The Differences in O2 Saturation between Neonates of Abused and Non-Abused Women

A proposal for the clinical project of

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To the faculty of Washington State University:

The members of the Committee appointed to examine the project of Kristin Townsend find it satisfactory and recommend that it be accepted.

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Acknowledgement

This project is based on a study conducted by Dr. Michael Rice and Dr. Kathie Records, entitled *Neonatal Health: Biophysical Outcomes of Maternal Abuse.* Specifically the project addressed one piece from their overall study. The methods and instrumentation suggested are parallel to those used by Dr. Rice and Dr. Records.
Abstract

This project addresses the issue of how abuse during pregnancy affects neonate’s oxygen saturation in response to stressful situations. Intimate partner abuse has been shown to cause stress which releases cortisol and activates a biological response within the hypothalamic-pituitary-adrenal (HPA) axis. Animal studies indicate maternal catecholamine elevations resulting in vasoconstriction of the uterine arteries (Franscisco, 1981). This in turn results in an altered stress response within the offspring. However, there remains a paucity of information regarding specific indicators of altered stress responses in human neonates exposed to maternal abuse.

One non-invasive way of measuring stress in neonates is oxygen saturation. The purpose of this study was to determine if there is a difference in mean oxygen saturation levels between neonates of abused versus non-abused mothers in response to a standardized stress of a routine PKU heel-stick. A factoral pretest/posttest design with comparison group was utilized with a sample of forty non-randomized neonates categorized into two groups.

The results suggest a moderately statistically significant difference in oxygen saturations at 25-minutes post-stick between neonates from abused and non-abused mothers, although statistically significant differences were not noted at other time periods. Possible explanations for the limited statistically significant values could be the lack of a large enough sample or data collection error. Overall the evidence indicates that oxygen saturations, in combination with other physiological changes, may indicate altered stress responses. However further research is needed to provide more conclusive evidence in response to the posed research question.
The Differences in O₂ Saturation between Neonates of Abused and Non-Abused Women

Introduction and Background

Abuse is a significant problem affecting a large portion of the females around the world. Previous studies have found that between 2 and 4 million women in the United States suffer from abuse each year. Most frequently, women are abused by a current or previous male partner, which is termed intimate partner abuse (IPA). In addition to physical injury, IPA causes an increase in emotional problems (McCawley, Kern, Kolodner, Dill, Schroeder, DeChant, Ryden, Bass & Derogatis, 1995) specifically psychological trauma, stress and anxiety (Romito, Turan, Margherita & Marchi, 2005). Unfortunately pregnancy does not prevent abuse. Often it triggers or exacerbates the violence, up to 21% in the United States (Rachana, Suraiya, Hirsham, Abdulaziz & Hai, 2002).

Stress significantly impacts a variety of biological systems but predominantly affects the hypothalamic pituitary adrenal axis (HPA). Dr. Hans Selye (1978) a renowned stress theorist stated that a stressor such as abuse initiates a series of adaptive biological systems, specifically the hypothalamic-pituitary-adrenal (HPA) axis. Stimulation of the HPA axis results in hypercortisolemia, leading to neurotoxicity particularly in the hypothalamus. The disruption in the HPA feedback loop can potentially cause depression, anxiety, and several other physiological problems (Austin, Leader & Reilly, 2005).

Several studies have demonstrated the psychological processes involved in the stress response. Results have supported Selye’s theory by describing the activation of the HPA axis and the role of cortisol in response to stress. One study (Bourdarene, Legros &
Timsit-Berthier, 2002) in particular addressed the stress response in relation to the role of anxiety and cortisol. The results showed a state of anxiety as the first stress response that eventually hit a plateau level, remaining stable. With sustained stress an increase in cortisol was noted (Bourdarene, Legros & Timsit-Berthier, 2002). This increase in cortisol, if it occurs during pregnancy has a direct affect on the infant (Wadhwa, 2005). Maternal stress during the prenatal period increases corticotropin-releasing hormone (CRH) before the usual increase at term, thus impacting normal hormonal regulation during pregnancy.

Rat studies have shown that excess CRH and cortisol cross the placenta, causing a down regulation of fetal receptors involved with feedback regulation of the HPA axis (Austin et al., 2005). Normal fetal HPA axis responds to changes in maternal stress hormones from day seventeen of gestation (Boudouresque, Guillaume, Grino, Strbak, Chautard, Conte-Devolx & Oliver, 1988). Thus fetuses are vulnerable to elevations in cortisol anytime after the 17th day of conception. Several other rat experiments have analyzed these adaptive neuroendocrine alterations (Joffe, 1978; Neumann, 2003; Henry, Kabbaj, Simon, Le Moal, & Maccari, 1994; Takahashi, Kalin, Barksdale, Vandenberg & Brownfield, 1988; Takahashi, Turner & Kalin, 1998; Takahashi, Baker & Kalin, 1990; Takahashi, Turner & Kalin, 1992; Bakker, van den Dobbelsteen, Kroes, Kavelaars, Heijnen, Tilders & van Rees, 1982; Peters, 1982; Smythe, McCormick & Meaney, 1996; McCormick, Smythe, Sharma & Meaney, 1995; Szuran, Pliska, Pokorny, & Welzl, 2000; all as cited in Weinstock, 2005) indicating the possibility of detecting exposure to maternal stress throughout the pup’s lifetime (Weinstock, 2005). Unfortunately these studies have not been done in human populations.
Research Problem

The issue of maternal abuse has been recorded since 1963, yet there remains little knowledge about implications to the neonate's health and long term outcomes (Gazmararian, Lazorick, Spitz, Ballard, Saltzman & Marks, 1996). Multiple studies have shown a direct relationship between immediate adverse birth outcomes and maternal abuse. Immediate adverse health outcomes due to maternal stress include low birth weight, neonatal mortality, morbidity, and pre-term births (Rachana et al., 2002; Ng, Lee, Lam, Ma, Chan, Wong & Fok, 2004; Burlet, Fernette, Blanchard, Angel, Tankosic, Maccari & Burlet, 2005). However, knowledge about the baseline changes in neonates, within 24-hours of birth, have not been studied.

A considerable number of women, estimated up to 20%, experience IPA and stress during pregnancy (Cokkinides, Coker, Sanderson, Addy, & Betha, 1999). Prenatal stress, which might result from the abuse, is thought to stimulate maternal HPA hormones producing intrauterine programming of the fetal HPA axis. In turn, the hormones could affect the central nervous system and brain glucocorticoid receptors of the developing fetus (Van den Bergh, Mulder, Mennes & Glover, 2004).

There are two major concerns about how stress affects fetal development. First, in utero stress stimulates early maturation of the fetal organs (Wadhwa, 2005). The fetal energy spent on maturing the fetal HPA results in low birthweight and premature delivery. Second, stress experienced in utero results not only in early maturation of the fetal HPA, but in early programming of the HPA responses to stress. These programmed responses to stress may result in markedly different stress responses after birth (Rice & Records, 2006).
Maternal hormone alterations induced by abuse could have long term physiological and behavioral consequences for the baby (Weerth & Buitelaar, 2005). The HPA hormones program nervous system stimulation and provide physiological indicators for measuring a response to stress (Weerth & Buitelaar, 2005). The effect of maternal abuse on neonatal health outcomes has not been thoroughly investigated even though it involves a significant percentage of the overall population. In order to ensure health promotion and disease prevention for neonates it is imperative to address this issue now.

**Research Purpose**

The purpose of this study is to determine if there is a difference in oxygen saturation between neonates of abused versus non-abused mothers in response to a standardized stressor, induced by the PKU heel-stick. Oxygen saturation has been proven as an accepted method for measuring stress in infants as well as an indicator of overall health and therefore will be utilized in this study (Holsti, Grunau, Oberlander Whitfield & Weinberg, 2005). Oxygen saturation is a noninvasive technique that correlates well with blood gases (O’Brien, Stebbens, Poets, Heycock & Southall, 2000).

The goal is to begin a process of inquiry that will describe specific alterations in the health status of neonates exposed to maternal abuse. It is believed that cortisol, the stress hormone, crosses the placenta and affects the neonate’s stress response. The first system to be activated by stress is the autonomic nervous system with sympathetic response resulting in increased heart rate, respiratory rate, blood pressure and myocardial oxygen demand (Rice, 2000). This study will indirectly test the hypothesis that fetal HPA axis reprogramming results from maternal abuse and can be partially measured with oxygen saturations.
Theoretical Base and Conceptual Framework

The theoretical framework used for this study is Selye’s General Adaptation Syndrome (1978). The theory defines three stages of stress initiated by a stressor, such as intimate partner abuse. The body’s response to that stress involves physiological changes, specifically activation of the sympathetic nervous system (SNS). This is referred to as a fight or flight response with increased heart rate, respiratory rate, blood pressure, and myocardial oxygen demand. With continued stress the subject moves into a resistance stage where the body tries to return to baseline. However, if that is unsuccessful, exhaustion sets in because the essential hormone reserves have been used and damage to organs has occurred (McEwin & Wills, 2002).

When a mother experiences intimate partner abuse, she experiences physical and/or emotional stress, both capable of inducing the physiologic stress response. The fetus is subject to maternal hormones transferred through the placenta thus entering into the stages of stress with the mother (Van den Bergh et al., 2004). This study will use Selye’s General Adaptation Syndrome (1978) to understand the physiological changes in the HPA axis caused by a stressor, intimate partner abuse, in neonates. To support use of this theory, animal studies have demonstrated persistent physiological and behavioral changes as well as damage to organ systems due to maternal stress (Burlet, Fernette, Blanchard, Angel, Tankosic, Maccari & Burlet, 2005; Weinstock, 2005).
The concept of intimate partner abuse refers to physical, sexual or verbal abuse from a current or previous partner. Abuse as the stressor discussed in Selye’s theory initiates the body’s stress response. Maternal stress identifies the mother that is directly affected by the abuse. The hormone elevations created from the abuse also adversely affect the indirect subject, neonate, by passive transfer of maternal hormones through the placenta (Van den Bergh, et al., 2004). Therefore both human subjects are propelled into a stress reaction, termed physiologic response. One way to measure the outcome, or physiologic response, of neonatal stress is oxygen saturation. Two published studies have explored the relationship between physiological or behavioral stress to oxygen saturation (Harrison, Roane & Weaver, 2004; Stevens, 1993). Both reported decreased oxygen saturation in response to stress exposure.

The concepts addressed in this study include: stress, intimate partner abuse and physiologic response. The conceptual definition of stress is the adaptive state induced by
a stimulus. Operationally, stress is defined as “the state manifested by a specific syndrome which consists of all the nonspecifically-induced changes within a biologic system” (Selye, 1978, p. 64). Intimate partner abuse is conceptually defined for this study as a stimulus initiating a series of non-specific biological responses. Operationally, intimate partner abuse is a precipitating factor and can be measured based on the occurrence of non-specific adaptive biological responses. The conceptual definition of physiologic response is the non-specific biological change induced by a stressor. The operational definition of physiologic response is the measurable neonate oxygen saturation after the heel-stick (stressor).

Literature Review

Recent research has reported that abuse during pregnancy has an incidence of up to 21% in the United States (Campbell, 2002). The connection between intimate partner abuse (IPA) and stress has been examined by investigating the incidence of posttraumatic stress disorder (PTSD) among adults exposed to IPA. PTSD defines the common symptoms related to stress that occur after a traumatic event. One study noted a strong correlation of up to 84% between IPA and PTSD (Pico-Alfonso, 2004). Another study found an association between pregnant women exposed to IPA and cognitive deficits, specifically hippocampal dysfunction associated with elevated cortisol. Potentially stress induced neuropsychological changes could lead to significantly impaired daily activities with heightened difficulty during future episodes of stress (Stein, Kennedy & Twamley, 2002).

However, few studies have looked at the implications of IPA on the fetus. The majority of work addressing the effect of maternal stress on fetal health outcomes has
been conducted in animals. One prospective study, found in Appendix A, of twenty-eight rhesus monkey fetuses discovered that maternal stress resulted in neuromotor immaturity and inattention (Schneider, Roughton, Koehler, & Lubach, 1999). Maternal monkeys were placed in three groups, early gestational stress, mid to late gestational stress and a control group. Stress was induced on mothers by moving them from home cages in a dark environment with three noise bursts administered. This is similar to intimate partner abuse because the monkeys were not in control of their environment. Other primate studies have also yielded adverse neonatal outcomes (Schneider, Roughton, Koehler, Lubach, 1999; Gust, Stocker, Conrad, Plotsky, Gordon, 2000 & Ayala, Pushkas, Higley, Ronsaville, Bold, Chrousos, Pacak, Calis, Gerald, Lindell, Rice, Cizza, 2004).

Primate and other animal studies provide relevant information about the effects of maternal stress on the fetus. The primary strength of animal research is the controlled environment. Human research on this subject is intricately more complex due to social and ethical reasons. Therefore they have primarily addressed neonatal behavioral and emotional outcomes related to maternal stress (Knuth & Etgen, 2007; Lahti, Raikkonen, Kajantie, Heinonen, Pesonen, Jarvenpaa & Stranberg, 2006). Specifically studies have shown increased incidence of anxiety and depression into young adulthood (Watson, Mednick, Huttunen & Wang, 1999, as cited in Weinstock, 2005; Maccari, Piazza, Kabba, Barbazanges, Simon & Le Moal, 1995). One of these studies conducted by Watson et al. (1999) looked at a large sample (N=1215) of young adults, of which approximately half were exposed to an earthquake in-utero, the other half provided a control. The results showed a marked increase of depression in the neonates exposed to the earthquake and concluded that maternal stress reaction may alter the developing fetal HPA axis.
In addition to behavioral and emotional changes some human studies have shown lasting neurobiological changes associated with the transfer of maternal stress hormones, mainly cortisol, (Shelten, van Duursen, van der Graaf, Gispen & Kahn, 1997; van Os & Shelten, 1997 as cited in Watson et al., 1999; O'Brien, Skelton, Owens & Nemeroff, 2001). One study administered a corticosteroid (betamethasone) to mothers of one group (N=9) but not to the control group (N=9). The healthy full term infant’s salivary cortisol was collected after a heel-stick blood draw between 3-6 days after delivery. The study noted significant differences in cortisol levels at 20-minutes post-stick, which indicated the corticosteroids altered fetal HPA axis response (Davis, Townsend, Gunnar, Georgieff, Guiang, Ciffuentes & Lussky, 2004).

A few other studies by Watterberg & Scott (1995) and Ng, Lee, Lam, Ma, Chan, Wong & Fok (2004) addressed the association between cortisol and oxygen saturation. One found that low cortisol secretion in response to HPA activation was associated with oxygen dependence and development of bronchopulmonary dysplasia. The study concluded that the infants were unable to react adequately to stress and therefore were more likely to have persistent lung injury (Watterberg & Scott, 1995). Another study noted the relation between low cortisol levels within the first week of delivery and respiratory distress but also stated that increased cortisol in response to stress a week later was associated with necessary oxygen supplementation (Ng, Lee, Lam, Ma, Chan, Wong & Fok, 2004). A third study documented that prenatal stressful events resulted in exaggerated cortisol responses after birth and noted an association with oxygen supplementation (Ng, Lam, Lee, Ma, Fok, Chan & Wong, 2002). Basically this
information provides evidence that there is an association between cortisol level and oxygen saturation in neonates supporting the idea of reprogramming fetal HPA axis.

Overall, human studies have addressed fetal HPA axis alteration by largely noting behavioral and emotional symptoms with few looking at neonatal physiological response to maternal cortisol (Engliston, McMahon & Austin, 2007). One study looked at EEG, vagal tone, neurotransmitters (dopamine, serotonin and norepinephrine) and cortisol levels of depressed mothers and their infants. The results showed that the infant’s physiological status mimicked their maternal biochemistry (Field, Diego, Dieter, Hernandez-Reif, Schanberg, Kuhn, Yando & Bendell, 2004). Furthermore the literature review revealed a couple studies done on low birth weight infants that found a significant correlation between low levels of cortisol and increased respiratory problems requiring oxygenation (Ng et al., 2004; Watterberg & Scott, 1995). There have been no previous studies that have investigated the effect of maternal stress produced by IPA on oxygenation of healthy term neonates, post delivery.

Despite the above mentioned studies, there remains little knowledge about the direct hormonal impact, assessment techniques or possible interventions for affected neonates. This study aims to address that gap by comparing the oxygenation saturation after heel-stick (the stressor) in full term neonates exposed to maternal IPA and neonates without exposure to maternal IPA. Oxygen saturation is an accepted method for measuring stress in neonates (Holsti, Grunau, Oberlander Whitfield & Weinberg, 2005).

Research Questions

The research questions initially posed by Dr. Rice and Dr. Records were:
1. What are the differences in stress response between newborns from abused vs. non-abused mothers?

2. Is there a difference in a newborn’s mean oxygen levels from abused as compared to non-abused mothers?

This project will only address the last question on the variances in oxygen saturation levels between the two groups.

Definition of Terms

The major variables of interest for this project are maternal abuse and neonatal oxygen saturation. Many of the extraneous variables were controlled with the exclusion criteria and listed in the limitations. The routine neonatal PKU heel stick acts as the independent variable, or stimulus manipulated by the researcher (Burns & Grove, 2005), for this study. It is presumed that neonatal oxygenation will respond to the stress of the PKU heel stick and therefore is referred to as the dependent variable, or the outcome to be explained (Burns & Grove, 2005). For the purpose of this study the following definitions are used to explain the significant variables:

- Stress Response: A series of adaptive biological responses that are initiated by a stressor, specifically activation of the HPA axis causing measurable physiological changes, including oxygen saturation (Austin, Leader & Reilly, 2005).

- Newborn: A full term infant between 38 and 41 weeks of gestation who has a normal neonatal health baseline. Health baseline is assessed using birth weight, APGAR scores and the absence of illness.
- Mean oxygen level: define mean oxygen level. Gathered using the Invacare IRC700 neonatal pulse oximeter with oxygen saturation sensitivity of +/- 2% accuracy for saturations between 0 and 99%. The IRC700 calculates saturation rates on samples taken at 8-second intervals (Smith Medical, n.d.).

- Abused Mothers: The Centers for Disease Control (1997) defines abuse as a physical force intentionally used, with a possibility of causing injury and may include use of weapons. Mothers are classified as abused with one or more positive SVAWS scores, a recorded history of abuse in chart or verbal acknowledgement of abuse. A positive score is measured when one or more of the 46 situational questions were responded to with a value of 2 or more on the likert type scale (1 = never, 2 = once, 3 = a few times, 4 = many times) (Marshall, 1992).

- Non-abused Mothers: Mothers classified as non-abused when answered all 46 situational questions on SVAWS with a value of 1 = never (Marshall, 1992), had no recorded history and verbally denied abuse.

**Significance to Nursing**

There is a need for nurses to acknowledge the potential harmful effects of maternal IPA and stress on the fetus. Nursing practice would be irresponsible not to address the issue since studies suggest severe long term consequences of fetal HPA reprogramming (Ng, 2000). Currently, the nurse’s role in screening for IPA is limited to asking questions about relationship concerns, worries, what causes stress, coping mechanisms and about the primary support person during prenatal examinations (Ruiz &
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Avant, 2005). Each of these topics provide insight into the mother’s social atmosphere and relationship structure. If any illicit reason for concern is observed, the nurse is responsible to further examine the situation with a formal scale such as the SVAWS (Marshall, 1992). Additional valuable information could be gathered through observation of fetal and/or neonatal health outcomes, however, no indices currently exist.

Health outcomes that could be used to identify neonates exposed to maternal IPA could lead to improved interventions. Neonatal studies will help to validate the necessity of maternal abuse screening for disease prevention, as well as to promote neonatal health through improved measurement strategies and interventions to decrease hyperactive stress responses. Furthermore, increased awareness of this problem can potentially lead to the development of a non-intrusive methods of screening.

Methods

Design

This factorial pretest-posttest comparison group design (Burns & Grove, 2005). The inability to randomize the sample and purpose of examining the cause of stress make this an appropriate choice. It allows for assessment of the difference in oxygen values between the two non-equivalent groups, neonates from abused versus non-abused mothers. The pretest-posttest is the oxygen saturation as the dependent variable that will be examined for variation. The independent variable used as an intervention is the routine PKU lab draw which will act as a stressor to the infant.

Population and Sample

This study utilized a nonprobability convenience sample of forty neonates, which were selected from Sacred Heart Medical Center (SHMC) mother-baby unit. A nurse
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manager, not connected with the study, identified full term healthy neonates that met the following inclusion criteria:

- vaginal delivery without vacuum extraction or forceps assistance
- three or less glucose strips after birth
- a normal health evaluation, including a normal APGAR score and birth weight.

Neonates were excluded if the mother was diagnosed with any of the following:

- psychiatric illness
- depression
- use of any psychoactive medications
- physical illness
- pregnancy-related illness
- pregnancy-induced hypertension
- gestational diabetes
- musculoskeletal problems
- medical assistance for delivery
- cesarean sections
- artificial rupture of membranes

Additional neonate exclusion criteria were:

- neonates with independent illnesses or respiratory diseases.

A convenience sample is appropriate for this study because it provides a way to gather information in unexplored areas such as this study. The strengths include the fact that it is inexpensive, accessible and requires less time to find subjects. The primary weakness of this sampling method is the lack of control for biases (Burns & Grove,
In an attempt to control for this weakness a case worker, outside the study personnel, initially identified and approached the maternal participants.

**Measures**

Infant oxygen saturations and pulse rates were gathered using the Invacare IRC700 neonatal pulse oximeter with oxygen saturation sensitivity of +/- 2% accuracy for saturations between 0 and 99%. The IRC700 calculates saturation rates on samples taken at 8-second intervals. The IRC700 also calculates pulse on an 8 second average and has a +/- 2% accuracy. The IRC700 used a sensor specifically designed for neonates as larger infant sensors result in inaccurate data (Smith Medical, n.d.). Once the probe is in place the systemic oxygen saturation is displayed with a reading of the heart rate below. This type of measurement is used in various clinical settings. It has been repeatedly proven to be reliable and valid through consecutive prospective studies showing a median value of 97.6% - 97.8% for healthy newborns (O'Brien et al, 2000).

Maternal abuse was measured by the *Severity of Violence Against Women Scales* (SVAWS), developed by Linda L. Marshall (1992). The SVAWS is a questionnaire that is administered to the mother addressing forty-six items (see Appendix B). With a response of zero to four: the questionnaire is a Likert-type scale. It asks about socio-economic status, abuse history and pertinent demographic information. Similar to oxygen saturation measurements, the SVAWS has also proven to be valid and reliable over time. It has been referenced in at least forty studies since its development.
Data Collection Procedure

Table 1: Sampling sequence for primary study:

<table>
<thead>
<tr>
<th>Time</th>
<th>Postpartum SVAWS</th>
<th>T1</th>
<th>T2</th>
<th>PKU T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal 8 am</td>
<td>CHQ X</td>
<td>X</td>
<td>0</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Maternal 8 am</td>
<td>Cortisol</td>
<td>X</td>
<td>0</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Maternal 8 am</td>
<td>Heart Rate</td>
<td>X</td>
<td>0</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

KEY: T2=5 minutes pre-heel stick, T3=5 minutes post-heel stick, T4=25 minutes post-heel stick

Prospective participants initially were approached by a case manager at SHMC to obtain HIPAA preauthorization according to a prepared script. If they expressed an interest in the study the research nurse obtained informed consent the evening after delivery. The consent process involved a thorough explanation of the purpose, procedure, risks and benefits of the study. The participant was given the opportunity to ask questions. If there was an agreement to participate they were given a copy of the signed consent form with the option to withdraw at any time. A copy of the consent can be found in Appendix C. The study nurse communicated with the SHMC lab to verify arrival time the next morning. Data collection occurred at 7:00 am around the routine PKU lab draw. The nurse placed the neonate in their hospital crib, wrapped tightly in a blanket and maintained a low noise volume while collecting data. Wrapping an infant in a blanket, swaddling, has been shown to reduce the infant's pain response and is a standard procedure (Fearon, Kisilevsky, Hains, Muir, & Tranmer, 1997).

The mother was given the SVAWS questionnaire to fill out while the nurse taped the oximeter probe to the infant's great toe, after disinfecting it with alcohol. The pretest oxygen saturation was recorded five minutes prior to the routine neonate PKU heel stick.
This was repeated as a post-test at five and twenty-five minutes after the PKU, or stressor, as indicated above in Table 1.

The oxygen values and completion of the SVAWS were recorded on a form developed by the principle investigator, Dr. Michael Rice. The form consists of two rows with boxes designated for each oxygen measurement and a check mark for SVAWS completion. If extraneous variables were noted during the time of data collection a description was written above the appropriate box. The data was entered into a statistical software program (SPSS) for interpretation.

Data Analysis

An appropriate statistical analysis to describe the sample of this study is an Analysis of Variance (ANOVA). This one-tailed test would compare the variance within each group to the variance between the two groups, combined to get the total variance of the sample. Prior to this, an Analysis of covariance (ANCOVA) would reduce error term by separating out results due to confounding variables. In turn these would describe the distribution, homogeneity and independence of the groups (Burns & Grove, 2005).

An appropriate data analysis plan for the ordinal design and dependent sample of the study would be the Wilcoxon Matched-Pairs Signed Ranks Test. This test would assess changes that might transpire with pretest-posttest measures. It examines the direction and amount of change noted. The study hypothesizes that elevated cortisol levels in abused mothers cause neonate vasoconstriction and thereby decreases oxygen saturation. This is a bi-directional hypothesis that requires a one tailed t-test yielding a Z score $\leq 1.68$, or level of significance of .05.
A Chi-squared analysis was completed to establish whether the variables were associated or autonomous. For the purpose of this project, the variables of interest included: history of maternal abuse (SVAWS score) and neonatal oxygen saturations.

**Human Subjects Considerations**

Prior to data collection, Institutional Review Boards (IRB) from two different sites approved the study. One review committee is from the Spokane Institutional Review Board and the other through Washington State University (WSU). In addition a certificate of human subjects training was completed through the National Institute of Health by the research team members.

The purpose and procedures of the study were clearly explained to each maternal patient, or mother of the participating infant, prior to participation. The informed consent (Appendix C), written by Dr. Rice and Dr. Records, included the benefits, risks, discussion of the problem, duration of involvement, option to withdraw and confidentiality. The consent form was written in 12 point font with an estimated reading level of no higher than eighth grade.

All forms were kept confidentially in a locked drawer separate from informed consents containing identifiable information. Maternal patients were aware that their (mother and infant) participation was voluntary and they had the right to withdraw at anytime. They were also notified of the right to refuse answers to any of the questions and that their hospital care would not be affected by their participation. The maternal patients were aware that participation did not yield a direct benefit but were made aware that their contribution could yield improved methods of identifying mothers and neonates...
exposed to IPA and gain valuable information on the health effects of IPA on the neonate.

To decrease risk and discomfort for the infant, several strategies were utilized while gathering data. Specifically both data collectors were registered nurses, one with several years of experience working with newborn infants. The oximeter probe was taped gently to the newborn’s great toe and connected to the monitor at designated times to read the oxygen saturation. The infant was then wrapped snuggly in a blanket and placed in a bassinet with the probe connector easily accessible to minimize continued interference and manipulation of the infant by data collectors.

Findings

Sample Characteristics

The data was analyzed using the Statistical Package for the Social Sciences (SPSS version 14). The participating maternal subjects \((N=37)\), majority Caucasian, were characterized by a mean age of 25.3 years. On average they began care around 10.9 weeks of gestation, were classified as gravida 2 and had 7.9 hours of labor. There was a total sample of 37 neonates, 18 from abused and 19 from non-abused mothers. A valid birth weight was recorded for 34 of the neonates with a mean of 3458.53 grams \((SD=265.25, \text{ range}=2920 - 3898)\). APGAR scores at 1 and 5 minutes were recorded for 35 of the neonates with means of 8.29 \((SD=.99, \text{ range}=4 - 9)\) and 9.00 \((SD=.34, \text{ range}=8 - 10)\) respectively.

The mean oxygen saturation at five minutes pre-stick was 95.14 \((SD=2.68, \text{ range}=87 - 99)\) for the total sample \((n=37)\). An analysis of variance between the two sample groups did not show a statistically significant difference for the pre-stick oxygen
Neonatal Oxygen saturation \( (F=0.860, p=.36) \). Neonates of non-abused mothers \((n=18)\) had a mean oxygen saturation of 95.56 \((SD=2.62, range=90 - 99)\) at 5 minutes pre-stick. In comparison, neonates from abused mothers \((n=19)\) yielded a mean pre-stick oxygen saturation of 94.74 \((SD=2.75, range=87 - 98)\). With a 95% confidence interval the mean range was 94.25 to 96.86 for the no abuse group and 93.41 to 96.06 for the reported abuse group.

Neonate’s mean oxygen saturation at five minutes post-stick for the total sample \((n=37)\) was 95.27 \((SD=3.28, range=83 - 99)\). A test for variance at the five minute post-stick oxygen saturation using ANOVA indicated there were no reportable significant differences between the groups \((F=1.43, p=.239)\). For the five minutes post stick oxygen saturations, neonates of non-abused mothers \((n=18)\) had a mean of 94.61 \((SD=3.07, range=86 - 98)\) whereas neonates of abused mothers \((n=19)\) had a mean of 95.90 \((SD=3.43, range=83 - 89)\). In addition, the 95% confidence interval was 93.08 to 96.14 for the non-abused group and 94.24 to 97.56 for abused group.

Oxygen saturations at 25- minutes post stick yielded a mean of 94.84 \((SD=3.62, range=82 - 99)\) for the total sample \((n=37)\). An ANOVA between the two groups revealed a moderately statistically significant difference \((p<0.056)\). Neonates of non-abused mothers \((n=18)\) had a mean oxygen saturation of 96.00 \((SD=2.09, range=92 – 99)\) at twenty-five minutes post-stick as compared to neonates of abused mothers \((n=19)\) with a mean oxygen saturation of 93.74 \((SD=3.62, range=82 – 98)\).

Pearson’s correlation coefficients were run on the variables of interest to determine significant relationships. Report of maternal abuse was moderately correlated with the 25-minute post-stick oxygen saturation yielding an \( S \) value of 0.56, while the 5-
minute pre and post oxygen saturations were weakly correlated with abuse at 0.36 and 0.24 respectively. No other significant correlations were noted between oxygen saturation and abuse.

Discussion

Evidence from previous studies indicate a correlation between maternal abuse and the neonate’s stress response. It has been hypothesized that elevated cortisol levels in abused mothers may reprogram fetal HPA axis during fetal maturation, thus altering stress response (Rice & Records, 2006). Yet there remains little knowledge about the fetal physiological consequences. Oxygen saturation provides a non-invasive way to measure stress and overall health in neonates (Holsti et al., 2005) and therefore was a focus of this study. The study design was to test the difference in oxygen saturation of neonates from abused versus non abused mothers.

The results demonstrate that there was a moderately statistically significant correlation between neonate oxygen saturations at 25-minutes post-stick with report of maternal abuse. Probable rationale for lack of noteworthy results include the fact that few other studies have looked at these variables, none specifically with this population, so there was little knowledge to build on. Also, the study design was time limited meaning that the oxygen saturations were not measured beyond 25-minutes post-stick and the sample size may not have been sufficient.

First, there has been only one human study that explored physiological responses from fetal HPA alteration as a result of maternal cortisol stimulation. In that study, EEG tracings, vagal tone, and neurotransmitters alterations were noted (Field, et al., 2004). Other research has looked at the stress response in the non-pregnant population, noting
HPA programmed changes affecting immunity, cardiovascular status and metabolic changes leading to a variety of potentially fatal illnesses (Bosma, Marmot, Hemingway, Nicholson, Brunner & Stansfeld, 1997; Dhabhar, 1996; Gerin & Pickering, 1995; Kaplan, Pettersson, Manuck & Olsson, 1991; Munck, Guyre & Holbrook, 1984; as cited in McEwen, 1998). Despite this knowledge, no information was found regarding the outcome on oxygenation. There are several studies that looked at the association between cortisol and oxygen dependence in the neonatal population, however they were not healthy full term infants (Ng et al., 1995; Watterberg & Scott, 1995). Overall the literature supported fetal HPA axis reprogramming from maternal stress (corticosteroid exposure) (Engliston et al., 2007; Davis et al., 2004), yet no studies were found that addressed the outcome of neonatal oxygenation.

A second rationale for lack of noteworthy results could be due to the fact that the study design was time limited. Previous studies have looked at the consequences of prenatal corticosteroids on the neonatal HPA axis up to one week after delivery. They reported peak cortisol changes between 20-40 minutes (Engliston et al., 2007) with impaired ability to respond to stress (heel-stick blood draw) beyond one week after delivery (Davis et al., 2004). Perhaps changes in neonatal oxygenation were only noted at 25-minutes post-stick because the cortisol level had not reached its peak until that time period. Previous literature has noted the association between cortisol levels and oxygen saturation in neonates (Ng et al., 2004; Watterberg & Scott, 1995). Conceivably, testing oxygen saturations beyond 25-minutes post-stick may have yielded additional significant values and given valuable insight into the reprogrammed neonatal HPA axis.
A third possible explanation for the limited statistically significant values could be due to the lack of a large enough sample size to reach a desired effect size. With this sample size, perhaps the level of maternal abuse was not adequate enough to make a distinct difference from the control group. Another explanation could be due to data collection error. Infant’s oxygen saturation is highly associated with any movement. Neonatal sleep studies have shown that movement artifact can affect up to 50% of the recorded amount (Fletcher, Page, & Jeffery, 1998). This is also coupled by the fact that the oximeter is sensitive to any movement of the probe, potentially causing an inaccurate reading. The data collectors attempted to control this by keeping the infant calm and taping the probe to the infant’s great toe, although any movement could have greatly affected the results.

Overall the evidence indicates that maternal stress reprograms the fetal HPA axis, in turn, altering stress response and affecting oxygen saturations in combination with other physiological changes. The stress induced alterations leave neonates unable to adequately respond to stressful events. These changes have been shown to occur for an extended period of time and support the project’s conceptual model based on Selye’s theory of General Adaptation Syndrome (1978). No previous studies have looked at resulting neonatal oxygenation, an already proven method of measuring stress (Holsti et al., 2005) to address the issue of fetal HPA axis reprogramming. Further research would provide more conclusive evidence in reply to the posed research question, as well as to advance clinical practice and continue the development of accurate stress measurement methods. The recognized goal for nursing would be to develop coping mechanisms for these infants once they have been identified.
Limitations

Limitations of this study include extraneous variables. The first variable was recognized, involving the environment and reliance on SHMC lab personnel. An attempt to control this variable was made by conducting the study at 7:00 am each morning. In addition, a minimal amount of people were involved to improve communication. The research nurse directly communicated to the lab department and developed a working relationship over the course of the study.

The second extraneous variable or confounding variable involves maternal pain medication use during labor and delivery. Use of pain medication during labor and delivery showed moderate inverse correlations with oxygen saturations at 5-minutes pre-stick (-0.52), 5-minutes post-stick (-0.63) and 25-minutes post-stick (-0.60) (Rice & Records, 2006). These results indicate that perhaps pain medications played a role in lowering neonatal oxygen saturation.

There were internal and external threats to the validity of this design. Internal threats included selection and instrumentation. Selection refers to how subjects are chosen and posed a threat since randomization was not possible. Instrumentation posed a threat since the data collector may change measurement style between pre- and post-tests due to experience. External threats are the interaction of selection and treatment as well as the interaction of setting and treatment. The interaction of selection and treatment can be a threat due to the population being studied. There may be reluctance to involve a newborn in a study or hesitancy because of abuse. The interaction of setting and treatment refers to the potential bias of the setting thereby limiting generalizability.
Overall these threats were attempted to be controlled through homogeneity, matching, exclusion and statistical control (Burns & Grove, 2005).

Another limitation is the use of convenience sampling, meaning some patients with pertinent experiences may not have been included. The study's sample consisted of a majority of Caucasian mothers and neonates. Therefore the results have a limited generalization in that they are not ethnically diverse.

Implications

Results from this pilot study maintain the need to continue examination of physiological and behavioral changes in neonates linked to maternal abuse. This study found a statistically significant difference in oxygen saturations between groups at twenty-five minutes post-stick. This finding is supported by the fact that several previous rat studies have shown lasting and permanent alterations in rat pup's HPA axis due to prenatal stress. In turn, this causes physiological and behavioral changes that can be detected throughout their lifetime (Weinstock, 2005).

In combination with other physiological symptoms such as heart rate, lower oxygen saturations can be used by nurses to monitor infants for in-hospital assessment and teaching. Specifically, the newborn's associated behaviors with physiological changes and coping mechanisms unique to the neonate can be used to identify those at-risk. Furthermore, oxygen saturation and other physiological abnormalities can be utilized to initiate follow up referrals for at-risk newborns.

Recommendations for Further Research

Although the findings of this project are inconclusive, it lays a foundation for future studies to address a gap in current nursing knowledge. Specifically, future
research can address several avenues stemming from this study. First, whether the neonate's stress response is altered due to maternal abuse. Second, future studies can test various methods for accurate measurement of neonatal oxygenation. Finally, the goal would be to develop effective nursing interventions and assessment tools for maternal abuse that could be used to validate self report. This study has the potential to initiate a change in nursing practice. Future studies can use the findings and continue to explore the associations between maternal abuse and neonatal health outcomes.

Conclusion

In conclusion this pilot study was aimed at raising awareness to the fact that neonates suffer immediate and potentially long lasting effects from maternal abuse by testing physiological changes, specifically oxygen saturation, resulting from altered stress responses. Several rat studies have shown HPA reprogramming from maternal stress resulting in physiological and behavioral changes noted for several weeks after birth. The findings of this study yielded evidence to suggest that human oxygen saturations, in combination with other physiological changes, resulted from an altered stress response. Further research is needed to clarify the procedure of using neonatal oxygen saturation as a screening tool for maternal abuse and to examine interventions directed at helping affected neonates to cope. Current nursing practice would benefit greatly from information addressing this issue.


Centers for Disease Controls & Prevention (1997). *Key scientific issues for research on violence occurring around the time of pregnancy*. Atlanta, GA: Author.


Takahashi, L.K., Kalin, N.H., Barksdale, C.M, Vanden-Burgt J.A. & Brownfield, M.S.


### Appendix A

<table>
<thead>
<tr>
<th>Source</th>
<th>Purpose</th>
<th>Sample</th>
<th>Theory</th>
<th>Method</th>
<th>Design</th>
<th>Results</th>
<th>Conclusion</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gust, Stocker, Conrad, Plotsky, Gordon (2000)</td>
<td>To test cortisol levels in association with age and stress.</td>
<td>40 rhesus monkey, 20 young, 20 old</td>
<td>None listed</td>
<td>Comparison of cortisol at baseline, and after stress.</td>
<td>Correlational analysis.</td>
<td>Age did not affect the CRF response, social separation diminished elevation of cortisol and ACTH.</td>
<td>Possible hormone changes due to stress-induced or down-regulation of pituitary CRF hormones.</td>
<td>To clarify further study needed.</td>
</tr>
<tr>
<td>Stein, Kennedy, Twamley, (2002)</td>
<td>To assess the neuropsychological function of women who experienced IPA resulting in PTSD</td>
<td>39 female victims of intimate partner abuse</td>
<td>None listed</td>
<td>Test of attention, learning, executive functioning, language, visuoconstriction, and memory.</td>
<td>Constant comparative analysis.</td>
<td>IPA subjects had poorer performance on paced auditory serial</td>
<td>Cognitive deficits in IPA are consistent with frontal-subcortical dysfunction in traumatized</td>
<td>These findings deserve further study.</td>
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<tr>
<td>Authors</td>
<td>Study Objective</td>
<td>Methodology</td>
<td>Findings</td>
<td>Conclusion</td>
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<tr>
<td>DiPerto, Costigan, Gurewitsc (2003)</td>
<td>To determine if fetus respond to maternal stress, fetal response changes, and maternal and fetal response patterns.</td>
<td>137 low risk pregnant women with normal developed fetuses. None Stroop color-word test, pregnancy based emotionally evocative words and slides administered under a time pressure. Experimental Maternal sympathetic activation, fetal response noted.</td>
<td>Benign cognitive stressor suggest fetal neurobehavioral is disrupted by maternal environmental intrusion. Future studies necessary</td>
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<td>Ayala, Pushkas, Higley, Ronsaville, Bold, Chrousos, Pacak,</td>
<td>8 pre-adolescent male rhesus monkeys No theory, social separation as a model. 114 days through three phases monkeys put through three phases, adaptation, social separation, and Placebo controlled double blind cross-over design</td>
<td>ACTH and cortisol increased sig. after social separation Oral chronic administration of specific CRH antagonist does not blunt sympathoadrenal response to CRHR-1 antagonists may be a valid treatment for stress related</td>
<td>Maternal CRHR-1 antagonist may be a valid treatment for stress related</td>
<td>Maternal CRHR-1 antagonist may be a valid treatment for stress related</td>
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<tr>
<td>Study</td>
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<td>Sample</td>
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<td>Analysis</td>
<td>Findings</td>
<td>Implications</td>
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<td>Calis, Gerald, Lindell, Rice, Cizza (2004)</td>
<td>To examine the different features of IPA in determining PTSD.</td>
<td>75 abused women compared to 52 non-abused women.</td>
<td>Qualitative</td>
<td>Comparison questionnaire, structured interviews.</td>
<td>Correlational analysis</td>
<td>Strong positive association between PTSD and IPV. Women from IPV had significantly higher rate of PTSD.</td>
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<tr>
<td>Pico-Alfonso (2004)</td>
<td>To examine the different features of IPA in determining PTSD.</td>
<td>75 abused women compared to 52 non-abused women.</td>
<td>Qualitative</td>
<td>Comparison questionnaire, structured interviews.</td>
<td>Correlational analysis</td>
<td>Strong positive association between PTSD and IPV. Women from IPV had significantly higher rate of PTSD.</td>
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The study underlines IPA and its effect on women's mental health.