Pica in Pregnancy Among Mexican-Born Women: Effects of Magnesium Carbonate Ingestion

a. Specific Aims

Pica is a condition characterized by the repetitive ingestion of non-food items for more than one month. Due to the bizarre nature of this condition, pica has been studied and theorized over for many years. It is most often found among children, the mentally ill, and pregnant women. In regards to pica during pregnancy, the literature on pica covers the obviously detrimental effects on mothers of consuming clearly harmful substances. Magnesium carbonate, more commonly referred to as chalk, is one of the most frequently ingested substances by women during pregnancy. While often found within common brands of antacids, magnesium carbonate is frequently sold in block form and advertised as edible products within certain regions of the United States and Mexico. The immediate effects of chalk ingestion upon a pregnant mother has been explored to some extent, but not to the degree in which the effects of clearly harmful substances have been examined. A large gap is found in the literature when considering the effects of more benign substances such as magnesium carbonate not only on the mother, but the developing fetus as well. More specifically, the current literature fails to address the question of whether magnesium carbonate ingestion during pregnancy could carry enduring, long-term effects for a fetus post-birth that could detrimentally influence later cognitive, motor, and/or behavioral development.

The following study strives to investigate a possible relationship between the ingestion of magnesium carbonate during pregnancy and possible effects on the long-term health of infants born to pica practicing mothers. The objective is to determine whether infants born to

mothers who ingest magnesium carbonate through pica practices are at a greater risk for a number of negative developmental abnormalities at birth and through the first 9 months of life.

b. Background and Significance

As reviewed by Grigsby (1999), Bronstein found that pica is not an uncommon practice. While often associated with young children and the mentally ill, it has also been found to a significant degree in pregnant women. This condition has often been explored in relation to potential nutritional deficiencies such as iron deficiency. However, the context in which pica occurs, and the substance ingested, may point to additional driving factors such as cultural practices or obsessive compulsive disorders. While not an uncommon condition, the rates of pica within the United States as a whole are relatively low. A result of the widespread awareness of the condition across the United States is the perpetuation of a negative association with the practice. As a whole, the United States displays rather low rates of pica, most likely because social pressures prevent individuals form indulging in their pica urges. However, higher rates of ingestion of non nutritive substances are often found within specific populations. Grigsby (1999) explored the consumption of chalk in Georgia. Through a series of interviews, it was found that 20 of the 21 individuals included within the study who reported regular chalk consumption were female. In addition, chalk consumption was deemed a culturally bound occurrence as each subject was of African American descent. The individuals who were interviewed for this study reported frequently that they had begun consuming chalk after it was suggested by a friend or relative. Although these findings are interesting, it is important to note that Grigsby conducted this study in an area that is predominantly African American, which may explain why each pica

practicing individual found was of this particular descent.

However, Simpson et al. (2000) also explored pica through a cultural lens. The rates of pica were compared between towns in Mexico near the California border, and areas in Southern California. Low-income women who were born in Mexico were recruited as subjects within this study. Simpson found that magnesium carbonate was one of the most popular non-food items to ingest, and that some women even believed that consuming chalk would be beneficial for the fetus. The rates of pica among both Mexican born women living in Mexico and those who were living in Southern California were both higher than the pica rate for the United States as a whole, 44% and 31% respectively. In addition, pica rates during pregnancy were significantly higher for the women still living in Mexico than those who had migrated to California (Simpson & Longeley, 2000). This difference in pica rates was interpreted as indicating a strong cultural influence on consumption of non-food items during pregnancy such as magnesium carbonate. It may be this cultural drive that encourages women to consume such substances as magnesium carbonate and potentially increase their child's risk of serious abnormalities at birth and beyond.

While the consumption of magnesium carbonate has been found to be greater in specific cultures, very little research has explored the effects that this practice may have on the developing child. Nelson et al. (1971) found that magnesium carbonate was the main component of the antacids most frequently taken by pregnant women. In addition, those women who ingested large amounts of antacids birthed infants who showed a higher rate of abnormalities within the 56 days post birth than mothers who did not consume any magnesium carbonate (Nelson & Forfar, 1971). No further research on the effects of this particular compound was found. The literature does, however, include a number of studies focused on

magnesium sulfate, a similar compound.

Magnesium sulphate is a substance that is often given to a pregnant woman when signs of pre-eclampsia are displayed. Pre-eclampsia is a condition usually seen in the later trimesters where there is a marked increase in maternal blood pressure. If this high blood pressure is not reduced, mothers are then susceptible to eclampsia, where the high blood pressure leads to seizures and dangerous pregnancy complications, such as possible coma or death. The administration of magnesium sulfate has long been thought to reduce the risk of seizures, and therefore provide a better outcome for both mother and baby. Witlin et al. (1998) reviewed all known investigations of magnesium sulfate therapy in pre-eclampsia and eclampsia. It was concluded that throughout the literature, there does exist evidence to support the efficacy of magnesium sulfate treatment for pre-eclampsia and eclampsia. It was cautioned, however, that further research was required on the efficacy of this treatment to properly validate its increased usage (Witlin & Sibai, 1998). This caution grows from the lack of long term studies on the effects of magnesium sulfate not only on the mother, but on the developing infant as well.

The Magpie Trial Collaborate Group (2002) attempted such a validation. Women were recruited for this trial if they were experiencing pregnancy complications due to pre-eclampsia, and there existed doubt as to whether or not magnesium sulfate treatment was warranted. Participants were either administered magnesium sulfate or given a placebo. The Magpie trial strove to investigate the effects of magnesium sulfate on both the mother and the child. It was found that the women who had received magnesium sulfate had significantly fewer eclamptic convulsions, and lowered rates of maternal death. However, this study is unique from those before it in that a number of negative maternal effects were recorded. Those individuals within

the magnesium sulfate treatment condition exhibited a number of adverse physical side effects such as respiratory depression, respiratory arrest, pneumonia, cardiac arrest, coagulopathy, renal failure, haemorrhage, toxicity, vomiting, and weakness. In addition to maternal complications, a number of fetal complications were reported as well. A significantly greater incidence of induction, increased length of labor, and increased incidence of caesarean section was found among women treated with magnesium sulfate. There was also a greater prevalence of retained placenta, blood loss, transfusion, neontal morbidity (Apgar < 7 at 5 min), incubation at place of delivery, ventilation, abnormal cerebral ultrasound, and convulsions (Magpie Collaborative Group, 2002). While this study noted a number of maternal side effects of magnesium sulfate treatment in much greater detail than any studies that had come before, the focus on infants was very narrow in scope. The researchers within this study were only interested in infant health through the day on which they were born. There was not any follow up procedures enacted to further evaluate infant health in the following months. A final conclusion on the effects of magnesium sulfate treatment on infants was not possible based on the data gathered through this study as the infants included were only followed until discharged from the hospital shortly after birth.

In addition to the risks of magnesium sulfate treatment on the fetus at the time of birth identified by the Magpie Trial Collaborate Group, Holcomb et al (1991) discovered an additional potentially harmful outcome, abnormal fetal bone mineralization. Infants born to mothers who had undergone magnesium sulfate treatment for more than 7 days comprised the exposed group, while mothers who did not experience this particular treatment served as the control. Infants born to non-exposed mothers showed no signs of bone abnormalities, while the majority of the

exposed group displayed definite abnormalities in the proximal humerus. The abnormalities included discrete transverse metaphyseal radiolucent bands extending from just beneath the intact zones of provisional calcification, narrower sclerotic transverse band extending a variable distance through lucent metaphyseal lesion, and the thinning of the cortex at periphery of lucent bands (Holcomb et al., 1991) . The main confound to this study however, was the very small subject pool, with a subject total of 33 infants. Despite the small subject size, significant results were undoubtedly found. It would be beneficial to re-create this study within a much larger subject pool to determine whether these results would still be significant within a larger population.

It is clear, then, that more research efforts have been applied to examining the effects of magnesium sulfate than magnesium carbonate. While proven successful at reducing aspects of pre-eclampsia, magnesium sulfate was found to produce a number of negative side effects for both the mother and the fetus. The following study strives to first address the gaps within the present literature by questioning whether these effects of magnesium sulfate treatment during pregnancy on both mother and fetus can be recreated. If so, it then follows that perhaps maternal exposure to magnesium carbonate during pregnancy will produce similar results for infant health as magnesium sulfate, a similar compound, has been associated with. Within the present literature, very little regard is given to the effects of magnesium carbonate exposure on the fetus, and on the infant post birth. The proposed study will address the present shortcomings in the literature by not only assessing the effects of both magnesium sulfate *and* magnesium carbonate on the mother and child through birth, but also the possible longterm effects on the infant post birth.

c. Research Design and Methods

I. Rationale

In order to investigate pica behavior among pregnant women, it would be most beneficial to carry out the proposed study in an area known to have higher pica rates than the nation as a whole. As noted earlier, Simpson et al. (2000) compared pica rates in low-income Mexican born women in Mexico and in those who had moved to the United States and found especially high rates within both of these particular areas. The proposed study will draw from her research by recruiting study participants from the same areas. Recruitment of pregnant women in Ensenada, Mexico, will be facilitated by a researcher's presence at the community clinic. In addition, pregnant women will be recruited through researcher presence in outpatient clinics in Santa Ana, Bakersfield, and East Los Angeles. The proposed study will focus on these two areas in hopes of discovering supportive evidence for pregnancy interventions.

Within these areas, and among Mexican-born women specifically, the dangers of ingesting non-food items during pregnancy are not clearly understood. This lack of awareness is highlighted by the cultural influences that encourage women to ingest such items as magnesium carbonate to better the health of the fetus. This misunderstanding and confusion regarding pica during pregnancy may be resulting in increased rates of abnormal births and abnormal infant development. In order to ensure that individuals who practice pica will be found, the proposed study will recruit a number much larger than the final desired subject pool size. It is possible to recruit subjects by asking for women who practice pica to sign up for the study, however, this

method may deter women from coming forward. By presenting potential participants with a questionaire covering a range of topics, women will be more likely to give their consent for participation without being discouraged by a negative connotation associated with pica. This study will be longitudinal in nature, following pregnant women not only through the time that their child is born, but beyond birth until the infant reaches 9 months of age. Through this design, information can be gathered about infant health not only at the time of birth, but through the critical periods of development in the 9 months following.

II. Methods

A number of exclusionary criterium will be taken into account when recruiting women from both the Mexican, and the California locations. The researchers stationed at these various locations will approach possible candidates and inquire about the following qualifications. Participants who will be eligible to enroll in the study will be Mexican-born, and either still living in Mexico, or currently living in one of the Southern California locations. The mother's primary language must be Spanish. The women must be between the ages of 20-35 years and either pregnant, or planning to become pregnant shortly. Further qualifications include singleton birth, the mother's first pregnancy, and no other known pre-natal risks. Furthermore, possible participants will be eliminated from the subject pool if they reported a history of cigarette, alcohol, or elicit drug use. Mothers will also be eliminated if any serious, pre-existing maternal conditions are reported. Mothers must also be planning to give birth within a hospital setting as opposed to home birth or any other alternative birthing methods. For those individuals who meet all qualifications, informed consent will be collected.

Upon receiving informed consent from eligible study participants, a preliminary survey will be administered in a private room within the clinic from which they were recruited. Ideally this preliminary survey will be completed on the same day of recruitment in order to reduce any inconvenience on the participant. It will be available in Spanish. The questionaire will consist of a number of questions meant to asses the pica behavior of the participant. If responding that pica behavior had been engaged in during pregnancy, the subject will have the opportunity to elaborate on the history of this behavior, as well as the particular features such as frequency and type of substance. The mother's opinion on the dangers or benefits of consuming magnesium carbonate will also be probed. In addition, the questionaire will also inquire whether the mother had experienced magnesium sulfate treatment lasting over 7 days during the pregnancy.

Upon completion of the survey, the researchers will place the women into one of three possible experimental groups. The three conditions to be evaluated within the proposed study include pregnant women who have reported ingestion of magnesium carbonate during pregnancy, women who experienced more than 7 days of magnesium sulfate treatment during pregnancy, and a control group that neither ingested magnesium carbonate nor experienced magnesium sulfate treatment at any point throughout pregnancy. There will be two sets of three groups, one set for Mexican-born women living in Mexico, and a set for Mexican-born women living in Southern California. Those individuals who experienced more than 7 days of magnesium sulfate treatment and who also reported consuming magnesium carbonate during pregnancy will be excluded from the study. Those women who reported ingesting a different non-food substance during pregnancy will also be excluded from the proposed study. Due to the strict exclusionary criteria of the study, it will be necessary to recruit a large subject pool.

Researchers will continue recruiting possible participants until 1,000 individuals have been found to comprise each of the three conditions for the two locations. The recruitment of such a large subject pool will be difficult and time consuming, however over the duration of five years this recruitment goal will no doubt be a strong possibility.

The proposed study will utilize a longitudinal design to assess the health of infants born to women in each of the three conditions. This design begins with light maternal monitoring throughout pregnancy. After acceptance into the study, the pregnant women will be asked to complete and e-mail a short questionaire to the researchers. This will be designed to assess both current maternal and fetal health, pica frequency and timing, as well as details of any magnesium sulfate treatment. This survey will be emailed, or mailed if no email is provided, to each participant at the end of each trimester. If a participant was recruited at the beginning of their pregnancy, the most questionaires that a participant will be asked to complete while pregnant totals three. This questionaire will allow researchers to continually exclude mothers who no longer qualify, such as receiving magnesium sulfate treatment after reporting pica practices.

Whenever possible, a researcher will be present at the time of birth for the infants of women still eligible. The participants will be instructed to inform the researchers when they are admitted to a hospital for labor. In this case each infant will be given the Apgar test 1 minute post birth, and 5 minutes post birth. In addition, within an hour post birth infants will be given a low-radiation x-ray to evaluate bone health. A record of all women who require emergency induction or cesarean section will be gathered from the mothers by a self-report administered during a follow up call around the previously predicted due date. In any case possible, these infants will be given the same tests following birth as those birthed in normal conditions. In

addition, a report of any major maternal or fetal complications during labor or post labor will be gathered, along with the number of maternal and/or infant deaths.

Upon discharge from the hospital post-birth, maternal and infant health will be monitored through a series of maternal reports and clinic visits. At ages 3, 6, and 9 months mothers will be asked to bring their infants to the clinic from which they were recruited for follow up tests. At each of these visits, mothers will complete a questionaire assessing their magnesium carbonate ingestion practices post-pregnancy, and whether or not they are breastfeeding. At each of these three visits, infants will complete the Bayley Scales of Infant Development (BIDS). This test will be administered in order to measure the mental and motor development of infants, as well as assess their behavior at each age. The scores received at each age will be recorded for later comparison. Upon completing the questionaire and BIDS at each visit, mothers will be given a small amount of monetary compensation.

Once data has been collected from a total of 6,000 women and infants, a number of analyses will done. The x-rays taken immediately following birth will be analyzed and categorized as normal or abnormal. A comparison will then be made between groups and across the two populations. The frequency and amount of magnesium carbonate ingested by mothers during pregnancy will be tabulated and compared between Mexican-born women living in Mexico and Mexican-born women living in California. A similar comparison will be made between average length of magnesium sulfate treatment and average amount administered between the two locations. The amount of labor complications and rates of maternal and infant mortality rates will also be found. T-tests will be run to determine any significant differences between each of these location comparisons. The average BIDS scores for infants in each of the

6 groups will be found and using an Anova compared within both populations and between both populations. It will also be interesting to determine whether a mother's opinion on the risks or benefits for the fetus of consuming magnesium carbonate correlate with higher ingestion rates, and whether there is a significant opinion difference between the two studied locations.

d. Predicted Results

Based on information found in the literature, it is hypothesized that both locations included within this study will have higher than normal rates of maternal pica during pregnancy. Magnesium carbonate will be a substance frequently ingested by pregnant women who report pica behaviors. It is also predicted that infants born to women who ingested large amounts of magnesium carbonate or were treated for more than 7 days with magnesium sulfate will display abnormal developmental patterns. Abnormalities may be seen immediately post-birth through the Apgar score or the chest x-rays. In addition, the longitudinal design of this study will allow for possible abnormalities to be discovered through lower scores on the BIDS up until the age of 9 months. In addition, due to possible cultural effects, the rates of abnormalities may be greater for infants born to Mexican-born women living in Mexico.

While the proposed study should prove successful at pinpointing the effects of large-scale magnesium carbonate ingestion on the developing fetus and infant, there may be a number of limitations. To begin, as pica habits are to be self-reported by the mothers, there may be an underreporting of pica. Although the ingestion of magnesium carbonate appears to partially be a culturally encouraged behavior, there is also a widely known stigma against the condition. This negative connotation towards those who ingest non-food items may result in an underestimation

of how much magnesium carbonate is actually ingested during pregnancy. In addition, the duration of magnesium sulfate treatment and amount administered was reported by the mothers as well, and therefore may not be entirely accurate. Unknown drug usage could also affect the outcomes as it is difficult to ensure that a participant truly does not participate in any elicit drug use without the administration of periodic drug tests. As the current study already involves a long duration time, this type of drug testing appears to be too taxing for the participants. It may also be found that mothers are reticent to submit their infants to an x-ray post birth, no matter how safe the low-risk procedure may be. It may be difficult then, to gather enough data regarding infant bone formation if mothers are less willing to participate in this aspect of the study.

An interesting follow up to the proposed study would be to examine whether there are developmental differences among infants who are breastfed by mothers who ingested large amounts of magnesium carbonate, mothers who experienced magnesium sulfate treatment, and mothers who did not experience either. Whether or not exposure to these two substances may contaminate breast milk in some way, or harm maternal nutrition to such an extent that breastfeeding complications arise, would be informative for pregnancy interventions.

References

Grigsby, R., Thyer, B., Waller, R., Johnston, G. (1995) Chalk eating in middle georgia: A culture-bound syndrome of pica? *Southern Medical Journal,* 92, 190-192.

Holcomb, W., Shackelford, G., Petrie, R. (1991) Magnesium tocolysis and neonatal bone abnormalities: A controlled study. *The American College of Obstetricians and Gynecologists,* 78, 611-614.

Nelson, M., Forfar, J. (1971) Associations between drugs administered during pregnancy and congenital abnormalities of the fetus. *British Medical Journal,* 1, 523-527.

Simpson, E., Mull, J., Longley, E. (2000) Pica during pregnancy in low-income women born in mexico. *West J Med*, 173, 20-24.

The Magpie Collaborative Group (2002). Do women with pre-eclampsia, and their babies, benefit from magnesium sulphate? The Magpie Trial: a randomised placebo-controlled trial. *The Lancet*, 359, 1877-1890.

Witlin, A., Sibai, B. (1998). Magnesium sulfate therapy in preeclampsia and eclampsia. *The American College of Obstetricians and Gynecologists*, 92, 883-889.