's behavior for anxiety levels. Results showed that both of the experimental groups were less disruptive and had less anxiety than the control group. Although both coping techniques taught were very different, both were very effective in their intent. These were simple lessons to teach and did not take a long time. Because of their effectiveness, either could be placed for regular use in a dental office for young patients. This could also prevent future dental anxiety by instilling good habits in these children early on in their lives (Siegel and Peterson 1980). Parents can have a large effect on this, however. They have the ability to pass their irrational fears onto their children by not visiting the dentist themselves or making inappropriate comments about dentists, so it is important that this does not occur (Dr. Osdoba).

Anxiety can also arise or be strengthened by life events. Specific childhood fear (such as fear of the dentist) increases because of a general increase in fear of physical danger and the development of social anxieties unfortunately gained by a broader knowledge of the world. The general social anxiety around peers develops in the teenage years (Liddell and Murray 1989). Just think of those days in Junior High when everyone felt judged and tried to impress everyone else. These general insecurities can cause anxiety that can make adolescents question all of the aspects of their lives. This can also be enhanced by direct peer influence if adolescents see or hear of their peers' fears and relate it to themselves. Children are less likely to avoid the dentist even if they are fearful because of parental control. This is good for the children because it provides early exposure which prevents later fear if the visit is positive (Liddell and Murray 1989). It has been suggested that dental anxiety results in people who have a lower pain threshold, but in an experiment comparing self-reported pain, dental anxious patients overestimated expected and remembered pain but did not report high pain during dental treatment. Therefore, dental anxiety is psychologically induced (Thom et al. 2000).

Further research

For those in which a dentist's sympathy is not enough to extinguish their anxiety, more should seek psychological help for dental anxiety because it is cost-effective and time efficient and can save people from unwanted dental treatment costs and further health complications. Medication in this situation doesn't reach the root of problem; it is only temporary and people

shouldn't just try to get a "quick fix." Problems continue to exist with people who don't want to seek help for this fear. It could be attributed to lack of knowledge of the complications surrounding missed dental appointments, or failure to admit they have a mental condition. To begin to solve these problems it is necessary to learn more about dental anxiety. Important questions to answer are those that ask where it comes from and how it can be prevented. Know its roots and preventing it from prevailing are the next steps in curing a nation afraid of visiting their local dentist's office. This is interesting because an introductory psychology course is a prerequisite for Dental School, but perhaps there should be a larger emphasis on the training of dentists in the psychology field.

Although psychological help is the ideal option, it is not currently the most widely used among dentists. Nitrous is the most commonly accepted pharmacological additive for reducing dental anxiety in a general dental practice because it is quick and easy (Dr. Osdoba). It is not used by all family practice dentists, but is a relatively standard addition to pediatric dental offices. Although it doesn't treat underlying issues, it can produce some "lasting benefits by increasing coping skills for pediatric patients on subsequent visits" (Guelmann et al. 2012, p. 77). This is important because it is crucial to present children with early positive exposure to the dentist so they do not develop a debilitating fear that can carry into adulthood (Guelmann et al. 2012).

Avoiding pain is an important aspect of reducing anxiety, and the initial prick of local anesthetic injection can be ignored with the use of nitrous oxide. "Nitrous oxide-oxygen inhalation even at 10% N₂O has been shown to reduce significantly the heart rate during local anesthetic injection" (Guelmann et al. 2012, p. 77). (Heart rate measures the stress the body is undergoing, which is equivalent for these purposes to the level of anxiety.) There is even evidence that for mild to moderately anxious children, nitrous is not needed after local anesthetic injection. This is important because it would greatly reduce the time that dental professionals are exposed to nitrous oxide, which would reduce the risk of potential health hazards. Nitrous oxide may have adverse effects (including evidence of problems related to infertility that are not fully understood) if one is chronically exposed to it, and this can be especially detrimental to dental teams who are exposed to this gas several times per day (Donaldson and Meechan 1995). The questions remain, however, if nitrous oxide is needed the entire time for highly anxious children, and for all adults.

To answer the latter question concerning anxious adults, an experiment could be implemented, following a procedure similar to that of the experiment conducted by Marcio Guelmann, Ryan Brackett, Nathan Beavers, and Robert E. Primosch (2012). In this previous study, children (5 to 8 years old) who needed two similar restorative procedures and had never received dental care before received, randomly, one of two treatments for their first restoration, and the alternative treatment for their second. Both treatments began with a delivery of 100% oxygen to the patient for one to two minutes followed by a mixture of 50% oxygen-50% nitrous oxide during local anesthetic injection. Then, one of the treatments involved returning to a delivery of 100% oxygen immediately after injection continued for five minutes after the

procedure. The other treatment involved maintaining the 50%/50% mixture for the remainder of the procedure and returning to 100% oxygen for five minutes after the conclusion of the procedure (Guelmann et al. 2012).

In order to create the similar study, 30 adults (20 to 40 years old) who need two similar restorative procedures and have requested the use of nitrous oxide to calm their anxious state of minds, would be utilized. They would randomly (and without knowledge of each group) be assigned to either treatment for their first procedure, and would receive the alternative treatment for their second procedure. After the local anesthetic injection, while the tooth is being prepared for restoration, the maximum heart rate would be recorded for each patient during each treatment as a measurement of the maximum stress their body is undergoing.

A paired t-test would be used to measure differences in heart rate in the two treatments during tooth preparation, after local anesthetic injection for each patient (Guelmann et al. 2012). The assumption would be that there is no difference in heart rate in the different administrations of nitrous oxide, which is also the hypothesis. In order to accept this hypothesis, the obtained p-value would have to be greater than 0.05. This would suggest that both the use of a mixture of 50% oxygen-50% nitrous oxide and the use of 100% oxygen after local anesthesia produces no difference in anxiety levels. Therefore, it could be suggested that nitrous oxide should only be used during local anesthetic injection which would reduce dental teams' exposure to the potentially harmful gas. If patients were displaying a noticeable amount of distress later in the procedure though (because of instances such as the sound and vibration of dental instruments), or a child was initially extremely anxious, the oxygen/nitrous oxide mixture could be reinstated immediately without compromising the procedure (Guelmann et al. 2012).

Conclusion

Dental anxiety is a debilitating mental condition that can prevent people from receiving critical dental care. This lack of dental care can lead to several types of health conditions other than those that affect just the mouth. It is important to overcome dental anxiety in order to receive crucial attention from a dentist. Dental visits should occur more often than just when pain is felt so that severe problems can be avoided and more painful and expensive procedures are not required. It is important that parents instill good dental habits in their children so that fear does not develop at an early age. It is also important for anxious adults to not pass their irrational fears onto their children. If fear begins and persists, however, people should seek help for this specific type of anxiety, just as they would with any other type of mental condition.

References

- Anzini M, Valenti S, Braile C, Cappelli A, Vomero S, Alcaro S, Ortuso F, Marinelli L, Limongelli V, Novellino E et al. . 2011. New Insight into the Central Benzodiazepine Receptor–Ligand Interactions: Design, Synthesis, Biological Evaluation, and Molecular Modeling of 3-Substituted 6-Phenyl-4H-imidazo[1,5-a][1,4]benzodiazepines and Related Compounds. *Journal of Medicinal Chemistry* 54(16):5694-5711.
- Armfield JM. 2010. Development and psychometric evaluation of the Index of Dental Anxiety and Fear (IDAF-4C[sup]+[sup]). *Psychological Assessment* 22(2):279-287.
- Baron RS, Logan H, Kao CF. 1990. Some variables affecting dentists' assessment of patients' distress. *Health Psychology* 9(2):143-153.
- Beck FM, Kaul TJ, Russell RK. 1978. Treatment of dental anxiety by cue-controlled relaxation. *Journal of Counseling Psychology* 25(6):591-594.
- Deepika A, Rao CR, Vinay C, Uloopi KS, Rao VV. 2012. Effectiveness of two flavored topical anesthetic agents in reducing injection pain in children: a comparative study. *Journal of Clinical Pediatric Dentistry* 37(1):15-8.
- Donaldson D, Meechan JG. 1995. The hazards of chronic exposure to nitrous oxide: an update. *British Dental Journal* 178(3):95-100.
- Donaldson M, Donaldson D, Quarnstrom FC. 2012. Nitrous oxide-oxygen administration: when safety features no longer are safe. *Journal of the American Dental Association* 143(2):134-43.
- Fletcher JT, Boriraj G. 2010. Benzodiazepine Synthesis and Rapid Toxicity Assay. *Journal of Chemical Education* 87(6):631-633.
- Fujinaga M, Maze M. 2002. Neurobiology of nitrous oxide-induced antinociceptive effects. *Molecular Neurobiology* 25(2):167-189.
- Guelmann M, Brackett R, Beavers N, Primosch RE. 2012. Effect of continuous versus interrupted administration of nitrous oxide-oxygen inhalation on behavior of anxious pediatric dental patients: a pilot study. *Journal of Clinical Pediatric Dentistry* 37(1):77-82.
- Heines SV. 1945. The introduction of painless surgery. *Journal of Chemical Education* 22(9):428.
- Helfenbein J, Lartigue C, Noirault E, Azim E, Legailiard J, Galmier MJ, Madelmont JC. 2002. Isotopic Effect Study of Propofol Deuteration on the Metabolism, Activity, and Toxicity of the Anesthetic. *Journal of Medicinal Chemistry* 45(26):5806-5808.
- Kleiman MB. 1982. Fear of dentists as an inhibiting factor in children's use of dental services. *Journal of Dentistry for Children* 49:209– 213.
- Liddell A, Murray P. 1989. Age and sex differences in children's reports of dental anxiety and self-efficacy relating to dental visits. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement* 21(3):270-279.
- Lilienfeld SO. 2009. *Psychology : from inquiry to understanding*. Boston: Pearson/Allyn Bacon.

- Ohashi Y, Stowell JM, Nelson LE, Hashimoto T, Maze M, Fujinaga M. 2002. Nitrous oxide exerts age-dependent antinociceptive effects in Fischer rats. *Pain* 100(1–2):7-18.
- Orestes P, Bojadzic D, Lee J, Leach E, Salajegheh R, Digruccio MR, Nelson MT, Todorovic SM. 2011. Free radical signalling underlies inhibition of CaV3.2 T-type calcium channels by nitrous oxide in the pain pathway. *Journal of Physiology* 589(Pt 1):135-48.
- Shepherd GM, Hanson PI. 2012. "Synaptic transmission," in *AccessScience*. McGraw-Hill Education <http://www.accessscience.com>
- Siegel LJ, Peterson L. 1980. Stress reduction in young dental patients through coping skills and sensory information. *Journal of Consulting and Clinical Psychology* 48(6):785-787.
- Thom A, Sartory G, Jöhren P. 2000. Comparison between one-session psychological treatment and benzodiazepine in dental phobia. *Journal of Consulting and Clinical Psychology* 68(3):378-387.
- Vassend O, Røysamb E, Nielsen CS. 2011. Dental anxiety in relation to neuroticism and pain sensitivity. A twin study. *Journal of Anxiety Disorders* 25(2):302-308.
- Wilson E. 2009. dental anesthetics. *Chemical & Engineering News Archive* 87(26):33.