Use of Immersive Visualization for the Control of Dental Anxiety During Dental Hygiene Treatment

Carmelo Padrino-Barrios
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USE OF IMMERSIVE VISUALIZATION
FOR THE CONTROL OF DENTAL ANXIETY DURING
DENTAL HYGIENE TREATMENT

By

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BSDH May 2010, Old Dominion University

A Thesis Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE
DENTAL HYGIENE

OLD DOMINION UNIVERSITY
December 2013

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ABSTRACT

USE OF IMMERSIVE VISUALIZATION FOR THE CONTROL OF DENTAL ANXIETY DURING DENTAL HYGIENE TREATMENT

Carmelo Padrino-Barrios
Old Dominion University, 2013
Director: Prof. Gayle McCombs

Purpose: The purpose of this study was to determine the effectiveness of immersive visualization (IV) therapy, a technique that provides visual and stereoscopic display through the use of eyewear, in anxious patients during an oral prophylaxis.

Methods: A convenience sample of thirty adults was enrolled. A split mouth design was utilized. Subjects were randomly divided into two groups: group A (use of IV for the right side of the mouth), and group B (use of IV for the left side of the mouth). Subjects received a full mouth oral prophylaxis (removal of supra and subgingival calculus and selective polishing), always starting with the right side. Medical and dental histories and oral examinations were performed during the screening appointment. At screening, the Corah’s Dental Anxiety Scale- Revised (DAS-R) was scored. In order to qualify for the study, individuals were required to score 9 or higher on the Corah’s DAS-R, present with no severe dental calculus, severe periodontal disease, or severe dental caries. At baseline the Corah’s DAS-R was validated, and the Calmness Scale was scored pre- and post IV treatment. During treatment, subjects had the opportunity to select one of three IV videos: (1) documentary, (2) music videos, or (3) TV show. After the completion of the full mouth prophylaxis, subjects completed a Post IV Opinion Survey. Results: Twenty-three females and 7 males participated in the study ( $\bar{x}$ age 29.96 ± 7.8). The results showed no
statistically significant difference at the level of 0.05, between groups with regard to the anxiety level at baseline based on Corah’s DAS-R (p = 0.69). There was a statistically significant correlation between Calmness Scale and gender (p = 0.01), females report higher levels of anxiety than men. Ninety seven percent of the subjects responded positively to the use of IV eyewear during the treatment. **Conclusion:** The use of IV eyewear during oral prophylaxis can be an effective method to control anxiety.
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CHAPTER I

INTRODUCTION

Dental anxiety is a barrier some individuals face when seeking dental care. Unfortunately, dental anxiety is a common response in dental offices, which restrains many individuals from receiving needed oral care services. Several studies have explored the relationship between dental care and anxiety leading to poor oral hygiene, inconsistent dental visits, and inducement of dental pain.\(^1\)\(^5\) Locker reported that dental anxiety could lead to “psychological or social consequences in addition to avoidance of dental care and compromised oral health.”\(^2\) Dental anxiety is defined as a “nonspecific unease, apprehension, or negative thought about what may happen during a dental or dental hygiene appointment.”\(^6\) The specific origin of dental anxiety is unknown. People can develop anxiety at any stage of their lives, but child-onset shows a more severe negative response than adolescence or adults.\(^7\) Non-cognitive trigger factors such as fear of the unknown, previous negative experiences and perceptions transferred by family members, friends, and the media, can all lead to anxiety.\(^7\)\(^8\) Research suggests that cognitive factors such as vulnerability, negative expectations, patient-clinician relationship, lack of control, and negative thoughts have a greater impact on dental anxiety than non-cognitive factors.\(^1\)\(^8\)

Okawa, et al. concluded that patients reported high dental pain levels when anxiety levels were also high; therefore, it is important to manage dental anxiety with a therapeutic environment to help reduce pain.\(^3\) Procedures such as periodontal probing and scaling and root debridement may cause dental pain and anxiety during dental hygiene treatment.\(^9\) When managing the anxious dental patient, the American Dental Association
(ADA) recommends the use of pharmacological agents to make the experience as comfortable as possible.\textsuperscript{9} Currently, many of the general classes of drugs used to control and manage pain and anxiety, are nonsteroidal anti-inflammatory drugs (NSAIDs), acetaminophen, opioids, benzodiazepines, selective serotonin reuptake inhibitors (SSRIs), tricyclic antidepressants (TCAs), and monoamine oxidase inhibitors (MAOIs).\textsuperscript{10} Many dentists and dental hygienists are trained to regulate anxiety through the use of nitrous oxide.\textsuperscript{11}

Although pharmaceutical medications can help clients with anxiety, the efficacy of these therapies is not guaranteed. Therefore, new techniques such as the use of audiovisual immersion therapy and virtual reality (VR) are being studied to assist anxious patients. Virtual reality uses artificial or computer-generated sensory experiences, and is considered an alternative technique to control general anxiety and fear episodes.\textsuperscript{12,13} Research shows that VR is a viable option due to its ability to minimize anxiety, pain, and phobia symptoms.\textsuperscript{12-16} Botella and colleagues suggested that VR could be applied in any medical environment, including dental procedures, due to its effectiveness to control and minimize acute pain.\textsuperscript{17} The use of audiovisual eyewear in VR helps individuals obtain a more positive experience by allowing them to focus on the visualization environment, and provide a distraction from other sensory factors such as pain.\textsuperscript{18} The increased audio and visual stimulations provide a higher concentration in patients when using audiovisual immersion therapy and VR.\textsuperscript{16}

Immersive visualization (IV) is a technique that provides a stereoscopic display, giving better visual depth perception, and is able to simulate our perception of the real world. Immersive visualization distorts reality and can help individuals experience an
alternative physical environment, which helps alter elements such as stress, temperature and strain. The use of IV therapy has great potential in the dental field to allay anxiety, so that individuals can obtain needed oral care treatment. Moreover, many health care professionals and consumers want to move away from pharmaceuticals and IV provides an alternative or complimentary treatment to manage dental anxiety. The goal of this study was to evaluate the effects that IV therapy has on anxiety levels in patients during routine oral prophylaxis.

Problem Statement

The purpose of this study was to determine if immersive visualization (IV) therapy will have an effect on anxiety levels in patients during oral prophylaxis.

Definition of Terms

For the following study some key terms were defined:

**Anxiety:** A state of apprehension, uncertainty, and fear resulting from the anticipation of a realistic or fantasized threatening event or situation, often impairing physical and psychological functioning.

**Virtual Reality (VR):** The use of artificial or computer-generated sensory experiences.

**Immersive Visualization (IV):** A technique which provides a visual and a stereoscopic display through the use of IV eyewear. IV eyewear equipment is lightweight, adjustable and provides the subject with the ability to control audio and visual with a manual control switch (Figure 1 and 2).

**Oral Prophylaxis:** A preventive dental hygiene procedure that involves the removal of supragingival and subgingival calculus with selective polishing.
Research Hypothesis

**Ho:** There will be no statistical significant difference in anxiety levels during a dental hygiene prophylaxis with the use of immersive visualization (IV) compared to no IV treatment at $p \leq 0.05$. 
CHAPTER II

REVIEW OF THE LITERATURE

Avoiding dental and dental hygiene treatments due to anxiety problems is frequent. Dental anxiety has been associated with poor oral health and discourages people to seek routine oral care. DeDonno added that patients who seek frequent dental care have a better oral hygiene than those who visit the dentist irregularly. Furthermore, studies have shown that younger females are more prevalent to report or experience dental anxiety and fear when compared to the rest of the population. According to several studies, factors that might induce anxiety can be classified as cognitive (vulnerability, negative expectations, lack of control, and negative thoughts) and non-cognitive (fear of the unknown, negative experiences, and influence of close relatives). De Jongh & Stouthard sited expectation of pain, fear of the unknown, use or sound of dental instruments, and not being in control, as the most common factors that elicit anxiety.

The American Society of Anesthesiologists (ASA) Physical Status Classification System categorizes patients according to the level of medical risk in four groups: health (ASA I), mild systemic disease (ASA II), severe systemic disease (ASA III), and severe systemic disease with threat to life (ASA IV). According to the ASA classification, anxious patients are categorized as mild systemic. Dental hygienists are trained to manage anxious patients by using various management techniques such as: patient-centered communication, allowing the patient to observe the procedure, deep breathing relaxation, and hypnosis. Lahmann, et al. conducted a study in which brief functional relaxation and music distraction appeared to be effective in controlling dental anxiety.
The authors acknowledge that a possible reason for this result was that the participants were not screened for dental phobia or high level of anxiety, and that participation in the study was voluntarily. \(^{27}\)

Pharmacological agents, nitrous oxide, sedation, and breathing relaxation are options provided to anxious patients when seeking dental care.\(^{10,11}\) However, not all of these methods are effective. One study showed the poor effect breathing and focusing techniques provided during dental treatment.\(^{28}\) Fear of pain and previous experiences are reported as the primary reasons individuals feel anxious during dental hygiene procedures, although these could decrease during procedure as patients get comfortable.\(^{29}\) Dental hygiene procedures such as probing and scaling and root debridement often elicit some level of pain and anxiety during dental appointments.\(^{1,4,5,9}\)

According to Smith and Heaton, the general increase in anxiety has not lead to an increase in dental anxiety in the U.S. population.\(^{30}\) Based on literature reviewed between 1955 and 2000, the authors did not find an increase or decrease of dental anxiety. Date and geographic location were considered as factors related to population based anxiety. Data determined that there was an increase of dental fear in New York between 1967 and 1975, and a significant decrease of dental fear levels in Washington from 1994 to 2001, and in Kentucky from 1994 to 2001. The authors stated that different factors might play roles in the fear and anxiety levels such as environmental factors (rural versus urban), advertisement of new products and technologies that promote comfort, and the use of the industrial model (closer relationship with patients) in private dental offices, as compared with the hospitals which follow the factory models (less closer relationship with patient).\(^{30}\)
Assessment Technique

There are several psychological assessments available to assess dental anxiety and pain in adults. Corah’s Dental Anxiety Scale- Revised (DAS-R), Kleinknecht’s Dental Fear Survey, Dental Anxiety Question, Gatchel’s 10-point Fear Scale, Photo Anxiety Questionnaire, Dental Anxiety Inventory, and Visual Analog scale are examples.\textsuperscript{31,32} Corah’s DAS-R has demonstrated high reliability and validity; therefore, is the most commonly used scale to assess dental anxiety.\textsuperscript{31,33,34} Corah’s DAS-R scores are as following: 4-8 low; 9-12 moderate; 13-14 high; and 15 or higher indicate a severe anxious patient. Corah’s DAS-R also consists of four multiple-choice questions with a possible value point of 1 to 5 (Appendix A).

Virtual Reality and Immersive Visualization

New techniques such as VR and IV have emerged as methods to control general pain and anxiety in medicine.\textsuperscript{12-14,16-18} For instance, Schneider and Hood reported on the use of VR during chemotherapy for breast, colon, and lung cancer. Eighty six percent of the participants reported that VR was pleasant; however, symptoms of stress related with chemotherapy were not reduced.\textsuperscript{35} The use of VR in the dental field has also provided a positive response in patients by reducing pain and anxiety levels; therefore, making the appointment more pleasant.\textsuperscript{15,36-39}

Ram and colleagues reported that the use of audiovisual eyewear minimizes the discomfort and distress in children during dental restorative treatment.\textsuperscript{15} Two groups were established: group I control (use of nitrous oxide) and group II audiovisual group (without nitrous oxide). In this study, one hundred and twenty children enrolled and were required to have at least 2 clinical procedures with local anesthesia. The researchers
measured behavior from each participant using the Frank scale: which rating scores range from 1 (worst behavior) to 4 (best behavior). An independent observer scored behavior from each subject using the Houpt Scale. Subjects, clinicians, and parents scored the Visual Analog Scale (VAS) patient satisfaction. There was no statistically significant difference between groups in variables such as gender, use of nitrous oxide history, and complexity of procedure. The audiovisual group showed a better behavior than the control group as scored by the Frankl scale and the Houpt scale. Overall, the majority of the children’s behaviors in the audiovisual group rated as excellent (70%), followed by very good (19%), good (6%), and fair, poor or aborted (5%). During the second appointment, children’s behavior improved in both groups, with no significant difference. There was no statistically significant difference between clinical procedures in the audiovisual group. The VAS showed a satisfaction response by 85% of the participants.\textsuperscript{15}

In a study by Frere and colleagues, the effectiveness of AV eyewear use during oral prophylaxis in adults, was studied by measuring anxiety levels, pain levels, and appointment length.\textsuperscript{39} Subjects completed the Dental Fear Survey (DFS) and the Fear of Pain Questionnaire (FPQ- III) prior to treatment. A post-treatment questionnaire was provided to assess the AV eyewear preference and effectiveness. The use of eyewear was randomized (use of eyewear in the left or right side), as well as what side of the mouth was treated initially (left or right side of the mouth) by tossing a coin. Participants were divided into 2 groups: high fear and lower fear by using the DFS instrument. The results showed that the higher the DFS score, the less likely participants reported high anxiety using AV eyewear. All of the participants reported a positive response and would use AV eyewear in the future while undergoing oral prophylaxis.\textsuperscript{39}
Furman, et al. provided a different approach for pain management using VR during scaling and root planning procedures. Participants were randomized to three treatments: (1) control, (2) immersive virtual reality, and (3) watching a movie. Subjects were required to complete Corah's DAS as an anxiety screening pre treatment, VAS to measure pain during treatment, and a short post-treatment questionnaire about pain management. The results obtained showed no significant differences between men and women with regard to age, ethnicity, number of teeth, smoking status or Corah's DAS scores. There was no significant difference in probing depth, mean of probing depth, and clinical attachment level in quadrants between groups. Immersive VR group and movie group showed a statistically significant difference in pain levels when compared to control group as scored by VAS instrument. The researchers concluded that virtual reality is an effective tool to manage and minimize anxiety and pain during scaling and root debridement. Two thirds of the participants preferred the use of virtual reality during treatment. In addition, the use of virtual reality resulted in lower pulse rate and blood pressure.
CHAPTER III

METHODS AND MATERIALS

Research Design

The present study measured the effects of immersive visualization (IV) on anxiety in patients during a full mouth oral prophylaxis. An Institutional Review Board approved study was conducted. Subjects were randomly assigned into two equal groups: group A (use of IV for the right side of the mouth), and group B (use of IV for the left side of the mouth). All subjects received a full mouth oral prophylaxis, starting with the right side. The use of eyewear was randomized. All the appointments were performed in the Dental Hygiene Research Center (DHRC), room #1103 at Old Dominion University, Norfolk, Virginia. A single experienced dental hygienist performed all the procedures. Data was obtained to determine: level of calmness pre- and post IV treatment, level of anxiety while wearing IV eyewear, and comfort of IV eyewear. The current study used the Vuzix iWear AV 920 video eyewear and the iPhone 5 (Apple Inc.) (Figure 1 and 3). In order to avoid distraction from surroundings the room was as quiet as possible. A black disposable barrier was attached to the IV eyewear allowing the participants to concentrate on the video chosen. Subjects’ peripheral vision was kept open to minimize the anxiety to the unknown, to be familiar with the treatment room and instruments used.

Sample Description, Selection and Enrollment

Thirty adults were enrolled using convenience sampling (N= 30). Medical and dental histories were obtained and Corah’s DAS-R was scored to determine eligibility (Appendices A and B). Individuals with severe periodontal disease, dental calculus or
caries were excluded (Appendix C). All the participants were recruited through flyer and online advertisements (Appendix D and E).

**Inclusion Criteria**

Informed consent was obtained prior to study initiation (Appendix F). All subjects included in the study were: generally healthy, adults males and females, 18 years or older, scored a 9 or higher on Corah’s DAS-R at screening, and consented to wear the IV eyewear.

**Exclusion Criteria**

Subjects were excluded if they had severe dental calculus (Class IV or V), severe periodontal disease (American Academy of Periodontology (AAP) status of 3 or higher) or severe dental caries (3 or more open large lesions). Individuals were excluded if they presented any medical condition that required pre-antibiotic medication, reported current use of anxiety medication, history of seizures or convulsive disorders, vertigo or equilibrium disorder, use of psychiatric drugs, or a scored of less than 9 on the Corah’s DAS-R. A referral to the dental hygiene clinic at ODU was provided if individuals did not qualify for the study.

**Data Collection Indices**

Subjects who qualified and were enrolled completed Corah’s DAS-R and Calmness Scale at the treatment appointment (Appendix A and G). The Corah’s DAS-R index consists of four multiple-choice questions related to dental visits, dental procedures, and expectation at the dental office. Anxiety scores can range from 4 to 20 points: a score of 15-20 is considered severe; 13-14 high; 9-12 moderate; and 8 or less is
low. Each question had a possible score of 1 to 5. Corah’s DAS-R was scored at screening and repeated at baseline.

The Calmness Scale is a three question Likert-scale (1= most calm and 7= least calm). The Calmness Scale was completed pre, and post IV treatment. The Calmness Scale was self-developed by the research team. A Post IV Opinion Survey containing three questions assessed subjects’ opinion about wearing the IV eyewear (Appendix H).

**Procedures**

At screening, medical and dental histories, and the DAS-R were scored. If subjects scored 9 or higher, they were invited to participate in the study. An oral examination was performed to assess periodontal status, caries, and dental calculus. Eligible participants were scheduled for an oral prophylaxis appointment without anesthesia. The screening consisted of a 15 minutes length appointment.

Subjects were randomized to group A (IV eyewear on the right side) or group B (IV eyewear on the left side). At the treatment appointment, the Corah’s DAS-R was scored a second time to validate screening values. If the participant scored 9 or higher, the individual proceeded to the oral prophylaxis. All oral prophylaxis started on subjects’ right side of the mouth. The use of IV eyewear was randomized. Each subject had the opportunity to select one of three IV videos: (1) a documentary about Oregon (Aerial America; Smithsonian channel), (2) music videos, or (3) a TV show (Mr. Bean) with accompanying audio. The length for videos varied and subjects had the option to: 1) display the video and play the audio, 2) audio only, or 3) no video and audio through a Bluetooth big switch. Subjects were able to adjust the volume settings manually, and
could turn IV eyewear off at any time. Instructions for the use of both IV eyewear and Bluetooth switch were provided prior to use.

The Calmness Scale was scored pre-treatment. After scaling half of the mouth (right side), the Calmness Scale was scored again. After a brief rest 1-2 minutes, the other half of the mouth (left side) was scaled and full selective polishing was completed. The Calmness Scale was scored again at post-treatment. The oral prophylaxis was completed in one appointment approximately 60-90 minutes in length. A Post IV Opinion Survey scored to determine acceptability of the eyewear by the participants.

**Treatment Sequence:**

**Screening Examination**

- Medical/dental histories
- Corah’s Anxiety Dental Scale (DAS-R)
- Calculus assessment
- Periodontal assessment
- Dental caries assessment

**Baseline/Treatment:**

- Randomization IV eyewear: Group A (IV eyewear right side) Group B (IV eyewear Left side)
- Corah’s Anxiety Dental Scale (DAS-R)
- Calmness Scale
- Right side:
  - Oral Prophylaxis
- Calmness Scale (repeat as operator switches sides)
- Left side treatment
  - Oral Prophylaxis
- Calmness Scale

**Post Treatment:**

- Post IV Opinion Survey
Statistical Analysis

Data were entered into Microsoft Excel for Mac 2011 (Microsoft Corporation Version 14.3.5) (Appendix I). Data was reintroduced and analyzed using SAS® 9.3 statistical software under GLM (General Linear Modes) procedure. Data were reviewed three times for quality assurance. Data were analyzed using analysis of variance (ANOVA). Hypothesis was tested at a level of significance of 0.05.
CHAPTER IV

RESULTS AND DISCUSSION

Sample Size Analysis

Fifty participants were screened; thirty subjects were enrolled. Twenty-three females and 7 males with a mean age of 29.96 ± 7.8 (age range, 18 to 51 years) completed the study (Figure 4). Fourteen participants self identified as Caucasian, 6 as African American, 5 as Hispanic, and 5 as Asian (Figure 5). During oral prophylaxis, subjects had the opportunity to choose the type of video to view: 15 selected the documentary, 5 the T.V. show, and 10 chose music videos (Figure 6).

Corah’s Dental Anxiety Scale-Revised (DAS-R)

Corah’s DAS-R was scored prior to treatment to determine baseline anxiety levels. Baseline Corah’s DAS-R for Group A scored anxiety levels as followed: 8 moderate, 1 high, and 6 severe. Baseline Corah’s DAS-R for Group B scored anxious patients as followed: 7 moderate, 4 high, and 4 severe (Figure 7). Mean baseline Corah’s DAS-R scores in Group A was 13.33 ± 3.15 (Table 1, Figure 8); mean baseline scores for Group B was 12.93 ± 2.40 (Table 1, Figure 8). The results showed no statistically significant difference in both groups with regard to the baseline anxiety levels, thus all the participants started treatment with similar anxiety levels (p= 0.69) (Table 2). The baseline mean of Corah’s DAS-R score between group A and B was 13.13 ± 2.763 (Table 3).

Calmness Scale

The Calmness Scale was scored thru this; at the end of each treatment side (right and left). The pre- IV treatment mean for group A was 4.66 ± 1.04, and post-IV treatment
mean was 2.93 ± 1.22 (Figure 9, Table 4). Group A showed a statistically significant difference (p < 0.01) between pre- and post- IV treatment (Table 5). Pre- IV treatment for group B showed a mean of 4.33 ± 1.54, and a post- IV treatment mean of 2.13 ± 0.99 (Figure 10, Table 6). Group B also showed a statistically significant difference (p < 0.01) with regard to pre- and post-IV treatment results which indicates that the use of IV eyewear has a positive effect in lowering anxiety levels (Table 7).

When comparing pre- IV treatment values between groups by gender, females obtained a mean of 4.82 ± 1.15, and males a mean of 3.42 ± 1.27 which suggests that females report more anxiety levels than males (Figure 11, Table 8). There was a statistically significant difference between Calmness Scale and gender in both groups (p = 0.01) (Table 9). The mean value of pre- IV treatment between genders was 4.5 ± 1.18 (Table 10). Post- IV treatment by gender provided a mean value of 2.73 ± 1.17 for females, while males had a mean of 1.85 ± 0.89 (Figure 12, Table 11). Therefore, there was not a statistically significant difference (p = 0.07) in both groups with regard to gender during post- IV treatment (Table 12). Post-IV treatment values between both groups provided a mean of 2.53 ± 1.12 which indicates that both genders benefitted from the use of IV eyewear (Table 13).

**Post IV Opinion Survey**

The Post IV Opinion Survey (Appendix H) was scored post treatment (oral prophylaxis). Question 1: How anxious were you during your dental hygiene treatment when wearing immersive visualization eyewear, presented no statistically significant difference (p= 1.00) between Group A (x̄ = 2.73 ± 1.09) and group B (x̄ = 2.73 ± 1.03) (Figure 13, Table 14 and 15). When taking in consideration variables such as gender, race
and age, no statistically significant difference was found (p = 0.18). P-values for each variable were age = 0.08, race = 0.10 and gender = 0.08 (Table 16). Question 2: Did you find wearing the immersive visualization eyewear helped reduce your anxiety during treatment, showed no statistically significant difference (p = 0.19) between group A (\(\bar{x} = 6.53 \pm 0.63\)) and group B (\(\bar{x} = 6.13 \pm 0.99\)) (Figure 13, Table 17 and 18). The p-value was 0.36 when taking in consideration age (p = 0.21), race (p = 0.27) and gender (0.82) (Table 19). Question 3: Did you enjoy wearing the eyewear during the treatment, showed a high correlation (p = 0.64) between group A (\(\bar{x} = 6.06 \pm 0.138\)) and group B (\(\bar{x} = 6.26 \pm 0.96\)) (Figure 14, Table 20 21). When taking in consideration age (p = 0.14), gender (p = 0.59) and race (p = 0.35), there was no statistically significant difference in anxiety levels between treatment sides (p = 0.57) (Table 22).

**DISCUSSION**

The aim of the present study was to determine if the use of immersive visualization (IV) played a role in dental anxiety during oral prophylaxis. The results of this research support previous investigations corroborating the positive effect of IV eyewear in reducing and stabilizing anxiety levels during dental hygiene treatment.\textsuperscript{37-39} Therefore, the hypothesis formulated for this study is rejected. The current study differed from previous studies in the sample number, concentration in the subject of anxiety only, instrumentation and equipment used, and variety in videos offered. Therefore, results can only be generalized to similar populations.

A convenient sample of 30 adults from 18 to 51 years of age revealed that females were more anxious than males, which is supported in the literature.\textsuperscript{1,5,7,9,22-25} Ninety seven percent of the subjects who participated in the study would use IV eyewear during
an oral prophylaxis. Ninety seven percent of the participants found through the use of IV eyewear “helpful” and “great for distraction.” In addition, most of the participants felt that using IV eyewear during the treatment made the procedure appear faster. However, two subjects reported that the equipment was “heavy” and “uncomfortable.” One subject reported missing the patient-clinician interaction during the procedure. These results demonstrate that IV eyewear provides a positive response during oral prophylaxis; therefore, individuals with dental anxiety can benefit from this technique. Previous investigations have offered the use of eyewear to project movies during dental and dental hygiene procedures. In the present study, fifty percent of the sample chose the documentary (15), while 33 percent opted for music videos (10), and 17 percent for the TV show (5). None of the participants opted to use the bluetooth big switch or switch the type of video selected.

Corah’s DAS-R was chosen as a reliable instrument to assess dental anxiety at baseline. Fifty percent of the subjects were moderately anxious; 17 percent high; and 33 percent severe. The Calmness Scale facilitated the self-measurement of dental anxiety pre, and post treatment. Results from the Calmness Scale showed group A to be slightly more anxious when compared to group B. One possible explanation could be that group A started using the IV eyewear in the beginning of the appointment, as opposed to group B who started using the IV eyewear half way through the appointment. However, both groups showed statically significant differences in anxiety levels between pre-IV eyewear and post-IV eyewear, making people less anxious as time went through.

Post IV Opinion Survey data showed a correlation between anxiety and IV eyewear. Subjects who felt less anxious during the appointment had a higher
acceptability for the IV eyewear. When the overall level of anxiety increased during the treatment, the effectiveness and the acceptability of the IV eyewear decreased. In addition, when the effectiveness of the IV eyewear increased, the acceptability also increased, which means that subjects found the equipment comfortable and helpful if the level of anxiety was low.

Vital signs were not considered during this study due to no significant difference in behavior found in previous studies; however, a study conducted by Furman et al. demonstrated that the measure of vital signs during dental treatment was a factor to measure anxiety level in individuals.\textsuperscript{14,38,40} The use of IV eyewear has reported to induce nausea; however, none of the subjects experienced this symptom.\textsuperscript{16}

The clinician and subjects reported that the use of IV eyewear did not interfere with the dental hygiene treatment. However, the use of a microphone attached to the IV eyewear system is recommended to maintain a patient-clinician open communication.

**Limitations**

The following are considered limitations of the study design:

1. The immersive visualization (IV) glasses do not cover the peripheral sight of the patient’s eyes, leaving the patient with the option of light and distraction. However, research felt that some peripheral vision provides comfort in subjects. Every reasonable attempt was made to block unnecessary light by use of disposable light cloth covers on the eyewear.

2. The recording of blood pressure and pulse could provide more reliable results in measuring anxiety levels in participants.
3. The Calmness Scale has not been verified for its validity and reliability since it was a self-developed instrument.
V. SUMMARY AND CONCLUSION

Results from this study support the use of IV eyewear to minimize and control anxiety in patients during dental hygiene treatment. Implementation of this alternative or complimentary technique can be applied to reduce anxiety in patients and help provide a more positive experience. The use of simple questionnaires such as Corah’s DAS-R allows the health care professional to identify individuals with anxiety and modify treatment procedures.
Figure 1. Immersive Visualization Eyewear.
Figure 2. Bluetooth Big Switch for Audio and Visual Adjustment (ON/OFF)
Figure 3. iPhone 5 (Apple Inc.)
Figure 4. Gender Demographic

<table>
<thead>
<tr>
<th></th>
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<tr>
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<td>Group B</td>
<td>5</td>
<td>10</td>
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Figure 5. Race Demographic

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<td>Group B</td>
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Figure 6. Type of IV Video

![Type of IV Video](image)

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<th>Music Videos</th>
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<td>Group B</td>
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Figure 7. Baseline Corah's Anxiety Level

![Baseline Corah's Anxiety Level](image)

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<td>Group B</td>
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</table>
Figure 8. Distribution of Corah's DAS-R Baseline

Table 1. Mean of Group A and B Corah's DAS-R Baseline

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Table 2. P-value of Corah’s DAS-R Baseline

Dependent Variable: Baseline

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Table 3. Mean Difference Between Group A and B

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Figure 9. Group A: Right Side Pre and Post Treatment

Table 4. Mean of Group A Pre and Post Treatment

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</thead>
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Table 5. P-Value of Group A: Pre and Post-Treatment

Dependent Variable: value

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Pre and Post Treatment

Figure 10. Group B: Left Side Pre and Post Treatment

Table 6. Mean of Group B Pre and Post Treatment

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Table 7. P-value of Group B: Pre and Post-Treatment

Dependent Variable: value

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Table 8. Mean of Pre-Treatment by Gender

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<th>Std Dev</th>
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### Table 9. P-value of Pre-Treatment Between Genders

**Dependent Variable: A1**

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### Table 10. Mean of Pre-Treatment Between Genders

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Post Treatment by Gender

Figure 12. Post-treatment by Gender

Table 11. Mean of Post-Treatment by Gender

<table>
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<tr>
<th>Level of gender</th>
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<th>A2 Mean</th>
<th>Std Dev</th>
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<td>M</td>
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Table 12. P-value of Post-treatment and Gender Correlation

Dependent Variable: A2

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Table 13. Mean Deference of Post Treatment Between Genders

<table>
<thead>
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Q1: How anxious were you during your dental treatment when wearing the IV eyewear?

Table 14. Mean of Group A and B Question 1

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<th>Std Dev</th>
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### Table 15. P-value for Post IV Opinion Survey Question 1

Dependent Variable: q1

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<th>F Value</th>
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### Table 16. P-values Between Group A and B Post IV Opinion Survey Question 1 by gender, race, and age

Dependent Variable: q1

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Q2: Did you find wearing the IV eyewear helped reduce your anxiety during treatment?

Figure 13. Q2

Table 17. Mean of Group A and B Question 2

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Table 18. P-value for Post IV Opinion Survey Question 2

Dependent Variable: q2

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Table 19. P-values Between Group A and B Post IV Opinion Survey Question 2 by gender, race, and age

Dependent Variable: q2

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<th>Pr &gt; F</th>
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Q3: Did you enjoy wearing the eyewear the treatment?

Figure 14. Q3

Table 20. Mean of Group A and B Question 3

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<th>N</th>
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<th>Std Dev</th>
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Table 21. P-value for Post IV Opinion Survey Question 3

Dependent Variable: q3

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Table 22. P-values Between Group A and B Post IV Opinion Survey Question 3 by gender, race, and age

Dependent Variable: q3

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REFERENCES


APPENDIX A

CORAH’S DENTAL QUESTIONNAIRE SCALE-REVISED

Subject ID: ____________________________ Date: ____________________________

Norman Corah’s Dental Questionnaire

1. If you had to go to the dentist tomorrow for a check-up, how would you feel about it?
   a. I would look forward to it as a reasonably enjoyable experience. 
   b. I wouldn’t care one way or the other.
   c. I would be a little uneasy about it.
   d. I would be afraid that it would be unpleasant and painful.
   e. I would be very frightened of what the dentist would do.

   Q1: ___________

2. When you are waiting in the dentist’s office for your turn in the chair, how do you feel?
   a. Relaxed.
   b. A little uneasy.
   c. Tense.
   d. Anxious.
   e. So anxious that I sometimes break out in a sweat or almost feel physically sick.

   Q2: ___________

3. When you are in the dentist’s chair waiting while the dentist gets the drill ready to begin working on your teeth, how do you feel?
   a. Relaxed.
   b. A little uneasy.
   c. Tense.
   d. Anxious.
   e. So anxious that I sometimes break out in a sweat or almost feel physically sick.

   Q3: ___________

4. Imagine you are in the dentist’s chair to have your teeth cleaned. While you are waiting and the dentist or hygienist is getting out the instruments which will be used to scrape your teeth around the gums, how do you feel?
   a. Relaxed.
   b. A little uneasy.
   c. Tense.
   d. Anxious.
   e. So anxious that I sometimes break out in a sweat or almost feel physically sick.

   Q4: ___________

Scoring the Dental Anxiety Scale, Revised (DAS-R)

(a) This information is not printed on the form that patients see

(a) a = 1, b = 2, c = 3, d = 4, e = 5 Total possible = 20

Anxiety rating:

• 9 - 12 = moderate anxiety but have specific stressors that should be discussed and managed
• 13 - 14 = high anxiety
• 15 - 20 = severe anxiety (or phobia). May be manageable with the Dental Concerns Assessment but might require the help of a mental health therapist.

TOTAL: ________
APPENDIX B

MEDICAL AND DENTAL HISTORY

Name: ___________________________ Date: __________

Gender: __________________________
Age: ___________________________
Ethnicity/Race: ___________________

1. Do you feel anxious when going to the dentist or dental hygienist?
   Yes    No

2. Have you ever had your teeth cleaned before by a dental professional?
   Yes    No

3. Are you taking any medication for anxiety?
   Yes    No

4. Do you need antibiotics before dental treatment?
   Yes    No
   If yes, for what?

5. Do you or have you ever had any of the following conditions?
   a) Infective endocarditis (history): Yes/No
   b) Joint Replacement Yes/No
   c) Bypass surgery within the last 3 months Yes/No
   d) Kidney Dialysis/transplant Yes/No
   e) Heart Condition Yes/No
   f) Cardiac surgery Yes/No
   g) Artificial heart valves Yes/No
   h) Congenital heart defect Yes/No
   i) Myocardial (heart attack) less than 3 months ago Yes/No
   j) Uncontrolled Diabetes Yes/No
   k) High blood pressure Yes/No
   l) Sickle Cell anemia Yes/No
   m) Taking long-term immuno-suppressant medication? Yes/No
   n) Taking cortico-steroids Yes/No

If all of the responses are negative, the people are invited to the research center for screening appointment to see if the qualified. If any of the responses above are yes, they will be excluded from the study.

_____________________________  _______________________
Signature                        Date
APPENDIX C

ORAL EXAMINATION

Subject ID: __________________________

Calculus: 1 2 3 4 5

Perio: 1 2 3 4 5

Caries: Severe: Yes___  No:_____

Enrolled: Yes:____________________  No:__________________
APPENDIX D

FLYER ADVERTISEMENT

DENTAL RESEARCH STUDY

Immersive Visualization During Dental Hygiene Treatment

Free Dental Cleaning

Old Dominion University
Dental Hygiene Research Center,
Health Science Building # 1103
Requires 1-2 visits approximately 90 minutes
CALL 757-683-4719
For Screening Appointment

IRB APPROVAL #______________

We are looking for people who are anxious during dental hygiene treatment.

YOU must:
• Be generally healthy
• Adults males or females 18 years or older
• No Severe dental caries
• No severe periodontal disease
• Be able to wear visualization headsets for 60 minutes or less.
We are looking for people who are anxious during dental hygiene treatment.

YOU must:
- Be generally healthy
- Adults males or females 18 years or older
- No severe dental caries
- No severe periodontal disease
- Be able to wear visualization headsets for 60 minutes or less.

Old Dominion University
Dental Hygiene Research Center,
Health Science Building # 1103
Requires 1-2 visits approximately 90 minutes
CALL 757-683-4719
For Screening Appointment
APPENDIX F

INFORMED CONSENT DOCUMENT

INFORMED CONSENT DOCUMENT
OLD DOMINION UNIVERSITY

PROJECT TITLE: Interactive Immersive Visualization in the control of anxiety during dental hygiene treatment

INTRODUCTION
This project entails Interactive Immersive Visualization in the control of anxiety during dental hygiene treatment and will be conducted in the Dental Hygiene Research Center, Old Dominion University, 700 Health Science Building Room 6110.

The purpose of this form is to give you information that may affect your decision whether to say YES or NO to participation in this research and to record the reasons for your answer. This consent form may contain words that you do not understand. Please ask the study staff to explain any words of information that you do not clearly understand. You may have forms an unaltered copy of this consent form to keep should you choose to discuss with family or friends before making your decision.

RESEARCHERS
Responsibility for Investigator:
Gary McCandless, Ph.D., Ph.D., Professor, School of Dental Hygiene, College of Health Science
Investigator:
Gwendolyn Beal, PhD, MPA, Associate Professor, Medical, Law & Health Sciences, Virginia Modeling Analysis and Simulation Center
Joyce Ditto, B.S., M.S., Assistant Professor, School of Dental Hygiene, College of Health Science
Carmela Pedone-Bastien, Ph.D., B.S.D.H., Dental Hygiene master student

DESCRIPTION OF RESEARCH STUDY
Several studies have conducted research looking into the control of anxiety during dental treatments. The purpose of this study is to investigate the overall effects of interactive immersive visualization on dental hygiene care practice. IVN is a technique that displays a virtual environment such as a room or moving imagery if you decide to participate. Then you will join a study involving approximately 30 research participants between the age of 18 and 65 who will receive a free dental cleaning and answer short questionnaires before during and after treatment. You will be participating in a study where one half of your mouth will be cleaned using IVN and the other half using a brush. If you say YES and qualify for a free dental cleaning and oral exam, you will be required to come to the ODU Dental Hygiene Research Center for a screening appointment that will last approximately 15-30 minutes. If you qualify, you will receive an oral exam, a dental cleaning, and dental polishing.

EXCLUSIONARY CRITERIA
You should NOT have any of the following:
- Present any medical condition that contraindicates dental hygiene treatment
- Any condition that required antibiotic premedication such as:
  - Prosthetic cardiac valves
  - Previous infective endocarditis
  - Heart disease
  - Infective endocarditis
  - Total joint replacement
  - Immunosuppressed individuals
  - Unstable diabetes
  - Anasarca chemotherapy
  - Acute leukemia
  - Renal transplantation
  - Kidney dialysis
- Active tuberculosis
- Any blood disorder
- Drug or alcohol dependency
- History of seizures or convulsive disorders
- Vertigo or equilibrium disorder
- Use of psychiatric drugs
Use of anxiety medication
- Severe periodontal conditions
- Severe calcium deposits
- Severe dental caries
- Scored 6 or less on the Cohrs's Dental Anxiety Scale Revised
- Subjects younger than 18 years or older than 65 years of age
- Dental impairment that causes undue anxiety on one side of the mouth

INCLUSION CRITERIA
To be eligible for this study you should be
- Generally healthy
- Subjects between the ages of 18 and 65 years
- Present at screening with an anxiety level B or higher on the Cohrs's Dental Anxiety Scale Revised (DAS-R)
- Calculus no higher than class 3 on the American Academy of Periodontology classification
- Gum disease no higher than class 3 on the American Academy of Periodontology classification
- No cavities
- No taking any medication for anxiety or required antibiotic premedication
- Consent to wear the interactive immersive visualization eyepiece
- No dental impairment that causes undue anxiety on one side of the mouth

RISKS AND BENEFITS
RISKS - If you decide to participate in this study, then you may face a risk of nervous during or after the use of visualization eyewear device, tooth sensitivity, gum tenderness, redness or bleeding associated with the dental cleaning.

BENEFITS - The main benefit to you for participating in this study is that you will contribute to the general overall knowledge of dental anxiety and virtual reality. You will obtain a free dental cleaning and periodontal examination.

COSTS AND PAYMENTS
The researchers want your decision about participating in this study to be absolutely voluntary. Yet they recognize that your participation may pose some inconvenience such as parking. You will receive no payment from this study.

NEW INFORMATION
If the researchers find new information during the study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY
The researchers will take all reasonable steps to keep private information, such as medical histories and screening forms confidential. The researcher will remove personal identifiers from the information, store information in a locked filing cabinet located in Health Science Building #1103. The results of this study may be used in reports, presentations, and publications, but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE
It is OK for you to say NO. Even if you say YES now, you are free to say NO later and walk away or withdraw from the study - at any time. Your decision will not affect your relationship with Old Dominion University or otherwise cause a loss of benefits to which you might otherwise be entitled. The researchers reserve the right to withdraw your participation in this study at any time, if they observe potential problems with your continued participation.

COMPENSATION FOR ILLNESS AND INJURY
If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of harm arising from this study, report Old Dominion University, and the researchers are able to give you any money, insurance, coverage, medical care or any other compensation for any injury in the event that you suffer any as a result of participation in any research project. You may contact the responsible project investigator, Professor Shiva Mirzaei, at the following number: 757-868-1910, or the Old Dominion University Office of Research at 757-868-5640, or Dr. George Mustafa, the current IRB chair at 757-683-4028 at Old Dominion University who will be glad to review the
Matter with you. If you are injured or become a result of being in this study, you can the responsible project investigator immediately Professor Dave McCrum at 757-863-5160.

**VOLUNTARY CONSENT**

By signing this form, you are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study to which it relates, and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them. Contact Professor Dave McCrum at 757-863-5160 at any time if you have questions about your rights or the form. You should also contact the Office of Research at 757-863-3400 for any other issues.

Also importantly, by signing below you are telling the researchers that you agree to participate in this study. The researchers should give you a copy of this form. We recognize the importance of your health and will act accordingly in the pursuit of our research. By signing below, you acknowledge that you have read and understood the contents of this form.

By signing this consent form, I have no question of any of my rights.

<table>
<thead>
<tr>
<th>Subjects Printed Name &amp; Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

**INVESTIGATOR'S STATEMENT**

I certify that I have explained to this subject the nature and purpose of the research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice the subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged subject to ask additional questions at any time during the course of this study. I have witnessed the active signature(s) on this consent form.

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</thead>
<tbody>
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APPENDIX G

CALMNESS SCALE

Subject ID: ________________

On a scale of 1-7 (1 = lowest, 7 = highest) please circle the number that indicates how you feel.

**PRE**

1. How calm do you feel right now?

   [ ] 1 2 3 4 5 6 7

   Very calm    Less Calm

**DURING**

2. How calm do you feel right now?

   [ ] 1 2 3 4 5 6 7

   Very calm    Less Calm

**POST**

3. How calm do you feel right now?

   [ ] 1 2 3 4 5 6 7

   Very calm    Less Calm
APPENDIX H
POST IV OPINION SURVEY

Subject ID: __________________________

Please circle response on the scale below:

1. How anxious were you during your dental treatment when wearing the Immersive Visualization eyewear?

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2. Did you find wearing the Immersive Visualization eyewear helped reduce your anxiety during treatment?

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3. Did you enjoy wearing the eyewear during the treatment?

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## APPENDIX I

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### Notes

- **Level of Anxiety:**
  - Low: 1 to 8
  - Moderate: 9 to 12
  - High: 13 to 14

- **Verbal Scale:**
  - T = Test
  - M = Mixed

- **Opinion Survey:**
  - V = Verbal
  - D = Documentary
### APPENDIX J

SERVICES RENDERED FORM

Subject ID: ____________________

Group: __________

Type of Video:
- Documentary
- Music Videos
- TV Show

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<th>Time: Start:</th>
<th>Stop:</th>
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Side without Eyewear

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<th>Time: Start:</th>
<th>Stop:</th>
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Services Rendered

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VITA
CARMELO PADRINO-BARRIOS RDH, BSDH
Old Dominion University Department of Dental Hygiene
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EDUCATION:
Master of Science in Dental Hygiene Anticipating graduation date
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August 2011- May 2013 Graduate Teaching Assistant
G.W. Hirschfeld School of Dental Hygiene, Old Dominion
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2010-2011 Dental Hygienist (Pediatric & General Dentistry) part-time

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December- 2013 Anxiety During Dental Hygiene Treatment. Old Dominion
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HONORS, AWARDS AND PRIZES:
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Student Presentation Modeling Simulation & Visualization
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