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Periodontal Disease in Pregnant Women

Chancellor's Honors Program Senior Project

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Problem & Purpose

Preterm birth has been receiving an increasing amount of attention in the media in recent years thanks to the help of organizations such as March of Dimes. Infections and inflammation, maternal or fetal stress, bleeding of the uterus, and stretching of the uterus are currently recognized as the most common reasons for babies being born prematurely (March of Dimes Foundation, 2008d). Associated with the first problem, infections and inflammation, is periodontal disease. Periodontal disease is a bacterial infection of the gums that begins in the sulcus (the area between the tooth and the gums) and, if left untreated, can cause detachment of the teeth from the gums (American Dental Association, 2008). In unison, the presence of periodontal disease and the physical changes that occur in a pregnant woman's body make it easier for bacteria to enter the blood stream, leading to "placental seeding" (Clothier, Stringer, & Jeffcoat, 2007). With the help of an inflammatory cascade in the pregnant woman's body, pre-term labor is induced, forcing the baby to be born prematurely (Clothier, Stringer, & Jeffcoat, 2007). Periodontal disease in mothers is thereby a risk factor during pregnancy since it at least contributes to preterm birth, with many researchers insisting upon a causal relationship between periodontal disease and preterm birth. An analysis of salient literature provides an evidence base for this theory. By addressing the issue of periodontal disease in pregnant women, primarily though education, preventive treatment, and periodic screening, health care providers intend to decrease the number of babies born prematurely.

Significance of the Problem

Pre-term birth is a problem because it causes both physical and emotional pain and suffering. Physical problems that a premature newborn can experience are largely due to its body systems being underdeveloped. Such problems include respiratory distress syndrome (which can cause the baby not to receive enough oxygen), intraventricular hemmorhage (which can cause brain damage), patent ductus arteriosus (a heart defect that can lead to heart failure), necrotizing enterocolitis (death of the bowel that can affect how the baby eats and eliminates waste), and retinopathy of prematurity (which can lead to vision loss) (March of Dimes Foundation, 2008c). In addition, pre-term birth can be a frightening experience for parents (March of Dimes Foundation, 2008b). Strange and scary machines may be used on their baby in order to help the infant breathe, stay warm, or improve jaundice. Parents may feel guilty if they think they could have done something to prevent their child from being born prematurely, or they may feel that they are already failures as parents—especially since they may have minimal contact with their infant if the newborn is very ill. Altered or impaired attachment may occur between the parents and the child because of their infrequent and/or minimal interaction; the parents may not feel adequately close to their infant because of this, adding to feelings of guilt and failure (March of Dimes Foundation, 2008b). Lastly, parents may experience the ultimate emotional pain if their premature infant dies from complications of prematurity.

In addition to these physical and emotional costs, premature birth also incurs considerable financial costs. "In 2005, preterm birth cost the United States at least $26.2 billion, or $51,600 for every infant born preterm" (March of Dimes Foundation, 2008a).

Additionally, "the average first-year medical costs, including both inpatient and outpatient care, were about 10 times greater for preterm infants ($32,325) than for term infants ($3,325)" (March of Dimes Foundation, 2008a). This creates a huge financial burden for the United States as a nation and for individual families.

The significance of the periodontal disease-premature baby problem is evident when looking at the number of women and children affected, as well. At least 23% of women ages 30 to 54 have periodontitis (The American Academy of Periodontology, 2004). In addition, 12% of all births in the United States are premature (delivered at less than 37 weeks of gestation); this adds up to over half a million (Clothier, Stringer, & Jeffcoat, 2007). Looking at both sides of the equation together, then, women with severe periodontitis are 7.5 times more likely to have a pre-term, low birth weight baby (Drisko, 2000). This is a problem that affects many women of child-bearing age in our country, with lasting consequences for their numerous past, present, and future children.

Analysis of Salient Literature

Study 1. Boggess et al. (2006). Maternal periodontal disease in early pregnancy and risk for a small-for-gestational-age infant.

The research problem of this study is multi-dimensional: "Infants who are small for gestational age (less than the 10th percentile for birth weight) have significantly higher neonatal mortality rates when compared with appropriate- and large-for-gestational-age infants" (Boggess et al, 2006, 1316). "Human data suggest a relationship between maternal infection and poor fetal growth," and "periodontal disease is a chronic oral infection commonly identified in pregnant women" (Boggess et al, 2006, 1317). It therefore follows that the research problem is that periodontal disease has been identified

as a possible cause of poor fetal growth, and thus a factor in increased infant mortality rates. This problem is important to nursing in that the nursing profession aims to provide excellent prenatal care for every pregnant woman in order to increase positive birth outcomes and to decrease the rates of both small-for-gestational-age birth and infant mortality. The purposes of this study were "to determine the relationship between maternal periodontal disease and delivery of a small-for-gestational-age (SGA) infant and to determine the role of maternal systemic inflammation in this relationship" (Boggess et al, 2006, 1317). This purpose statement was clearly stated as the last sentence of the introduction.

A middle range theoretical framework was used in this study since the study is closely linked to clinical practice, and its purpose is to help build evidence-based practice related to a particular clinical problem (Burns & Grove, 2007). In addition, the authors provided conceptual definitions of each of their variables. Small-for-gestational-age (SGA) is defined as "a birth weight less than the 10^{th} percentile for gestational age based on population standards" (Boggess et al, 2006, 1317). The researchers determined the 10^{th} percentiles by creating population standard birth weight curves from birth certificate data obtained from the North Carolina Center for Health Statistics between 1997 and 2001; all "singleton live births" during this time period were included (Boggess et al, 2006, 1317). Gingival pocket depths and presence of gingival bleeding were used to define each category of periodontal disease—with periodontal health being "absence of gingival pocket depths greater than 4 mm and no gingival pocket depths greater than 3 mm that also bled on probing," mild periodontal disease being "1 or more tooth sites with greater than 4-mm pocket depth or 1 or more tooth pockets greater than 3 mm that bled

on probing, up to 15 tooth sites," and moderate/severe periodontal disease being "15 or more tooth sites with pocket depths greater than 4 mm" (Boggess et al, 2006, 1317). To determine the level of maternal systemic inflammation, maternal serum C-reactive protein levels were measured (Boggess et al, 2006).

A correlational quantitative research design was used for this study, because the researchers conducted a "systematic investigation of relationships between or among variables," mainly between the 3 aforementioned variables maternal periodontal disease, SGA infants, and maternal systemic inflammation (Burns & Grove, 2007, 25). In addition, the type of correlational design used was the model testing design in which all variables relevant to the model were measured and all of the paths expressing relationships between concepts were identified; the authors of this study do exactly this in the Results section of their article (Burns & Grove, 2007). This research design was appropriate for answering the research questions because the purpose of the study is to determine relationships between the 3 primary variables.

Data was collected for this study and for another study (the Oral Conditions and Pregnancy study of the relationship between maternal periodontal disease and preterm birth risk) simultaneously; from the time these two studies were conceived, this study conducted by Boggess et al was intended to be a secondary analysis of the same data as the Oral Conditions and Pregnancy study (Boggess et al, 2006). One thousand one hundred seventeen women enrolled at an average of 14 weeks' gestation served as the subjects in this study (Boggess et al, 2006). Two hundred eighty-four of these women (28.0%) had periodontal health, 588 (57.8%) had mild periodontal disease, and 145 (14.3%) had moderate/severe periodontal disease (Boggess et al, 2006). Sixty-seven of

the total 1017 women (6.6%) delivered an SGA infant, with SGA being more common among preterm, rather than term, deliveries—11% SGA preterm versus 5.6% SGA term (Boggess et al, 2006). C-reactive protein levels were divided into quartile ranges, with the mean being 16.1 ± 25.1 pg/mL and with the median being 4.8 pg/mL (Boggess et al, 2006). These direct measures of the data collected are appropriate research instruments since they provide numeric data for comparison between the variables. The data collection methods were appropriate for this study since the researchers planned to determine correlational relationships and not to identify a specific causal relationship as in an experimental research design.

Appropriate steps were taken to protect the rights of the subjects involved in this study. Approval to conduct this study was granted by the Institutional Review Board, and "written informed consent was obtained from all study participants" (Boggess et al, 2006, 1317). Clinical implications stem from the findings that "moderate/severe maternal periodontal disease identified early in pregnancy is a risk factor for delivery of an SGA infant that is independent of traditional risk factors" and that "maternal periodontal disease is a chronic exposure to oral pathogens that may represent a treatable condition that contributes to impaired in utero fetal growth" (Boggess et al, 2006, 1321). These findings imply a need for nurses and other healthcare professionals to screen pregnant women for periodontal disease, preferably early in pregnancy, and to refer those with periodontal disease to appropriate oral health professionals; the clinical implications of this study are thus appropriate, considering the correlational relationship between periodontal disease and SGA infants. Such periodontal prophylaxis and treatment is

strongly recommended by The American Academy of Periodontology, as well (The American Academy of Periodontology, 2008).

Strengths of the study include a large sample size, clear operational definitions, and a thorough analysis of data. Weaknesses include not considering all maternal factors that can impact fetal growth (like BMI, since the data were not consistently available) and not including information on the placenta; though, with regard to the placental information, the authors made reference to a study in which no difference was found between the placentas of pregnant women with periodontal disease and those without it (Boggess et al, 2006).

Study 2. Farrell, S., Ide, M., & Wilson, R.F. (2006). The relationship between maternal periodontitis, adverse pregnancy outsome and miscarriage in never smokers.

The research problem of this study is multi-factorial, as well. The authors assert that "although periodontitis is localized to the periodontal tissues, a low-grade bacteraemia or circulating inflammatory mediators such as interleukins could have a deleterious effect on distant tissues, such as the pregnant womb" (Farrel, Ide, & Wilson, 2006). In addition, they state that "as smoking is a risk factor common to many diseases, it may be a confounding factor that is complicating apparent associations between periodontal disease and poor pregnancy outcome" (Farrel, Ide, & Wilson, 2006). Thus, the purpose of their study is to determine if the relationship between periodontal disease and poor pregnancy outcome still exists when the possible confounding factor (smoking) is removed from the equation. The authors aim to investigate this relationship among "never smoker" mothers in order to better determine if periodontal disease does truly play a role in adverse pregnancy outcome, especially in cases of pre-term birth, low birth

weight, and late miscarriage (spontaneous abortion at 12-24 weeks gestation) (Farrel, Ide, & Wilson, 2006).

In this study, like in the Boggess et al. study, a middle range theoretical framework is used, and the study was completed in order to improve clinical practice. The authors performed a thorough literature review prior to beginning their own research, and they found both studies that supported the periodontal disease-poor pregnancy outcome relationship, and studies that found no relationship. They further identified potential causes for error or confusion in these studies, with the main one being smoking as a confounding factor that had not been properly measured or accounted for; thus, Farrel, Ide, & Wilson intended to remove smoking as a confounding factor altogether in the present study. The literature review therefore concretely supports this study.

The research design used in this study is a correlational quantitative approach since the authors are systematically investigating relationships between periodontal disease and pre-term birth, low birth weight, and late miscarriage, respectively (Burns & Grove, 2007). The authors also make use of the model testing design by measuring all of the variables potentially related to the outcome of the study and relating them to other variables involved (Burns & Grove, 2007). This research design is appropriate for the study because there are too many factors involved to make the study even quasi-experimental; the variables are not well-controlled enough to make this possible.

The study setting is appropriate because it is where the desired subjects can be found: attending an ultrasound scan at Guy's Hospital in the UK. The sampling design is somewhat appropriate for answering the research question. The sample size was considerable (1793 never smokers between 10 and 15 weeks pregnant), but it was

certainly a convenience sample since it was obtained from only the women who actively sought an ultrasound from only one hospital in only one region of the world (Farrel, Ide, & Wilson, 2006). No random sampling could be performed, either, since the variables involved (periodontal health/disease, pregnancy outcome, baby weight, ethnicity, and socioeconomic status) were not under the researchers' control. Research instruments used included the ultrasound at approximately 12 weeks gestation, a partial-mouth periodontal examination performed between 10 and 15 weeks gestation, determination of pre-term birth (less than 37 weeks gestation), and determination of low birth weight (less than 2500 grams) (Farrel, Ide, & Wilson, 2006). These instruments are appropriate for this study because they measure the variables that will later be examined for relationships.

The data collected during this study revealed the following: 130 of 1793 subjects (7.3%) experienced pre-term birth, and 17 (0.9%) experienced a late miscarriage (Farrel, Ide, & Wilson, 2006). Low birth weight and clear/obvious periodontal examination data were not provided. In addition, many other data measurements were taken—like ethnicity, socioeconomic status, age of mother, presence of urinary tract infection, use of antibiotics, use of oral steroids, and previous obstetrical history—and related to one of the main variables (periodontal disease, pre-term birth, low birth weight, or late miscarriage), but their place in the overall study was never discussed or explained. In fact, without such an explanation, these additional factors seem superfluous, merely muddying the picture. Only in one short paragraph of the Results section do the authors even refer to the relationship between periodontal disease and pregnancy outcome: they reported finding no statistically significant association between periodontal disease in pregnancy and either pre-term birth or low birth weight, but they did report an association between

poorer periodontal health and late miscarriage (Farrel, Ide, & Wilson, 2006). The data analysis methods in this manner did not comprehensively answer the research question.

Subjects were adequately protected during this study in that local ethical committee approval was obtained, and informed consent was obtained from all subjects (Farrel, Ide, & Wilson, 2006). Clinical implications of this study are limited due to the inconclusive nature of the results, but the authors determined the following: "Clinicians may choose to advise relevant patients of this apparent relationship [between periodontal disease and late miscarriage], even in the absence of a smoking habit" (Farrel, Ide, & Wilson, 2006). Nonetheless, research implications are evident. "It would be advantageous to further investigate this potential relationship [between periodontal disease and late miscarriage] and such a study would require a larger number of subjects who experienced a late miscarriage" (Farrel, Ide, & Wilson, 2006). This study has thus opened another avenue for future studies concerned with the adverse effects of periodontal disease on pregnancy outcomes.

Strengths of this study include its excellent literature review and its initial design and concepts. Another strength lies in its unique qualities: it completely eliminates smoking as a confounding factor and it includes late miscarriage as one of its adverse pregnancy outcomes. One weakness is its non-random and convenience sampling—only women who elected to have an early ultrasound were included, thus eliminating those who did not seek early pre-natal care. This elimination may have, in effect, also eliminated a portion of the pregnant population that is at higher risk for periodontal disease, therefore skewing results in this manner. This constitutes a definite recruitment bias. In order to make up for this weakness, the researchers performed a case-control

study of all women who experienced a pre-term birth at the same hospital, regardless of their previous involvement in the study, and again assessed for a relationship between pre-term birth and periodontal disease; they found none (Farrel, Ide, & Wilson, 2006). This addition to the study that seemed to have been haphazardly tacked onto the original, and the discussion of all the extra confounding variables that seemed to take precedent over the variables actually involved in the research problem served only to confuse. The authors were being thorough in obtaining this information, and hopefully in controlling for these confounding factors, but the presentation of their data within the article was in no way clear or straightforward; it was difficult to follow the jump from data collected to clinical conclusion.

Study 3. Bosnjak et al. (2006). Pre-term delivery and periodontal disease: a case-control study from Croatia.

The research problem of this study is that "pre-term birth is still considered to be the greatest problem in obstetrical medicine and remains the leading cause of morbidity and mortality among the newly born children despite the advances in obstetrical prevention, diagnostics, and therapy" (Bosnjak et al, 2006, 710). In addition, "there is convincing evidence linking pre-term birth with infections" (like periodontal disease) (Bosnjak et al, 2006, 711). The purpose of the study is then clearly stated: "we performed a similar case-control study [to the study by Offenbacher et al, 1996] in Croatia in order to assess the supposed positive correlation between periodontal health of delivering mothers and pre-term birth" (Bosnjak et al, 2006, 711). Literature supports the need for this study in that so many similar studies conducted on different populations have produced conflicting evidence on the relationship between periodontal disease and

premature birth. The authors are therefore conducting a study similar to the one described in Offenbacher et al.'s influential and much-referenced article in an attempt to further uphold or to further disprove the strong correlation found between periodontal disease and pre-term birth.

The theoretical framework is again based on middle range theory, with the authors hoping to use the study to help build evidence-based practice. The participants of the study were "primiparous mothers who had a spontaneous delivery of one child per partum," and their ages ranged from 19 to 39 years (Bosnjak et al, 2006, 711). The research design used in this study was a correlational quantitative one in which the authors intended to investigate the relationship among variables; this design is therefore appropriate for either supporting or undermining the alleged relationship between periodontal disease and pre-term birth. The study setting—the Department of Gynecology and Obstetrics at "Sveti Duh" General Hospital—is appropriate for answering research questions since the researchers had easy access to the subjects and the subjects' medical records. The sample size for this study was adequate (81 women), and randomization was performed in the following way: "every day only primiparous mother(s) with singleton babies from one room were examined, according to the room number (1-7), and day of the week (Monday-Sunday)" (Bosnjak et al, 2006, 711). In this way, the authors extracted a sample representative of the target population, women of child-bearing age in Croatia.

In order to collect periodontal data, "a full-mouth periodontal examination was performed on all subjects within two days of delivery at 'Sveti Duh' General Hospital, in a dental office using standard dental light and assistance" (Bosnjak et al, 2006, 711).

Clinical attachment loss, probing depth at four sites per tooth, buccal and lingual gingival recession, and papillary bleeding index were recorded on all present teeth except for third molars on each participant (Bosnjak et al, 2006). Next, scores of Extent and Severity Index were computed for each subject based on this collected data. These scores were then compared between women in the pre-term birth group and women in the full-term birth group. Group determination was based upon estimation of gestational age, calculated from last menstrual period, ultrasound scan, and/or post-natal examination of the infant using Ballard's neonatal assessment (Bosnjak et al, 2006, 711). Pre-term birth was defined as delivery at less than 37 completed weeks gestation, while full-term birth was defined as delivery after 37 completed weeks gestation. These instruments for data collection were appropriate because they accurately measured the variables that the authors wished to investigate.

The rights of the participants included in this study were adequately protected via approval of this study by the Zagreb School of Dental Medicine Ethical Committee, "with written consent, according to the 2nd Helsinki Declaration" (Bosnjak et al, 2006, 711).

Results of this study were as follows: "it was shown that periodontal disease, expressed as Extent 4:60, displayed a very strong association with pre-term birth" (Bosnjak et al, 2006, 713). Age, socioeconomic factors, alcohol use, and tobacco use were all used as control variables, since their effects on pregnancy are fairly well-known, and these variables "showed no significance when compared with periodontal disease" (Bosnjak et al, 2006, 713). Clinical implications of these findings are that "the elimination or control of periodontal disease in pregnant women in Croatia would

decrease the number of PTBs [pre-term births] for almost 500 yearly, as well as cut the cost of intensive care for pre-term children, and complications arising therein" (Bosnjak et al, 2006, 714). The authors go on to say that "for a country where there are more than 2000 PTBs every year (from a total of around 40,000 births), a preventive pre-natal programme that would include periodontal therapy seems well justified" (Bosnjak et al, 2006, 714). The findings of this study support a positive correlation between periodontal disease and pre-term birth, and therefore the advocation of preventive periodontal treatment in all pregnant women. These clinical implications are appropriate since this study was well-designed and well-controlled, using specifically defined instruments for data collection. Major strengths of this study are its clarity and focus, directness and brevity. It was straightforward, and provided obvious connections between its results and implications. A major limitation is that its results cannot be directly compared with many other studies in that the researchers used a more in-depth and all-inclusive definition and score of periodontal disease; in trying to make their criteria for periodontal disease as strict and precise as possible by using the extent score, they deviated from the traditional method of many previous studies that only took into account the pocket depths of two tooth sites per tooth. In all, though, the results of this study provide excellent evidence for preventing and controlling periodontal disease in pregnant women.

Study 4. Kunnen et al. (2007). Women with a recent history of early-onset pre-eclampsia have a worse periodontal condition.

This study's research problem addresses pre-eclampsia instead of pre-term birth. The authors define their problem as follows: "Pre-eclampsia is a complication of pregnancy characterized by systemic vascular dysfunction and pathological changes in

placental arteries. Growing evidence of chronic infection as an aetiological factor in vascular diseases promted us to study maternal periodontal disease in subjects with early-onset pre-eclampsia (<34 weeks)" (Kunnen et al, 2007, 202). The purpose of the study is therefore "to investigate the periodontal condition in a homogenous Caucasian population with a recent history of early-onset pre-eclampsia" (Kunnen et al, 2007, 202). The authors' literature review supports the need for this study in that many previous studies have had differing definitions of periodontal disease. The researchers therefore chose one study's definition that they then used to define periodontal disease in the present study. This definition included the following variables: plaque index, bleeding on probing, pocket probing depth, clinical attachment level, and gingival recessions (Kunnen et al, 2007). Again, a middle range theoretical framework was used to organize this study since the authors were trying to build an evidence base to support a particular clinical problem (Burns & Grove, 2007).

The authors also chose a correlational quantitative research design to systematically investigate the relationship between early-onset pre-eclampsia and periodontal disease (Burns & Grove, 2007). The research design is not truly experimental because the authors are not determining cause and effect, and they are not manipulating the independent variable (being pre-eclamptic or not) in any way, but merely measuring it. The correlational design is therefore appropriate for answering the research question. The study setting is also appropriate (the Department of Obstetrics and Gynaecology, University Medical Center, Groningen) since it provided easy access to the desired subjects and their medical records. The sampling design was driven by convenience since all of the case participants were referred by the same Department of Obstetrics and

Gynaecology, but a semi-random selection method was used when recruiting the control participants (those women without early-onset pre-eclampsia) since they used a newspaper ad (Kunnen et al, 2007). In order to control for several confounding factors, the authors did not include women with pre-existing hypertension, diabetes mellitus, renal disease, cardiovascular disease, other systemic illness, multiple pregnancy, or postpartum thyroiditis; they also excluded women who had received periodontal treatment in the past or who had been taking antibiotics during pregnancy or the postpartum period (Kunnen et al, 2007). The obtained sample of 52 women is most likely large enough to represent the target population (Caucasian women from the Netherlands), but may not be sufficient to carry results over even to other homogenous Caucasian populations in different parts of the world.

The research instruments used were a questionnaire, health records, and a full periodontal examination by a single certified dental hygienist (Kunnen et al, 2007). These data collection methods were appropriate, but there may be some discrepancies between the case and control groups just because of this difference in methods; the medical records of the case group's pre-eclamptic women may be much more accurate than the memories of the control group's healthy women (because the questionnaire was used only for collecting data from the control group). Sufficient steps were taken to protect the rights of all participants, though, by acquiring informed consent prior to participation, and by informing the participants after the study about their periodontal status and suggesting treatment when indicated (Kunnen et al, 2007).

Results of this study were as follows: "severe periodontal disease was found in 14 of the 17 (82%) pre-eclamptic women and in 13 of the 35 (37%) women in the control

group" (Kunnen et al, 2007, 204). The researchers then adjusted for age, BMI, smoking, and educational level, and determined that these factors did not significantly alter the results. Therefore, "this study shows that Caucasian, western European women with a recent history of early-onset pre-eclampsia have a worse periodontal condition compared with healthy controls" (Kunnen et al, 2007, 205). Clinical implications are that "screening for periodontal disease and treatment of affected women might effectively prevent adverse pregnancy outcomes, such as pre-eclampsia, if causality of periodontal disease is evidenced" (Kunnen et al, 2007, 207). The researchers did indeed find a strong correlation between early-onset pre-eclampsia and severe periodontal disease, and thus recommend periodontal screening and treatment for pregnant women.

The major strengths of this study were how thorough the authors were in addressing confounding factors that might skew their results, and how precise their operational definitions were. Their major limitations were the very different manners in which data was collected for the case group and for the control group, and the range of the periodontal examination periods among the women (anywhere from 3 to 28 months postpartum, in which periodontal status may have changed drastically from the status during pregnancy).

Adequacy of Literature

Overall, there was an adequate quantity of literature on the relationship between periodontal disease and poor pregnancy outcomes, such as pre-term birth, low birth weight, late miscarriage, and pre-eclampsia. Whether these studies produced consistent results is quite another story, though; of twelve research articles published on original studies regarding periodontal disease and poor pregnancy outcome, three related

periodontal disease to pre-term deliveries, three related periodontal disease to low birth weight babies, three related periodontal disease to ple-eclampsia, two related periodontal disease to spontaneous abortion, and the last one assessed the extent of periodontal disease awareness among pregnant women. Of the eleven studies regarding periodontal disease and pregnancy outcomes directly (i.e. not including the knowledge assessment study), eight provided evidence of a statistically significant relationship between periodontal disease and poor pregnancy outcomes. In-depth research analyses on four of these eight studies are included in this paper; but this still leaves three studies that showed no correlation between the variables at hand, and surely the explanation is not as simple as "these studies were all conducted poorly while the studies showing positive correlations were conducted very well." Each of the studies had its own strengths and weaknesses.

In addition, a larger meta-analysis yielded these results: "Of 31 published studies, 22 show a positive association between premature birth and periodontal disease" (Clothier, Stringer, & Jeffcoat, 2007, 451). So, research certainly seems to be leaning towards a firm connection between periodontal disease and poor pregnancy outcomes, but without all of the known variables accounted for in every study, and without adequate knowledge regarding the causative nature of the relationships of these variables, a definitive answer cannot yet be devised. Many more case-controlled studies must be performed, along with true experimental studies that test treatment options and their respective effects on pregnancy outcomes. The reason more of the latter may not have been conducted could be that withholding periodontal treatment in order to maintain a control group may border upon unethical, given the strong positive correlation in about

one-third of published studies. Without experimental studies a true cause-effect relationship between periodontal disease and poor pregnancy outcome may never be established; but can we apply the utilitarian principle of sacrificing the health and happiness of a few in the present to benefit the health and happiness of many in the future? This is what future researchers need to decide, which will in turn set the course for new literature on this topic. Until then, preventive treatment and regular screenings for periodontal disease should remain the recommendation for pregnant women.

Proposal

Having decided that preventive treatment and regular screenings for periodontal disease are adequately supported by the available literature, what in particular needs to be addressed when pregnant women seek these interventions? First and foremost, women need to be educated about periodontal disease and the potential harm that untreated periodontal disease can cause their unborn babies. In a study assessing the periodontal disease awareness of 275 pregnant women, it was found that only 16.4% could identify dental plaque and only 22.5% could identify plaque's harmful effects (Alwaeli & Al-Jundi, 2005). 88% of these women were aware that bleeding gums indicated the presence of periodontal disease, and 71.6% even knew the main cause of gum disease, but 56% of them did not believe that they should increase the frequency of brushing their teeth during pregnancy, and only 5.1% believed that there might be a relationship between periodontal disease and pre-term birth (Alwaeli & Al-Jundi, 2005). This study illustrates how little the public actually knows about periodontal disease, and how important it is to teach pregnant women about how periodontal disease can affect them and their babies.

A pregnant woman should be screened for periodontal disease in a minimum of three settings: 1) in her general dentist's office by both the hygienist and the dentist on a regular 3-6 month basis, depending on her periodontal health prior to pregnancy and how her gums are responding during the pregnancy; 2) in her OB/GYN healthcare provider's office during routine prenatal visits; and 3) in her primary care healthcare provider's office, even before becoming pregnant, since periodontal disease can affect her systemic health, not just her pregnancy. She should be educated regarding the importance of performing periodontal care at home on a daily basis. "Prevention [of periodontal disease] is best accomplished by practicing effective daily oral care, eating nutritiously and seeking regular professional care from a dentist and dental hygienist" (Wener & Lavigne, 2004, 428). Specific recommendations regarding daily oral care include brushing with a soft-bristled toothbrush for two minutes, twice a day, "with a focus on removing harmful plaque accumulating at the gum line" (Wener & Lavigne, 2004, 428). The pregnant woman should also be advised to floss daily, in between each tooth-gum connection (Wener & Lavigne, 2004).

Nurses can be critical in providing periodontal education to expectant mothers. "In a four-state study in the U.S., only 34.7 percent of mothers received dental care during pregnancy. Even among those mothers with a dental problem, half did not seek dental treatment" (Wener & Lavigne, 2004, 428). Because so few pregnant women seek regular preventive dental treatment, they must be educated in settings other than the dental office. Nurses must become these front-line educators who can screen for periodontal disease and hopefully intervene by recommending professional treatment if problems do already exist, especially in OB/GYN healthcare providers' offices and

primary care healthcare providers' offices. Nurses can even take this knowledge to the community by offering free informational sessions and screenings at local birth preparation classes, and in doing so, offer help to women who may not otherwise be receiving professional prenatal care. Some of the information that a nurse can provide may include how to consume a nutritious diet that includes all of the necessary nutrients to keep the woman's gums healthy and to promote adequate development of her unborn baby's teeth (Wener & Lavigne, 2004). A nurse can also recommend the following to women who experience frequent vomiting during pregnancy to decrease effects of harmful stomach acid on dentition: rinse with a sodium bicarbonate solution (1/4 teaspoon baking soda in 1 cup warm water) to neutralize acid on the teeth, and then wait 30 minutes before brushing teeth to avoid removing any damaged tooth structure; after 30 minutes, strengthen teeth with a fluoride toothpaste and mouth rinse (Wener & Lavigne, 2004). Nurses can also provide pregnant women with written materials or online resources from organizations like the American Academy of Pediatric Dentistry, the American Academy of Periodontology, the American Association of Dental Hygienists, the American Dental Association, March of Dimes, and the National Maternal and Child Oral Health Research Center (Wener & Lavigne, 2004). Most importantly, nurses should be able to identify signs and symptoms of periodontal disease (bleeding and/or swollen gums, loose teeth, and a foul taste and/or bad breath) and be able to effectively teach these signs and symptoms to expectant mothers (Wener & Lavigne, 2004). This way, if a woman discovers that she is experiencing these signs and symptoms, she will be able to associate them with possible periodontal infection and seek early professional treatment before she begins experiencing systemic effects.

Contributing factors to the problems associated with the periodontal disease-poor pregnancy outcome relationship (especially the problem of delivering pre-term, low birth weight babies) of which nurses should be aware are pregnancy itself, pre-eclampsia, diabetes mellitus, and tobacco smoking or chewing. During pregnancy, a woman's gingiva is affected by increased levels of hormones; these hormones cause her gums and the associated vasculature to become more permeable, and thus more susceptible to bacteremia, a systemic blood infection (Clothier, Stringer, & Jeffcoat, 2007). Diabetes mellitus alters immune and inflammatory responses within body, causing greater susceptibility to infections such as periodontitis (Campbell, 2007). "Pre-eclampsia is a multisystemic maternal vascular disease with endothelial dysfunction, clinically manifest during the second half of pregnancy by hypertension, proteinuria and varying dysfunction of major organs [such] as the liver, the kidneys, and the brain" (Kunnen et al, 2007, 202). One mechanism of such vascular dysfunction is thought to be an exaggerated inflammatory response, of which a possible cause is periodontal disease (Kunnen et al, 2007). And lastly, smoking is the contributing factor that is probably best understood to play a role in the development of both periodontal disease and pre-term births. Tobacco smoking or chewing reduces the amount of oxygen and nutrients available to gum tissue and interferes with healing (American Dental Hygienists' Association, 2005). Likewise, it can reduce the amount of oxygen reaching the placenta, contributing to pre-term, low birth weight babies (March of Dimes Foundation, 2007). Each of these contributing factors plays a role in periodontal disease and/or poor pregnancy outcomes, but whether they play a role as a cause or as an effect then further complicates the issue.

Because of all of these health factors, and other factors such as age, race, socioeconomic status, and antibiotic use, the results of studies on the periodontal disease-poor pregnancy outcome issue are extremely difficult to sort out; at best, correlations exist between these two main variables, with very few studies conducted intending to establish a causative relationship. In addition, nurse researchers need to become more involved in conducting studies on this topic, especially since nurses play a key role in screening for and identifying periodontal disease in pregnant women. Most of the studies analyzed were from medical journals related to obstetrics and gynecology or periodontology; only two articles that were merely informational in nature were found in nursing journals. Nurses need to become more active in not only educating on the periodontal disease-poor pregnancy outcome issue, but also in researching the issue by using case-control studies in order to further an evidence-based practice.

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