Maternal Report of Perinatal Information as a Predictor of Cardiopulmonary Functioning in the Neonate

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Abstract: None available.

Full Text: Headnote ABSTRACT: This study examined the relationship between neonates cardiopulmonary condition and relevant information from the perinatal period. Multiple regression analyses showed that a linear composite of mother's report of perinatal information accounted for a significant amount of the variability in three of the five APGAR components at one minute (i.e., Heart Rate, Respiratory Effort, and Reflex Irritability) and all five APGAR components at five minutes. The results were interpreted as lending support to the utility of structured maternal report of perinatal information. Perinatal risk factors refer to potential etiological events occurring during a period extending from the 12th week of gestation through the 28th day of the neonates life. Although modern medical technology has decreased the risks involved in giving birth, as many as eight percent of all live births result in perinatal complications (Behrman, 1981). Moreover, the children born under these high risk conditions have been shown to have an increased incidence of childhood developmental disorders (e.g., Commey &Fitzhardinge, 1979; Field, Dempsey, &Shuman, 1981; Hobel, 1985; Pfeiffer, Heffernan, &Pfeiffer, 1985). However, there is mounting evidence that the early recognition of perinatal difficulties and appropriate treatment may reduce the morbidity rate of cognitive and neurodevelopmental handicaps resulting from these complications (e.g., Cohen, Parmelee, Sigman, &Beckwith, 1982). With intervention available, the need for a reliable method of identifying high risk infants soon after birth seems clear (Gray, Dean, &Rattan, in press; Parmelee, Beckwith, Cohen, &Sigman, 1983; Shennan, Milligan, &Hoskins, 1985.) Although specialists in child development have recognized the potential impact of perinatal complications, when compared to the scope of the problem the research has been scant with rather small samples (Gray, et al, in press). Generally speaking, while the importance of information concerning the perinatal period is recognized, research and clinical application of such data has been impeded by the lack of reliable methods of collecting retrospective data. Hospital charts offer a rich source of perinatal information however, they are of questionable utility in a mobile society. Methodological concerns not withstanding, research which has examined the relationship between perinatal complications and childrens development have shown that infants born at risk are more likely to present with developmental deficits than children of unremarkable births. Along these lines, Field, Dempsey, &Shuman (1981) examined the cognitive, behavioral, temperamental, social, and language functioning, of 92 two-year old high risk children. All subjects had neonatal histories of either prematurity with respiratory distress syndrome, postterm delivery with postmaturity syndrome, and/or specific obstetric complications. The results of this investigation showed that when compared to a full term control group the high risk infants experienced significantly more developmental delays, hyperactivity, speech difficulties, and attentional deficits. While the subjects in this study were two-years old it is interesting to note that in other research the rate of cognitive, neurodevelopmental, and behavioral disorders in high risk infants was even greater by the age of four (Field, Dempsey, &Shuman, 1979; Pfeiffer, et al., 1985). Although it seems clear that complications in pregnancy, labor, and/ or delivery place the fetus and/or infant at risk (e.g., Butler &Goldstein, 1972; Caputo, Goldstein, &Taub, 1981; Field, et al., 1979,1981; Hobel, 1985; Kajanoja &Widholm, 1978; Low, Galbraith, Muir, Killen, Patar, &Karchmar, 1985; Niswander &Gordon, 1972; Saxton, 1978; Stott, 1973; Williamson, Murdina, &LaFevers, 1982), there does not appear to be a one-to-one relationship between such complications and long-term morbidity. Indeed, many children born under adverse conditions may show no sign of subsequent physical or psychological sequelae (Freeman, 1985a). A number of investigators have argued that the environment in which the infant is born and reared may be a mediating factor (e.g., Avery, 1985; Gray, Dean, &Lowrie, 1987; Miller, Hassanein, &Hensleigh, 1978). This being the case, high risk infants born to low socioeconomic families may be more likely to experience long term morbidity than infants of middle class mothers (Avery, 1985.) Moreover, perinatal complications may interact with psychosocial factors, such that lower socioeconomic infants are at a greater risk for perinatal complications. Much of the retrospective research examining the impact of perinatal complications has relied upon unstructured maternal reports as the major source of data (McNeil &Kaij, 1978). Problems with this approach relates to the potential unreliability of information when collected in an unstructured fashion (e.g., Goddard, Broder, &Wenar, 1961; Robbins, 1963; Wenar, 1963). Pollack and Woerner (1966) argued that these assessment problems may originate from parental errors of omission, while other investigators report that inconsistencies are due to selective memory and/or unconscious confabulation (e.g., Rutt &Offord, 1971; Taft &Goldfarb, 1964). Indeed, methodologies which depend upon unstructured interviews and open-ended questionnaires would seem to lack the rigor necessary for either clinical or research purposes. Medical chart reviews, while reliable, offer a major obstacle to any large scale research or clinical effort in the retrospective study of perinatal risk factors. Thus, the utility of an instrument that would allow assessment of perinatal histories in a structured and reliable manner is clear. With the methodological concerns of the past in mind, a scale was constructed which collected information pertaining to pregnancy, birth, and psychosocial factors (Maternal Perinatal Scale) (Dean &Gray, 1985). This self-report measure requires respondents to recognize, rather than the more difficult task of recall, such factors as the neonates weight at birth, type of anesthesia administered during delivery, extent of vaginal bleeding during pregnancy, prior medical conditions, amount of psychosocial stress, etc. (see sample items in Appendix 1). The specific factors assessed by the scale are shown in Table 1. The MPS allows the consideration of potential interaction of individual risk factors on the infants development. Indeed, because the MPS queries information pertaining to the pregnancy, labor, and delivery, as well as social-cultural information, the multivariate influence of these variables in later development can be studied. Investigations in the perinatal area have often considered the behavioral effects of individual complications (e.g., birth weight) in a univariate fashion. Also problematic, most studies have not considered the effects of perinatal complications beyond the preschool years. It was thought that the MPS would serve as a screening instrument for pediatric specialists (e.g., pediatric/child psychologists, school psychologists, pediatricians, etc.) who characteristically collect perinatal information from the patient's mother. Although in the present form of the MPS items or clusters of items are considered, standard scores and factors are envisioned as the end product. From a research point of view, the format of the MPS was thought to have potential in the examination of the link between a number of cognitive/behavioral disorders (e.g., mental retardation, learning disabilities, speech pathology, childhood psychiatric, disorders, etc.) and perinatal risk factors. As such, these data would further delineate the complexities of the perinatal period of development.

Table 1

Factors Assessed By The Maternal Perinatal Scale

Factors	
Factors Prior to Pregnancy	*Maternal Disorders*
Mother's weight	Maternal Medical Conditions
Mother's height	*Labor and Delivery*
Father's height	Anesthesia employed during delivery
Number of prior births	Length of labor
Mother's age at time of birth	Induced labor
History of gynecological surgery	Forcep use
History of previous problem pregnancy	Multiple pregnancy
Factors During Pregnancy	Presentation of infant during delivery
Vaginal bleeding	Time from water break to labor
Amount of maternal psychosocial stress	Child's color at birth
Weight gain	*Birth Weight and Gestational Age*
First consulted physician	Child's birth weight
Pregnancy planning	Months to term
Medication & vitamin use during pregnancy	*Social-Cultural Factors*
$\bar{X}$ number of cigarettes during pregnancy	Mother's & Father's race
$\bar{X}$ amount of alcohol during pregnancy	Families socioeconomic status
Edema	

In a recent demonstration of its reliability, Gray et al., (in press) showed that mothers' responses to items on the Maternal Perinatal Scale (MPS) were consistent when administered on two different occasions. Importantly, these investigators found that greater than 90% of the items had correlations with the second administration which exceeded .90. A subsequent investigation examined the agreement between mothers responses to the MPS and the same relevant information contained within the medical chart (Gray, Dean, Rattan, &Bechtel (in press). The results showed 91% of the validity estimates to exceed r = .90. In sum, it would seem that the MPS has psychometric qualities which recommend it. Indeed, the measure appears stable over time and offers information consistent with that provided by the medical records. However, the utility of the MPS squarely rests upon its ability to predict the child's functioning at a given point in time. Infants cardiopulmonary condition, as measured by the APGAR Scoring System (Apgar, 1953), has been shown to be an important indicator of the neonate's general health and a predictor of morbidity (e.g., Laursen, 1983). Clearly, cardiac dysfunction and attenuated circulation has been shown to be an underlying factor in numerous birth anomalies (e.g., Butnaresau, Tillotson, &Villarreal, 1980). The present investigation was designed to examine the utility of perinatal factors as predictors of neonate's cardiopulmonary condition. Specifically, perinatal information gleaned from the MPS was used to predict each of the five categories of the APGAR assessment (color, heart rate, reflex response, muscle tone, respiratory effort) (APGAR, 1953) at one and five minutes post partum. Prediction of Apgar Scores would support the MPS and perinatal information as a retrospective measure of children's medical condition at birth. METHOD Subjects The subjects were 50 consecutively delivered infants (24 male, 26 female) at a large midwestern teaching hospital. Generally speaking, infants came from white lower middle class backgrounds as determined by the occupation of the major wage earner in their family. A summary of the deliveries is included in Table 2. Assessment Procedures Information concerning the perinatal period was collected using the Maternal Perinatal Scale described earlier. Each infant's mother was administered the MPS at bedside within the first 96 hours post partturn. Following general instructions, mothers completed the scale independently with any questions being answered by one of the investigators. None of the mothers reported difficulty in reading or understanding the measure.

Table 2

Summary of Deliveries

Factor	*Incidence*
Epidural	5
General Anesthesia	10
Local Anesthesia	35
Small for gestational age	4
Cesarean delivery	11
Forceps used in delivery	3
Labor induced	8
Breach presentation	4
Vertex presentation	46
Premature rupture of membranes	5
Males	24
Females	26
$\underline{X}$ one minute APGAR Score	7.68
$\underline{X}$ five minute APGAR Score	8.76
$\underline{X}$ birthweight	7 lbs. 3 oz.
X gestational age	36.8 months

The neonates cardiopulmonary condition was assessed using the APGAR Scoring System. Routinely administered in most delivery rooms, the APGAR assessment is considered to be a summary of the neonates post delivery condition (e.g., Apgar, 1953). Using a rating of 0,1, or 2, the APGAR scoring system evaluates newborns in the areas of color, heart rate, reflex response, muscle tone, and respiratory effort at one and five minutes of life. A composite score is derived from addition of the five component scores, which ranges from 0 to ten. The APGAR Scoring System is seen as an important source of information regarding the neonates ability to adjust to the stresses of labor and delivery (James, 1962). Moreover, APGAR Scores have been shown to predict neonatal mortality (e.g., Apgar &James, 1962). APGAR assessments were performed at one and five minutes post partum by the attending obstetrician or registered nurse assigned to the patient. All APGAR assessment were performed blind to mothers responses to the MPS items. RESULTS Each neonate's one and five minute Apgar Scores were obtained from their medical charts. Perinatal information was gleaned from the MPS as completed by the mother. To assess the degree to which perinatal information would predict Apgar Scores, a series of multiple regression analyses were performed. Specifically, 26 perinatal items from the MPS were used to predict each of the five categories (heart rate, respiratory effort, muscle tone, reflex irritability, and color) of the Apgar Assessment at one and five minutes. A forward stepwise method was chosen to identify the items of the MPS which added significantly ($p < .01$) to the prediction of the five Apgar components. Because responses to one item of the MPS ("Was the pregnancy for this child a multiple pregnancy?") offered no variability, this item was excluded from the analyses thereby leaving a total of 25 possible predictors. Table 3 presents the multiple correlation (R) and standardized beta weights for each Apgar Component at one minute. The corresponding analyses for the five minute Apgar Assessment are offered in Table 4. It is clear from these data that approximately 85% of the variability ($R = .92$) for heart rate at one minute was explained by perinatal variables involving the direction of presentation of the fetus at delivery, mothers use of vitamins during the pregnancy, the need for a medically induced labor, and the amount of weight gained by the mother during pregnancy. When contrasted to Apgar heart rate at five minutes, however, 100% of the variability was explained by but two perinatal variables (direction of presentation, and maternal use of vitamins).

Table 3

Hierarchial Step-wise Multiple Regression Analyses in Predicting Apgar Measures at One Minute

MPS Predictors[a]	Heart Rate R	Heart Rate SWB[b]	Respiratory R	Respiratory SBW	Reflex R	Reflex SBW	Muscle R	Muscle SBW	Color R	Color SBW
Presentation	.62**	−1.272	.36*	−0.802						
Vitamins	.89**	0.852	.58**	0.634						
Labor	.91**	−0.171								
Weight Gain	.92**	0.147								
Age					.43*	−0.482				
Anesthesia					.51*	−0.283				

Note. Presentation = direction of fetus at time of delivery; Vitamins = mothers's use of vitamins during pregnancy; Labor: medical induction of labor; Weight Gain = weight gained by mother during pregnancy; Age = mother's age; Anesthesia used during delivery.

[a] Only MPS variables that contributed significantly in predicting Apgar scores are included in this table.

[b] *SBW* = standardized beta weight.

*$p < .01$. **$p < .001$.

Slightly more than 33% of the variability in respiratory effort at one minute was accounted for by the perinatal factors of presentation of the neonate at delivery and mothers vitamin use. The variability accounted for in respiratory effort at five minutes was not significantly different than that at one minute. Indeed, approximately 38% of the variability in the five minute score was accounted for by the inclusion of the same predictors with the addition of the father's height. The 26% of the variability of the Apgar Score for reflex irritability at one minute was explained by the mother's age and the type of anesthesia employed during delivery. At five minutes, the variability increased significantly (p <.05) to 81% with the majority of this increase attributed to items concerning mothers use of vitamins during pregnancy (36%) and the presentation direction of the fetus at delivery. To a lesser extent, the inducing of labor (11%) and weight gained by the mother during pregnancy (four percent) accounted for the remaining explained variability for the five minute reflex response measure. Thus, it appears that while mother's age and anesthesia were important considerations for reflex irritability at one minute, they failed to account for significant amounts of variability at the five minute assessment. Perinatal factors were significant predictors of muscle tone and color only in the five minute Apgar Assessment. In this case, the daily amount of ethanol consumed during pregnancy and the mother's weight prior to pregnancy explained 38% of the variability in muscle tone (see Table 2). When Apgar color was examined, the degree to which labor was medically induced was the only significant predictor, explaining but 16% of the variability. The Apgar component assessments were collapsed into a one and five minute summary score for each child. The prediction of each of these scores was attempted with the same 25 items of the MPS. The results of these analyses are offered in Table 5. This analysis showed that the presentation of the fetus at delivery and mothers use of vitamins during pregnancy were salient perinatal factors at one minute. Not surprisingly, the above variables also accounted for the major proportion of the variability for the composite Apgar Score at five minutes. Presentation of the fetus at delivery and maternal vitamin use were responsible for some 67% of the variability while mothers daily ethanol use explained an additional three percent of the Apgar measures at five minutes. In sum, slightly more than 70% of the variability in Apgar Scores at five minutes was explained by these three variables.

Table 4

Hierarchial Step-wise Multiple Regression Analyses in Predicting Apgar Measures at Five Minutes

MPS Predictors[a]	Heart Rate R	Heart Rate SBW[b]	Respiratory R	Respiratory SBW	Reflex R	Reflex SBW	Muscle R	Muscle SBW	Color R	Color SBW
Presentation	.70**	−1.398	.37*	−0.765	.55**	−1.177				
Vitamins	1.0**	1.0	.56**	0.670	.81**	0.770				
Height			.62**	0.276						
Labor					.88*	−0.323			.40*	0.404
Weight Gain					.90**	0.185				
Ethanol							.56**	0.604		
Weight							.62**	0.252		

Note. Presentation = direction of fetus at time of delivery; Vitamins = mother's use of vitamins during pregnancy; Height = father's height; Labor = medical induction of labor; Weight Gain = weight gained by mother during pregnancy; Ethanol = daily alcohol consumption during pregnancy; Weight = mother's weight before pregnancy.

[a] Only MPS variables that contributed significantly in predicting Apgar scores are included in this table.

[b] *SBW* = standardized beta weight.

*$\underline{p} < .01$ **$\underline{p} < .001$.

Table 5

Hierarchial Step-wise Multiple Regression Analyses in Predicting Composite Apgar Measures at One and Five Minutes

MPS Predictors[a]	Apgar One Minute R	Apgar One Minute SBW[b]	Apgar Five Minutes R	Apgar Five Minutes SBW
Presentation	.46*	−0.950	.55**	−1.150
Vitamins	.68**	0.708	.82**	0.848
Ethanol			.84**	0.186

Note. Presentation = Direction of fetus at time of delivery; Vitamins = mothers's use of vitamins during pregnancy; Ethanol = daily alcohol consumption during pregnancy.

[a] Only MPS variables that contributed significantly in predicting Apgar scores are included in this table.

[b] *SBW* = standardized beta weight.

*$\underline{p} < .01$ **$\underline{p} < .001$.

DISCUSSION The current study not only points to the MPS as a valuable source of perinatal data, but also as a post-hoc indicator of infant condition at birth. An examination of the multiple correlations between summary Apgar Scores and MPS items demonstrates a substantial relationship between perinatal risk factors and infant condition as measured by the Apgar score. Moreover, it is interesting to note that the proportion of variability in Apgar Scores which could be accounted for by MPS items at one minute (46%) increased to 70% at five minutes. Such a temporal increase in predictability is consistent with prior research (Nelson and Ellenberg, 1981). In an investigation by Nelson and Ellenberg (1981) Apgar summary scores, taken at 5, 10, 15 and 20 minute intervals, were shown to be more salient predictors of cerebral palsy at later periods. In addition, the heart rate APGAR Score is more objective than other components (heart rate <100). Thus, greater reliability for the heart rate score would seem to have contributed to the strength of the present findings. Clearly, the most impressive finding of the present study is that an extraordinary proportion of the variance in Apgar heart rate was accounted for by a rather small composite of perinatal factors from the MPS. Indeed, the 85% of variability explained by heart rate at one minute increased to 100% at five minutes. The superior prediction of heart rate is important in that prior research reveals the clinical potency of fetal heart rate as an indicator of an infant's general condition (Laursen, 1983). Indeed, research which has examined electronic fetal monitoring devices has further validated the physiological relationship between heart rate and infant condition (Schifrin &Dame, 1972). Thus, the present data supports the MPS as a predictor of an infant's physiological condition at the time of birth. Physiologically, the initial consequence of abnormally low heart rate is decreased cardiac output. If low heart rate is prolonged, eventual circulatory collapse will incur. Decreased respiratory effort, cyanosis, depressed reflex irritability and muscle tone are symptoms of such collapse (Butnaresau, Tillotson &Villarreal, 1980; Klaus &Fanaroff, 1973). Thus, heart rate seems to be an underlying factor of each of the other Apgar components. If, in fact, the MPS is a valid predictor of infant condition at birth, then a relatively higher relationship between MPS items and heart rate would be expected. From both animal studies and human data it has been well established that hypoxia can cause brain damage (Myers, 1972). Apgar Scores with an emphasis upon cardiopulmonary functioning offer good predictors of neonatal hypoxia (e.g., Gilles &Burton, 1985). However, contrary to what one might expect, some infants with early signs of hypoxia show little or no evidence of compromised neurological integrity (Freeman, 1985a). In a recent National Institutes of Health (NIH) (Freeman, 1985b) report of the perinatal correlates of mental retardation, cerebral palsy and epilepsy, it was stressed that the neurological outcome of hypoxia seems to depend on the nature of the oxygen deprivation. Moreover, in summarizing some 20 years of research, the NIH (Freeman, 1985b) report argues that while low APGAR scores predict hypoxia, this finding may be the result of prior maternal medications, infections or the gestational age and condition of the fetus. With MPS assessing a comprehensive array of perinatal risk factors, the present study supports the NIH conclusion (Freeman, 1985b) of multiple variables which underlie the Apgar score. Given the fact that the effect of hypoxia does not appear to be as simple and direct as previously portrayed, the MPS offers potential for research which examines the factors responsible for neurological impairment as well as the study of childhood maladies with a perinatal etiology. As with any research which relies upon multiple regression, the present results warrant replication. However, when Theil's (1971) formula for estimating an unbiased multiple correlation was applied to the present data, the variance remained clinically significant. Indeed, even if one assumes greater than normal shrinkage of the relationship in the general population the present findings with the MPS are impressive. The fact that the relative order of predictors were similar for both one and five minute Apgar Assessments, adds further credibility to the stability of the present findings. The individual items of the MPS which best predicted Apgar components are of interest. The findings for items concerning abnormal presentation, lack of maternal vitamin use during pregnancy and increasing quantities of maternal ethanol consumption were the most consistent predictors of low scores on the Apgar component scores. The contribution of abnormal presentation to prediction of the infant's APGAR scores suggests a depressive effect on the infant for general anesthesia to the mother during the Caesarean section. The drastic withdrawal of the infant from an alcoholic environment has also been known to have detrimental effects on an infant's immediate post delivery condition. Indeed, when compared to normal controls, offspring of alcoholic mothers present with a greater than normal incidence of mental retardation, growth retardation, hyperactivity, and speech difficulties (e.g., Kalant, 1980; Losub, Fuchs, &Bingol, 1981). Although a regime of maternal vitamins is important during pregnancy, the lack of maternal vitamin use as a predictor of low APGAR Scores may also be a reflection of less than optimal prenatal care (Hobel, 1985). Since each MPS item represents a documented perinatal risk, one would expect these items to be interrelated (Gray, et al, 1987).

Thus, while multivariate analysis has been shown to be an especially viable method of studying perinatal risk factors (Gray et al., 1987; Lester, Emory, Hoffman &Fitzman, 1976), multicollinearity may be such that the relative importance of individual predictors can be expected to fluctuate between studies. In the present investigation the relative importance of significant MPS items may have been affected by the order of entry into the regression equation, with the most significant item being entered first. Although multicollinearity needs to be considered, the direction of each of the significant items in the present study supports previous research in perinatal risk (Naeye &Tafari, 1983). SUMMARY A number of investigators have questioned the utility of perinatal information obtained from maternal self reports, however the present results with the MPS suggest that a systematic maternal report of perinatal events may be a method of gathering retrospective information reflective of a child's condition at birth. The potential utility of the MPS for early identification of high risk children is obvious. Moreover, the measure would seem to have the potential to offer the pediatric specialists insight into the etiology of childhood disorders which they may be called upon to evaluate. This potential is suggested in a recent investigation which allowed the diagnosis of mental retardation with an 82% hit rate solely on the basis of the items of the MPS (Gray, Dean, Strom, Wheeler, &Brockly, 1987). Further research which examines the diagnostic utility of the MPS with other pediatric populations would seem of value. References REFERENCES

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Appendix Appendix Sample Items of the Maternal Perinatal Scale _____ Approximately what was the length of labor (with regular contractions) prior to birth? 1. 1-2 hours 2. 3-5 hours 3. 6-10 hours 4. 11-16 hours 5. more than 16 hours _____ About how much weight was gained by the mother during pregnancy? 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. _____ This child's weight at birth was: 1. less than 3 lbs. 2. 3 lbs., 1 oz. to 4 lbs. 3. 4 lbs., 1 oz. to 5 lbs. 4. 5 lbs., 1 oz. to 6 lbs. 5. more than 6 lbs. _____ During the pregnancy when did the mother first consult a physician? 1. months 1-3 2. months 4-6 3. months 7-8 4. after 8th month

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