THE MATERNAL PERINATAL SCALE AS A PREDICTOR OF DEVELOPMENTAL RISK

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ABSTRACT

With increases in medical technology, infant mortality has decreased, while infant morbidity has increased over the past half century. Moreover, the definition of high-risk pregnancy continues to lack true universal acceptance. Thus, continued research in the area of perinatal complications is warranted. There have been studies that have suggested short-term and long-term deficits considered to be secondary to perinatal complications. Psychologists often gather information about a given child's perinatal history, but do not always have means to interpret how those complications may impact the child later in life. The Maternal Perinatal Scale (MPS) has been shown to have good reliability and validity in past studies, but a scoring system has yet to be established. This project consisted of two studies. The first study created a preliminary scoring system for the Maternal Perinatal Scale. This questionnaire has proven to have potential for good clinical utility, but prior to this study, had nothing beyond item-by-item analysis for interpreting the results. To test the validity of the proposed scoring system, a second study was conducted to determine cutoff scores and classification rates for the scoring system on data previously collected with children in elementary school. Results revealed proposed scores for each item on the MPS and classification rates associated with certain developmental disorders later in life.

DEDICATIONS

This dissertation is dedicated to the following people:

- My husband, Dennis Anthony Trammell, Jr., who has given up countless hours to care for our children, listen to me rant, and lift my spirits when I was utterly exhausted through the process.
- My children, Mya Elizabeth Trammell & Mason Anthony Trammell, who provided unconditional love and acceptance, comic relief, and a break from the grind of research and literature reviews.
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CHAPTER ONE

The rate of infant mortality has decreased significantly over the past century from 100 deaths per 1,000 live births in 1900 (MacDorman & Mathews, 2008) to 33.58 per 1,000 in 1958 (Feldstein & Butler, 1965) to 6.89 per 1,000 in 2000 (MacDorman & Mathews, 2008). This decline in mortality represents a direct reflection of advances in medical technology, as well as factors related to more positive maternal health habits, progress monitoring by physicians, and questions from policymakers as to the effectiveness of recently implemented tools and interventions (MacDorman & Mathews, 2008). However, with these advancements, though the number of infant deaths has decreased, the number of infants who survived with increased developmental difficulties has increased (Gray & Dean, 1991). Indeed, the viability of earlier deliveries has improved and the infants who would have otherwise been terminated are now surviving with more severe neurological and neuropsychological abnormalities (Gray & Dean, 1991). These developmental difficulties are argued to be secondary, in part, to perinatal complications (Dean & Davis, 2007). With increasing infant morbidity, despite advances in the medical field, additional research in the area of prenatal and neonatal assessment is warranted.

Although infant mortality is an obvious concern for health professionals, infant and maternal morbidity may be of even more interest to professional psychologists. Morbidity is defined as a diseased state, disability, or poor health outcome (www.mercksource.com, 2010) and is the very focus of many psychological evaluations. As psychologists and health professionals are gathering data about a client's background, prenatal history often is obtained. However, there is often little ability to integrate these data without specific training and experience in the impact of early perinatal events. Thus, collecting these data does not provide any clinical evidence aside from background information. The psychologist and health professional are in need of a more objective method of understanding the impact of those perinatal factors as a group, so as to make more informed diagnoses and more specific treatment plans. The Maternal Perinatal Scale (MPS) was designed to be a short maternal-report measure that illuminates clinically relevant information about their child's perinatal period. The items on the MPS have proven valuable (Dean and Gray, 1985). However, a method is lacking that would allow the integration of items to establish a risk probability. With a validated method of scoring items of the MPS, it could provide far more clinical utility for psychologists in the evaluation and treatment of children with pertinent perinatal information some ten years later.

Perinatal complications have been defined as deviations from normal pregnancy, labor, and/or delivery during the perinatal period (from conception through the first 30 days of life) (Gray & Dean, 1991) or any factor or group of factors in the perinatal environment that would increase the infant's risk of mortality (Prechtl, 1968). These may include abnormal events during pregnancy, pre-existing conditions of the mother,

complications during labor and/or delivery, and any problem after birth, including illness, disease, and abnormal development. In recent decades, with the increase in sophistication of medical technology, perinatal complications are becoming more commonplace in the clinical setting. As mentioned, medical technology has improved the age of viability, allowing for smaller (i.e., lower birth weight, premature) babies to survive. Indeed, there has been a reported nine percent increase from 2000 to 2005 in preterm (less than 37 weeks gestation) babies (MacDorman & Mathews, 2008). Unfortunately, advancements within the field of psychology with regard to understanding and treating the short and long-term effects of the associated complications have had a slower progression. Psychologists and pediatricians alike recognize the importance of abnormal perinatal events but do not have the data or research to describe how these abnormalities affect later childhood development. Furthermore, with an increase in utilization of artificial insemination and in-vitro fertilization, the number of multiple births, particularly in older women, has tended to inflate the trend for smaller babies to be born with increased numbers of coinciding complications (CDC, 2009). The aforementioned changes call for the development of a better tool for understanding those infants' risks of later developmental disorders. Without these data, we are less able to implement effective interventions and treatment plans. This research attempted to refine a measure used to gather data related to this period of life from the mother in a fashion in which a total risk factor could be calculated to make clinical predictions about the possibility of developmental difficulties in childhood.

Before examining perinatal complications, defining a related concept, *high-risk pregnancy*, is warranted. The lack of consistency in the field with regard to who is at risk

or not at risk, low-risk or high-risk, has significant consequences with regard to treatment planning. For example, according to the Merck Manual (2009), there is no universal definition for "high-risk" pregnancies. A more generally accepted description of high risk pregnancy that is provided in the Merck Manual consists of at least one factor that either the woman or baby has that makes them "more likely to become ill or die" around the time of birth as compared to others (www.mercksource.com, 2009). If this factor is absent, a woman may still be considered high-risk if "complications before or after delivery are more likely to occur than usual" (www.merck.com, 2009). High-risk pregnancy also has been defined as one "in which some feature of the maternal environment or reproductive performance in the past represents a substantial risk to fetal well-being" (Goodwin, Dunne, & Thomas, 1969, p. 57). Based on the former definition, it could be argued that all aspects of the pregnancy, including maternal factors, labor and delivery factors, and neonatal, or newborn, factors should be considered when determining if a woman should be treated as high-risk. The latter definition may argue for an assessment of previous maternal history and current pregnancy risk factors in determining risk categories for pregnant women. Creating a valid measure for assessing risk during pregnancy may help to establish a more consistent vocabulary throughout the literature. A measure such as the MPS, that could create a common threshold for risk categories may allow for a user-friendly, empirically-based assessment tool. As such, this measure would increase the accuracy of diagnosis and treatment planning early in the evaluation. The long-standing benefits of appropriate treatment planning are obvious and necessary, particularly with recent changes to the American health care system.

In general, the research of perinatal complications has been approached in one of two ways: retrospectively or prospectively (Molfese, 1989). Research that employs a prospective approach looks at any current factors and examines the risk factors over time or protective factors that contribute to or hinder the development of some such outcome (www.statsdirect.com, 2010). These types of studies often have fewer sources for bias or confounds, though they may be more expensive if they are longitudinal in nature. Retrospective studies, in contrast, entail examining past events or experiences, such as risk factors or protective factors, and considering how they affect a particular outcome that was already established at the onset of the study. Retrospective studies are more susceptible to error due to confounds that may have occurred between the onset of the outcome variable and the first data collection period (www.statsdirect.com, 2010). Both types of research have important use within the field of perinatal complications, and it is not clear which option is the *best* per say. However, based on the expected use of the information, perinatal assessment scales have used one approach or the other. Some scales are intended to provide a relative risk (Dean & Gray, 1985), whereas others are simply to be used as educational tools in conjunction with physician knowledge (Coopland et al., 1966, Goodwin et al., 1977).

There have been studies that have suggested short-term and long-term deficits considered to be secondary to perinatal complications. Research suggests a relationship between perinatal insult and a number of cognitive deficits (e.g., learning disabilities) (Ma, 1996) or motor abilities (Drillien, 1964, Stanton et al., 1991, Werner et al., 1967), and that they also may be linked to a number of common childhood disorders, such as ADHD and autism (Dean & Davis, 2007), and anxiety disorders (Hirshfield-Becker et al.,

2004, Rapee & Szollos, 1997). As a result, over the past decades, there have been numerous intervention programs and educational initiatives to better inform pregnant mothers of the risks associated with certain behaviors (such as drinking alcohol or using drugs during pregnancy). However, it could be argued that these programs have limited success as the mortality rate has remained stable over the past 10 years and morbidity has increased (MacDorman & Mathews, 2008). It should be noted that research in the area of perinatal complications is difficult to conduct for a number of reasons. Primarily, inconsistent results are common because perinatal insults and poor neonatal outcomes are rare, as compared to normal pregnancy and delivery. With small samples, it is not only difficult to find statistical significance, but it is difficult to make generalized predictive statements about later risk. Indeed, a researcher may need to sample hundreds or thousands of women to obtain even a small number of women who experience multiple complications and/or corresponding poor outcomes. For this reason, it was argued here that a population-based study was most appropriate.

Another difficulty related to current assessment of perinatal events is that there is frequently an overlap between the number of symptoms experienced during the perinatal period and the severity of the outcome. Known as a synergistic effect, multiple perinatal complications create increased risk for the mother and/or infant. Goodwin and Reid (1963) reported specific increases in mortality and morbidity based on increasing numbers of complications at birth. As the number of complications increased, the incidence of mortality and morbidity increased dramatically. Additionally, some screening scales use scoring criteria that place those women with higher incidence of complications in a higher risk category (i.e., 0-2 complications = “low risk”, 4-6

complications = “high risk”) (Coopland et al., 1966; Goodwin et al., 1977). The difficulty with this type of scoring system is that it gives all complications the same weight with regard to risk. In other words, a woman who is obese and age 35 (2 complications) would be rated the same as a woman who has diabetes and high blood pressure (2 complications). Though the cumulative score may be the same for both of these women, hypertension and diabetes are far more dangerous to both the mother and fetus. For this reason, weighted scoring systems have been introduced. Many assessment scales use arbitrary scoring guidelines to weight those items that are considered most important with regard to increasing maternal or fetal morbidity or mortality. For instance, advanced maternal age (age 35 years or older) would receive a score of 2 and having diabetes would receive a score of 3. However, this system also has its drawbacks. Primarily, each scale utilizes an arbitrary system to score the measure. Since it is considered arbitrary, each scale developer used whichever method seemed most appropriate; some using 0, 1, 2, 3 points, while others use 0, 5, 10, 20 points per item. For a full review of others’ interpretations of those arbitrary scores see Appendix A. Thus, there is not universal agreement on the weight that each complication substantiates. For this reason, having a more specific risk score that would account for appropriate and inappropriate diagnoses of risk categories is warranted so as to create a more uniform definition of risk during pregnancy.

Identification of the high-risk infant (related to either infant mortality or morbidity) has been proposed by a number of methods in the past several decades. The most common postpartum (after delivery of the child) measurement is that of the Apgar score as introduced by Virginia Apgar (Apgar, 1953). Five domains of functioning are

assessed; including skin color, heart rate, reflex response, muscle tone, and respiration, and given a score between 0 and 2 for each area. A cumulative score is then given at one and five minutes after birth, with a score of 7 and above being within normal limits. The clinical utility of the Apgar scale has been questioned based on the reliability of raters (O'Donnell et al., 2006). Indeed, research suggests a good deal of variability between raters at one minute, perhaps related to hectic conditions in the birthing room, or inexperience in using the Apgar scoring system (Jepson, Talashek, & Tichy, 1991). This makes the five minute score more reliable. Although the Apgar appears to be a good estimate of overall functioning immediately after birth, its utilization to predict later cognitive or behavioral problems is uncertain, as the literature is inconsistent. Some research suggests there is no relationship between low Apgar and later outcomes (Maerin & Paes, 1988), though others report the possibility of a correlational relationship between Apgar and neurological difficulties (Drage et al., 1966; Tenbrink, 1974). One population-based study in Norway suggested significant differences in learning problems, behavioral problems and minor motor difficulties (Moster, Lie, and Markestad, 2002). Another longitudinal study of infants surviving after one- and five-minute Apgar scores of 0 had varying problems, from severe mental retardation and quadriplegia, to normal neurological functioning at 12 years (Haddad, Mercer, Livingston, Talati, and Sibai, 2000). One particular study defining "low" scores as those less than five did not find significant differences between groups and normal controls on later outcomes (Shipe, Vandenberg, and Williams, 1968). However, when scores of less than four were used, more consistent signs of morbidity were found (Odd, Lewis, Whitelaw, & Gunnell, 2009; Odd, Rasmussen, & Gunnell, 2008; Serunian & Broman, 1975). Consequently, three

groupings of Apgar one-, five-, and ten-minute scores have been established to be more universally accepted in the medical community (0-3, 4-6, and 7-10) (Chong & Karlberg, 2004). An Apgar score of 0 to 3 indicates an infant in need of resuscitation; a score of 4 to 6 is considered intermediate; a score of 7 or greater indicates that the neonate is in good to excellent physical condition (www.cdc.gov; Chong & Karlberg, 2004). As suggested by Pasamanick and Knobloch (1960) over five decades ago, there exists a continuum of reproductive casualty whereby although severe perinatal complications cause obvious mortality or neurological problems, those milder events may still cause subtle deficits that are detected when the child is older. Therefore, although the research is still not consistent with regard to the exact relationship of low Apgar scores have on later development, its use as an outcome variable appears to still provide useful information for the clinician working with children from infancy through young adulthood.

The use of the Apgar score to predict developmental disorders in later self-report measures are problematic because of the mother's lack of knowledge of her child's Apgar score. To improve on this, the assessment of neonatal outcome has taken on other forms. These include evaluation of varying times during the perinatal period; during the antepartum (before birth), intrapartum (during labor/delivery), or postpartum periods as completed by the medical staff. Although these may appear to have additional validity because they are gathering more information, there have been inconsistent findings with regard to their predictability of cognitive or behavioral difficulties in infancy and early childhood (Molfese, 1989). Indeed, perinatal complications do not have to be shown to have negative future outcome, but in many cases, this is the expected result.

It is important to understand that, based on items assessed and method of assessment, nearly all perinatal measures are intended to be used by medical professionals, many not bound by psychometric principles. The assessment itself is written using medical terminology with little effort to integrate or share the information with the patient's mother (Molfese, 1989). Although this is likely helpful to medical professionals, for non-medical clinicians, the medical jargon makes is nearly impossible to interpret, let alone integrate as a part of a standard clinical work-up. By using less jargon and more simplified terms, the MPS becomes an option for both medical professionals, pregnant women, and new mothers. Written at a fourth grade reading level (Dean & Gray, 1985), MPS items were found to be easily understood by patients while not being overwhelming or intimidating. In developing the MPS, a preliminary list of reported events during the perinatal period were derived from past research, previously published assessment methods, and clinical experience. These known risk factors were used to create a measure of: (1) perinatal complications, (2) severity of those complications on a continuum, (3) a list of other maternal health factors, and (4) a list of developmental milestones expected of the child during his or her prospective age (Dean & Gray, 1985). Only factors that had been supported by research were included on the scale (i.e. though caffeine intake during pregnancy has been thought to be detrimental, research does not necessarily support this). One notable benefit of utilizing medical staff or medical records is the likelihood for reliability in the responses. When completing a scale by reviewing medical records, one could argue that the information in the patient's medical chart may be more accurate than the patient's recall of her medical history (Dean & Gray, 1985). Herein lies one disadvantage of patient-completed scales. Another

difficulty with scales that rely on patient recall is that there is more opportunity for factitious responding, or simply inaccurate recall of the information. Thus, it may seem less reliable to utilize maternal report. However, accessing medical records is often a daunting task, particularly considering this information is but part of a longer diagnostic interview. So too, for non-medical clinicians, such as psychologists or neuropsychologists, it is unrealistic to expect a review of 10-year-old medical charts when doing psychological assessment or mental health therapy. With a structured questionnaire, the psychologist would be able to obtain valuable information a child's development, albeit the possibility of it being tainted or without some details that may be lost with patient recall. What a simplistic model of assessment lacks in reliability, it makes up for in ease of utilization and swiftness. However, even with this information, the psychologist still lacks the ability to make interpretative statements about the importance of each or all of the endorsed items.

Indeed, as mentioned, there is a synergistic effect of multiple complications that is more complicated than a simple sum of all of the complications. For this reason, it may be necessary to take careful consideration in analyzing total scores. Though it was beyond the scope of this project to discern all the synergism within perinatal variables, it is argued here that an epidemiological approach would help address the natural history of disease etiology.

Epidemiological research by definition is a quantitative science that has its foundation in probability, statistics and research methods (CDC, 1992). The two major objectives of this type of research are to determine the risk factors for the disorder and the prevalence of the disorder (Brinkman, 2004). The relative risk ratio is defined as the

proportion of the disorder in an "exposed" group (in this case, a group of women who have a certain disorder) divided by the corresponding proportion of the disorder in an "unexposed" group (Israni, 2007). Relative risks are often calculated in cohort studies, whereas odds ratios often are calculated in case-control studies (Israni, 2007). The odds ratio is defined as the likelihood of exposure in the group with the condition divided by the likelihood of exposure in the control group (Israni, 2007). For conditions related to perinatal risk, it is important to understand the relative risk and odds ratio so as to make more informed clinical judgments with regard to treatment planning rather than relying on vague descriptions of "high risk."

In summary, currently there are no maternal self-report scales that assess information during the perinatal period and its impact on a child's later development. This information was seen as having the potential to add tremendous clinical utility for psychologists who are evaluating children with academic, social, or developmental difficulties. Though the Maternal Perinatal Scale provides this information, it does not currently allow for further interpretation by the clinician as to the impact that early complications have on later outcomes. By adding a scoring system to the Maternal Perinatal Scale, clinicians will have a tool that will provide risk data that allows them to make treatment recommendations that would facilitate early intervention.

Purpose of the Study

The goal of the present research is twofold. The first study attempted to establish preliminary scoring criteria for the Maternal Perinatal Scale so as to improve its clinical utility. Though the MPS is a good measure of perinatal factors, the only scoring criterion involved item-by-item analysis with no statistical validation of the interpretation.

Furthermore, the item-by-item interpretation requires the clinician to have expertise in the field of perinatal complications; an expertise that is not always present in practicing psychologists. Therefore, the first study utilized population-based data from the CDC birth sample. Since many perinatal complications and poor neonatal outcomes are rare, collecting enough participants in a single sample to identify relationships among variables is difficult. By essentially utilizing the population of babies born in 2006, there was as high a likelihood as possible to capture enough conditions to analyze risk factors for the development of poor neonatal outcomes which are often associated with poor developmental outcomes. This study examined a sample that was almost entirely unbiased with regard to sampling bias, as it was as close to the actual population of interest as was statistically possible. However, this study examined an outcome that was immediately following the child's birth. To better understand the impact that those perinatal events may impact the child's later development, a second study was conducted.

The second study utilized local MPS data as filled out by mothers some five to ten years later. This study aimed to establish the validity of the scoring system as proposed in Study 1. By creating a cutoff score to establish children who are at-risk or not at-risk, the clinician can establish more accurate diagnostic and treatment planning tools. In addition, this added to the body of literature that would offer additional understanding of the specific conditions that place a child at-risk or not at-risk.

Significance

Currently, no standardized scales of perinatal risk created for maternal self-report are available. While it is noted that medical staff are appropriate reporters of such information as perinatal events, it provides very little utility for the practicing

psychologist who is presented with a child who is five or seven years of age. Since psychometric studies of the MPS show good reliability in maternal responses, this could be a reliable tool for obtaining this information. Those instruments that are staff-reported are always completed within the first few days of life, or for the purposes of research. If the MPS could have cutoff scores that have associated risk scores, it could provide substantial clinical utility with regard to understanding impact of early biological events. Furthermore, the MPS is easy to administer and can be completed as part of any standardized psychological or neuropsychological batteries. By using a population-based approach, this will allow more generalized statements to be made about results.

CHAPTER TWO

Review of the Literature

Retrospective Versus Prospective Scales

In general, research of perinatal complications has been approached in one of two ways: retrospectively or prospectively (Molfese, 1989). That research that uses a prospective approach examine the risk factors over time to identify protective factors that contribute to or hinder the development of some outcome (Hess, 2004). Such studies have an increased potential to control for confounding factors, though these studies may be more expensive if they are longitudinal in nature. Retrospective studies, on the other hand, entail examining past events or experiences, such as risk factors or protective factors, and assessing how they affect a particular outcome that has already occurred at the onset of the study. Retrospective studies are more susceptible to confounds and error due to uncontrollable factors that may have occurred between the onset of the outcome variable and data collection period (Hess, 2004). Both types of research have important use within the field of perinatal complications, and it is not clear which option is the *best* per say. However, based on the expected use of the information, developers of perinatal assessment scales have utilized one approach over the other. Some scales are intended to

provide a relative risk (Dean & Gray, 1985), whereas others are simply to be used as educational tools in conjunction with physician knowledge (Coopland et al., 1966, Goodwin et al., 1977).

Complication Scales Versus Optimal Scales

When assessing perinatal information, there are two approaches to interpreting the information obtained; either through compiling the total number of complications or identifying the most optimal situation for healthy pregnancy and outcome (Molfese & Thomson, 1985). Though the type of information that is assessed is similar for both types of scales, the way in which it is scored and interpreted is different. With complication scales, various conditions that may be associated with poor maternal or fetal outcome are measured and weighted according to the severity of the potential impact. In short, conditions well known to have negative impact are weighted higher than those with less impact or inconsistent impact. It should be noted that these weights may differ based on the outcome of interest. In general, with complication scales, higher scores are indicative of higher risk. In contrast, optimality scales have equal weighting whereby any non-optimal element is scored as a 1 and those that are optimal are scored as 0; thus, higher scores are considered less optimal. One optimality scale assigns a one-point advantage for optimal conditions, in which case, higher scores are indicative of more optimal conditions (Prectl, 1968).

Proponents of complication scales would argue that certain aspects of the perinatal period warrant increased weighting due to the increased attention required to maintain maternal and fetal health. In contrast, optimality scales rely on the premise that only mothers in the healthiest conditions would be considered optimal and as a result,

their infants would be the healthiest as well (Molfese & Thomson, 1985). Studies that have evaluated the effectiveness of both types of scales revealed that complication scales have more predictive value than do optimality scales (Molfese & Thomson, 1985). The MPS would be considered a complication scale and its authors believe weighted items are most closely linked with the current research (Dean, personal communication, 2010).

Sensitivity and Specificity

When assessing issues as critical as maternal and perinatal health, measures need to have balanced levels of sensitivity and specificity of the clinical outcome. Generally speaking, sensitivity of a measurement is indicative of its ability to identify certain diseases or conditions (Blackburn, 1986). Highly sensitive measures are often intended for capturing an overall picture of the individuals with a certain outcome. As such, there is a higher possibility of identifying those people who may not actually have the outcome, or result in a false-positive, though nearly all true positives will be identified. Statistically speaking, sensitivity is the number of true positives divided by the sum of true positive and false negative results (Israni, 2007). While this type of screening system is often helpful, it is certainly not helpful in cost reduction or treatment planning when false positives are identified. For this reason, a measure must also be markedly specific. Specificity indicates the accuracy of a measure in diagnosing without giving false-positive results (Blackburn, 1986). Tests that are highly specific are often used as confirmatory tools as the probability of a highly specific test to incorrectly identify a person with a disease who does not truly have the disease is very low. Statistically, specificity is the number of true negative results divided by the sum of true negative and false positive results (Israni, 2007). These principles are inherent in the development of a

relative risk ratio. While some scales utilize arbitrary cutoff scores to identify those women or infants who are at risk, using an odds ratio or relative risk ratio establishes more precise information for the clinician.

Relative risks and odds ratios allow the clinician to have a more precise quantification of the relative risk of developing a condition as opposed to the categorical term "at risk" or "high risk." The relative risk ratio is defined as the proportion of the disorder in an "exposed" group, (in this case, a group of women who have a certain disorder) divided by the corresponding proportion of the disorder in an "unexposed" group (Israni, 2007). Relative risks are often calculated in cohort studies, whereas odds ratios are often calculated in case-control studies (Israni, 2007). The odds ratio is defined as the likelihood of exposure in the group with the condition divided by the likelihood of exposure in the control group (Israni, 2007). For conditions related to perinatal complications, it is important to understand the relative risk and odds ratio so as to make quantitative clinical judgments with regard to treatment planning rather than relying on vague descriptions of "high risk." Computation of the relative risk can be seen below in Table 1.

Table 1

Relative Risk Calculation

	Disorder?		Disorder?	
	YES	NO	YES	NO
(+) response	A	B	A	B
(-) response	C	D	C	D

	Relative Risk	Odds Ratio
	$\frac{A/(A+B)}{C/(C+D)}$	$\frac{AxD}{BxC}$

Antepartum, Intrapartum, and Postpartum Scales

Antepartum assessment.

Antepartum scales offer a unique opportunity to identify risk factors during pregnancy before the child is born. This type of scale is often used to implement appropriate treatment so as to remedy any situations that may cause additional complications of labor and delivery. Scale developers often see this time as opportune because of the ability to monitor the pregnancy at various points (i.e. the scale can be administered at the first visit and subsequent visits to monitor the progression of symptoms). Two published scales are the Antepartum Fetal Risk Scale (Goodwin et al., 1969), the Prenatal High-Risk Scoring Form (Coopland et al., 1977) and the Risk Index (Gomez & Young, 2002).

The Antepartum Fetal Risk Scale (Goodwin et al., 1969) uses a simple scoring technique to identify infants at risk for later complications. It was purported to formulate a cumulative fetal risk score based on three categories including pre-pregnancy data, conditions that developed during the current pregnancy before the onset of labor, and the gestational age of the time of the scale's implementation. The authors indicate the scale should be utilized as an additional tool for physicians when working with high-risk pregnant women. Initially, each item was scored on a scale from 0 to 10 (0 being the most at-risk, 10 being the least at-risk), reportedly chosen as a parallel system to the

Apgar scoring criteria, which continues to be used on a regular basis in the medical setting. Furthermore, Goodwin and colleagues (1969) noted that this scoring criterion was simple and practical, making it user friendly. The final version of the scale assigns an arbitrary score to each item, but each of the 3 categories can also receive a "summary score" of 0 to 3. Table 2 includes all items for consideration on this scale. The scale was used in numerous studies to establish the final scoring system. The authors reported that this scale is not intended to be predictive of infant death or morbidity, but rather an additional tool that could be used by physicians, reportedly residents who may be new to the field (Goodwin et al., 1977).

Table 2

Antepartum Fetal Risk Scale *(Goodwin et al., 1969)*

Baseline data	Score	Obstetric History	Score
Age 35+	1	Abortion	
Age 40+	2	Stillbirth	
Parity = 0	1	Neonatal death	
Parity = 6+	2	Premature infant	
Interval <2 yrs	1	Antepartum bleeding	
Obesity (200lbs+)	1	Toxemia	
Diabetes	2	Difficult midforceps deliv	
Chronic Renal	1	C-section	
w/ decreased	3	Major Congenital anomaly	
Hypertension		Baby 10+lbs	
140+/90+	1	One instance above	1
160+/110+	2	Two + instances above	2
Present Pregnancy			
Bleeding early (no pain)	1	Toxemia I; II	1;3
Bleeding early (w/pain)	2	Eclampsia II	3
Bleeding late (ceased)	1	Hydramnios (single fetus)	3
Bleeding late (continuous)	2	Multiple pregnancy	3
Bleeding late (w/pain)	3	Abnorm glucose tolerance	1
Bleeding late (w/hypotension)	3	Decreasing insulin req.	3
Spontaneous PROM	1	Maternal acidosis	3
Latent period 24 hr +	2	Maternal pyrexia	1
Anemia <10gm Hb	1	Pyrexia + fetal HR >160bpm	2

< 8 gm Hb	2	Rh negative w/ rising titer	2
No prenatal care	2	w/ amniotic fluid	3
< 3 prenatal visits	1		
Gestational Age			
28 weeks or less	4	37 weeks or less	1
32 weeks or less	3	42 weeks or less	1
35 weeks or less	2	43 weeks or less	2

The Prenatal High-Risk Scoring form (PHRS) is a short assessment tool that is completed by medical professionals typically on the first visit and then again at 36 weeks gestation. Based on a simplified version of the Goodwin et al. (1969) Antepartum Fetal Risk Scale, the PHRS obtains information within four categories including reproductive history, associated conditions, present pregnancy, and outcome. The latter category was developed to identify specific outcomes associated with factors. However, developers note the scale is intended to be a simple educational tool to assist professionals in their treatment rather than a predictive tool for specific outcomes. Each item is associated with an arbitrary risk score within the range of 0 to 3 with higher scores representing greater risk. There are proportionally more high scores (2 & 3) in Category III, the present pregnancy, so as to skew the importance of present risk factors. A sum of the item scores yields a total score that is then given a descriptive label of "low-risk" (0-2), "high-risk" (3-6), or "extreme-risk" (7+). Developers identified these cutoff scores by evaluating perinatal mortality. Authors reported risk scores between 3 and 6 were associated with twice the likelihood of infant mortality than overall average mortality at the hospital where the data was collected; risk scores > 7 associated with more than 5 times the likelihood compared to hospital average (Coopland et al. 1977). Indeed, the authors noted the importance of maintaining clinical judgment when using that scale, as some women

with particularly remarkable obstetric history may have elevated risk scores, though may not necessarily be at "extreme risk;" thus interpretation of the scale should always be used in conjunction with good clinical judgment. Validity of the scale was developed based on 5459 patients at the University of Manitoba hospitals. Risk scores were analyzed based on their relations to Apgar scores, birth weight, prematurity, and intensive care needs. All risk scores associated with the aforementioned outcome variables in a way that the increased score was indicative of more problematic outcomes (i.e., the higher the risk score, the lower the Apgar; the higher the risk score, the lower the birth weight). A compiled list of the items on the scale is listed in Table 3.

Table 3

Prenatal High-Risk Scoring Form *(Coopland et al. 1977)*

I: Reproductive History		Score	II: Associated Conditions		Score
Age	<16	1	Previous Gyn surgery		1
	16-	0	Chronic Renal disease		2
	>35	2	Gestational diabetes		1
Parity	0	1	Diabetes mellitus		3
	1-4	0	Cardiac disease		3
	5+	2	Other medical disorder		1-3
Past OB history			III. Present Pregnancy		
Habitual		1	Bleeding	<20	1
PPH/manual		1		>20	3
Baby 9lbs+		1	Anemia		1
Baby 5.5-		1	Prolonged Preg (42 wks		1
Hypertension		1	Hypertension		2
Previous C-sect		1	Premature Rupt of		2
Stillbirth		1	Polyhydramnios		2
Prolonged labor		1	Small for date		3
			Multiple pregnancy		3
			Breech		3
			Rh isoimmunization		3

The Risk Index (RI) as proposed by Gomez and Young (2002) also is considered an antenatal scale that was developed to predict the incidence of low birth weight, low Apgar scores, and the probability of cesarean delivery. The RI contains 63 items that were each given a specific weight (1, 2, 3, or 6) based on the clinical severity of the condition. Based on responses from 782 pregnant women, a threshold of 6 was established, and sensitivity and specificity of the measure were reported. Authors then applied sensitivity and specificity analysis of regression models used by other authors (Holst et al., 1990) and determined the RI had nearly as much statistical girth and substantially more clinical utility than the regression equation. Though promising, the RI only assesses outcome measures related to low birth weight, low Apgar, and cesarean delivery. A more thorough exploration of other outcomes is necessary to further these implications to be even more clinically relevant.

Some authors find significant benefits in only assessing the antepartum period. Goodwin and colleagues (1977) contended that identifying high-risk pregnancies is a critical component to saving the unborn child from impending difficulties during labor and/or delivery. Another benefit to antepartum assessments is the ability to monitor the pregnancy by administering this assessment at a number of points throughout the pregnancy (Coopland et al., 1977). This type of monitoring is commonplace in the medical field for other illnesses and/or conditions, particularly during pregnancy. Each obstetrical visit during the pregnancy entails regular urinalysis and intermittent physical examinations. Thus, it could be argued that progress monitoring is important to the well-being of both mother and baby. However, though it is not argued here that the antepartum period is not important, it is argued that it is not the only important aspect of neonatal

outcome (i.e. complications of labor and delivery should also be considered). If the underlying goal of any assessment tool is to ensure the health of the pregnant mother and neonate, it seems remiss to ignore other aspects of information; particularly that information that is related to the labor and delivery, and immediate health of the newborn. Indeed, there have been a number of other scales that have examined other aspects of perinatal risk, including intrapartum and combination scales.

Intrapartum Assessment.

Though fewer, there are also scales that assess the period that entails labor and delivery as a means to evaluate the outcome of the mother and baby. In general, these scales are often used in combination with other types of information-gathering tools, such as antepartum assessments, or clinical observations. As mentioned, the main advantage of antepartum assessment is that physicians are able to manage treatment planning more appropriately if they are alerted to possible complications that may arise later in the pregnancy or during labor and delivery (Coopland et al., 1977). In the same sense, intrapartum assessment would enable physicians to provide better intrapartum care, with the ability to make more informed decisions during an already swift and intense time that is labor and delivery. Proponents of intrapartum assessment claim that though intrapartum factors are not always informative of mortality indicators, conditions that are present during labor may further complicate delivery. Thus, having this information available from intrapartum assessment will better prepare physicians for events that would otherwise be unbeknownst to them. For instance, prolonged labor, particularly in the second stage, may put a mother at higher risk of operative delivery. To aid physicians

in making the most informed decision, Morrison and colleagues (1980) and Aubry and Pennington (1973) developed intrapartum assessment scales.

Morrison and colleagues (1980) developed the Intrapartum Screening Scale as a means to combat the criticism that intrapartum assessments do not provide information in a timely manner so as to allow doctors to make changes that would affect maternal or fetal outcome. Other intrapartum scales may include such events as prolapsed cord, problems with anesthesia or shoulder dystocia; however, these events happen so late in the intrapartum period that it would be nearly impossible to implement changes in the treatment plan. In their study, authors aimed to also understand the amount of time that may be available for to alter management of the patient, once she is evaluated to be at risk. In their assessment of 1,999 mothers in Winnipeg, Canada, the authors evaluated 12 factors that could be evaluated early in labor so as to have the choice of intervention as it became appropriate. Table 4 represents those items assessed on the Intrapartum Screening Scale and the associated arbitrary score. In studying perinatal deaths, morbidity and maternal morbidity, authors created an arbitrary division between mothers who would be “high risk” and “low risk” that is parallel to previous scales (Coopland et al., 1977). Morrison and colleagues used this arbitrary division to predict outcome. Though there were a small number of neonatal mortalities, the intrapartum score predicted 87% of the cases correctly. In terms duration, more than 60% of abnormal outcomes were admitted to the hospital for more than 6 hours. This could arguably be enough time for physicians to make adjustments to the treatment plan to produce better outcomes. Though authors may have achieved simplicity of this scale at predicting poor

outcomes, more thorough research, with increased incidence of these outcomes, is required to make general comments about the utility of intrapartum scales in isolation.

Table 4

Intrapartum Screening Scale (*Morrison, Carter, McNamara, & Cheang, 1980)*

Labor	Score
Labor greater than 20 hours	2
Slow latent phase progress (defined as <3cm dilated with contractions for 10 hours)	1
Slow active phase progress (defined as "no progress or <1.5cm dilated in 2 hours)	2
Meconium in the first stage (dark, fresh, heavy)	4
Meconium in the first stage (light, old staining)	1
Associated conditions	
Gestation <34 weeks	3
Premature rupture of membranes >24 hours	2
Syntocinon induction or augmentation of labor	2
Miscellaneous	
Height: <5 feet, 2 inches	1
Weight: <100 pounds or >200 pounds	1
Smoking (current): >20 to 25 cigarettes per day	1
Ethnicity: American Indian	1

In response to what they considered significant societal problems, Nesbitt and Aubry (1969) developed the Maternal-Child Health Care Index (MCHCI). They believed that health care was not being applied to the appropriate to the level of care needed, nor was the health care dollar being applied to those who were the most severely in need. The MCHCI was intended to address all of these concerns by creating a more objective scale that could assist clinical judgment. Factors included on this scale include previous obstetric history, age, parity, nutrition, emotional, social and economic variables. Items were given an arbitrary score based on previous research and clinical experience. Endorsed items are scored and subtracted from an arbitrary perfect score of 100. A score

of greater than 70 is considered acceptable, which scores below 70 considered “failing” an arbitrary cut-off created by the authors. Later studies indicated scores between 70 and 85 were considered moderate risk, and those below 70 were high risk. Scores above 85 were considered normal (Aubry & Pennington, 1973).

Data were collected on 1000 women at Upstate Medical Center in New York beginning in 1964. Analyses were conducted based on the patient’s passing score (greater than 70) and the outcome. Authors reported that only 29% of the patients were categorized “at risk.” This was disconcerting because patients were already more at risk than their counterparts who attended private hospitals and clinics. As such, authors collected additional data adding a questionnaire that assessed events of labor and delivery. The Labor Index, as it was called, included items such as prenatal care, toxemia, diabetes, anemia, vaginal bleeding, gestational age, and meconium staining, among others. The Labor Index also was given an arbitrary perfect score of 100 and so when the two scales were used in combination, a perfect score is considered 200 with a failing score being less than 150. Authors then collected data on 450 women from both the aforementioned hospital, as well as private hospitals in the area so as to minimize the aforementioned limitation. Results were more consistent with hypotheses in that women with failing scores had higher rates of prematurity, low birth weight, neonatal depression and respiratory distress syndrome. However, when both scores were added together, the relative risk became even more elevated suggesting importance of both the prenatal period and intrapartum period information be assessed and evaluated. Items from the MCHCI are listed in Table 5.

Table 5

Maternal-Child Health Care Index *(Nesbitt and Aubry, 1969)*

		Score			Score
Age	<15	20	Race & Marital Status	White	0
	15-19	10		Nonwhite	5
	20-29	0		Single	5
	30-34	5		Married	0
	35-39	10	Past abortions	1	5
	40+	20		2	15
Parity	0	10		3+	30
	1-3	0	Past premature births	1	10
	4-7	5		2+	20
	8+	10	Past fetal deaths	1	10
				2+	30
			Past neonatal deaths	1	10
				2+	30
			Previous cong. Anomalies	1	10
				2+	20
			Previous damaged infants	Physical	10
				Neuro	20

Combination Scales

The High Risk Pregnancy Screening System (HRPSS; Hobel, Hyvarinen, Okada, & Oh, 1973) is an assessment of the prenatal period, as well as intrapartum and postpartum periods. The HRPSS contains 51 items pertaining to the prenatal period, 40 items related to labor and delivery, and 35 factors related to the neonate. Each item was assigned a value of 1,5, or 10 based on previous studies and personal experiences of the scale developers. The prenatal and neonatal sections can be administered once or at multiple points, with the final score being an average of the total number of administrations. The intrapartum score is a cumulative score at the time of delivery. The arbitrary cutoff score of 10 was established to allow for group membership of 725 women in either a low risk or high-risk group based on prenatal and intrapartum scores. These groups were then assessed to understand the importance in assessing the prenatal period,

the intrapartum period, or both in combination. Findings suggest prenatal information alone is an important predictor of neonatal morbidity; however the addition of intrapartum information creates more predictive power of the scale (Hobel et al., 1973). Additionally, the authors performed a regression analysis to predict length of infant stay in the hospital following birth complications and reported that "actual scores are more predictive of risk than are dichotomized scores." (Hobel et al., 1973, p. 8). Therefore, detailed scores provide more predictive information than a dichotomous category, arguing for specific risk ratios rather than categorizations such as "high risk," "medium risk," or "low risk," as are commonplace in previously published scales. The HRPSS has been validated in various studies (Baruffi et al., 1984; Sokol et al., 1975) and it was later changed to the Problem-Oriented Perinatal Risk Assessment System (POPRAS) that is still used in medical settings and available for purchase on the internet. Table 6 represents those items include on the HRPSS.

Table 6

High Risk Pregnancy Screening System (*Hobel, Hyvarinen, Okada, & Oh, 1973)*

Prenatal factors	Scor		Score
Cardiovascular & renal		Metabolic	
Moderate to severe	10	Diabetes	10
Chronic hypertension	10	Previous endocrine	10
Moderate to severe renal	10	Thyroid disease	5
Severe heart disease	10	Pre-diabetes	5
History of eclampsia	5	Family history of diabetes	1
History of pyelitis	5	Anatomic abnormalities	
Mild toxemia	5	Uterine malformation	10
Acute pyelonephritis	5	Incompetent cervix	10
History of cystitis	1	Abnormal fetal position	10
Acute cystitis	1	Polyhydramnios	10
History of toxemia	1	Small pelvis	5
Previous histories		Miscellaneous	
Prev. fetal Rh transfusion	10	Abnormal cervical	10
Stillbirth	10	Multiple pregnancy	10
Post-term >42 wks	10	Sickle cell disease	10
Premature infant	10	Age >35 or < 15 yrs	5
Neonatal death	10	Viral disease	5
C-section	5	Rh sensitization only	5

Habitual abortion	5	Positive serology	5
Infant >10 lbs	5	Severe anemia	5
Multiparity 5+	5	Excessive use of drugs	5
Epilepsy	5	Weight <100 or >200 lbs	5
Fetal anomalies	1	Pulmonary disease	5
		Vaginal spotting	5
		Smoking >1 pack per day	1
		Alcohol (moderate)	1
		Emotional problem	1
Intrapartum factors			
Moderate to severe	10	Hydramnios	10
Amnionitis	10	Uterine rupture	10
Mild toxemia	5	PROM >12 hrs	5
Primary dysfunctional	5	Secondary arrest of	5
Demerol >300mg	5	Labor >20 hrs	5
Clinical small pelvis	5	Second stage >2 ½ hrs	5
Medical induction	5	Precipitous labor <3hrs	5
Primary C-section	5	Repeat C-section	5
Elective induction	1	Prolonged latent phase	1
Uterine tetany	1	Pitocin augmentation	1
Placenta previa	10	Abruption placentae	10
Post-term >42 wks	10	Meconium stained	10
Marginal separation	1	Meconium stained	5
Abnormal presentation	10	Multiple pregnancy	10
Fetal bradycardia >30min	10	Breed delivery	10
Prolapsed cord	10	Fetal weight <2,500g	10
Fetal acidosis	10	Fetal tachycardia >30min	10
Operative forceps or	5	General anesthesia	5
Outlet forceps	1	Shoulder dystocia	1
Neonatal factors			
General		Respiratory	
Prematurity <2,000gm	10	Respiratory distress	10
Apgar (5min) <5	10	Meconium aspiration	10
Resuscitation at birth	10	Congenital pneumonia	10
Fetal anomalies	10	Anomalies of respiratory	10
Dysmaturity	5	Apnea	10
Prematurity <2,000-	5	Other respiratory distress	10
Apgar (1min) <5	5	Transient tachypnea	5
Feeding problem	1	Metabolic disorders	
Multiple birth	1	Hypoglycemia	10
Cardiac & Central Nervous		Hypocalcemia	10
Major cardiac anomalies	10	Hypo/hypermagnesemia	5
CHF	10	Hypoparathyroidism	5
Persistent cyanosis	5	Failure to gain weight	1
Minor cardiac anomalies	5	Jitteriness with specific	1
Murmur	5	Hematologic problems	
CNS depression >24hrs	10	Hyperbilirubinemia	10
Seizures	10	Hemorrhagic diathesis	10
CNS depression <24hrs	5	Chromosomal anomalies	10
		Sepsis	10
		Anemia	5

Littman and Parmelee (1978) introduced the Obstetric Complications Scale (OCS) as a means to assess the prenatal, intrapartum and postpartum periods. An additional assessment tool developed and used by Littman and Parmelee, the Pediatric Complications Scale, assesses the infant through the second year of life. The OCS would be considered an optimal scale rather than a complication scale. As a result, when administering the scale, one would endorse items on a dichotomous scale (i.e. either they have the condition or they do not). The OCS contains 41 items relating to maternal history and prenatal factors, and labor/delivery factors, as well as 10 postnatal items. Each item had an equal weight of 0 or 1 and scores were obtained by summing the number of items endorsed and subtracting from the total items. Specific items are listed in Table 7. On the OCS, higher scores indicate more optimal conditions, or fewer complications. Participants included 126 preterm infants, defined as gestation less than 37 weeks, with findings that infants with increased numbers of complications during the perinatal period performing worse on measures at 2 years of age (Littman & Parmelee, 1978). Though this measure is relatively short and has simplistic administrative procedures, this does not account for a continuum-type of complication that is generally created in clinical practice. For instance, birth weight is considered optimal (receiving a score of 1) if it is 2,500 grams, or 5.5 pounds and non-optimal (receiving a score of 0) if it is less than 2,500 grams. This becomes problematic when birth weight is seen more as a continuous variable, such as low birth weight infants (between 1,500 and 2,500 grams) have fewer problems than very low birth weight infants (less than 1,500 grams) (Schieve et al., 2002), though on this scale they receive the same score. Similar problematic

variables may be gestational age and bleeding during pregnancy. Therefore, though simplistic, it may lack the specificity necessary for more acute situations.

Table 7

Obstetric Complications Scale *(Littman & Parmelee, 1978)*

	Optimal (1)	Non-Optimal (0)
Gestational Age	>37 weeks	<37 weeks
Birth weight	2,500 grams	<2,500grams
Marital status	Married	Other
Maternal age	18-30	Other
Previous abortion	2 or fewer	3 +
Previous premature births	No	Yes
Previous stillbirths	No	Yes
Prolonged unwanted sterility	No	Yes
Length of time since last pregnancy	>12 months	<12 months
Parity	1-6	0 or 7 +
Pelvis	Proportional	Disproportional
Rh antagonism or other blood incompatibility	No	Yes
Bleeding during pregnancy	No	Yes
Infections or other medical probs	No	Yes
Drugs or medications	No	Yes
Maternal chronic diseases	No	Yes
Chronic drug abuse	No	Yes
Blood pressure during pregnancy	< 140/90	>140/90
Albuminuria	No	Yes
Hyperemesis	No	Yes
Hemoglobin level at end of pregnancy	>10	<10
Twins or multiple birth	No	Yes
PROM	0-12hrs	>12 hrs
Delivery	Spontaneous	Other
Forceps	No	Yes
Duration first stage	3-20hrs	<3 or >20hrs
Duration second stage	10-120min.	<10 or >120min
Induced labor	No	Yes
Drugs during labor/delivery	No	Yes
Amniotic fluid	Clear	Other
Fetal presentation during delivery	Vertex	Other
Fetal heart rate during labor	100-160bpm	<100 or >160bpm
Knotted cord	No	Yes
Cord prolapsed	No	Yes
Placental infarction	No	Yes
Placenta previa or abruption	No	Yes

Onset of stable respiration within 6 min	Yes	No
Resuscitation required	No	Yes
Prenatal care during 1st half of pregnancy	Yes	No
Apgar (1min)	7-10	Other
Apgar (5min)	7-10	Other

Prechtl (1967) was one of the frontrunners with regard to developing a scale based on optimality rather than on complications during the perinatal period. In his research, Prechtl identified variables in the obstetric history, prenatal and intrapartum periods that would be considered optimal versus non-optimal. He reported on 10 variables that were the most frequently occurring non-optimal events including: maternal age greater than 30 years, moderate or severe toxemia, non-vertex presentation, non-spontaneous delivery, prolonged labor in the first or second stage, cord around the neck, fetal bradycardia, or post-partum apnea (Prechtl, 1967). Based on data collected from 1,515 infants at Groningen University Hospital in the Netherlands, Prechtl developed a scale with 42 items grouped into 3 categories: maternal factors (20 items), parturition (8 items) and fetal factors (12 items). All items are scored as 1 (non-optimal) or 0 (optimal) with cutoff scores set at 0-1 non-optimal conditions to be considered "low risk," 2-6 considered "medium risk" and more than 7 non-optimal conditions to be considered "high risk." Table 8 shows the items on Prechtl's scale. Though the author would argue that weighting of items occurs naturally (i.e. generally these conditions do not happen in isolation), it does not seem to account for the variability of severity of each item that is present. It is argued here that optimality scales do not include enough emphasis on the importance of each individual factor's impact on perinatal outcome.

Table 8

Prechtl, 1968

Maternal factors	Optimal (0)
Maternal age primipara	18-30 years
age multipara	20-30 years
Marital status	Married
Parity	1-6
Abortions in history	0-2
Pelvis	Proportionate
Luetic infection	Absent
Rh antagonism	Absent
Blood-group incompatibility	Absent
Nutritional state	Well nourished
Hemoglobin level	70 +
Bleeding during pregnancy	Absent
Infections during pregnancy	Absent
Abdominal x-rays during pregnancy	No
Blood pressure	<135/90
Toxemia	Mild/absent
Edema and albuminuria	Absent
Hyperemesis	Absent
Psychological stress	Absent
Prolonged unwanted sterility (2yrs+)	Absent
Maternal chronic diseases	Absent
Parturition	
Twins or multiple	No
Delivery	Spontaneous
Duration 1st stage labor	6-24 hours
Duration 2nd stage labor	10min – 2 hrs
Contractions	Moderate/strong
Drugs given to mother	Oxygen/local anesthesia
Amniotic fluid	Clear
Membranes broken	<6hrs
Fetal factors	
Intrauterine position	Vertex
Gestational age	38-41 weeks
Fetal presentation	Vertex
Cardiac regularity	Regular
Fetal heart rate (2nd stage)	100-160bpm
Cord around neck	No or loose
Cord prolapsed	No
Knot in cord	No
Placental infarction	No or small

Onset respiration	Within 1 min
Resuscitation	No
Drugs given	No
Body temperature	Normal
Birthweight	2,500-4,990 gm

Understanding the Maternal Perinatal Scale (MPS)

The Maternal Perinatal Scale (Dean & Gray, 1985) is a self-report measure that was developed to ascertain the relative risk associated with various perinatal complications in the development of cognitive, psychological, and/or behavioral impairments. It assesses the ante-, intra- and postpartum aspects of risk-related complications, thus considered a combination scale here. The idea of the relative risk ratio is based on correlational data, which does not allow for statements of causation, but does provide the ability to make predictions about possible outcomes. In developing the MPS, a preliminary list of variable to be addressed were derived from reviews of the research literature, already published assessment tools, and clinical experience. These known risk factors during the perinatal period were created to assess a list of perinatal complications, the severity of those complications on a continuum, a list of other maternal health factors, and a list of developmental milestones of the child in question. Only factors that had been supported by research were included on the scale (i.e. though caffeine intake during pregnancy has been thought to be detrimental, research does not necessarily support this). A complete list of factors assessed is shown in Table 9. Items were constructed in a 'multiple choice' type format, so as to utilize mothers' ability to recognize critical information as opposed to recalling it. This format was employed so as to increase the reliability of mothers' responses, as well as increase the utility of the

measure (it could be given longer after the delivery with few concerns of memory lapse).

Table 9

Factors assessed by the Maternal Perinatal Scale

Mother's weight and height	Weight gain
Mother and father's race	Mother's age at time of birth
History of problem pregnancy	First consulted physician
Father's height	Induced labor
Number of prior births	Forceps use
Vaginal bleeding	Pregnancy planning
Anesthesia employed during birth	Multiple pregnancy (twins, triplets)
Child's birth weight	Medication and vitamin use during pregnancy
Amount of maternal psychological stress	Presentation of infant during delivery
Months to term	Time from water break to labor
Length of labor	Child's color at birth
History of gynecological surgery	Edema
Cigarette smoking during pregnancy	Maternal medical conditions
Alcohol consumption during pregnancy	

In terms of the scale's development, the MPS has undergone a number of psychometric studies to estimate the validity and reliability of the scale. After a preliminary draft of items was completed, it was reviewed by obstetricians, pediatricians, obstetric nurses and five mothers to ensure readability and medical consistency. The final version of the MPS included 46 items; 25 that relate to information about the pregnancy, birth, and early life of the child (i.e., vitamin use during pregnancy, forceps use, birth weight), and 21 that relate to specific medical conditions that occurred just prior to or during the pregnancy. A series of studies was then conducted to assess the reliability and validity of the instrument.

The first study (Gray, 1987) examined test-retest reliability as mothers completed the MPS and then completed it again two days later. Internal validity was established based on 41 mothers with a mean chronological age of 34.98 (SD = 7.41) whose children were 7.95 years old on average (SD = 6.96). Most women were middle class with two or more prior births. Of the 18 items that were thought to be placed on a continuum (i.e. length of labor), a standard Pearson Product Moment Correlation was calculated. Correlations ranged from 1.00 to .85 and exhibited stability over time as well. Cramer's V coefficient was used to examine 29 of the items that were nominal (i.e. type of anesthesia used) with similar results; coefficients ranging from 1.00 to .86. To develop an understanding of the predictability of the MPS in relation to previous research, inter-item correlations were developed. Finally, an internal consistency coefficient (alpha coefficient) was calculated to be .56. Based on the range of information elicited by the MPS (pregnancy, labor, delivery, and neonate period), it is not expected to have high consistency.

Study 2 (Gray, 1987) consisted of a validity check that compared maternal responses with hospital charts. This is a critical component of the self-report format of the questionnaire. Participants of this study included 50 women who completed the MPS 24-96 hours postpartum, with a mean chronological age of 27.29 (SD = 4.32), consisting mostly of lower and low average class Caucasians. Results indicated significant ($p < .05$) agreement between mother's responses and hospital chart information. Correlation coefficients ranged from 1.00 to .42, with more than 90% of the validity estimates were greater than $r = .90$. The only question that became problematic with regard to inconsistency was the item pertaining to the color of the infant after birth (correlation <

.70). This may be explained by the mother's lack of awareness or lack of information about the exact color of the child after birth or inconsistency in reporting this information in the hospital chart.

A third validity study (Gray, 1987) examined the cardiopulmonary condition of the infant as a predictor of Apgar scoring criteria. Participants for this study were the 50 corresponding infants to the mothers in Study 2. Multiple regression analyses were performed using all items from the perinatal scale to predict each of the five items assessed by the Apgar score (heart rate, respiration, muscle tone, reflexes and color). Analyses were conducted in stepwise fashion to identify the most salient factors for each of the five Apgar items. Furthermore, those five Apgar items were then collapsed into 1- and 5-minute Apgar scores. Results revealed that some 70% of the total variability of 1- and 5-minute Apgar scores could be predicted by three factors on the MPS including presentation of the fetus, vitamin use, and fetal alcohol exposure.

A fourth validity study (Gray, 1987) during the MPS development examined the ability of the MPS to differentiate between children with developmental disabilities and normal children. Developmental delay was defined as IQ < 70. Participants included 117 children with developmental disabilities and 146 normal controls with a mean age of 12.09. Stepwise discriminant analysis was performed, producing one discriminant function. Chi square transformation was significant ($p < .001$) with 16 items found to be significant possible predictors. The overall correct prediction of group membership from this one discriminant function was 81.71%.

The MPS is completed by mothers or by individuals who have extensive knowledge of the birth and delivery of the child. It is expected that this will be completed

within at least five years after birth, but has been shown to have good reliability up to 10 years after birth (Dean & Gray, 1985). As such, no particular administration qualifications are required. It would likely be helpful if the person administering the MPS were somewhat familiar with symptoms of perinatal complications so as to answer any questions that may arise for the mother, but this is not a requirement. Directions for completing the MPS are included on the first page. The MPS can be read aloud to the mother or can be completed independently based on the mother's comfort level and reading ability. The MPS is written so that it can easily be read by an individual with a fourth grade reading level. Items containing medical terminology that may be unfamiliar to the informant may be explained prior to completion of the assessment or during the assessment if necessary. During administration, it should be explained to mothers that the MPS was developed to obtain a better understanding of how difficulties during pregnancy and/or delivery may impact the child later in life, and the likelihood (relative risk ratio) that this may occur. Parents are first asked to complete a short section on demographic information. After reading the directions noted in the first section, mothers may then proceed to the remainder of the items. Mothers should be reminded to answer every question honestly and to the best of their ability. Completion time is typically less than 20 minutes.

The major limitation to the MPS is the lack of standardized scoring procedures. Current interpretation of scores on the MPS are such that, the higher the score, the higher the risk for cognitive, physical or behavioral problems. This does not relate directly to say that there is a causal relationship, but rather there is a clear relationship between the development of problems later in life with a higher score. While this does not implicate

any one particular factor to increase the risk of any specific problem in isolation, there are some factors that are closely related to the development of specific deficits in functioning (i.e., low birth weight and lower cognitive functioning, etc.). Although this does provide additional information to the clinician, it is tedious and time-consuming to look item-by-item, and unlikely to be implemented appropriately on a regular basis. The scale has also been studied through factor analysis to develop correlations between items that may then be used to better understand the interpretation of the scale (Dean, Gray, & Anderson, 1996). However, this analysis yielded 10 factors, thus not really adding any clinical utility to the scale. The final page of the MPS is a collection of possible dependent variables and need not be included in this study. Also, for the purposes of this study, the first 25 items that pertain to the pregnancy, labor and delivery will be included in the analysis.

Perinatal Complications

The variables to be measured in the present study were those consistent with the variables in the MPS. The following is an examination of each variable as it is described in the literature.

Maternal characteristics.

Maternal age. One of the most commonly studied maternal variables in relation to its effect on newborn development is that of maternal age. With changes in the workforce over the past 60 years, more women are waiting to begin having children until later in life. Indeed, since 1990, the number of women having children after age 35 has increased by 57% and women having children over 40 has increased by over 200% (National Vital Statistics System, 2006). Though results are not always consistent, most

researchers have found advanced maternal age to be correlated with low birth weight (Cnattigius, Forman, & Berendes, 1993; Jolly et al., 2000; Morrison, 1975) and prematurity (Kessler et al., 1980; Jolly et al., 2000; Morrison, 1975). Others have also studied the impact that age has on small for gestational age (SGA) effects, finding a negative correlation (Cnattigius, Forman, & Berendes, 1993; Prysak, Lorenz, & Kisly, 1995). However, it is still unclear how much impact maternal age in isolation has on the mortality of the child. Indeed some research has failed to find significance when controlling for other factors, such as SES (Seidman et a., 1990). Advanced maternal age has also been associated with increased risk of cesarean delivery and instrumental delivery (Ezra, McParland, & Farine, 1995).

It is not only advanced maternal age that is of importance to fetal outcome. Undeniably, early maternal age can also be problematic for prenatal and perinatal factors. Teenage pregnancy (age < 18) has become less prevalent over the past two decades, dropping over 20% since 1990 (National Vital Statistics System, 2006) and now constitutes only 6% of all pregnancies. However, the infant mortality rate is over 1.5 times higher for women under age 20 than any other age group (National Vital Statistics System, 2006). So although teenage pregnancy has decreased and now represents a smaller portion of the total pregnancies, it still represents a disproportionally high number of infant deaths. Teenage pregnancy is associated with pre-term delivery, low birth weight, and low Apgar scores (Chen, Wen, Flemind, Demissie, Rhoads, & Walker, 2007). In addition, it is also clear that nutrition for pregnant adolescents be closely monitored as competition for nutrients between a pubescent mother and her developing fetus can have negative affects for both organisms (Lenders, McElrath, & Scholl, 2000).

The vast majority of perinatal assessments recognize the importance of maternal age in understanding perinatal risk; generally finding the most favorable outcome to be for women aged 20-29 (Brazie et al., 1976; Coopland et al., 1977; Dean & Gray, 1985; Goodwin et al., 1969; Hobel et al., 1973; Littman & Parmelee, 1978; Merck Manual, 2009; Nesbitt & Aubry, 1969; Prectl, 1968). Generally speaking, pregnancy before age 15 is recognized as a risk factor, as is pregnancy over the age of 35 (Brazie et al., 1976; Coopland et al., 1977; Dean & Gray, 1985; Hobel et al., 1973; Littman & Parmelee, 1978; Merck Manual, 2009; Nesbitt & Aubry, 1969; Prectl, 1968). As it appears, maternal age is an important variable that should be assessed when one does an investigation of later developmental outcomes.

Maternal weight gain. Maternal weight gain during pregnancy is a direct reflection of many facets of overall maternal health. Maternal, or gestational, weight gain is considered any amount of weight accumulated from conception to delivery. Though most times, studies evaluate total gestational weight gain as a predictor of specific outcomes (Althuizen et al., 2009; DeVader et al., 2007), some have completed research that explores the impact of weight gain at varying stages of the pregnancy. For instance, early maternal weight gain, defined as weight gain in the first trimester, is associated with higher weight retention postpartum and higher total weight gain (Olafsdottir, 2006). In a similar fashion, lower weight gain during the latter half of pregnancy is associated with fetal growth retardation and subsequent low birth weight infants (Muscati, Gray-Donald, & Koski, 1996). Thus, it is important to recognize that total weight gain and the timing of that weight gain may both be important variables to predict perinatal complications.

According to the Institute of Medicine (IOM; 1996), there are guidelines established about the recommended amount of weight gained based on the mother's weight and height ratio (also known as body mass index). The range of weight gain recommended is contingent on the mother's prepregnant weight with underweight women being encouraged to gain more weight than obese women. Table 10 offers the IOM (1996) recommendations. Women who deviate from these recommendations are at risk for a variety of perinatal complications. Less than ideal weight gain is associated with low birth weight, particularly in already underweight mothers (IOM, 1996). On the contrary, high maternal weight gain is associated with macrosomia, cesarean delivery and preterm delivery (IOM, 1996). Based on the rising trends of obesity in the U.S., and the prevalence of higher weight gains, gestational weight gain is an increasing health concern in this country. Even more so a concern when considering the prevalence of increased weight gain is most common in low SES, minority women (IOM, 1996) who are already at higher risks of perinatal problems such as decreased prenatal care, poor nutrition, lower folic acid intake (Fowles & Fowles, 2008). Since obesity in general is also highly correlated with other medical and emotional disorders that can impact perinatal complications, continuing to address this problem in the research is imperative.

Table 10

IOM Recommendations for Weight Gain during Pregnancy

Weight	Prepregnancy BMI	Total Weight Gain (lb)
Underweight	<19.8	28–40
Normal weight	19.8–26.0	25–35
Overweight	> 26.0–29.0	15–25

Obese	>29	At least 15

Pre-pregnancy weight.

Although weight gain during pregnancy is important, the mother's weight immediately prior to the pregnancy also has lasting impact on the perinatal period and beyond. Typically, normal weight trends are monitored by the use of the body mass index (BMI), calculated as the division of weight versus height. According to the Institute of Medicine (IOM; 1996), the following terms are given based on maternal BMI: the term *underweight* is given to those women with a BMI of less than 19.8, *normal* weight is established as BMI between 19.8 and 26.0, *overweight* is defined as BMI between 26.0 and 29.0, and *obese* is defined as BMI greater than 29.0. Though low BMI and high BMI rarely occur in isolation (i.e., there are not other risks factors as well), maternal weight is associated with varying degrees of complications based on the gravity of the weight distribution from the norm.

Low BMI is often associated with other substandard conditions during pregnancy as well as specific complications during the perinatal period. In general, the lower the BMI, the more likely she is to be undernourished (IOM, 1996). In addition, low maternal weight is associated with low SES and adolescence mothers (DiPietro et al., 2003). Low maternal prepregnancy weight has been associated with increased risk for intrauterine growth restriction, perineal tears, and preterm labor (Ehrenberg, Dierker, Milluzzi, & Mercer, 2003; Salihu, Mbah, Alio, Clayton, & Lynch, 2009). With increased societal pressures to be thin, women of childbearing age are struggling to find a balance between

the appropriate weight to conform to societal stereotypes while maintaining the health of their pregnancy (DPietro et al., 2003).

Though low prepregnancy weight has notable contribution in the literature, maternal obesity has recently received much more interest. According to the Centers for Disease Control and Prevention (CDC), the number of overweight and obese Americans has been continually rising over the past 30 years. Indeed, 59.5% of women of child-bearing age are considered overweight and 34% are considered obsess by IOM standards (Flegal, Carroll, Ogden, Curtin, 2010). With these increases in national trends, understanding the consequences in terms of perinatal health is imperative. Obesity during pregnancy is associated with higher rates of gestational diabetes (IOM, 1996), risk for cesarean delivery and macrosomic fetus (Baeten, Bukusi, & Lambe, 2001), as well as higher rates of hypertension (Parker, 1988), heart defects (Paladini, 2009) and early pregnancy loss (Fedorcsak et al., 2000). Unfortunately, though heart defects are more common in the fetus of an obese woman, the opportunity to identify this defect in advance is more problematic. Paladini (2009) reported significant difficulties in detection of heart and neural tube defects in obese women due to the lack of sophisticated sonography tools to penetrate larger women. In society, this may become even more problematic as the availability of these sophisticated scanning instruments are only available at specialists' office and with the increasing trend of obesity, specialists may become overwhelmed by the increasing demand. Clearly the risks associated with obesity are numbered and this evidence, along with the aforementioned risks associated with low BMI are reason to obtain information about maternal pre-pregnancy weight when conducting perinatal assessment.

Maternal height. Though one of the lesser studied maternal factors related to perinatal outcome, maternal height does seem to have some significant associations in the literature. Particularly with regard to short stature, identified as maternal height less than 5 feet, 0 inches, women within this category have associated risks of cesarean delivery (Scott et al., 2989). On the contrary, taller women are at risk for more disproportionate maternal-fetal ratio with regard to uterine anatomy linked to increased labor and delivery complications (Barnhard, Divon, & Pollack, 1999). Though it is seldom researched in the United States, it may still contribute to perinatal complications and is an easily obtained, reliable variable that contribute to overall clinical understanding.

Previous pregnancy. Previous medical history is generally considered highly pertinent information when assessing risk of any kind. With regard to obstetric health, previous events are considered equally important. Those aspects most commonly assessed are previous miscarriage, abortion, and previous birth outcome. As would be expected, the more remarkable the history, the more likely the occurrence.

Previous miscarriage, also known as spontaneous abortion, is considered the loss of the fetus prior to 20 weeks gestation (Petrazzo & Berin, 2010). This occurs in approximately 15-20% of pregnancies, though true prevalence is difficult to establish as most women do not even know they are pregnant (Petrazzo & Berin, 2010). Wilcox and colleagues (1988) explored the prevalence of miscarriage by following 221 women through their menstrual cycles, assessing the number of pregnancies created. Their results revealed that 22% of pregnancies created (198 total) were lost prior to the next menstrual cycle and another 10% were considered clinical losses (Wilcox, Weinberg, O'Conner, et

al., 1988). Later analyses also revealed that many women are unaware of miscarriage when it happens (Wilcox, Weinberg, & Baird, 1990)

There are numerous causes for the occurrence of a spontaneous abortion including biological, environmental, and anatomical factors. Biological influences include events related to either genetic contributions or unsuccessful unification of the sperm and egg. Genetic causes are the most common explanation for miscarriage, particularly those occurring within the first 8 weeks of gestation (Petrazzo & Berin, 2010; Rubio et al., 2003). The most commonly occurring genetic abnormalities occur on one of 7 chromosomes (13, 14, 15, 16, 21, 22, & X) that causes spontaneous abortion (Hassold et al., 1980; Stephenson et al., 2002). In those cases, the number of chromosomes would be abnormal, or parts of the individual chromosomes would have mutation. Post first trimester, the rate of genetically induced miscarriage is almost nil (Rubio et al., 2003). Environmental causes of miscarriage include occupational toxins, obesity, and smoking (Mishra, Dodson, & Schofield, 2000). Caffeine consumption has been hypothesized to be a contributing factor, though epidemiological studies have not established solid evidence that caffeine significantly contributes to miscarriage (Bech et al., 2005; Fenster et al., 1997; Signorello & McLaughlin, 2004). Anatomical considerations include the shape of the mother's uterus. Petrazzo and Berin (2010) report anatomic abnormalities to be relatively uncommon among healthy mothers (3% of total women); however, women with a history of pregnancy loss have a much higher rate of abnormal uterine presentations (27%).

Elective abortion is defined as the medical or surgical removal of the fetus prior to the 6th month of pregnancy. Nearly one third of all voluntary abortions are completed via

surgical removal within the first trimester (Kedel, 2003). Generally, these are completed in outpatient offices, with local anesthesia (Stubblefield, Carr-Ellis, Borgatt, 2004) with varying consequences. Population based studies have suggested previous voluntary abortion is related to preterm birth (Lumley, 1998; Martius et al., 1998; Swingle et al., 2009) though this is not consistent with studies looking specifically at vacuum aspiration in the first trimester (World Health Organization, 1979). Indeed, studies that have looked at the occurrence of both types of abortions occurring indicate increased risk of poor perinatal outcomes (Lumley, 1998; Swingle et al., 2009).

Data suggest that the health of previous born children does have a strong relationship with subsequent pregnancies. Nearly all scales identify obstetrical history factors as being important indicators of later neonatal outcomes (Coopland et al., 1977; Dean & Gray, 1985; Goodwin et al., 1969; Hobel et al., 1973; Littman & Parmelee, 1978; Nesbitt & Aubry, 1969; Prectl, 1968). Previous preterm and small for gestational age births have been associated with increased risk of still-birth (Surkan, et al., 2004). In addition, those with recurrent stillbirths have been found to be significantly at-risk for subsequent still-births (Frias & Silver, 2005; Samueloff et al., 1993). History of delivery low-birth births is also related to subsequent low birth weight births (Rasmussen et al., 2000).

Nicotine. When assessing maternal substance use during pregnancy there are several issues that disconcerting. Primarily, the social stigma associated with using any substance during pregnancy may hinder a woman's honesty with self-reporting drug use. Though drug screenings are more accurate, they are more expensive and time consuming to obtain. A second problem in research with substance use during pregnancy is that it is

obviously unethical to have true experimental research on human participants. As a result, no causal relationships can be assumed from the research and the number of confounding variables present with substance use makes it extremely difficult to establish a clear understanding of the relationship.

It is well established that substances such as nicotine and alcohol are detrimental to the developing fetus, other substances are less obvious in their impact on neonatal outcome. The impact that any substance has on the fetus can be dependent on six established factors: chemical structure of the drug, mode of administration, dose, duration of administration, developmental stage of the baby, and susceptibility of both mother and baby (Weinberg et al., 1992).

Weinberg and colleagues (1992) also noted that timing of the use has an impact on the types of malformations that result. Structural formations, such as physical abnormalities, are more highly associated with drug use during the embryonic period (consisting of the first 10 weeks of pregnancy) as this is the sensitive period for most major organs. Later substance use, during the fetal period (10 weeks to 38 weeks gestation) is more highly associated with minor changes or functional changes, such as emotional or social deficits (Miao et al., 1998; Weinberg et al., 1992).

With regard to maternal cigarette smoking during pregnancy, there are several implications for the fetus that have been well established. Fetal exposure to nicotine places the fetus at risk for low birth weight, preterm birth, spontaneous abortion, and Sudden Infant Death syndrome (Haustein, 1999). Longitudinal studies have also established clear links between maternal smoking to cognitive ability, academic achievement and behavior in childhood. High exposure (more than 10 cigarettes daily) is

associated with lower overall cognitive abilities at age 3-4 (4 points lower) (Olds, Henderson, & Tatelbaum, 1994) as well as lower verbal ability (Fried, Watkinson, & Gray, 1998). In a similar fashion fetal nicotine exposed has been related to problems with poor academic achievement (Bastra et al., 2003). As fetal growth retardation ensues during the last trimester, low birth weight becomes more and more common. As a result of this low birth weight, Frisk and colleagues (2002) reported lower cognitive ability and reading ability at age seven.

Differences in behavior in children exposed to nicotine prenatally have described symptoms of inattention and hyperactivity (Bastra, Hadders-Algra, & Neeleman, 2003; Thapar, Fowler, Rice, Scourfield, van den Bree, & Thomas, 2003). These behavior changes may be explained by the chemical structure of nicotine. Nicotine binds to certain neurotransmitters that affect prefrontal cortex regulation, which is directly involved in behavioral manifestations of hyperactivity, impulsivity, attention, working memory and motivation (Weinberg, Sonderegger & Chasnoff, 1992). Thus, children who are exposed to nicotine prenatally may present in a clinical situation with symptoms very similar to children with ADHD. It would be extremely important for treatment planning to differentiate between prenatal nicotine exposure and organic ADHD.

Experimental studies with non-humans have produced some interesting findings, particularly with regard to gender differences in nicotine exposure. Prenatal exposure to nicotine reduced the birth weight in males, as well as increased male mortality, but this impact was not as prevalent in females (Peters & Tang, 1982; Riesenfeld, 1985). Fishman and Breedlove (1988) described gender differences in central nervous system make up that could help explain this. They suggested that males and females differ in neuron

morphology and concentrations of neurotransmitters in some brain regions that may cause differences in functional impact of the exposure. Moreover, Fishman and Breedlove discussed the possibility of teratogenic effects being sex-hormone dependent as males and females produce varying concentrations of different hormones (Weinberg, Sonderegger, & Chasnoff, 1992).

Alcohol. Maternal alcohol consumption during pregnancy has established effects on the developing fetus (Bowersox, 2007). Though Fetal alcohol syndrome (FAS) was first described by Jones and Smith (1973), more recent evidence has illuminated the need for further classification of the syndrome to better understand the implications of prenatal alcohol exposure. Currently, classifications are defined under the umbrella term Fetal alcohol spectrum disorders (FASD) and include: FAS, Fetal alcohol effects (FAE), alcohol-related neurodevelopmental disorder, and alcohol-related birth defects (SAMHSA, 2004).

Fetal alcohol syndrome is a birth defect that is diagnosed based on a number of symptoms including growth deficiencies, brain damage, facial abnormalities and maternal alcohol use during pregnancy (Weinberg, Sonderegger & Chasnoff, 1992). Craniofacial abnormalities include small eye openings, thin upper lip, flat philtrum (the vertical groove in the midline of the upper lip) and poor head size or shape (SAMHSA, 2004). FAS is the consequence of heavy drinking and is considered the most severe case of prenatal alcohol exposure due to the detrimental effects on the cognitive, academic, social and emotional functioning. Studies have suggested the frontal cortex, hippocampus, corpus callosum and cerebellum to be more sensitive to alcohol exposure (Archibald et al., 2001; Bowersox, 2007).

Fetal alcohol effects, alcohol-related neurodevelopmental disorder, and alcohol-related birth defects are those disorders that describe an infant who does not meet criteria for FAS, but was exposed to alcohol prenatally. Oftentimes, those children with FAE have very similar behavioral and cognitive struggles, though they physical facial abnormalities may not be present (SAMHSA, 2004). The Institute of Medicine has continued to examine the diagnostic criteria and the means to which appropriate diagnosis effects treatment and interprofessional communication with these individuals (Stratton, Howe, & Battaglia, 1996).

Research has confirmed diagnostic criteria that cognitive and behavioral deficits exist in this population. Though children with FASD can range from normal cognitive abilities to very low cognitive abilities (Kodituwakku, 2009), studies have suggested deficits in specific areas of cognitive functioning such as processing speed (Burden, Jacobson, & Jacobson, 2005), executive functions (Conner et al., 2004; Kodituwakku, 2009) and motor skills (Testa, Quigley, & Eiden, 2003). Furthermore, studies also have suggested deficits in attention (Boyd et al., 1991; Brown et al., 1991) and memory functioning (Mattson & Riley, 1999) that further affects cognitive and social abilities.

As mentioned, the research on most substances is troubled by numerous confounding variables, making the true relationship between substance use and poor outcome difficult to establish. Indeed, it seems the cumulative effect of suboptimal environmental conditions and associated maternal factors are more likely the culprit of poor outcomes than the actual teratogenic effect of the drug itself. Though alcohol and nicotine do have long-term implications, other substances are only generally problematic

immediately after birth and long lasting effects can be mediated by positive variables to have positive results.

Maternal stress. Pregnancy is a biological process that is synergistic with all aspects of daily functioning. As such, though the physical changes are most evident, the connection with a woman's is also present. Stress for any individual, pregnant or not, can lead to poor health if severe and chronic. The difficulty in assessing maternal perinatal stress lies in the subjectivity in the term. That which is high stress for one person may be minimal stress for another. Continually, stress may include symptoms of depression, anxiety, or personal conflict that may have quite substantial inter-individuality. Nevertheless, stress manifesting through any symptom, if chronic and severe is likely problematic. Maternal psychological distress has been suggested to relate to lower birth weight (Henrichs et al., 2010), preterm delivery (Rondo et al., 2003), and still-birth (Wisborg, Barklin, Hedegaard, & Henriksen, 2008). Though these studies attempted to control for confounding variables, stress during pregnancy also has been related to poor maternal nutrition (Fowles, 2004) that may also contribute to poor fetal outcome. Therefore, for the purposes of this study, despite its inclusion on the MPS, it was not included in the analysis due to the difficulty in managing confounds and the unavailability of such data within the current sample of data.

Vaginal Bleeding. Vaginal bleeding during pregnancy is a prenatal event for which the impact or consequence is yet to be understood. Some studies identify poor outcomes of prematurity (Hossain, Harris, Lohsoonthorn, & Williams, 2007), low birth weight or miscarriage (Hasan et al., 2009) to be related to vaginal bleeding. However, other studies reported that vaginal bleeding alone is not the culprit for poor perinatal

outcomes (Yang et al., 2004). Rather, other confounding factors, such as maternal age and substance use, may have more impact. As such, it seems the issue of vaginal bleeding during pregnancy requires additional attention in the research literature.

There are varying difficulties with regard to studying and understanding the implications of vaginal bleeding during pregnancy. Primarily, it is difficult to concisely operationalize vaginal bleeding in a way that could be universally interpreted, as well as remain statistically relevant for interpretation. Vaginal bleeding has been described by Yang and colleagues (2004) by explaining various aspects of bleeding, including trimester of occurrence, heaviness, number of episodes, duration, and amount of blood loss. As is evident, it is extremely difficult to capture all that vaginal bleeding entails and the subsequent consequences that may ensue.

Most studies include information from the first and second trimesters, as data is collected before the 3rd trimester (Anath et al., 2006; Hasan et al., 2009; Hossain et al., 2007; Yang et al., 2004, 2005). Bleeding in both trimesters has been reportedly associated with preterm birth (Hossain et al., 2007; Williams et al., 1992; Yang et al., 2004), though heavy bleeding in the first trimester also has been noted to be associated with miscarriage (Hasan et al., 2009). In their sample, Yang and colleagues (2005) found that most women who experience bleeding have single episodes within the first two months of pregnancy and without complication. Indeed, the timing of the bleeding has been noted to be of importance, other aspects, such as heaviness or associated pain with the bleeding seems to hold more significance.

Heaviness of bleeding is often described as light spotting or heavy bleeding and categorized as a dichotomy rather than a continuum (Yang et al., 2004). Light spotting is

generally noted in the first trimester and may be prevalent in approximately one fourth of all pregnancies (Anuth & Savitz, 1994) with no complications. However, as heaviness increased, it was more likely to be lengthier in duration, which ultimately was more strongly associated with more complications and poorer outcomes (Yang et al., 2004).

As mentioned, since vaginal bleeding affects approximately one fourth of all pregnancies, it is a relatively common occurrence that is still not fully understood. This lack of understanding is also likely due to the lack of etiological origin of half of bleeding episodes during pregnancy (Hammouda, 1966; Scott, 1972). While bleeding at any point could be the direct result of infection or trauma (Chamberlain, 1991) and late (3rd trimester) bleeding indicative of possible placental rupture, other bleeding episodes during pregnancy remain an enigma. Predictors of vaginal bleeding have been explored (Yang et al., 2005), though more evidence is needed to make generalized statements. In an attempt to identify predictors of bleeding, Yang and colleagues (2005) reported older mothers, previous miscarriages or abortions, and prior preterm births were related to more vaginal bleeding. Additionally, obstetric history that was marked with numerous events (i.e. more than one miscarriage or abortion) was related to increased bleeding.

It is clear that any vaginal bleeding could have the potential to become problematic during pregnancy. As such, it is an important variable to maintain on perinatal assessment scales. The way in which vaginal bleeding should be measured appears to be a matter of opinion based on inconsistent results in the research and limited means for accessing this information. It has been reported that self-report of bleeding could be considered most appropriate, as many women do not seek medical attention or become hospitalized for light or intermittent bleeding during pregnancy (Axelsen,

Henriksen, Hedegaard, & Secher, 1995). This becomes important when one considers that scales obtain perinatal information from medical records rather than from maternal self-report.

Factors during labor and delivery.

Prolonged labor. Normal labor begins with a latent phase, followed by active phase, and then the birth of the baby. These terms are fairly universal among obstetricians in describing normal labor progression and identifying deviations from this (Friedman, 1955). Labor that deviates from this normal labor may be termed dystocia, literally meaning difficult labor (Shields & Ratcliffe, 2009). Dystocia is most common in nulliparous women and is the most common cause for primary cesarean delivery (Ressel, 2004).

Upon admission, a woman in labor may be assessed with progress being monitored on a graph called a partogram (Lavender, Alfirevic, & Walkinshaw, 1998). It is important to understand the differences between latent and active phases of labor so as to accurately plot cervical dilation on the partogram to minimize unnecessary medical interventions (Shields & Ratcliffe, 2009). Latent phase of labor is defined as that period of time from the onset of labor until the beginning of active labor; the onset of labor is defined as the time when contractions are strong, regular and painful. Continually, active labor is defined as the period of time when contractions are regular and 4 centimeters dilation is reached (Chelmow, Kilpatrick, & Laros, 1993). Normal labor progresses at a rate of approximately one centimeter per hour (Zhang, Troendle, & Yancey, 2002). According to Friedman (1955) latent phase that goes beyond twelve hours for nulliparas and six hours for multiparas is considered prolonged. Prolonged latent phase is associated

with increased prevalence of other labor complications and probability of cesarean delivery (Albers, 1999; Chelmow, Kilpatrick, & Laros, 1993). Problems during the active phase are identified if the woman does not dilate 1.2 centimeters per hour in nulliparas and 2.5 centimeters per hour in multiparas (Chelmow, Kilpatrick, & Laros, 1993). Poor neonatal outcomes are not documented in the literature (Cheng, Hopkins, & Caughey, 2004; Myles & Santolaya, 2003), however negative maternal outcomes include maternal morbidity and operative delivery (Cheng, Hopkins, & Caughey, 2004). Risk factors for labor dystocia include short stature, advanced maternal age (>35 years), postterm pregnancy (>41 weeks), obesity, and abnormal fetal position (Ressel, 2004; Shields & Ratcliffe, 2009).

Induction of labor. As medical technology continues to advance, induction of labor has become more commonplace over the past several decades (Martin et al., 2009). Current rate of labor induction is 22.5 percent, a rate that is twice the rate of induced labor in 1990 (Martin et al., 2009). There are a number of reasons, both practical and medical, why labor is induced in the United States. Elective induction, which is not medically indicated, is reported nearly as often as labor induction as a whole (Grobman, 2007; Lydon-Rochelle et al., 2007). Pregnant women may request elective induction due to physical discomfort, scheduling concerns, and fear of maternal or fetal complications (Rayburn & Zhang, 2002). Obstetricians may be motivated by similar concerns such as scheduling conflicts, maternal or fetal risks, and increased risk of litigation if poor outcomes result (Caughey, Waashington, & Laros, 2005). Medically indicated labor induction may be implemented due to maternal factors such as postterm pregnancy, premature rupture of the membranes (PROM), eclampsia, or gestational diabetes,

(Caughey et al., 2009), or fetal factors such as intrauterine growth restriction (IUGR), macrosomia, or fetal distress (Mozurkewich et al., 2008). However, the evidence to support the induction of labor in these conditions is not always consistent.

Induction of labor in postterm pregnancy has received support in the literature that suggests decreased perinatal mortality and meconium aspiration syndrome (Gulmezoglu et al., 2006; Sanchez-Ramos et al., 2003) and is generally considered best practice after 41 weeks gestation (Mozurkewich et al., 2008). Induced labor after PROM has been associated with decreased admissions to the neonatal intensive care unit as well (Dare at al., 2006). Research on induction as a result of eclampsia or gestational diabetes is inconclusive with regard to maternal and fetal outcomes (Sibai et al., 1994; Hall et al., 2001; Mozurkewich et al., 2008). The numbers of women who experience conditions such as eclampsia or diabetes and are induced are likely to have other perinatal conditions as well, making controlled research difficult to establish.

When fetal macrosomia, or enlarged head size, is suspected, induction of labor may be ordered, though the evidence to support this has not been substantiated. In fact, induction does not seem to improve outcomes for the fetus and the rate of cesarean delivery may be increased when labor is induced based on suspected fetal macrosomia alone (Irion & Boulvain, 2000; Sanchez-Ramos, Bernstein, & Kaunitz, 2002). It has yet to be confirmed that induction decreases the rate of perinatal death in suspected IUGR (GRIT Study Group, 2003). As such, it is not recommended that labor be induced on the suspicion of IUGR alone (Mozurkewich et al., 2008). It is important to note that in general, the benefits associated with medically indicated induction of labor, seem to outweigh risks of associated complications. For instance, the rate of cesarean delivery did not increase with

labor induction (Dyson, Miller, & Armstrong, 1987), or neonatal morbidity (Heimstad et al., 2007). Thus, although the rate of induction is increasing and the reasons for induction may be practical or medical, there is inconclusive evidence as to the effect of induction on the development of the baby. For this reason, it is argued that induction of labor should be a variable of interest when assessing perinatal complications.

Forceps use. Obstetric forceps were invented in the early to mid 17th century during a time when complications during labor and delivery often meant maternal or neonatal mortality (Dunn, 1999). Centuries later, through the use of instrumental vaginal delivery, using forceps or the vacuum extractor (which was developed as a tool in the mid 19th century) has decreased in the past 50 years (Yeomans & Gilstrap, 1994). However, forceps and vacuum extractors are still being used in the delivery room with outcomes for the mother and child that are varying and yet to be clarified in the literature. Based on a number of studies, higher forceps use is highly discouraged. Johnson and colleagues (2004) reported six percent of all vaginal deliveries result in the use of either forceps or vacuum. Though forceps have been the more common tool, the use of vacuum extractor has become more popular among obstetricians over the past 30 years, although vacuum extraction holds a certain amount of risk as well (Caughey et al., 2005). Some of this shift in popularity comes from a decrease in the training of medical residents in their use and physicians lack of perceived competence with the tool (Powell, Gilo, Foote, Gil, & Lavin, 2007). Other reasons for decreased use of forceps is related to the increase of litigation after instrumental delivery and the improved safety of the cesarean delivery (Yeomans & Gilstrap, 1994).

It is clear that with instrumental delivery there are increased risks for the mother and child as opposed to spontaneous vaginal delivery, though the severity of complication is much less clear (Benedetto et al., 2007). It has been found that forceps increase the likelihood for maternal injury and vacuum extractor increases the likelihood for neonatal injury (Johnson, Figueroa, Garry, Elimian, & Maulik, 2004). Specifically, the use of forceps increases the risk of maternal perineal tears and neonatal facial and head lacerations and bruising, whereas vacuum extraction was related to increased risk of cephalohematoma in the neonate (Johnson et al., 2004). The American Congress of Obstetricians and Gynecologists (ACOG) Medical Student Teaching Module 2009 indicate maternal consequences include postpartum hemorrhage and lengthening of episiotomy and fetal injuries to include intracranial hemorrhage, cephalic hematoma, facial or brachial abrasions, injury to the face and forehead, and skull fracture. Aside from these risks, no significant differences have been found with regard to perinatal mortality or intracranial hemorrhage (Demissie et al., 2004; Towner, Castro, Eby-Wilkens, and Gilbert, 1999). Long-term consequences of instrumental delivery have not been established.

As is the case with other perinatal events, the need for instrumental delivery is often indicated when there are also other problematic events in labor or delivery. In other words, the use of forceps is generally associated with other perinatal risks, such as prolonged delivery or fetal distress. Indeed, guidelines set forth by the ACOG (2009) designate the following implications for operative vaginal delivery: 1. Shortening of the second stage of labor as identified by fetal or maternal indications, 2. Prolonged second stage labor (more than 3 hours with regional analgesia in nulliparous women), 3. Fetal

distress, and/or 4. Maternal exhaustion or cardiac disease (ACOG, 2009; Yeomans and Gilstrap, 1994). Based on the inherent confounds, knowledge of instrumental delivery would seem imperative when assessing perinatal risk. Thus, it remains an important item on the MPS as it contributes to the overall risk for both the mother and infant.

Anoxia/Hypoxia. With each contraction during labor, the fetus experiences momentary decelerations of heart rate and subsequent decreased oxygen levels (Sweha, Hacker, & Nuovo, 1999). Though these are normal changes to during labor and delivery, severe forms of decreased oxygen can result in hypoxia, or "low oxygen." Anoxia, a related term is a total decrease in the level of oxygen and is a much more serious complication, as this means that the infant's brain and vital organs are not receiving oxygen. Recognized as early as 1946, Robertson (1946) described the impact of low or no oxygen on the mother and the child, hypoxia continues to be one of the most severe factors associated with fetal mortality (Vannuci, 2000). It is important to note that hypoxia rarely occurs in uncomplicated deliveries of healthy women (Robertson, 1946). Careful metal monitoring has decreased the incidence of hypoxia, though it has increased the risk for false-positive risks that lead to unnecessary cesarean or instrumental deliveries (Coughlin & Huntzinger, 2005). Based on its relation to mortality, hypoxia continues to be an important variable to consider in perinatal assessment in combination with other correlated variables such as low birth weight and prematurity.

Another complication related to oxygen levels is respiratory distress syndrome. This is a condition that is diagnosed after delivery, usually coincides with hypoxia in preterm infants and can continue into childhood asthma (Hermansen & Lorah, 2007). Respiratory distress occurs in less than 10 percent of all live births with nearly 40 percent

of those originating from excessive fluid remaining the neonate's lungs after delivery (Kumar & Bhat, 1996). This condition is benign in most cases, resolving itself without medical intervention; however, in preterm neonates, the condition can be more serious due to the less developed lungs in the preterm neonate (Hermansen & Lorah, 2007).

Obviously, every moment that the brain is without oxygen, there may be short term and long-term consequences. However, longitudinal studies have had inconsistent results with regard to lasting effects on the infant. Hypoxia has a clear relationship with 1- and 5-minute Apgar scores (Laptook et al., 2009), though oxygen is necessary for all aspects of the Apgar scoring. Therefore, it would not be surprising that Apgar score of the hypoxic infant would be abnormally low. Long-term effects were attempted by Low and colleagues in 1984 but no significant differences were found. The authors reported there were deficits in a small portion of the group, but these infants experienced prolonged episodes of hypoxia (greater than 1 hour) and had a history of other perinatal problems. This study used a small sample of participants, which could explain the lack of significance, though other longitudinal studies are sparse in the research.

Neonatal status.

Low birth weight, prematurity, & small for gestational age. Three common and many times overlapping neonatal complications are prematurity, low birth weight and small for gestational age (SGA). Since these conditions often co-occur, many researchers examine them in unison with each condition independently contributing to later problems is difficult to discern. For the purposed of this paper, each condition will be discussed separately with the underpinning understanding that these conditions are highly intercorrelated.

Prematurity is generally defined as birth prior to 37 weeks gestation and very premature infants are those born before 32 weeks gestation (LaHood & Bryant, 2007). Though the prevalence of premature infants and very premature infants is relatively low, 13% and 2% respectively, prematurity is the second leading cause of neonatal mortality (LaHood & Bryant, 2007). According to the CDC, the number of premature infants has increased over the past two decades, with the U.S. having more than twice the number of preterm infants per year (MacDorman & Mathews, 2009). This increase could be due to several overarching social factors. One factor in the increase of premature infants includes advancements in medical technology that now saves infants that would have previously died without recent medical interventions (Trachtenbarg & Goleman, 1998a). Another factor is the increase in multifetal pregnancies that are likely the result of assistant fertilization techniques. Indeed, multifetal pregnancies have increased 70 percent from 1980, particularly in Caucasian women over 30 (Martin et al., 2009). Regardless, medical management of preterm birth and premature infants plagues the country with over three billion dollars of health related expenses annually (Weismiller, 1999).

Premature infants are at risk for a number of problematic circumstances. Primarily, infant mortality is highly correlated with premature birth. In fact, mortality increases 5-fold when born at less than 27 weeks and 45-fold when born less than 32 weeks compared to term infants (Trachtenbarg & Goleman, 1998a). Other common medical problems include anemia, due to lower iron stores, and respiratory distress due to immature lung development (Trachtenbarg & Goleman, 1998b). Vision and hearing

problems are also common due to immature optic and auditory brain development (Trachtenbarg & Goleman, 1998a).

Prior to discussing LBW and SGA, one must first develop an understanding of the term intrauterine growth restriction. Intrauterine growth restriction (IUGR) is defined as less birth weight that is less than 10 percent of what is to be expected based on gestational age (Vandebosche & Kirchner, 1998) and whose abdominal circumference is below the 2.5 percentile (Peleg, Kennedy, & Hunter, 1998). IUGR is one of the top two leading causes of death in infants, along with prematurity (Bernstein & Gabbe, 1996) and accounts for approximately one-third of all infants who are born weighing less than 2500 grams (Creasy & Resnik, 1994). The etiology of IUGR is difficult to establish, however there are known factors that are associated with IUGR. Numerous fetal and maternal factors are reported to be: chronic hypertension, pre-eclampsia, diabetes, chronic renal disease, smoking, substance use, malnutrition, previous IUGR birth, and other infectious and congenital abnormalities (Vandenbosche & Kirchner, 1998). Classification of IUGR is generally considered symmetric or asymmetric. Symmetric IUGR is defined by proportionally smaller fetal measurements throughout the body, whereas asymmetric IUGR occurs in only parts of the body, generally abdominal circumference and extremities (Peleg et al., 1998). Asymmetric IUGR is more often the result of malnourishment in-utero and is an indication of the fetus' attempt to maintain function of the major bodily organs by expending available energy and nutrients on those organs at the expense of other less important organs (Peleg et al., 1998). Asymmetric IUGR, if chronic can lead to more prominent developmental difficulties for the infant later in life (Bernstein & Gabbe, 1996).

Low birth weight (LBW) is one of the most frequently researched and cited perinatal factors in the literature. One reason LBW is particularly important is that there are implications for other problematic conditions to be present. Inherently, LBW is directly related to fetal growth problems in-utero (Beslau et al., 1996). In general, LBW is defined as birth weight less than 2500 grams or 5.5 pounds and very low birth weight (VLBW) is defined as less than 1500 grams. Prevalence of LBW was reported to be 8.3 percent in 2006, the highest rate reported in four decades (Martin et al., 2009). VLBW infants constituted a very small portion of overall births at 1.5 percent, though these infants represent the highest rate of mortality and morbidity among premature infants (Martin et al., 2009).

Infants who are born weighing less than 2500 pounds are generally categorized as LBW infants. However, it is important to note that only one third of those infants are pathological. The remaining 70 percent of LBW infants are considered constitutionally small (Ott, 1988). These infants are born small for a number of benign reasons (the mother was small or had a history of small babies) and generally do not have corresponding developmental difficulties. Those 30 percent with a known pathological concern are indeed at a higher risk for poor outcomes however (Vandenbosche & Kirchner, 1998). LBW has been associated with a number of academic, cognitive, social, and neurological outcomes (Anderson & Doyle, 2003; Caputo & Mandel, 1970; Dean & Davis, 2007; Dombrowski, Noonan, & Martin, 2007; Korkman et al., 2008).

Infants who are SGA are generally at risk for the poorest outcomes (Hutton et al., 1997) This can be explained by the underlying pathology of SGA infants. When an infant is born smaller than would be expected based on his or her age, it is indicative of stunted

fetal growth at some point throughout the pregnancy (Lundgren & Tuvemo, 2008). Moreover, there is an inverse relationship with SGA and birth weight in that the longer the growth is stunted in-utero, the smaller the infant with regard to birth weight.

Though it may not be immediately apparent, the aforementioned conditions (prematurity, LBW and SGA), as well post term, are all contingent on accurate dating of gestational age. As reported by the American College of Obstetrics and Gynecologists (2004), the most accurate diagnostic tool for estimation of the due date is early ultrasound. However, this tool is not always used in clinical practice if a woman is able to confidently estimate the date of her last menses. It has been recommended to include early ultrasound for all pregnant women, rather than just those who are either high-risk or cannot remember the date of their last menses, as a means to more accurately estimate the due date (Mandruzzato et al., 2010). As will be evident, though SGA and prematurity are implicated in accurate diagnosing of fetal outcome, gestational age is also used to make medical decisions about labor and delivery as is the case of prolonged, or postterm, pregnancy.

Postterm. The normal length of pregnancy is 40 weeks or 280 days. Pregnancy that goes beyond this time is anecdotally considered past due and that which goes beyond 42 weeks (294 days) is considered post term (Mandruzzato et al., 2010; Morantz & Torrey, 2004). As mentioned, these diagnoses are contingent on accurate estimation of the due date. The term past due is difficult to diagnose and rarely used as a medical definition (Morantz & Torrey, 2004). Moreover, the implications of pregnancy that goes beyond the due date by less than two weeks are not reportedly detrimental. However, post term pregnancy that which goes beyond 42 weeks, does have documented consequences

for both the mother and the baby (Rand, Robinson, Economy, & Norwicz, 2000). Maternal complications include prolonged labor, perineal tearing and increased rates of cesarean delivery (Alexander, McIntire, & Leveno, 2001; Campbell, Ostbye, & Irgens, 1997). Negative outcomes for the baby include macrosomia, stillbirth, and respiratory problems (Cleary & Wiswell, 1998; Divon et al., 2004; Mandruzzato et al., 2010). The rate of infant mortality is doubled for infants born at 42 weeks, and multiplied six times when born after 43 weeks gestation (Morantz & Torrey, 2004). Clearly, the length of the pregnancy is an important perinatal risk factor.

The precise etiology of prolonged pregnancy is generally unknown and may be the result of inaccurate estimation of the due date. Though not causal, there are some risk factors that have been found to be associated with prolonged pregnancy. Some evidence suggests risk factors such as fetal abnormalities such as anencephaly and maternal hormone deficiencies may contribute to the occurrence of postterm pregnancy (Mandruzzato et al., 2010). Other reported causes are male gender (Divon et al., 2002; Laursen et al., 2004). The prevalence of postterm pregnancy is approximately 7 percent (Morantz & Torrey, 2004), as many obstetricians elect for induction of labor if a patient's pregnancy goes beyond 41 weeks gestation.

There are numerous aspects to the perinatal period that could be considered abnormal and detrimental to the neonate, as discussed above. However, this discussion is anything but exhaustive. For the purposes of this discussion, the factors explored here will be those that are directly related to those that have been selected to be a part of the Maternal Perinatal Scale (Dean & Gray, 1985). Research in the area of perinatal complications has been continually growing and adding additional factors that may be

important as society changes. Thus, continued research to identify those factors that are most important is warranted. Consistently, low birth weight, small for gestational age, and smoking has been shown to have negative outcomes. However, as technology continues to advance, it is interesting to explore how these factors may become more or less influential with regard to infant outcome. It is clear that a better assessment tool to aid in predicting poor outcomes is needed; but finding the balance between having enough factors (perinatal complications) to be predictive of outcome and not having so many factors that the scale is overwhelming can be a challenge. Future research should use quantitative methods to develop more precise risk ratios for each of the factors and then include only those are the most predictive. This would help to streamline the number of factors, while still maintaining predictive power. These factors could then establish a scale that could be user-friendly, predictive, and succinct; a powerful tool for physicians, psychologists and school psychologists alike.

The Birth Certificate.

The information included within the CDC group is taken directly from the child's birth certificate (Freedman, 2001). For decades, the U.S. Standard Certificate of Live Birth, issued by the U.S. Department of Health and Human Services, has served as a national means of collecting information on births in the United States (i.e. all mothers who wish to register their birth fill out the same birth certificate form) (www.CDC.gov). When collecting information regarding the birth of a child, it is important to obtain information from two informants: the mother and the medical staff who delivered and cared for the infant. The "Mother's Worksheet" contains information pertinent to the mother, such as race, age, marital status, and educational attainment. The "Facility

Worksheet" contains information that would include information from the mother's medical record and the birth of the child such as date of last normal menses, pregnancy risk factors, and method of delivery (www.cdc.gov). Hospital staff members are educated and trained on how to complete the worksheet through a comprehensive instruction manual published by the CDC in 2003 (www.cdc.gov). These worksheets are completed and transmitted within days of the birth, frequently before discharge from the hospital.

As with any data, complete and accurate reporting is key to the utility of the information. Electronic Birth Registration (EBR) systems are now being implemented to ensure ease of data entry and completeness of reporting (www.cdc.gov). Although there is not yet a national system in place, the Director of the CDC's National Vital Statistics Online division, Mary Freedman, established a manual in 2001 to assist birthing facilities in choosing appropriate specifications for EBR software. As reported in the manual, the overall goal of the specifications is to have a system that would automatically identify and correct data entry errors, minimizing the number of incomplete accounts (Freedman, 2001). Currently, most EBR systems are designed for freestanding software in birthing facilities (www.cdc.gov). This software captures the data, carries out limited editing, and transmits data to the state for further processing. State processing is then done either with software developed by the same vendor who developed the facility software, or by software developed by state staff. After processing at the state level, the information is then transmitted to the federal level for final entry into the database (www.cdc.gov). At the federal level, as electronic files are received, they are automatically checked for completeness, individual item code validity, and unacceptable inconsistencies between

data items (www.cdc.gov). If any problems are found, entries are sent back to the facility for correction.

Special features within EBR systems minimize the likelihood of incomplete entry. Primarily, the system allows only one response when it is appropriate (a yes/no question) and does not allow any items to be deleted (i.e. all questions need some response). In addition, EBR encourages completeness of the information by reminding the medical staff entering the data that he or she has not completed an item by placing it on a pending list. This pending list must be completed before closing out the birth record. Lastly, the final screen of the EBR includes alerts to any missing information that must be completed before closing the record as well (www.cdc.gov; Byrd, personal communication, 2011). The User's Guide to the dataset includes a report of the percentage of data that is missing for each variable in the dataset (www.cdc.gov). Table 11 includes the range of missing data across the individual states within America (each state is required to report the amount of missing data on the birth certificate). As is evident, those variables pertinent to this investigation are consistently endorsed and could be considered to be complete and accurate.

Table 11

Percentage of missing data across national sample in CDC dataset (U.S. state by state)

Variable	Minimum (state) percentage missing	Maximum (state) percentage missing
Father's age	6.7%	33.6%
Father's race	5.2%	36.0%
Educational Attainment (mother)	0.0%	4.4%
Live Birth Order	0.0%	4.3%
Prenatal Care	0.0%	7.7%
Birthweight	0.0%	0.8%

5-Minute Apgar	0.0%	1.2%
Weight Gain	0.4%	15.7%
Tobacco Use	0.4%	12.4%
Method of Delivery	0.0%	0.8%
Risk factors of pregnancy	0.0%	2.5%
Obstetric Procedures	0.0%	4.1%
Characteristics of labor/delivery	0.0%	4.4%
Alcohol Use	0.0%	4.5%

CHAPTER THREE

Methods

Study 1

The major objective of the research in Study 1 was to create a preliminary scoring system for the MPS that was empirically based to increase the ease of interpretation. By creating an overall score and subscale scores, the clinician is offered an understanding of a child's early medical risk and a clearer understanding of the potential risk of developmental or cognitive deficits. Currently, clinicians may obtain perinatal information as part of the psychological evaluation, but rarely do they have the knowledge to understand the impact that those perinatal events may have on later outcomes. With the proposed scoring system, clinicians can use the objective information from the score to make statements about the possible reason for current developmental difficulties, or the risk of developing problems later.

This study used data from the population of 2006 newborns to explore the relationship between specific variables and poor neonatal outcome as defined by low Apgar scores (Apgar score of less than 4). Those variables in the 2006 newborn population data that paralleled items on the MPS were selected for the study. In other

words, Question #4 on the MPS "The child's weight at birth was:" corresponds to the variable "Birthweight" in the population data. By using a population-based approach, it allowed more generalized statements to be considered about results, particularly since perinatal complications and poor neonatal outcomes are a relatively rare occurrence. The 5-minutes Apgar score was selected rather than the 1-minute Apgar score based on previous research showing increased reliability (Behnke, Carter, Hardt, Eyler, Cruz, & Resnick, 1987; Hardy, Drage, & Jackson, 1979). Previous research has shown consistent signs of morbidity for the neonate when scores of less than four on the 5-minute Apgar were present (Odd, Lewis, Whitelaw, & Gunnell, 2009; Odd, Rasmussen, & Gunnell, 2008; Serunian & Broman, 1975). Thus, it was inferred that those infants who had low Apgar scores were more likely to have neurological deficits that may be manifested in developmental difficulties later in life as discussed above. By understanding the relationship between specific variables and poor outcome, a weighted score was assigned to that particular item on the MPS.

Participants

The first study was comprised of participants from the 2006 Natality Public Use file (herein called the CDC group). These data were collected by the CDC and have been available to researchers on a yearly basis since 1968 (www.cdc.gov). The 2006 group was selected because it was the most recently available dataset for public use and offered the depth and breadth of information required for this analysis (i.e., it is a very large sample with all variables of interest for the study). The Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS) receives birth data electronically, prepared from individual birth certificates. These data include all live births (i.e. miscarriages

and stillbirths not included) occurring in the U.S. to both residents and nonresidents. These participants represent 100 percent of the birth certificates registered in all states and the District of Columbia (Martin et al., 2009), with more than 99 percent of all births in the U.S. being registered births. The total number of individuals included in this study was 4,273,225.

Measures

CDC Worksheets. The data collected from the CDC group was taken directly from the child's birth certificate (Freedman, 2001). When collecting information regarding a birth, it is important to obtain information from two informants: the mother and the medical staff who delivered and cared for the infant. The "Mother's Worksheet" contains information pertinent to the mother, such as race, age, marital status, and educational attainment. The "Facility Worksheet" contains information from the mother's medical record and from the birth of the child such as date of last normal menses, pregnancy risk factors, and method of delivery (www.cdc.gov). Hospital staff members are educated and trained on how to complete the worksheet through a comprehensive instruction manual published by the CDC in 2003 (www.cdc.gov). These worksheets are completed and transmitted within days of the birth, frequently before discharge from the hospital.

As with any data, complete and accurate reporting is essential to the generalizability of the information. Electronic Birth Registration (EBR) systems are now being implemented to ensure ease of data entry and completeness of reporting (www.cdc.gov). At the federal level, as electronic files are received, they are automatically checked for completeness, individual item code validity, and unacceptable inconsistencies between data items (www.cdc.gov). If any problems are found, entries are sent back to the facility for correction.

As mentioned in the review of the literature, special features within EBR systems minimize the likelihood of incomplete entry.

Establishing a Scoring System

Prior measures that have been developed report specific criterion for scoring each item within the scale. However, arbitrary scores were established based on clinical judgment of "expert panels" that examined individual perinatal factors (Aubry & Pennington, 1973; Coopland et al., 1977; Goodwin et al., 1969; Littman and Paralee, 1978; Merck Manual, 2010; Nesbitt and Aubry, 1969; Prectl, 1968). To establish a more empirical based method and to avoid using arbitrary scores, several steps were taken to establish an empirical basis.

Prior to discussing the procedures used to achieve individual scores, it is important to understand the complex nature of creating such a scoring procedure. The MPS contains 22 individual items, as shown in Appendix A. As can be seen, each item contains several response choices, each of which could have a differing impact on the outcome scores. Herein lies the complexity of the scoring system; each item potentially carries differing weight on the Apgar score, but *each response within the item* may carry differing weight as well. As mentioned, other scale developers have established arbitrary scores for each response (Aubry & Pennington, 1973; Coopland et al., 1977; Goodwin et al., 1969; Littman and Paralee, 1978; Merck Manual, 2010; Nesbitt and Aubry, 1969; Prectl, 1968). However, a score of 2 on one item may not necessarily represent the same level of morbidity as a score of 2 on a different item despite carrying the same weighted score. In other words, those arbitrary scores have been established within items, but failed to consider the impact between items. Therefore, comparing those arbitrary scores across

items is questionable. As such, several steps were taken in an attempt to create a more reliable score (rather than arbitrary) that would allow comparison across items. First, logistic regression was used, with referent categories established based on previous research. Also, items from the MPS, as corresponding to the CDC Worksheets, were selected to create an overall score and subscale scores.

Study 2 - MPS Participants

The second study consisted of information about 714 children whose mothers completed the MPS (herein called the MPS group) and data were available. An overview of the validity and reliability of the MPS may be found in Chapter 2 of this paper. Parents or legal guardians of all participants completed an informed consent form and verbal consent was solicited. These data were collected following appropriate and ethical procedures of the Institutional Review Board. The mean age of the child in question was 8.83 years (SD = 4.3 years) at the time of evaluation. Mean chronological age of the mothers was 34.50 years (SD = 9.72 years). The median age of the mother was 33 years of age. The mean age of the father was 36.34 (SD = 10.35 years). Total number of participants in the groups to test for group differences of the Overall score was as follows: Overall score 80% cutoff at-risk (n=122) and not at-risk (n=530); 75% cutoff at-risk (n=159) and not at-risk (n=499); 70% cutoff at-risk (n=188) and not at-risk (n=464). Total number of participants in the groups to test for group differences of the Maternal subscale score was as follows: 80% cutoff at-risk (n=122) and not at-risk (n=530); 75% cutoff at-risk (n=159) and not at-risk (n=497); 70% cutoff at-risk (n=196) and not at-risk (n=457). Total number of participants in the groups to test for group differences of the Labor and Baby subscale score was as follows: 80% cutoff at-risk (n=122) and not at-

risk (n=530); 75% cutoff at-risk (n=148) and not at-risk (n=501); 70% cutoff at-risk (n=180) and not at-risk (n=469).

Procedures

Extrapolating the scores. Once proposed scores were calculated for each item's set of responses in Study 1, these scores were extrapolated onto the MPS participants. Next, by adding all of the scored responses for each participant in the dataset, three risk scores were derived: 1) an overall score, 2) a Maternal score and 3) a Labor/Neonatal score. Group differences were tested and classification rates calculated.

CHAPTER FOUR

Results

Study 1 – CDC group

In an attempt to establish scores that were not arbitrary, but based on empirical data, relative risk ratios were initially calculated. These relative risks allowed a comparison of responses within items, rather than between items. The relative risk ratios also were used as a comparison to previous scales to ascertain how closely this data aligns with what previous scales have assigned as risk scores. The relative risk ratios are reported in Table 15 along with the risk that other scales have identified the variable to be. In doing this, it allowed for a side-by-side comparison of how each item should be "weighted" as compared to the other variables.

Compiling Preliminary Scores. First, a review of the literature revealed several other scales, as mentioned above, that have scored items in an arbitrary manner (Aubry & Pennington, 1973; Coopland et al., 1977; Goodwin et al., 1969; Littman and Paralee, 1978; Merck Manual, 2010; Nesbitt and Aubry, 1969; Prectl, 1968). By compiling a list of each scale's scoring criteria, similar scores across scales were revealed. This outcome suggested that specific responses carried the most weight within each item, but did not

reveal specific scores (those that are not just arbitrarily created by a panel of experts) that could be compared across items. The review also revealed several items within the MPS that were not studied by others (e.g. type of medication taken during pregnancy, maternal stress, type of anesthesia used, and planned pregnancy). Based on this review, it was decided to eliminate those items from the analysis based on a lack of empirical support for their use. Therefore, the total number of items on the MPS used in this study was 18.

Logistic Regression. To compare responses across items, all responses were included within the same analysis by using logistic regression. This method allows for all predictors to enter the equation at the same time and for examination of how much each predictor contributes to the outcome variable of interest (Tabachnick and Fidell, 2007). For this exploration, the outcome variable is binary (Low Apgar (<4) score versus intermediate/normal Apgar score (5+)) and thus, should not be analyzed using the standard general linear regression approach. As described by McGullagh and Nelder (1989), logistic regression is used to describe the effects of independent variables on a binary response. Logistic regression does not require that the outcome variable be normally distributed, linearly related or of equal variance within each group (Tabachnick and Fidell, 2007), which is the case with both datasets. By entering all of the variables into the same equation using the Enter Method, beta weights will reveal those variables that carried the strongest weight to the predicted outcome and could be used as the assigned score for each response.

Recoding the variables. Logistic regression requires that each variable have a referent category. In other words, for each item, there was a response, or set of responses that were the most optimal response (i.e. those responses should carry a weight of 0

because they should not be predictive of poor outcomes). That reference group was selected based on the literature review of previous scales' scores (Aubry & Pennington, 1973; Coopland et al., 1977; Goodwin et al., 1969; Littman and Paralee, 1978; Merck Manual, 2010; Nesbitt and Aubry, 1969; Prectl, 1968), the relative risk ratio calculations, and the CDC risk cutoff scores for each of the variables (www.cdc.gov). Based on that information, each referent group was considered a "National Referent Group" for each item and they are described in Table 12.

Table 12

Maternal Perinatal Scale – Reference categories for logistic regression

MPS Item		MPS responses	National Referent group
The number of pregnancies prior	1	none	
	2	one	X
	3	two	X
	4	three +	
Vaginal bleeding during pregnancy	1	none	X
	2	some near end of pregnancy	
	3	some at beginning of pregnancy	
	4	a good deal throughout	
Child's weight at birth	1	less than 3lbs.	
	2	3lbs., 1 oz. to 4lbs.	
	3	4lbs., 1 oz. to 5lbs.	
	4	5lbs., 1 oz. to 6lbs.	X
	5	more than 6lbs.	X
Child born after how many months	1	6	
	2	7	
	3	8	
	4	9	X
	5	greater than 9 months	
	6	not sure	
Length of labor	1	1-2 hours	
	2	3-5 hours	X
	3	6-10 hours	X
	4	11-16 hours	X
	5	more than 16 hours	
Maternal weight gain	1	less than 10 lbs.	
	2	11-15 lbs.	
	3	16-25 lbs.	X
	4	26-35 lbs.	X
	5	36-45 lbs.	
	6	in excess of 46 lbs.	
Mother's age	1	under 15 years	
	2	15-19 years	
	3	20-29 years	X
	4	30-34 years	X
	5	35-39 years	
	6	over 40 years	

Prenatal care obtained	1	months 1-3	X
	2	months 4-6	
	3	months 7-8	
	4	after 8th month	
Labor induced	1	no	X
	2	yes—prior to the ninth month	
	3	yes—after ninth month	
Forceps used	1	no forceps were necessary	X
	2	yes, forceps were used	
	3	not sure, birth was cesarean	
	4	not sure	
Multiple pregnancy	1	yes—twins	
	2	yes—triplets or more	
	3	no	X
Presentation of the baby	1	feet first presentation (breech birth)	
	2	head first presentation	X
	3	side presentation	
	4	no reason to believe different	
Time between water break/labor	1	medication needed to induce labor	
	2	contractions began prior or at the time	
	3	began naturally < two hours	X
	4	began naturally > two hours	X
	5	not sure	
Prior risk pregnancies	1	none	X
	2	one+ full term stillbirth/neonatal death	
	3	one or more resulting in normal birth	
	4	one + spontaneous abort/(miscarriage)	
Cigarette use during pregnancy	1	none	X
	2	1 to 10	
	3	11 to 20	
	4	21 to 30	
	5	more than 30	
Average alcohol per day	1	none	X
	2	1 to 2 drinks	
	3	3 to 4 drinks	
	4	more than 5 drinks	
Maternal high blood pressure	1	Blood pressure was normal	X
	2	Blood pressure was high at end	
	3	Had high bp, weight gain, swelling,	

	4	Was told preeclampsia, hospitalized	
Rh incompatibility	1	No "Rh problems" were reported	X
	2	This was 2+ child born Rh problems.	
	3	I was hospitalized / took medication	
	4	Child have anemia following birth.	

Although the risk ratios allowed for comparison with other scales, they did not identify those responses that carry the most predictive ability on the scale as a whole. To identify the responses that would be most predictive of low Apgar, a logistic regression was used. These data are unique in that only one other study (Larks and Larks, 1968) has attempted to use regression to understand the precise weight that each variable should carry on the outcome variable, while others use arbitrary or expert opinion to establish the weight of each variable. Beta weights from the logistic regression are listed in Table 13. Based on the results, item responses with the highest beta weights were: gestation less than 27 weeks, birthweight less than 2500 grams, advanced maternal age, and excessive tobacco use. These results are consistent with many of the items listed as the highest relative risk ratios as described above, as well as those items that previous research has deemed as being important to poor neonatal outcome (Cnattigius, Forman, & Berendes, 1993; Haustein, 1999; Jolly et al., 2000; Morrison, 1975; Peters & Tang, 1982; Riesenfeld, 1985; Trachtenbarg & Goleman, 1998a).

Establishing a score for the proposed scoring system, maintaining the specific empirical data (beta weight) was important. However, beta weights, as decimals, are not necessarily user-friendly for a scoring system. Thus, all beta weights were multiplied by

10 and rounded to the nearest tenth for ease of scoring for the clinician. These new values were the proposed score for each item's response. Table 15 shows the proposed score for each response alongside the beta weights.

Table 13

Relative Risks, Beta weights and proposed score associated with each item response

Number of previous children		Relative Risk Ratio	Beta weight	Proposed Score
1 – 3 children	Referent			
no children		1.31	-.043	0.4
4 children		1.28	-.177	1.7
more than 5 children		1.50	-.233	2.3
Prenatal care obtained				
1st trimester	Referent			
2nd trimester		0.70	-.421	4.2
3rd trimester		0.49	-.784	7.8
No prenatal care		8.75	-.269	2.6
Maternal weight gain				
16-35 pounds	Referent			
Less than 16 pounds		4.44	-.319	3.1
36-40 pounds		0.53	-.005	0
41-45 pounds		0.52	-.011	0.1
More than 46 pounds		0.60	-.030	0.3
Hypertension				
Absent	Referent			
Present Prepregnancy		2.15	.581	5.8
Present during pregnancy		1.27	.550	5.5
Bleeding				
Absent	Referent			
Present		6.31	-.066	0.6
Excessive		4.03	-.529	5.2
Eclampsia				
Absent	Referent			
Present		3.01	.373	3.7
Rh Sensitivity				
Absent	Referent			
Present		0.73	.074	0.7
Labor Induced				
Absent	Referent			

Present		0.59	-.171	1.7
Labor				
3-16 hours	Referent			
Precipitous Labor (<3hrs)		2.06	-.129	1.2
Prolonged Labor (>16hrs)		1.34	-.584	5.8
Presentation				
Cephalic	Referent			
Breech		4.49	-.131	1.3
Forceps use				
Absent	Referent			
Present		0.77	-.248	2.5
Alcohol use				
None	Referent			
1 drink per week		1.01	-.031	0.3
2 drinks per week		1.01	-.265	2.6
3 drinks per week		2.08	-.186	1.7
4 drinks per week		2.77	-.018	0.2
5 or more drinks per week		3.86	-.319	3.2
Gestation				
37-41 weeks	Referent			
Less than 20 weeks		189.4	-3.110	31.1
20-27 weeks		99.86	-1.538	15.4
28-31 weeks		6.78	-.621	6.2
32-33 weeks		2.61	-.688	6.8
34-36 weeks		0.90	-.503	5.0
42 weeks		0.38	-.065	0.6
Birthweight				
2500-3999 grams	Referent			
Less than 499 grams		224.9	-6.757	67.6
500-999grams		45.7	-3.868	38.7
1000-1499 grams		8.79	-2.778	27.8
1500-1999 grams		3.70	-2.164	21.6
2000-2499 grams		1.23	-1.258	12.6
4000-4499 grams		0.35	-.080	0.8
4500-4999 grams		0.61	-.628	6.3
5000-8165 grams		1.21	-1.365	13.6
Maternal Age				
20-34 years	Referent			

Less than 15 years		2.99	.046	0.5
15-19 years		1.47	.001	0
35-39 years		0.94	.164	1.6
More than 40 years		1.71	-1.698	17.0
Plurality				
Singleton	Referent			
Twin		4.49	-.342	3.4
Triplet		8.48	-.697	7.0
Quadruplet		19.51	-.438	4.4
Quintuplet+		24.09	-1.349	1.3
Tobacco Use				
No Tobacco Use	Referent			
1-5 cigarettes per day		1.28	-.018	0.2
6-10 cigarettes per day		1.28	.000	0
11-20 cigarettes per day		1.30	-.121	1.2
21-40 cigarettes per day		1.04	.439	4.4
40+ cigarettes per day		1.69	3.506	35.1

Creating the overall score and subscale scores. Based on the review of the literature, two subscale scores (Maternal Subscale and Labor/Neonatal Subscale) and an overall scale score were created. Table 14 shows the items that were included in each of the scales. The Maternal subscale includes 11 items from the MPS, while the Labor/Neonatal subscale includes 7 items. The advantage to creating subscales, in this situation, is to allow the clinician additional information about the areas for why a child is at-risk or not at-risk.

Table 14

Proposed subscales for the MPS scoring system

Maternal Subscale – 11 items		
MPS Item		MPS responses
The number of pregnancies prior	1	none
	2	one
	3	two
	4	three +
Vaginal bleeding during pregnancy	1	none
	2	some near end of pregnancy
	3	some at beginning of pregnancy
	4	a good deal throughout
Maternal weight gain	1	less than 10 lbs.
	2	11-15 lbs.
	3	16-25 lbs.
	4	26-35 lbs.
	5	36-45 lbs.
	6	in excess of 46 lbs.
Mother's age	1	under 15 years
	2	15-19 years
	3	20-29 years
	4	30-34 years
	5	35-39 years
	6	over 40 years
Prenatal care obtained	1	months 1-3
	2	months 4-6
	3	months 7-8
	4	after 8th month
Multiple pregnancy	1	yes—twins
	2	yes—triplets or more
	3	no
Time between water break/labor	1	medication needed to induce labor
	2	contractions began prior or at the time
	3	began naturally < two hours
	4	began naturally > two hours
	5	not sure
Prior risk pregnancies	1	none
	2	one+ full term stillbirth/neonatal death

	3	one or more resulting in normal birth
	4	one + spontaneous abort/(miscarriage)
Cigarette use during pregnancy	1	none
	2	1 to 10
	3	11 to 20
	4	21 to 30
	5	more than 30
Average alcohol per day	1	none
	2	1 to 2 drinks
	3	3 to 4 drinks
	4	more than 5 drinks
Maternal high blood pressure	1	Blood pressure was normal
	2	Blood pressure was high at end
	3	Had high bp, weight gain, swelling,
	4	Was told preeclampsia, hospitalized

Labor/Neonatal Subscale – 7 items		
Child's weight at birth	1	less than 3lbs.
	2	3lbs., 1 oz. to 4lbs.
	3	4lbs., 1 oz. to 5lbs.
	4	5lbs., 1 oz. to 6lbs.
	5	more than 6lbs.
Child born after how many months	1	6
	2	7
	3	8
	4	9
	5	greater than 9 months
	6	not sure
Length of labor	1	1-2 hours
	2	3-5 hours
	3	6-10 hours
	4	11-16 hours
	5	more than 16 hours
Labor induced	1	no
	2	yes—prior to the ninth month
	3	yes—after ninth month
Forceps used	1	no forceps were necessary
	2	yes, forceps were used
	3	not sure, birth was cesarean

	4	not sure
Presentation of the baby	1	feet first presentation (breech birth)
	2	head first presentation
	3	side presentation
	4	no reason to believe different
Rh incompatibility	1	No "Rh problems" were reported
	2	This was 2+ child born Rh problems.
	3	I was hospitalized / took medication
	4	Child have anemia following birth.

Study 2 – MPS group

Previous research has identified similar subscales to be important predictors of mortality and morbidity (Prechtl, 1968) and were thus created for this preliminary scoring system. Once proposed scores were created, three risk scores were derived: 1) an overall score, 2) a Maternal score and 3) a Labor/Neonatal score. In an attempt to separate the participants into groups that would be considered "at-risk" or "not at-risk," a cutoff score was chosen. Since the scores are not normally distributed and a "two standard deviation" approach could not be used, a percentage score was selected. Since there has not been a large amount of research done in the area, three cutoff scores were selected to begin the preliminary stages of the scoring system. An arbitrary cutoff score of 70% was selected based on previous research (Nesbitt and Aubry, 1969) and the underlying assumption among clinicians that a condition that is present in less than 30% of the population is considered clinically significant (Dean, personal communication, 2011). Cutoff scores of 75% and 85% were also calculated to identify which cutoff score would allow the best predictive ability for placing the child in the "at-risk" category for the purposes of this study. Those individuals whose score on the scales fell within the lower 70% of all scores were considered "not at-risk" (Group 2) and those who scored in the highest 30% were

Table 15
Descriptive statistics for each of the scales

	Mean	SD	Median	Range (Low)	Range (High)
Overall Score	8.66	11.80	5.70	0.00	95.88
Maternal Subscale	3.21	5.21	1.60	0.00	50.50
Labor/Neonatal Subscale	5.45	10.08	2.40	0.00	78.30

considered "at-risk" (Group 1). For the overall scale, to be above the cutoff and within the at-risk group, 70% corresponded to a score of 8.3, 75% corresponded to a score of 9.1 and 80% corresponded to a score of 10.50. For the Maternal subscale, the 70% cutoff score to be at-risk was 4.11, while 75% corresponded to a score of 4.61 and 80% corresponded to a score of 5.21. Finally, for the Labor/Neonatal subscale the 70% cutoff score was 4.1, the 75% cutoff score was 5.0, and the 80% cutoff score was 6.7. Mean, median and range of scores for each of the scales can be found in Table 16.

Testing to differentiate groups. To estimate the validity of the scoring system and its ability to differentiate groups that were at-risk or not at-risk for later developmental or psychological problems, a test to identify group differences was conducted. The independent variable was the group membership (either at-risk or not at-risk as described above by the 70%, 75%, or 80% cutoff) and the dependent variables were maternal report of developmental problems as defined by the Childhood Checklist: "CC1 - A medical doctor has reported this child to have some kind of neurological problem"; "CC2 - The school has reported a learning problem for this child which required special help (special education)"; "CC3 - The school, a medical doctor, or psychologist has reported this child

to have low intelligence." The total number of participants in the analysis of MPS childhood checklist items was 656.

Overall score differences. Results from the *t-test* for the Overall score revealed statistically significant group differences at the 80% cutoff rate, the 75% cutoff rate, and the 70% cutoff rate for each of the Childhood Checklist (CC) items. The at-risk group as defined by the 80% cutoff was significantly different from the not at-risk group on CC1 (p = .042), CC2 (p = .032), and CC3 (p = <.001). In addition, the 75% cutoff for the Overall Score was also statistically significant for CC1 (p = .029), CC2 (p = .046) and CC3 (p = <.001). The 70% cutoff of the Overall Score yielded significant differences as well; CC1 (p = .031) and CC3 (p = <.001), but not at CC2 (p= = .153).

Maternal subscale T-Test. Results from the T-test for the Maternal subscale score also revealed statistically significant group differences at the 80% cutoff rate, the 75% cutoff rate, and the 70% cutoff rate for each of the Childhood Checklist items. The at-risk group as defined by the 80% cutoff was significantly different from the not at-risk group on CC1 (p = .029), CC2 (p = .018), and CC3 (p = .001). In addition, the 75% cutoff for the Maternal Score was also statistically significant for CC1 (p = .001), CC2 (p = .028) and CC3 (p = <.001). The 70% cutoff of the Maternal Score yielded significant differences as well; CC1 (p = .001), CC2 (p = .002), and CC3 (p = .001).

Labor/Neonatal Subscale T-Test. Results from the T-test for the Labor/Neonatal revealed fewer statistically significant results. Childhood Checklist 3 revealed statistically significant differences at the 80% cutoff (p = .045), the 75% cutoff (p = .033) and the 70% cutoff (p = .057). In addition, CC1 yielded a significant difference at the 70% cutoff

Table 16

	CC1		CC2		CC3	
Overall Score	p-value	t-statistic	p-value	t-statistic	P-value	t-statistic
80% cutoff	.042*	1.775	.032*	2.165	<.001**	3.949
75% cutoff	.029*	2.202	.046*	2.004	<.001**	3.669
70% cutoff	.031*	2.174	.153	1.395	<.001**	3.694
Maternal Subscale						
80% cutoff	.029*	2.208	.018*	2.385	.001**	3.461
75% cutoff	.001**	3.298	.028*	2.216	<.001**	3.987
70% cutoff	.001**	3.177	.002**	3.384	.001**	4.736
Labor/Neonatal Subscale						

(p = .039). No other significant differences were found. A summary of the results from the T-tests can be found in Table 16.

80% cutoff	.528	-.234	.959	.163	.045*	.769
75% cutoff	.271	.351	.776	-.286	.033*	.177
70% cutoff	.039*	.061	.399	-.018	.057*	-.166

Classification rates

Validity of the Cutoff Score. A classification rate (i.e. a hit versus miss rate) was calculated to determine the specificity and sensitivity of the cutoff score. Classification functions are used to identify the proportion of cases that are correctly identified and those that are incorrectly described (Tabachnick and Fidell, 2007). In classification functions, there are two types of errors, similar to that of hypothesis testing. As described in Tabachnick and Fidell (2007), "classifying a truly nondiseased individual as diseased (Type I error or false alarm) or classifying a truly diseased individual as a nondiseased individual (Type II error or miss) (p. 468)." As could be expected, there are costs associated with each error. For the purposes of this study, it is less costly to have Type I error; in that situation, the clinician would be telling a patient that he or she should be further evaluated for developmental or cognitive deficits. The Type II error in this situation would miss a child who would be at-risk which would hinder the ability for that child to receive early intervention. It has been aforementioned that the earlier an intervention is implemented, the better the outcome (Majnemer, 1998; Guralnick, 1997).

The results from the classification rate revealed hit rates between 60.09% and 81.50% with Type I errors ranging between 12.04% and 31% and Type II errors ranging between 2.50% and 21.93%. The classification rates can be found in Table 17. Results yielded the highest hit rates to be at the 80% cutoff level for both subscales and the overall score. However, the consequence of having a higher cutoff score lies in having a greater rate of Type II error. In this instance, a child who truly had developmental

difficulties would be missed by the cutoff. As such, it is important to find the balance between acceptable Type I and Type II error rates. In other words, a balance must be made between being sensitive enough to capture the number of individuals with risks for developmental problems, but specific enough so as not to identify false-positives.

Table 17			
	CC1	CC2	CC3
Overall Score			
80% cutoff			
- Hit rate	77.59	66.76	76.33
- Type I error rate	16.15	12.04	12.97
- Type II error rate	6.09	20.57	10.53
75% cutoff			
- Hit rate	74.08	64.86	73.12
- Type I error rate	20.42	15.79	17.25
- Type II error rate	5.33	19.32	9.77
70% cutoff			
- Hit rate	70.12	61.80	69.92
- Type I error rate	24.84	19.87	21.67
- Type II error rate	4.87	18.40	8.24
Maternal Subscale			
80% cutoff			
- Hit rate	77.69	67.32	75.41
- Type I error rate	16.31	12.26	13.58
- Type II error rate	5.79	20.39	10.83
75% cutoff			
- Hit rate	75.14	65.02	73.12
- Type I error rate	20.12	15.95	17.25
- Type II error rate	4.57	19.01	9.47
70% cutoff			
- Hit rate	70.72	64.72	69.92
- Type I error rate	25.30	18.86	21.67
- Type II error rate	4.11	16.4	8.24
Labor/Neonatal Subscale			
80% cutoff			
- Hit rate	75.8	64.1	72.07

- Type I error rate	17.15	13.49	15.18
- Type II error rate	6.89	21.93	12.57
75% cutoff			
- Hit rate	73.04	61.93	68.70
- Type I error rate	20.52	16.79	18.86
- Type II error rate	6.27	21.26	12.26
70% cutoff			
- Hit rate	68.60	60.09	64.62
- Type I error rate	25.26	20.18	23.20
- Type II error rate	5.97	19.72	11.60

CHAPTER FIVE

Discussion

This research established a preliminary scoring system for the Maternal Perinatal Scale to improve its clinical utility. Though the MPS is a good measure of perinatal factors as reported by the mother, the current scoring criterion involves item-by-item analysis with no consideration of the interaction of the items. In contrast to other perinatal scales that have been developed in the past, this study used empirical data to create specific scores for each item's response, rather than arbitrary scores as decided by expert panels. Results revealed that our empirical scoring criteria were able to significantly differentiate between an at-risk group and non-at-risk groups on later developmental outcomes such as having neurological problems, learning problems, and low IQ. This suggests perinatal events are indeed associated with later developmental/cognitive problems as described by previous research (Dean & Davis, 2007; Ma, 1996; Stanton et al., 1991, Werner et al., 1967).

The current scoring system has an advantage over other scoring protocols, as it is based on a relatively vast number of normative data. Since many perinatal complications and poor neonatal outcomes are rare, collecting enough participants in a single sample to

identify relationships among variables is difficult. No other previous scales' scoring system has been developed with nationally representative population data. This is an important distinction for three reasons. First, both perinatal complications and poor neonatal outcome are rare within the population. Thus, it is necessary to gather a very large sample to ensure enough events associated with poor developmental outcomes are captured. Second, as mentioned previously, frequently those mothers and infants at greatest risk have numerous perinatal complications (Goodwin and Reid, 1963). In other words, typically those mothers who smoke, also delay prenatal care, deliver prematurely, have low birthweight infants, are of SES and have low motivation to participate in research. As such, it may be very difficult to obtain a sample that is free of sampling bias. Third, the CDC dataset has undergone rigorous data collection procedures to ensure accuracy and completeness, allowing for very few, if any, missing data.

The current findings support previous use of regression equations to understand which variables predict poor neonatal outcome. Larks and Larks (1968) used linear regression to predict Apgar scores, stillbirth, and neonatal death in the first year of life. Their results support our findings that gestation and birthweight are significant predictors of Apgar score. Additionally, consistent with our findings, plurality is also a common predictor of poor neonatal difficulties. Current findings acknowledged the importance of advanced maternal age and cigarette smoking, which was not accessed in the Larks and Larks study.

This study also adds important information to the body of literature that defines the specific conditions or event that contribute to a high-risk pregnancy. Indeed, high-risk pregnancy is frequently described as a set of vague symptoms that consists of at least one

factor that either the woman or baby has that makes them more likely to become ill or die around the time of birth as compared to others (www.merck.com, 2009). With the specific results from this study, clinicians, physicians, and policy makers can make more informed decisions about ways to prevent, identify and treat these types of pregnancies in the future. Namely, our study identifies that the most at-risk aspects include prematurity, small for gestational age, advanced maternal age, plurality (triplets or more), and smoking.

These results supported the need to use a complication-type scale versus the use of an optimality-type scale to identify risks of later impairment (Molfese, 1989). As mentioned in the review of the literature, optimality scales have equal weighting across items. However, as argued above, the results clearly suggest there are certain items that should carry more weight than other items. By treating each item equally, as in optimality scales, the measure loses a great deal of information about the potential risks for later problems. As such, the proposed weighted scoring system seemed the most logical and applicable option. Consistent with other weighted scoring systems in the past, this research revealed specific responses within items that carried more weight than others. However, unlike other studies, this study used empirically-based scoring criteria that were specific to each individual response within the items.

This outcome argues the proposed scoring system for the MPS to be a vast improvement over previous measures for two reasons. First, because responses within each item should be scored in such a way that a specific score on one item carries the same weight toward predicting the outcome as that same score on another item (i.e. a score of 2.4 on item #2 carries the same predictive power as a score of 2.4 on item #9). In

addition, this scoring system proposed scores that were empirically-based rather than arbitrary. Although clinical experience and expert opinion are thought to be important informants of scoring systems on other scales, empirical evidence provides even stronger evidence that such a relationship exists and should be continually explored with empirical studies.

The Overall score and the Maternal subscale score provided good evidence for the ability to differentiate between poor developmental outcomes later in life. Previous studies have identified how certain perinatal events are associated with cognitive deficits (Ma, 1996), motor deficits (Drillien, 1964, Stanton et al., 1991, Werner et al., 1967), and/or other common childhood disorders, such as ADHD and autism (Dean & Davis, 2007). Consistent with those findings, our results suggest that perinatal complications are associated with risks for neurological problems, being involved in special education, and having low intelligence. Further research is needed to identify the severity of the impact that each specific perinatal event may have on later development.

While the Labor/Neonatal subscale did not produce statistically significant results at differentiating at-risk and not-at-risk groups, it is still thought to be of great value for the clinician to have such a subscale for the MPS as both gestation and birth weight are included in this subscale. The lack of statistical significance could be explained by the large variability of scores within this subscale (response scores range from 0 to 67), the few number of items on this subscale (five labor items and two neonatal items), and the low incident rate of high scores (86% of the infants in question were born at term with average birthweight, resulting in the neonatal items producing a score of 0). In addition, the current scores relied on beta weights produced by a logistic regression. Although this

does allow for all variables to be entered into the equation at the same time, it also may dilute the impact that two very powerful, yet collinear, variables have on the outcome. As one variable accounts for a good deal of the variance, it does not allow the other variable to also account for a good deal of the variance, even if they are both very important to the outcome.

To create a more predictive neonatal subscale, a number of other options may be possible for future research. One previous perinatal scale highlighted the importance gestation by creating a subscale devoted to just that single variable (Goodwin et al., 1968), while other scales have identified numerous other neonatal risk factors to include on the neonatal subscale including items such as prolapsed cord, cardiac problems, respiratory problems, metabolic problems, and hematologic problems (Hobel et al., 1973; Prechtl, 1968). Thus, to improve this current scoring system, it is possible that additional neonatal items should be included or a separate criterion should be used for gestation and birthweight to improve the predictive power of the score.

Although the original hypothesis denoted a 70% cutoff score to be the acceptable rate for identifying risks, after conducting classification rates at 70, 75, and 80%, the cutoff selected to have the best balance of sensitivity and specificity was the 80% cutoff score. This score allowed for a high percentage of hit rate and still a low percentage of Type II error. Indeed, the Type II error rate increased between two and four percent in most cases, while the hit rate increased as much as 10 and 12 percent. For this type of study, the costs associated with delaying intervention may be greater than those associated with identifying false-positives within the sample.

In the light of the results, using the MPS in a clinical setting now seems to have several broad implications. Prior to this study, the only scoring criterion for the MPS involved item-by-item analysis with no statistical validation of the interpretation, which required clinicians to understand the breadth and depth of the impact that perinatal complications have on later development. Now, as further research validates the scoring system, clinicians will be able to use this short self-report measure to obtain information about a child and know the extent to which risks of later developmental problems exist. This is particularly important as the rate of infant morbidity continues to increase as medical technology becomes more advanced, allowing for smaller and less mature infants to survive (MacDorman & Mathews, 2008).

In summary, currently there are no maternal self-report scales that assess information during the perinatal period and its impact on later development for the child for the practicing clinician. The MPS gathers maternal self-reported information pertinent to the perinatal period, but lacked scoring criteria for interpretation by the clinician. This study created a preliminary scoring system that can now be further validated to aid in the interpretation of pertinent perinatal events and their impact on the child's later development. This has impact for the clinician by advancing early intervention options, developing treatment plans, and lowering health care costs associated with poorly defined high-risk pregnancy terminology.

Limitations and Future Directions

Although the preliminary scoring system using empirical data to create scores, it is certainly not a perfect mean for creating a scoring system for a measure. One limitation of the study is the outcome variable as the Apgar score. Research has been inconsistent in

the findings of whether the Apgar is a good predictor of childhood problems or not. Some research suggests there is no relationship between low Apgar and later outcomes (Maerin & Paes, 1988), though others report a correlational relationship between Apgar and neurological difficulties (Drage et al., 1966; Tenbrink, 1974), learning problems, behavioral problems and minor motor difficulties (Moster, Lie, and Markestad, 2002). This study identified low Apgar as a score of less than 4, as defined in other previous studies (Odd, Lewis, Whitelaw, & Gunnell, 2009; Odd, Rasmussen, & Gunnell, 2008; Serunian & Broman, 1975). However, this is not to say that intermediate scores (Apgar scores of 4 – 6) may not carry the potential for developmental risks as well. It would be an interesting investigation to understand the interaction effects of the Low (Apgar 0 – 3), Intermediate (Apgar 4 – 6), and Normal (Apgar 7 – 10) (Chong & Karlberg, 2004) had on later developmental problems as well. Future research is needed to understand the extent to which the Apgar is predictive of development later in life.

The results of this study are also limited by the inclusion of only one overall score and one subscale score. Other studies have argued the importance of having numerous subscales when assessing perinatal complications (Coopland et al.,1977; Goodwin et al., 1973; Prechtl, 1968). However, since the MPS is intended to be a short self-report measure, there are not enough items to create multiple subscales. Continued research on the MPS should be conducted to ensure all of the items on the MPS are still relevant and capture all of those items that are important perinatal complications. Indeed, this leads to another limitation. All previous scales have been developed some 40 or 50 years ago. The MPS validation studies were done some 30 years ago (Dean & Gray, 1991; Gray, 1987). Despite many items' continued inherent risk to the perinatal period multiple decades

later, it cannot be denied that some items may be out of date. For instance, decades ago, forceps use and cesarean delivery were considered high risk procedures and used more sparingly than they are today (MacDorman & Mathews, 2008). In fact, the rate of cesarean delivery rose from 34 percent in 1996 to 54 percent in 2006 (Martin et al., 2009). Nonetheless, the MPS was selected for this study based on its potential to be an invaluable tool that can be very quickly administered to aid clinicians. Despite dated validation studies, those items included on the MPS are believed to be relevant perinatal predictors. It is possible, however, that as medical technology has improved there are now contemporary complications that have emerged. As such, more updated examination of the most relevant items may be needed.

Although this study evaluated some 99% of the live births in 2006, these results are not able to be generalized beyond the sample at hand. Although this study does parallel results found by previous research (e.g. low birthweight, gestation, maternal age, tobacco are important predictors of poor outcome) (Anderson & Doyle, 2003; Bernstein & Gabbe, 1996; Cnattigius, Forman, & Berendes, 1993; Haustein, 1999; Jolly et al., 2000; Trachtenbarg & Goleman, 1998a; Vandenbosche & Kirchner, 1998) numerous studies have all examined a variety of variables. Of course, there are several variables that overlap from study to study, but each study contains its own unique set of perinatal complications and outcome variables. Future research is needed to identify only those variables that are most predictive of neonatal morbidity and those variables should undergo a series of population studies to best understand their impact on development. As more population studies are conducted and consistent results are revealed, the identity of the most serious perinatal complications can be revealed.

Perhaps the most profound limitation in this study, and most studies of this nature, was that it was not a longitudinal study that would allow for a direct relationship between those perinatal events and specific developmental outcomes. However, considering numerous difficulties associated with perinatal research (i.e. low incidence, need for large sample) and the expense of longitudinal data, it was beyond the scope of this project. Future research should focus on following those children who are born with perinatal complications to establish better associations with specific outcomes. This information could be invaluable to aid clinicians in appropriate treatment planning and early intervention for those at most risk.

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Appendix A

MPS items and responses compared to others' scores/weights for a similar item and response

Key for Appendix A

Goodwin et al. (1969)	D	score (0,1,2)
Hobel et al. (1973)	E	score (1, 5, 10)
Brazie et al. (1976)	F	score (% risk)
Coopland et al. (1977)	G	score (0,1,2,3)
Littman&Paralee (1978)	H	score (0,1-optimal)
Morrison (1980)	I	score (0,1,2,3)
Merck Manual	J	score (1,5,10)
Prectl (1968)	K	score (0-optimal,1)
Nesbitt & Aubry (1969)	L	score (0,5, 10,15, 20,25,30)
Aubry & Pennington (1973)	M	score (10,20,30)

MPS Item		MPS responses	D	E	F	G	H	I	J	K	L	M
The number of pregnancies prior	1	none	1	0		1	0		0	1	10	
	2	one	0	0		0	1		0	0	0	
	3	two	0	0		0	1		0	0	0	
	4	three +	0	5		0	1		5	0	5	
Vaginal bleeding during pregnancy	1	none	0	0		0	1		0	0		0
	2	some near end of pregnancy	2	5	31	3	0		10	1		20
	3	some at beginning of pregnancy	1	5		1	0		__	1		10
	4	a good deal throughout	__	5		__	0		__	1		0
Type of anesthesia	1	anesthesia injected into the spine					0			1		
	2	inhaled general anesthesia		5			0			1		
	3	injected general anesthesia		5			0			1		
	4	local anesthetic		0			0			0		
	5	none		0			1			0		
Child's weight at birth	1	less than 3lbs.				3	0		10	1		
	2	3lbs., 1 oz. to 4lbs.				3	0		10	1		
	3	4lbs., 1 oz. to 5lbs.				3	0		10	1		
	4	5lbs., 1 oz. to 6lbs.				__	0		__	0		
	5	more than 6lbs.				0	1		0	0		
Maternal Stress	1	very little					1			0	0	
	2	moderate amount					0			1	5	
	3	a good deal throughout					0			1	10	
Child born after how many months	1	6	4	__		__	0	3		1		30
	2	7	3	__		__	0	0		1		20
	3	8	2	__		__	1	0		0		0
	4	9	0	0		0	1	0		0		0
	5	greater than 9 months	1	10		1	0	0		1		20
	6	not sure	0	0		0	0	0		0		0

MPS Item		MPS responses	D	E	F	G	H	I	J	K	L	M
Length of labor	1	1-2 hours	0	0		0	0	0	0	1		
	2	3-5 hours	0	0		0	1	0	0	0		
	3	6-10 hours	0	0		0	1	0	0	0		
	4	11-16 hours	0	0		0	1	0	0	0		
	5	more than 16 hours	1	5		1	0	2	5	1		
Maternal weight gain	1	less than 10 lbs.										
	2	11-15 lbs.										
	3	16-25 lbs.										
	4	26-35 lbs.										
	5	36-45 lbs.										
	6	in excess of 46 lbs.										
Mother's age	1	under 15 years	0	5	6	1	0		5	1	20	
	2	15-19 years	0	0	6	0	0		0	1	10	
	3	20-29 years	0	0	0	0	1		0	0	0	
	4	30-34 years	0	0	2.7	0	0		0	1	5	
	5	35-39 years	1	5	2.7	2	0		5	1	10	
	6	over 40 years	2	5	2.7	2	0		5	1	20	
Prenatal care obtained	1	months 1-3	0		0		1					0
	2	months 4-6	0		1.3		1					0
	3	months 7-8	1		4.4		0					10
	4	after 8th month	2		7.6		0					20
Maternal swelling	1	minimal										
	2	some near the end of pregnancy										
	3	some near the beginning of pregnancy										
	4	a good deal throughout										

MPS Item		MPS responses	D	E	F	G	H	I	J	K	L	M
Labor induced	1	no		0	0	0	1	0	0	0		
	2	yes—prior to the ninth month		1	27.2	__	0	2	5	1		
	3	yes—after ninth month		1	27.2	__	0	2	5	1		

Forceps used	1	no forceps were necessary		0	0	0	1		0			
	2	yes, forceps were used		1	10.4	__	0		5			
	3	not sure, birth was cesarean		0	0	__	0		5			
	4	not sure		0	0	0	0		0			
Planned pregnancy	1	carefully planned for					1			0		
	2	not planned but pleased					1			0		
	3	not planned & unhappy w/news					0			1		
	4	unplanned and unmarried					0			1		
Multiple pregnancy	1	yes—twins	2	10	7.2	3	0		10	1		20
	2	yes—triplets or more	2	10	7.2	3	0		10	1		20
	3	no	0	0	0	0	1		0	0		0
Medication taken during preg	1	prescribed vitamins and/or iron					1					
	2	drugs to reduce tension					0					
	3	water loss medication					0					
	4	aspirin on at least a weekly basis					0					
	5	other					0					
	6	no medication was taken					1					
Presentation of the baby	1	feet first presentation (breech birth)		5	13.5	3	0		10	1		
	2	head first presentation		0	0	0	1		0	0		
	3	side presentation		10	24.6	3	0		10	1		
	4	no reason to believe different		0	0	0	0		0	1		

MPS Item		MPS responses	D	E	F	G	H	I	J	K	L	M
Time between water break/labor	1	medication needed to induce labor	__				0					
	2	contractions began prior or at the time	0				1					
	3	began naturally < two hours	0				1					
	4	began naturally > two hours	2				1					

	5	not sure	0				0					
Color of child after birth	1	yes, some blue										
	2	no										
Gynecological surgery prior	1	surgery necessary to correct infertility	__	__		1	0		__	1	__	
	2	surgery necessary during pregnancy	__	__		__	0		__	1	__	
	3	prior therapeutic abortion	1	5		1	0		__	1	5	
	4	prior voluntary abortion	1	5		1	0		__	1	5	
	5	surgery necessary 2 years + prior	__	__		1	0		__	1	__	
	6	episiotomy for previous baby	1	__		1	0		__	1	0	
	7	no history of surgery	0	0		0	1		0	0	0	
Prior pregnancies	1	none	1	__	0	1	1		__	1	10	
	2	one+ full term stillbirth or neonatal death	1	5	8.1	3	0		10	1	10	
	3	one or more resulting in normal birth	0	0	0	0	1		0	0	0	
	4	one + spontaneous abort/(miscarriage)	1	__	__	1	0		5	1	10	
Cigarette use during pregnancy	1	none		0		0	1	0	0	0		
	2	1 to 10		0		__	0	0	__	1		
	3	11 to 20		1		__	0	0	1	1		
	4	21 to 30		1		__	0	1	1	1		
	5	more than 30		1		__	0	1	1	1		
MPS Item		MPS responses	D	E	F	G	H	I	J	K	L	M
Average alcohol per day	1	none		0		0	1		0	0		
	2	1 to 2 drinks		0		__	0		__	1		
	3	3 to 4 drinks		1		__	0		1	1		
	4	more than 5 drinks		1		__	0		1	1		
Maternal high blood pressure	1	Blood pressure was normal	0	0	0	0	1		0	0	0	0
	2	Blood pressure was high at end	0	__	__	1	0		5	1	0	20

	3	Had high bp, weight gain, swelling,	3	10	22.4	2	0	10	1	15	30
	4	Was told preeclampsia, hospitalized	3	10	22.4	__	0	10	1	30	30
Rh incompatibility	1	No “Rh problems” were reported	0	0	0	0	1	0	0	0	0
	2	This was 2+ child born Rh problems.	0	0	__	__	0	__	1	30	20
	3	I was hospitalized / took medication	3	5	39.4	3	0	10	1	30	20
	4	Child have anemia following birth.	3	5	__	3	0	10	1	30	__