

Perinatal factors and their relationship to mental retardation and other parameters of development

PAUL F. MULLER, M.D.
H. EDWIN CAMPBELL, M.D.
WILLIAM E. GRAHAM, M.D.
HARRY BRITTAIN
JOSEPH A. FITZGERALD, M.D.
MICHAEL A. HOGAN, M.D.
VICTOR H. MULLER, M.D.
A. H. RITTENHOUSE, P.H.D.

Indianapolis, Indiana

The correlation of perinatal experience with developmental results in the growing child provides a much more sensitive evaluation of obstetric practices than perinatal mortality studies. This is a retrospective study, made in conjunction with an on-going prospective study, involving delivery of 2,383 infants and a 9 year follow-up of 1,698. Lorge-Thorndike intelligence tests, arithmetic achievement levels, grades repeated in school, and other means of evaluating development were used. Several statistically significant correlations were established. Advanced age of the mother, breech presentation, premature rupture of the membranes, and prematurity were all found to have a statistically significant deleterious effect. Breech presentation produced such a high percentage of poor developmental results that further analysis in the prospective study and further research are essential.

ONE TRADITIONAL approach to the evaluation of obstetric procedures and policies has been the study of perinatal mortality. In recent years efforts have been made to add more sensitive evaluation techniques to this fairly gross method. As early as 1933 Bayley reported a series of developmental

studies as related to perinatal factors.¹ Other studies were done through animal experimentation,^{2, 3, 4} and also extensive investigation of those exposed to irradiation at Hiroshima.^{5, 6}

It was not until 1958 that the Collaborative Perinatal Study was set up to evaluate these correlations on a large scale involving 50,000 deliveries. Most of these papers,⁷⁻¹⁰ and others in the area,¹¹⁻¹⁴ have been written by investigators outside the specialty of obstetrics and gynecology; probably because of the proximity of those authors to the developing child.

It was felt that we, as obstetrician-gynecologists, should direct our attention to this very important area. In Indianapolis a unique situation existed in the relationship

From St. Vincent's Hospital, St. Mary's Child Center, Archdiocesan Catholic School System, and the Public School System of Indianapolis.

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between St. Vincent's Hospital, the St. Mary's Child Center for Special Education, and the Indianapolis Archdiocesan School System. A high percentage of infants could be traced through this school system and many of those with developmental problems were on the rolls of the St. Mary's Child Center.

The project was designed as a retrospective study going back to charts 9 years old and a prospective study of present-day deliveries to be correlated with future measures of development. This report gives the findings of the retrospective study. The smaller sample, although less desirable statistically, presents an excellent opportunity for more accurate, uniform, and concentrated study with coding, testing, etc., being done by a minimum of individuals.

Material and methods

The obstetrical charts of 2,383 infants delivered at St. Vincent's Hospital in 1956 were analyzed and pertinent variables coded and punched on computer cards. One thousand six hundred ninety-eight children, 9 years old in 1965, were traced and developmental factors obtained through the following means.

1. All children of this age in the Indianapolis Archdiocesan Parochial School System were given a Lorge-Thorndike intelligence test. Five hundred and thirty-three of these were found to be part of the study.

2. Questionnaires asking for information regarding physical and mental development were sent to: (A) parents; (B) pediatrician or family physician; and (C) school principal (both parochial and public school systems were most cooperative).

These data were analyzed in three ways:

1. Chi square analysis of obstetric factors at delivery—*anesthesia, type of delivery, length of time that the membranes are ruptured, weight of the infant, as correlated with developmental factors at age 9 years—grade repeated, remedial measures recommended, speech difficulty (reported by parents), brain damage (reported by parents), mental retardation (reported by parents), arithmetic*

Table I. Grades repeated and infant weight*

Infant weight (grams)	No. of infants	No grade repeated	One or more grades repeated
< 2,500	79	67	12—15.2%
2,501-4,000	1,449	1,328	121— 8.3%
> 4,001	169	158	11— 6.5%

*Chi square = 5.456954; P < 0.10.

Table II. Grades repeated and type of delivery*

Type of delivery	No. of infants	No grade repeated	One or more grades repeated
Spontaneous or low forceps	1,558	1,428	130— 8.3%
Midforceps	58	56	2— 3.4%
Breech	49	37	12—24.5%
Cesarean section	33	33	0— 0.0%

*Chi square = 21.168529; P < 0.005.

Table III. Grades repeated and status of membranes*

Membranes	No. of replies	No grade repeated	One or more grades repeated
Not ruptured until delivery	166	160	6—3.6%
Ruptured < 24 hours	1,122	1,016	106—9.5%
Ruptured > 24 hours	65	61	4—6.1%

*Chi Square = 6.786705; P < 0.05.

achievement level (reported by school), speech problem (reported by school), brain damage (reported by school), behavior problems (reported by physician), emotional problems (reported by physician), learning problems (reported by physician).

2. Analysis of variance of obstetric factors at delivery—*anesthesia prior to delivery in minutes, mother's age, hemoglobin post partum, blood loss (c.c.), weight of infant,*

Table IV. Arithmetic achievement level and type of delivery*

Type of delivery	No. of replies	Below normal		Normal		Above normal	
		No.	%	No.	%	No.	%
Spontaneous or low forceps	1,412	214	15.2	771	54.4	427	30.4
Midforceps	54	5	9.2	36	66.8	13	24.0
Breech	44	14	31.9	23	52.2	7	15.9
Cesarean section	31	4	12.9	19	61.3	8	25.8
Total	1,541	237		849		455	

*Chi square = 14.566097; P < 0.025.

Table V. Arithmetic achievement level and status of membranes*

Membranes	No. of replies	Below normal		Normal		Above normal	
		No.	%	No.	%	No.	%
Not ruptured until delivery	157	21	13	99	63	37	24
Ruptured < 24 hours	1,020	141	14	553	54	326	32
Ruptured > 24 hours	52	12	23	31	60	9	17
Total	1,229	174		683		372	

*Chi square = 11.324084; P < 0.025.

Table VI. Recommendation of remedial measures and type of delivery (reported by parents)*

Type of delivery	No. of replies	Not recommended		Recommended	
		No.	%	No.	%
Spontaneous or low forceps	1,509	1,392	92.3	117	7.7
Midforceps	54	49	90.8	5	9.2
Breech	47	38	80.9	9	19.1
Cesarean section	32	30	93.8	2	6.2

*Chi square = 8.196082; P < 0.05.

minutes to cry, minutes to breathe, membranes ruptured, type of delivery, as correlated with developmental factors at age 9 years—Lorge-Thorndike I, Lorge-Thorndike II, Lorge-Thorndike III, total Lorge-Thorndike.

3. Analysis of variance of obstetric factors at delivery—mother's age, anesthesia

prior to delivery, blood loss, hemoglobin post partum, as correlated with developmental factors at age 9 years—grade repeated, remedial measures recommended, *speech difficulty (reported by parents)*, brain damage (reported by parents), *mental retardation (reported by parents)*, arithmetic achievement level (reported by school), speech problems (reported by school), brain damage (reported by school), behavior problems (reported by physician), emotional problems (reported by physician), learning problems (reported by physician).

Results and comment

Of the twelve developmental parameters examined, significant relationships to obstetric parameters were obtained for six:

- Grade repeated
- Arithmetic achievement levels
- Speech defect—as reported by parents
- Mental retardation—as reported by physician
- Remedial measures recommended by physician, or school—as reported by parents
- Lorge-Thorndike testing

Table VII. Speech defects (reported by parents)*

<i>No. of replies</i>	1,657—No	27—Yes
Mother's age at delivery (mean)†	27.1 years	30.2 years

*F = 7.4749; P < 0.01.

†A 3.1 year difference.

Table VIII. Mental retardation (reported by parents)*

<i>No. of replies</i>	1,673—No	13—Yes
Mother's age at delivery (mean)†	27.1 years	31.4 years

*F = 7.1480; P < 0.01.

†A 4.3 year difference.

The grade repeated was the most productive, as indicated by Tables I, II, and III. Grade repeated indicated poor results in premature infants and very poor results in children after breech delivery, with 24.5 per cent of the latter repeating one or more grades in school. The grade repeated parameter indicates good results in those infants whose membranes were not ruptured until time of delivery.

Arithmetic achievement level (Tables IV and V) supported the above by showing very poor results after breech delivery and membranes ruptured over 24 hours prior to delivery. Membranes intact at delivery time again indicated good results.

Parental reports on their child produced statistically significant results in three areas as shown in Tables VI, VII, and VIII. The reply to the question "Have remedial measures been recommended?" produced positive results in 19.1 per cent of the breech deliveries. Speech defects replies indicated that in the mothers giving positive answers, the mean age at time of delivery was 3.1 years higher than those giving negative answers. Mental retardation replies indicated that in the mothers giving positive answers the mean age at time of delivery was 4.3 years higher than those giving a negative answer.

Table IX. Lorge-Thorndike I and weight of infant*

<i>Weight of infant (grams)</i>	<i>Sample size</i>	<i>Mean score</i>
< 2,500	21	15.43
2,501-4,000	456	16.88
> 4,000	60	17.17

*F = 3.1019; P < 0.05.

Table X. Lorge-Thorndike II and type of anesthesia*

<i>Type of anesthesia</i>	<i>Sample size</i>	<i>Mean score</i>
None	14	18.36
Regional	62	18.77
Inhalation	453	17.39
Combination	7	19.14

*F = 5.2626; P < 0.01.

Lorge-Thorndike testing produced significant results in two areas only. Table IX (Lorge-Thorndike I): The mean score was 1.45 points lower in children who were born premature. Table X (Lorge-Thorndike II): The mean score was 1.38 points lower in children delivered with inhalation anesthesia than those delivered with regional anesthesia. There were insufficient cases for significant statistical evaluation of those who were delivered with no anesthesia or combined anesthesia.

Negative results contained some surprising information. Although 89.5 per cent of the deliveries were conducted with inhalation anesthesia and the mean duration of anesthesia was 15.77 minutes prior to delivery, there was no indication that duration of anesthesia had any significant effects. Minutes to breathe was over 5 minutes in 18 cases and of these 7 achieved above average in arithmetic achievement levels. Minutes to cry was above 7 minutes in 27 cases and of these 13 were above average in arithmetic achievement levels.

It is not suggested that obstetrical practices be modified at this time because of these findings. Anesthesia practices have been changed since these deliveries and the

results concerning breech delivery should be confirmed by the above mentioned prospective study and by further research.

It is felt that the primary value of this

paper is the establishment of reliable parameters for the evaluation of progress in the developing child.

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Discussion

DR. DOUGLAS M. HAYNES, Louisville, Kentucky. Drs. Muller, Campbell, and their co-workers deserve to be congratulated on their patience and perseverance in collecting the immense body of data they have presented involving an important area of investigation which has not hitherto received adequate attention in the obstetric literature. Their work represents a major project in the general area of "correlation" research, and as such it is subject to correlation strengths and weaknesses. Correlation is an excellent method for hypothesis formulation; it makes possible meaningful study of variables that are not susceptible to experimental manipulation; and it permits the establishment of relationships on discrete, noninterval data as well as the elucidation of the interrelationship of many variables. On the negative side, correlation analysis does not readily allow the establishment of cause and effect relationships. Moreover, when as many variables as those involved in this study are correlated, some of the correlations may be significant by chance alone, and it is necessary to recognize that significant relationships may themselves be a function of some common underlying factor.

In spite of the drawbacks of the method mentioned, the authors have clearly used the only technique that was available to them under the circumstances of their study. The method has been used correctly, and their findings can legitimately be advanced as hypotheses pending cross-validation. The authors indicate their in-

attention to cross-validate their findings in the future to determine if the findings hold, and they should do so, since most retrospective studies "wash out" when cross-validated. As their case now stands, the importance of their findings cannot be overlooked, supporting as they do a growing body of evidence that perinatal events affect behavior throughout the life-span of an individual. Little is known about the sampling procedures used in obtaining their population. Many other variables affect the child's inability to learn; one thinks of socioeconomic class, intelligence, parent-child relationship and so forth. Control of these variables might have clarified the reason for the importance of such things as socioeconomic class to subsequent development after known obstetric and perinatal events. Further, the reliability of behavioral measurement is problematic at best, since mothers and physicians vary greatly in their capacities to judge behavior. For example, when a child repeats a certain grade, the reason can be one or a combination of many circumstances, ranging from physical illness unrelated to developmental defects to individual school policy. Thus, grade level may not represent a reliable measure of individual development. The fact that the principal independent variables were not related to the Lorge-Thorndike Intelligence Test, probably the most reliable dependent measure available in the study, suggest that measurement reliability may be a problem in the authors' study.

Since I, to put it mildly, lack sophistication in the field of statistics, I asked Doctor Lovick

Miller, Director of the Child Psychiatry Research Center of the University of Louisville School of Medicine, to run additional tests on the authors' data. He found that the authors' major conclusions are, indeed, supported by their results—for example, developmental patterns are significantly different following breech delivery as compared with low forceps extraction. It must, however, be kept in mind that when one runs as many correlations as reported in this extensive report, some will be significant by chance alone. For this reason, we await with interest the results of the cross-validation study which the authors have promised us.

Finally, some thought should be given to the identification of common factors which may underlie the specific findings reported. For instance, are there underlying factors responsible for producing a breech presentation which are more significant than the circumstances surrounding the obstetric delivery of the infant? Superficially one might assume that the untoward developmental problems shown to follow breech delivery were related to hypoxia associated with delivery of the aftercoming head; but since the authors' other measures such as "minutes to breathe and cry" did not correlate, it is possible that some other unrecognized factor may be operative in this situation. I am not competent to comment on purely psychologic matters, but another possibility is that negative parent-child relationships could conceivably be connected in some way to breech delivery, and that these, in turn, might affect a child's capacity to perform.

With due consideration for the many problems inherent in this type of research which inevitably raise questions about reliability and validity, Drs. Muller, Campbell, and associates should be commended for their diligent and conscientious work in this difficult and important area of research. It would seem reasonable to consider their findings as hypotheses awaiting confirmation by cross-validation. In the meantime, it is heartening to note that at least for the time being they do not suggest that their findings constitute a mandate to obstetricians to modify their current obstetric practices. We all await with interest the findings of the prospective study, and especially the analysis of the factors surrounding breech delivery.

DR. R. RALPH MARGULIS, Royal Oak, Michigan. I would like to use this opportunity to add a few comments derived from our study.

This study was conducted at the Neuro-Education Center of the William Beaumont Hospital. Two hundred children between the ages of 4 and 15 years have been studied for evaluation and elucidating reasons for academic failure in school. Three hundred variable parameters were investigated for each child.

In the majority of these children, indications are present that minimal organic central nervous system changes are evident (minimal brain dysfunction). These findings are showing a high correlation with complications encountered in pregnancy and labor. Induction of labor has been a common denominator in about 30 per cent of the tested subjects. I am not advocating, at present, changes in our obstetric practice relative to elective induction, but I would be interested to have members of our Association evaluate these findings in similar studies. Our preliminary results make it imperative to evaluate the entire problem in a future prospective study.

DR. GEORGE J. L. WULFF, JR., St. Louis, Missouri. Sub-lethal damage is also highly prevalent in breech presentations, and cerebral palsy is one example of this potential damage. The incidence of breech among total term presentations is about 3 per cent. The incidence of breech presentations in cerebral palsy children, however, is 8 times as great, and this has been tabulated by Dr. Nicholas Eastman in retrospective studies of cerebral palsy children.

I should like to ask Dr. Campbell his experience with cerebral palsy children in his study.

DR. CAMPBELL (Closing). The findings from our study have left some questions unanswered. We now have various factors which we will check in our prospective study. The prospective study has been started, and the children are now 4 and 5 years old. It should be finished in 5 years and we are eagerly awaiting the results.

As to the question about cerebral palsy, we did not have any reports in our study on this subject.

Of the 2,383 deliveries included in the study, there were 101 breech deliveries. There were 11 perinatal deaths from this group of deliveries. This, plus the fact that 24.5 per cent of the children found on follow-up were one or more years behind in school, is rather frightening.

We hope others will join us in this type study.