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Value of Pediatric Sleep Questionnaire in Referrals for Obstructive Sleep Apnea at VCU Pediatric Dental Clinic

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

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Abstract

VALUE OF THE PEDIATRIC SLEEP QUESTIONNAIRE IN REFERRALS FOR OBSTRUCTIVE SLEEP APNEA AT VCU PEDIATRIC DENTAL CLINIC

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

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Purpose: The purpose of this study is to determine the number of VCU pediatric dental patients screened for obstructive sleep apnea (OSA) relative to the number of referrals made for a pediatric sleep study.

Methods: This was a retrospective chart review of children between the ages of 1-18 years seen at the VCU Pediatric Dental Clinic between 2016-2020. Patients with a completed sleep apnea screening questionnaire in the health history form or sleep apnea form/referral were identified. The data was used to determine how many referrals were made for a pediatric sleep study in patients screening positive for sleep apnea.

Results: A total of 1,265 patients were included in the analysis. Only 147 of the 1,265 patients had a PM-STOP-Bang form in their dental record (12%). There was a significant relationship with the number of "yes" responses from the screening questions and completion of the PM-STOP-Bang form (p-value <0.0001). Of the 147 patients with a PM-STOP-Bang form, 37 were referred to a physician for an evaluation (25%). Having a documented referral was significantly associated with the PM-STOP-Bang score (p-value < 0.0001).

Conclusion: The purpose of this study is to determine the number of VCU pediatric dental patients screened for Obstructive Sleep Apnea using the Pediatric Modified (PM) STOP-Bang questionnaire relative to the number of referrals made for a sleep study. The screening questions from the patient's electronic health record proved to be useful in aiding the dental provider to complete a PM-STOP-Bang. The PM-STOP-Bang proved to be a useful tool in providing referral to a patient's physician following a positive screening for Obstructive Sleep Apnea. Based on the results of this study, this tool has an important role not only in pediatric dentistry, but when modified to serve the adult dental patient.

Introduction

Obstructive Sleep Apnea (OSA) is one of the most common, unrecognized, and undiagnosed chronic diseases in children. The prevalence of OSA is increasing,[1] affecting roughly 1-5% of the pediatric population[2] between ages 2-8 years.[3] OSA occurs when the cessation of air flow in the upper airway during sleep causes an interference with normal respiratory gas exchange and sleep interruption.[1] Symptoms of snoring, sleep structure disorder, oxygen desaturation, daytime sleepiness, and attention deficit disorder are all a result of the low ventilation and airway obstruction that occur during sleep.[2] In children, the most prevalent symptom of OSA is snoring;[4] however, there is a spectrum of symptoms ranging from snoring to complete airway obstruction.[3]

There are more than 80 different types of sleep disorders. These must be classified by age as the presentation of each varies depending upon patient age.[5] The three main classifications of sleep disorders are 1) dyssomnias, 2) parasomnias, and 3) sleep disorders associated with mental, neurologic, or medical disorders.[5] The dyssomnias are classified by problems initiating or maintaining sleep, resulting in poor quality, amount, and timing of sleep. Dyssomnias are further grouped into either intrinsic or extrinsic types, with sleep disordered breathing (SDB) falling into the intrinsic classification. Intrinsic dyssomnias are defined by a patient abnormality that alters sleeping. Many problems such as obstructive sleep apnea, obesity, and craniofacial abnormalities may affect sleeping.[5] Neuromuscular disease, mandibular micrognathia, and narrow upper airway will predispose a patient to OSA. Patients with sleep disorders may also be obese and experience elevated systemic blood pressure.[3] A milder form of obstructive sleep apnea, called upper airway resistance syndrome, occurs when children have OSA symptoms but lack the polysomnographic findings. Children with true OSA have more detrimental clinical findings – failure to thrive, behavioral issues, nocturnal enuresis, and pulmonary heart disease.[5]

Obstructive Sleep Apnea is the most common breathing disorder of sleep.[5] Chronic loud snoring is a sign of airway obstruction, resulting in reduced airflow. The blockage of the upper airway results in continued chest and abdominal muscle movement;[5] despite the appearance of breathing, gas exchange does not occur.[6] Although snoring and mouth breathing are common in children,[5] these symptoms along with recurrent headache, frequent daytime sleepiness, hyperactivity, inattention, and irritability[3] indicate the need for further evaluation. Unlike adults, sleep deficits in children present with more behavioral issues rather than daytime sleepiness alone.[5] There is also no clear correlation between the severity of OSA and daytime symptoms.[3]

OSA in children is characterized by a respiratory pause lasting at least 3-4 seconds. Unlike adults, children have much quicker respiratory rates, a smaller functional residual capacity, and a more compliant chest wall. The higher chest wall compliance indicates a more pliable lung, and airway in general, leading to an increased ease of collapse. A breathing obstruction lasting three seconds can quickly lead to oxygen desaturation,[5] a decrease in blood oxygen,[7] and may result in sleep arousal.[5] Sleep arousal does not necessarily wake a patient up, but rather results in a release of chemicals such as adrenalin which may contribute to the long-term health effects of undiagnosed sleep apnea.[7] Both apneas and hypopneas, the complete obstruction of airflow and the partial decrease in airflow, respectively, result in desaturation and arousal throughout the night.

Additionally, intermittent hypoxia affects central neuromodulator systems such as the endogenous opioid system. The result of intermittent hypoxia is an increase in the density of mu-opioid receptors in the brainstem. Included in this neuromodulator system are the neurons which control the pharyngeal dilator muscles. The lack of oxygen alters the sensitivity of the opioid receptors on the brainstem to exogenously administered opioids. Opioid receptors located on the pharyngeal dilator muscles modulate respiratory related activity. Stimulation of these receptors via opioid administration, depresses the muscle activity, promoting collapse of the upper airway.[8]

The Apnea-Hypopnea Index (AHI) is one factor measured during Sleep Laboratory-Based Polysomnography (PSG) and is considered a diagnostic value for obstructive sleep apnea.[4,5] The AHI represents the average number of apneas and hypopneas that occur per hour of sleep.[1] More than one obstructive event per night is considered abnormal in children[1] and diagnostic for OSA.[5] Polysomnography (PSG) is the gold standard for both diagnosis and assessment of obstructive sleep apnea in children. These studies are difficult and labor-intensive, which can create challenges for children and their families in receiving treatment. Another complication that can arise is the time lapse between referral and evaluation, with some families waiting up to five to six months for appointments.[4] Because of these reasons, prompt identification and screening of at-risk patients is clinically relevant.[9]

A study by Gulotta et. al. explored the risk factors for pediatric obstructive sleep apnea. For both adults and children, obesity is one of the most important risk factors. The presence of fat throughout the body not only decreases the lumen of the airway, but can significantly reduce the respiratory function.[3] Multiple studies have discovered that despite adenotonsillectomy in children with OSA, obesity results in an increased risk of OSA after surgery. The authors of this study suggest that weight loss become a first line therapy for children with both OSA and elevated Body Mass Index (BMI).[3]

The increase in volume of lymphoid tissue during childhood also contributes to OSA.[10] It is important for dental professionals to monitor the size of the oropharynx as tonsil and adenoid hypertrophy is a primary cause of OSA.[11] One way for dentists to monitor tonsil size is through the Brodsky classification. The Brodsky scale categorizes tonsil size on a scale of one to five based on the percentage of space occupied within the oropharyngeal airway.[12] A Brodsky score of 0 indicates that the tonsils sit within the tonsillar fossa. Brodsky 1 tonsils occupy less than 25% of the oropharyngeal width. Brodsky 2 tonsils occupy 25-50%, Brodsky 3 tonsils occupy 50-75%, and Brodsky 4 tonsils occupy greater than 75% of the oropharyngeal width.[12] Typically, pediatric dentists classify large tonsils as Brodsky 3 or above. Due to the exponential increase in lymphoid growth during early childhood, children ages 3-6 years have the highest proportion of lymphoid tissue in the upper airway relative to lumen size.[10] This results in a much narrower airway and also corresponds with the peak incidence of OSA.[10] The volume of lymphatic tissue typically shrinks after age 6; however, the size may be so large that the tissue reduction still does not remove oropharynx obstruction.[11] Tonsillar size is one of the most frequent causes of OSA, especially in otherwise healthy children.[3] There is a correlation between tonsil size and severity of OSA.[3] The gold standard of treatment is surgical removal of the tonsils and adenoids, with studies showing resolution of OSA in 83% of children.[3] It should be noted that not all children with large tonsils are affected by OSA;[3] thus, a thorough understanding of other predisposing factors is important for dentists when evaluating patients.

It is also believed that allergic rhinitis may affect sleep and contribute to OSA.[3] Lofaso et. al. highlighted the correlation between nasal obstruction and OSA through the use of polysomnography. The study found that permanent nasal obstruction that is unresponsive to nasal decongestants may contribute to sleep disordered breathing.[13] Although this study was completed in an adult population, the results may correlate to a pediatric population.[3] In children diagnosed with mild OSA who cannot undergo surgery for therapy, the American Academy of Pediatrics recommends nasal steroid administration.[3]

Craniofacial anomalies may also contribute to pediatric OSA.[11] Discrepancies in the size, position, and geometry of both the mandible and tongue may cause thickening of the retro-palatal area leading to obstruction.[3] There are several clinical syndromes that are strongly associated with OSA. Syndromes associated with narrow facies, mid-face hypoplasia, micro or retrognathia, and macroglossia[8] such as Down, Prader-Willi, and Beckwith-Wiedemann,[3] may predispose children to OSA.[8] Disorders of the cranial base, such as Arnold Chiari malformation, may also predispose children to OSA due to impaired functioning of the cranial nerves.[8] Finally, the abnormal muscle tone associated with some neuromuscular disorders also increase the likelihood of OSA in children.[8] For patients with craniofacial anomalies, the most common surgical procedure to mitigate the narrowed nasopharynx, oropharynx, and hypopharynx is maxillo-mandibular advancement (MMA).[3] Although this is not indicated in all syndromic patients, a retrospective study by Saxby et. al. demonstrated improvement in OSA grading and Apnea-Hypopnea index following MMA surgery.[14] A meta-analysis by Camacho et. al. studied the effects of Rapid Maxillary Expansion (RME) as a treatment modality for pediatric OSA. The researchers found that the Apnea-Hypopnea index was reduced by 50% and was an effective treatment for both primary and secondary OSA in children with a maxillary skeletal discrepancy. In children with previous adenotonsillectomy but persistent OSA symptoms, RME can also be considered an effective treatment.[15] According to the study, RME treatment is more effective in patients with small (grade 1) tonsils than in patients with larger (grade 2-4) tonsils.[15]

A study by Tamasas et. al. assessed dental caries, periodontal status, occlusion and dental features of children diagnosed with OSA. Their study also examined the oral health-related quality of life using an oral health impact profile. Children diagnosed with OSA had higher body mass indices than those without diagnosis. They also had significantly larger tonsil size, as indicated by Brodsky score. Most children in the study diagnosed with OSA exhibited tonsils graded Brodsky 2 or above, indicating a much narrower airway than the controls. The presence of crowding was also significantly higher in OSA patients. Along with these oropharyngeal morphological findings, the authors found both the caries and periodontal status to be affected in children with OSA. The incidence of untreated caries in the permanent dentition was statistically higher in children diagnosed with OSA than those without a diagnosis. This trend was not seen in the primary dentition. The periodontal markers, while statistically insignificant, demonstrated that children with OSA exhibited more frequent sites with bleeding on probing (BOP) and deeper pocket depths (PD). These periodontal findings coincide with studies in adults demonstrating a significant association between periodontal disease and OSA.[16]

The effects of obstructive sleep apnea are not just limited to the oropharyngeal spaces. Multiple studies have demonstrated that repetitive events of hypoxia, arousal, and fluctuations in both heart rate and blood pressure increase sympathetic activity of the nervous system and cause vasoconstriction throughout the body.[17–19] This vasoconstriction in turn increases the blood pressure, leading to cardiac remodeling in children diagnosed with OSA.[17] One study, by Walter et. al., reported adverse cardiac outcomes in children diagnosed with OSA. They observed that arterial stiffness, as measured by both pulse wave velocity and central aortic systolic blood pressure, was higher in children with OSA.[20] The study highlights the importance of not only treating sleep disordered breathing but treating obesity to prevent the long-term cardiovascular consequences.[20]

If left untreated, OSA in children can lead to severe long-term consequences.[2] Failure to thrive is common in children, caused by both the disruption in growth hormone secretion and increased work of breathing.[8] Multiple studies have shown an increased risk for both cardiovascular and pulmonary complications, like pulmonary hypertension and right-side heart failure.[3] Repeated infections of both the upper and lower respiratory tracts are common, with lower respiratory infections being linked to chronic aspiration during sleep.[8] Children diagnosed with severe OSA may begin to see signs of early metabolic syndrome to include insulin resistance, systemic hypertension, and dyslipidemia.[3] Other complications include cognitive dysfunction. Untreated OSA causes neuropsychological dysfunction in children. If there is impairment in these skills prior to maturation of the prefrontal cortex, the cognitive potential and health of a child may be severely affected.[21] Zhao et. al. studied the association between mild to moderate OSA and cognitive impairment in children. The study found that in children under 6 years of age with mild or moderate OSA, the full IQ, visual IQ, comprehension, and visual analysis skills were significantly lower than the control group. Children above 6 years also demonstrated significantly lower visual IQ scores. The results of the study signify that children diagnosed with mild to moderate OSA may have worsened cognitive abilities, specifically verbal function, compared to healthy children.[2] The findings of the study suggest that there may be an adverse effect on the intellectual development of children diagnosed with OSA, a finding which supports early diagnosis and intervention.[2]

The increased frequency of patient interactions allows dentists a greater opportunity to observe the signs and symptoms of OSA.[1] SDB is recognized as a source of significant morbidity in children, and dentists are in a unique position to identify patient characteristics that may predispose them to this chronic disease.[4] Common symptoms observed in patients with OSA include daytime sleepiness, recurrent headache, inattention, hyperactivity, irritability, and depression.[3] Nocturnal symptoms range from snoring, witnessed apnea, oral breathing, and nocturnal enuresis.[3] Due to the increased frequency of patient interactions as compared to a pediatrician or primary care physician, dentists have the opportunity to observe signs and symptoms of OSA[1].

Dentists practicing sedation or general anesthesia should exercise additional precautions when treating patients at risk for OSA. Patients are more likely to experience both perioperative and postoperative breathing complications.[22] Both sedation and general anesthesia can increase the vulnerability of children diagnosed with obstructive sleep apnea to pharyngeal collapse. Management of the airway becomes difficult once a child is exposed to sedative medications,[8] a technique that pediatric dentists use often for behavior management. As discussed earlier, the sensitivity to exogenously administered opioids, such as those used during moderate sedation procedures, is heightened due to intermittent hypoxia caused by OSA. Additionally, the group of neurotransmitters responsible for controlling respiration in pharyngeal dilator muscles are also targeted by sedative and anesthetic medications.[8] Both the pharmacologic and physiologic effects of sedation and general anesthesia mimic the effect of sleep on the airway. During sleep, the decreased diameter of the pharynx along with its increased compliance promote collapse. Further, the pharyngeal dilator muscles are inhibited, which decreases pharyngeal patency.[8] Sedation and general anesthesia enhance the vulnerability of the airway to collapse.[8] It is for these reasons that effective airway management is essential during both sedation and general anesthesia for children with OSA. In children requiring sedation as a behavior management technique for dental procedures, general anesthesia is preferable to moderate sedation due to the ability to secure the airway via endotracheal tube.[8] OSA can lead not only to airway obstruction, but increased risk for postoperative respiratory complications. While postoperative respiratory complications are relatively infrequent in children without OSA, children diagnosed with OSA have respiratory complications ranging from 16-27%.[1] It is for these reasons that alternative diagnostic methods have been evaluated. Through a combination of thorough evaluation of patient medical history and physical examination of the craniofacial features, the dentist is in a unique position to identify and refer patients for OSA treatment.[4]

There are several factors contributing to the development of Obstructive Sleep Apnea in children. Many questionnaires have been developed for use as a screening tool, but the STOP-Bang questionnaire is one of the most widely used. In 2015, Chiang, et. al., developed a Pediatric Modified STOP-Bang (PM-STOP-Bang) for use in the pediatric setting as a screening tool for pediatric sleep apnea. This questionnaire considers eight different factors which contribute to an increased risk for OSA. It assesses the presence of snoring (S), tonsillar hypertrophy (T), observed obstruction (O), neuropsychological-behavioral symptoms such as ADHD or daytime irritability (P), BMI percentile for age and gender above 95% (B), age at diagnostic screening (A), presence of a neuromuscular disorder (N), and presence of a genetic/congenital disorder (G).[1] Scores range from 0-8 based on the number of “yes” responses to the questionnaire. Results of the study indicate that 20% of participants with score of four were diagnosed with moderate to severe OSA while 58% of pediatric patients with a score of five or six were diagnosed with moderate to severe OSA.[1]

Purpose of Study

The purpose of this study is to determine the number of VCU pediatric dental patients screened for Obstructive Sleep Apnea using the Pediatric Modified (PM) STOP-Bang questionnaire relative to the number of referrals made for a sleep study. This information is important because dentists have an important role in screening patients for obstructive sleep apnea. Dentists have a greater opportunity to observe the signs and symptoms of OSA in their patients. The results of this study may also be applicable to the general dental clinic population, which currently does not screen patients for obstructive sleep apnea. If the Pediatric Modified STOP-Bang questionnaire proves a useful tool in the recognition and diagnosis of OSA in children, it may also be a tool that can be incorporated into adult dental exams.

For the purpose of this study, the following questions were addressed:

1. How many PM-STOP-Bang questionnaires were completed in the VCU Pediatric Dental clinic since its implementation as a component of a patient's medical history?
2. How many PM-STOP-Bang questionnaires resulted in referral for a pediatric sleep study?

As part of this study, investigation included one research hypothesis:

1. In patients of the VCU Pediatric Dental clinic will a score of ≥ 4 as compared with a score < 4 result in a referral for a pediatric sleep study?

Definition of Terms

1. *Sleep Disordered Breathing (SDB)* – an umbrella term for several chronic conditions resulting in partial or complete cessation of breathing throughout the night, resulting in daytime sleepiness/fatigue interfering with one's ability to function and quality of life[7]
2. *Obstructive Sleep Apnea (OSA)* – one of the most common forms of SDB;[7] a breathing disorder characterized by disruption in normal sleep patterns due to prolonged, upper airway obstruction and/or intermittent or complete obstruction[22]
3. *Pediatric-Modified STOP-Bang questionnaire* – snoring (S), tonsillar hypertrophy (T), observed obstruction (O), neuropsychological-behavioral symptoms such as ADHD or daytime irritability (P), BMI percentile for age and gender above 95% (B), age at diagnostic screening (A), presence of a neuromuscular disorder (N), presence of a genetic/congenital disorder (G)[1]
4. *Apnea Hypopnea Index* – the number of mixed, obstructive or central apneas and hypopneas per hour of total sleep time. The parameter used to describe the severity of sleep disordered breathing[23]

Methods

This study was granted exempt status from the Virginia Commonwealth University Institutional Review Board HM 20018249. This was a retrospective chart review of children between the ages of 1-18 years seen at the VCU Pediatric Dental Clinic between 2016-2020. Study data was collected through axiUm, an electronic dental health record, identifying patients with either completed Sleep Apnea Screening questionnaire in the health history form or Sleep Apnea Form/Referral. Protected Health Information (PHI) was deidentified through the chart review and none of the 18 HIPPA identifiers were recorded during research records.

The screening questionnaire data set generated 1,265 patients. To be included, patients needed a "yes" response to at least one of the three sleep apnea screening questions in the patient medical history form. Patients with incomplete screening questions or screenings completed within other dental school clinics were not included. Each patient chart was reviewed in axiUm, using their patient chart number as a reference. Charts were examined to determine if a "yes" response was generated for one or more of the following three questions:

1. Does your child snore loudly?
2. Does your child experience daytime sleepiness/fatigue?
3. Has anyone observed your child stop breathing during sleep or rest?

Following clinic protocol, patients with a "yes" response to any of the above questions were then asked a series of questions presented in the PM-STOP-Bang. If four or more positive responses occurred in the PM-STOP-Bang, the Sleep Apnea Referral Form was completed and explained to the patient's guardian. It was then up to the guardian to schedule the appointment with the sleep apnea clinic for consultation and possible testing.

Each patient chart was reviewed to identify the number of patients with a completed PM-STOP-Bang Sleep Apnea Referral Form. Patients with incomplete forms were excluded from the data set. Patients with Sleep Apnea Forms completed in other dental clinics were also excluded. The number of positive PM-STOP-Bang questionnaires (≥4 positive responses) were then used to determine the frequency of patient referrals for a pediatric sleep study. Patients without referral to a sleep medicine physician were also recorded. A flow chart of both inclusion and exclusion for this study is included in Figure *1*.

Results were summarized using descriptive statistics. Associations were evaluated using chi-squared, Fisher's exact tests, and logistic regression models. Significance level was set at 0.05 and SAS EG v8.2 (SAS Institute, Cary, NC) was used for all analyses.

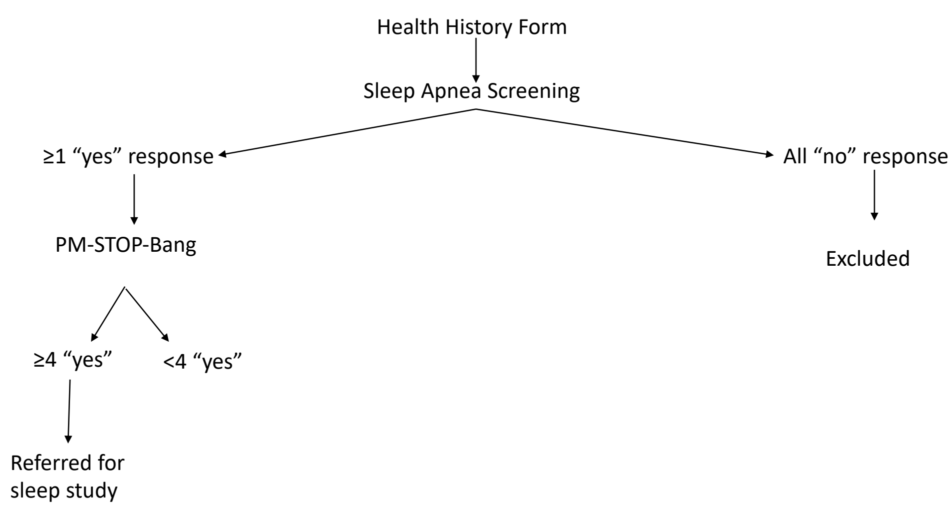

Figure 1: Inclusion and exclusion criteria

Results

A total of 1,265 patients were included in the analysis. The average age was 7.9 (SD = 4.3). Of all patients, 47% were female, 53% were male, and less than 1% had an unknown gender (n = 3). The majority had one "yes" response to one of the three screening questions (n = 1,000, 79%), 16% had two "yes" responses, and 5% responded "yes" to all three questions. When examining the three screening questions, the most common positive response was snoring (n = 1,121, 89%) followed by fatigue (n = 269, 21%) and witnessed apneic episodes (n = 206, 16%). A summary is given in Table *1*.

Table 1: Screening questions

	n	%
Snore	1121	89%
Fatigue	269	21%
Stop Breathing	206	16%
Number of Flags		
1	1000	79%
2	199	16%
3	66	5%

Only 147 of the 1,265 patients had a PM-STOP-Bang form in their dental record (12%). There was a significant association with a "yes" response to each screening question with completion of the PM-STOP-Bang form. Patients experiencing snoring (13%, p-value <0.0001), daytime fatigue (16%, p-value = 0.0138), and witnessed apnea (16%, p-value = 0.0425) triggered the dental provider to complete the PM-STOP-Bang form in the dental chart. There was a significant relationship with the number of "yes" responses from the screening questions and completion of the PM-STOP-Bang form (p-value <0.0001). Nine percent of patients with one "yes" response had a PM-STOP-Bang form completed compared to over 20% of patients with either two or three “yes” responses (21%, 23%, respectively). A summary of these results is provided in Table *2*. Completion of the PM-STOP-Bang form was not significantly associated with patient gender (p-value = 0.7321) or patient age (p-value = 0.8835).

Table 2: Percent of Patients with Completed PM-STOP-Bang form based on Responses to Screening Questions

		PM-STOP-Bang	
		Yes	**P-value**
Overall		**147, 12%**	
Snore		143, 13%	<0.0001
Fatigue		43, 16%	0.0138
Stop Breathing		33, 16%	0.0425
Number of Flags			<0.0001
	1	90, 9%	
	2	42, 21%	
	3	15, 23%	

Of the 147 patients with a PM-STOP-Bang form, 37 were referred to a physician for an evaluation (25%). Having a documented referral was significantly associated with the PM-STOP-Bang score (p-value < 0.0001). None of the 46 patients with a score of 0 or 1 had a documented referral. All of the patients with a score ≥ 5 had a documented referral (note: there were no patients who scored 7 or above). Using the proposed cutoff of 4 as an indicator for referral was also significantly associated with documented referral (OR: 63.5 (95% CI: 13.6 – 296.6, p-value < 0.0001)). For the 22 with a score of 4 or above, 91% were referred compared to just 14% with a score below 4. A summary of the increasing referral rates by score is presented in Figure *2*.

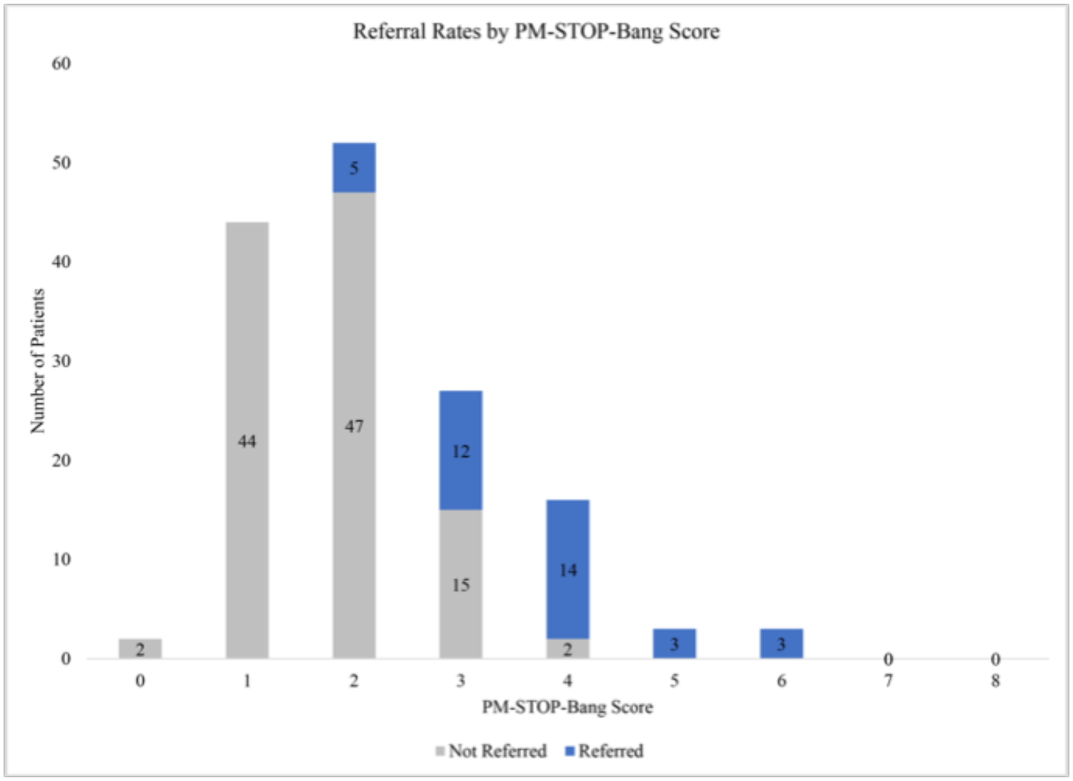

Figure 2: Referral Rates by PM-STOP-Bang Score

Discussion

This retrospective chart review examined the number of VCU pediatric dental patients screened for obstructive sleep apnea using the PM-STOP-Bang. It also examined the number of patients referred for a sleep study based off their PM-STOP-Bang score. Although only 12% of the 1,265 patients screened had a completed PM-STOP-Bang, there was a significant association with a "yes" response to the screening questions and completion of the questionnaire. The dental provider was significantly more likely to administer the PM-STOP-Bang to patients who snore, experience excessive daytime fatigue, or have witnessed episodes of apnea. The provider was also significantly more likely to administer the PM-STOP-Bang to patients with multiple positive responses to the screening questions.

Of the 22 patients scoring four or higher on the PM-STOP-Bang, 20 were referred for a sleep study (91%). The recommendation for referral comes from previous work completed by Chiang, et. al., who modified the STOP-Bang screening for pediatric use. In this study, patients with a STOP-Bang score less than or equal to three were significantly less likely to be diagnosed with OSA.[1] Chiang also found that 20% of patients with a STOP-Bang score of four tested positive for OSA based on their Apnea Hypopnea Index (AHI).[1] Based on the results provided by Chiang's study, the PM-STOP-Bang provides the highest sensitivity and specificity for OSA screening when a patient scores four or higher. Using this data, it can be inferred that a positive OSA diagnosis could be made for 20% of the 20 patients from this study who were referred for a pediatric sleep study, thus warranting its use.

To follow up on this data, chart review was completed in Cerner, the VCU Health System Electronic Health Record, to determine if any of the 20 patients referred for a sleep study followed up with the VCU Sleep Medicine Clinic. Of the 20 patients referred, seven were evaluated by the Sleep Medicine Clinic for sleep apnea. Four out of the seven were subsequently diagnosed with OSA. The sleep physician recommended these four patients seek treatment via adenotonsillectomy, which was completed for all. The initial screening of these four patients via the PM-STOP-Bang yielded scores ranging from two to four, demonstrating the importance of this tool in identifying patients susceptible to OSA. However, this also highlights the importance of the dental practitioner's knowledge of OSA signs and symptoms, as two patients were diagnosed without yielding a positive screening via the PM-STOP-Bang.

The significant relationship between the screening question for witnessed apnea and completion of the PM-STOP-Bang aligns with the literature, which states that the presence of sleep obstruction is positively correlated to the diagnosis of sleep apnea.[1,4] The presence of witnessed apnea should be an indication to the dental practitioner that further questioning should occur to determine the patient's risk for OSA, since the diagnostic criteria of OSA, the AHI, is used to determine the severity of disease.[5] According to Keating, parent reported symptoms of OSA range from 4-11% for pediatric patients.[24] With a prevalence of OSA ranging from 1-5% for pediatric patients[1] it is critical that dentists have a thorough understanding of the disease and the screening tools at their disposal.

In considering referral for a pediatric patient for whom OSA is suspected, the PM-STOP-Bang does not account for some clinical symptoms. Dentists should also take into account general patient characteristics. Patients with the clinical presentation of a long, narrow face or a narrow, high vaulted arch[3] who do not score four or above on the PM-STOP-Bang may warrant a referral for evaluation, as these morphologic signs are consistent with a child with SDB. The PM-STOP-Bang also does not consider another important clinical symptom, nocturnal enuresis.

Nocturnal enuresis is a major risk factor for OSA,[3] and according to the literature, children age five and older often demonstrate this clinical symptom.[5] A child scoring less than four on the PM-STOP-Bang questionnaire typically does not indicate referral; however, the presence of other clinical signs or symptoms should influence the dental provider's recommendation for evaluation. This may explain why 17 patients with scores < 4 were still referred.

The PM-STOP-Bang evaluates patients for behavioral diagnoses including attention deficit and hyperactivity as well as daytime irritability. Behavioral and neurocognitive changes are common daytime symptoms associated with OSA[23] and are important for the dentist to account for when considering referral. A study by Testa analyzed behavioral changes in patients diagnosed with moderate-severe OSA following adenotonsillectomy. Their study demonstrated improvement in visuoperceptual and constructional abilities, through the Visual-Motor Integration (VMI) test. The significant improvement in post-adenotonsillectomy[23] VMI score in this study demonstrates another important reason for routine OSA screening in the dental setting. The presence of daytime neurocognitive and behavioral symptoms, along with nocturnal symptoms may be a significant finding and reason to refer a patient for evaluation. The dental practitioner's knowledge of OSA symptoms is an important part in patient evaluation, even with a low PM-STOP-Bang score.

There were several limitations to this study. Although there were 147 patients with the PM-STOP-Bang form, not all of these were filled out to completion. Of the patients with a form, 76% (n = 112) had values entered for all eight questions in the PM-STOP-Bang. Fourteen percent (n = 20) were missing one question, 7% (n = 10) were missing two, and 3% (n = 5) were missing three or more questions. Missing values were considered to be a "no" response, so the PM-STOP-Bang scores may be underestimated for nearly 25% of the patients. Another limitation was discovered during data collection for the sleep apnea screening questions. There were many patients that screened positive to one of the three questions; however, a PM-STOP-Bang form was not completed. The reasoning for this was provider error and lack of understanding of the proper screening method for sleep apnea in the patient population. As a result, there are potentially many less PM-STOP-Bang questionnaires completed than are indicated by the initial screening. Consequently, this may have resulted in fewer referrals for sleep studies. Finally, because this study was retrospective, the researchers were limited in the variables collected from the screening questionnaires. Missing data could not be filled in and was considered a "no" response.

Another important consideration and limitation to this study is the definition of snoring when completing the sleep apnea screening questions. The initial screening question asks, "does your child snore loudly?" Snoring can be interpreted in many different ways and may not be uniformly described to parents when asked. Some parents and providers may interpret intermittent snoring as a qualification for sleep apnea screening. Others may answer "yes" if the child snores when congested from allergies. The literature defines clinical diagnostic criteria for pediatric obstructive sleep apnea. A history of airway obstruction during sleep includes snoring that is loud enough to be heard through a closed door.[8] A history of frequent snoring is also important[8] to help distinguish the need for referral. An estimated 14% of children have benign snoring symptoms, but only 1-3% of these children meet the criteria for OSA diagnosis.[8] The presence of snoring alone is not an accurate predictor of OSA.[1] As stated previously, a polysomnogram is the gold-standard for OSA diagnosis and can help distinguish simple snoring from that associated with OSA.[25] Although it is not the dental provider's role to diagnose a patient with OSA, a more thorough investigation of snoring symptoms may help delineate the necessity for referral, even if the PM-STOP-Bang score is lower than four.

While the PM-STOP-Bang is a screening tool solely for the use in pediatric patients, another version, the STOP-Bang, was validated in a study by Boynton, et. al.[26] The study compared STOP-Bang scores with full polysomnography and found there was a benefit to the screening tool in identifying patients with more mild forms of OSA.[26] The questionnaire asks eight questions, similar to the PM-STOP-Bang, that are more tailored towards the adult population: (S) snoring loudly, (T) daytime fatigue, (O) observed apnea, (P) high blood pressure, (B) BMI, (A) age, (N) neck circumference, and (G) gender. Currently the STOP-Bang questionnaire is not in use at VCU for adult dental patients. Given the effectiveness of the PM-STOP-Bang in identifying patients for referral to the sleep clinic, the adult version may be a useful tool to incorporate into the medical history during dental exams for the adult population.

Conclusion

The purpose of this study was to determine the number of VCU pediatric dental patients screened for Obstructive Sleep Apnea using the Pediatric Modified (PM) STOP-Bang questionnaire relative to the number of referrals made for a sleep study. Based on the study results, the following conclusions were made:

1. The use of the three screening questions in the patient's medical history resulted in a significant number of patients who completed the PM-STOP-Bang. All three screening questions proved statistically significant for completion of the PM-STOP-Bang.
2. Having a documented referral to a sleep clinic was statistically significantly more likely when four or more positive responses occurred within the PM-STOP-Bang.
3. The PM-STOP-Bang proved to be a useful tool in providing referral to a patient's physician following a positive screening for Obstructive Sleep Apnea.

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