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## Umbilical cord complications as a cause of perinatal morbidity and mortality

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The fetal heart pattern of variable deceleration has been correlated with compression of the umbilical cord [5]. It is the most frequently occurring pattern, being seen in approximately 30% of labors [2, 9, 10, 11, 12, 13]. Changing the maternal position will sometimes modify or even abolish this pattern [5]. This has led to the general belief that variable deceleration is benign, particularly if the heart rate does not fall below 80/min. As a consequence, the potential for the development of serious problems later in labor may be overlooked. Because of this we have examined the various factors contributing to perinatal mortality and morbidity. This study has revealed that compression of the umbilical cord is the major single factor associated with depression at birth in our clinic.

### 1 Material

The patient population includes 8038 infants born at the Columbia-Presbyterian Medical Center, New York City, over a three-year period from January 1974 to December 1976. All the known antepartum complications and identifiable complications at delivery were noted and tabulated for each stillbirth, neonatal death and all surviving newborns with an APGAR score of 6 or less at 1 or 5 minutes over the three years under review. Those infants having an APGAR score of 6 or less at 1 and 5

### Curriculum vitae

*Dr. SAMUEL BRUCE was born in 1941 in Ghana. He graduated from the University of Bridgeport, Connecticut, in 1965 and the Mt. Sinai School of Medicine in 1971. He completed his training in obstetrics and gynecology at New York University in 1976 and in Perinatal Medicine at Columbia University, College of Physicians and Surgeons, New York in 1978.*



visually identified either as a loop or loops around the neck or body or as a prolapsed cord.

The data for the total number of births, stillbirths, neonatal deaths and perinatal mortality are presented by year in Tab. I. The stillbirth rate has remained essentially unchanged for 1974, 1975 and 1976 respectively. In Tab. II are listed by year the percentages of newborn infants with an APGAR Score  $< 6$  at 1 and 5 minutes. It can be seen that the number of infants considered morbid has remained the same for each of the three years under review.

Tab. I. General statistics

	1974	1975	1976
Total deliveries*	2,790	2,714	2,534
Still births*	7.9/M	7.4/M	8.3/M
Neonatal deaths*	8.7/M	8.2/M	6.0/M
Perinatal mortality*	16.6/M	15.5/M	14.3/M

\* Over 1000 gms.

Tab. II. APGAR scores at 1 and 5 minutes

	1974	1975	1976
Number of deliveries*	2,790	2,714	2,534
1 Minute APGAR $\leq 6$	11.1%	9.2%	11.6%
5 Minute APGAR $\leq 6$	2.4%	2.1%	2.4%

\* Over 1000 gms

## 2 Results

In Tab. III are listed the factors associated with stillbirth in the three years under review. It can be seen that Rh sensitization (14.5%), umbilical cord complications (14.5%), abruptio placenta (13.2%) and congenital malformation (6.8%) represent the leading factors associated with all stillbirths that occurred in the review period. Rh sensitization is a leading factor at our institution because it is a referral center for this disease. **Umbilical cord complications are as frequently associated with stillbirths during this three year review.** The category of "others" (15.8%) represents twelve other single factors added together. In twenty-four of the cases (31.6%), the factors associated with stillbirth were unknown.

Factors associated with neonatal deaths are presented in Tab. IV. It can be seen that prematurity is associated with over one third of the deaths, congenital anomalies with 14.6%, while other causes represent the sum of forty single factors. Umbilical cord complications represent 3.1% of the factors associated with neonatal deaths.

Tab. V lists the factors observed to be associated with depression at birth during this three year survey. Morbidity (depression at birth) is defined as an APGAR score of  $\leq 6$  at 1 or 5 minutes.

Tab. III. Factors associated with stillbirths\*. 3 year survey of 8038 births.

Factors	No.	% of factors
Rh	11	14.5%
Cord	11	14.5%
Abruptio	10	13.2%
Cong. anomalies	5	6.6%
Toxemias	2	2.6%
Prematurity	1	1.3%
Unknown	24	31.6%
Other Factors**	12	15.8%
Total	76	100%

\* Over 1000 gms

\*\* Maternal diabetes, amnionitis, placenta previa, maternal trauma, anemia, unregistered mother, meconium stained fluid at delivery, advanced maternal age.

Tab. IV. Factors associated with neonatal deaths\*. 3-year survey of 8038 births.\*\*

Factors	No.	% of total factors in population
Prematurity <sup>1)</sup>	37	38.5%
Cong. anomalies	14	14.6%
Rh disease	11	11.5%
Abruptio placentae	3	3.1%
Meconium	3	3.1%
Group B-strep	3	3.1%
Umb. cord compl.	3	3.1%
Unregistered mother	2	2.1%
Diabetes mellitus	2	2.1%
Amnionitis	2	2.1%
Other causes <sup>2)</sup>	16	16.7%
Total	96	100%

\* Liveborn infants dying during first 28 days of life

\*\* Over 1000 gms

<sup>1)</sup> Less than 2500 gms<sup>2)</sup> Small for gestational age, fetal anemia, incompetent cervix, maternal hypertension, preeclampsia, premature rupture of membranes, maternal drug addiction, prolonged uptake of membranes.

**Umbilical cord complications are seen to be most frequently associated with depression at birth, accounting for 16.4% of the factors while meconium stained amniotic fluid is the second most frequent factor. Together these two constitute almost a third of all the factors associated with depression at birth.**



Tab. V. Factors associated with perinatal morbidity.\*  
A 3-year survey of 8038 births\*\*.

Factor	No.	% of total population of factors
Umbilical cord	111	16.4%
Meconium	81	12.0%
Prematurity	44	6.5%
Breech or abn. presnt.	41	6.1%
CPD	30	4.4%
Precipitous labor	24	3.6%
Post maturity	23	3.4%
Unregistered preg.	17	2.5%
Multiple pregnancy (Twin B)	17	2.5%
Placental problems	14	2.0%
Rh disease	12	1.8%
Toxemia	12	1.8%
Amnionitis	11	1.6%
Difficult delivery (C/S)	6	0.9%
Other factors***	219	32.4%
Unknown causes	14	2%
Total population of factors	676	100%

\* Apgar score  $\leq 6$  at 1 or 5 minutes

\*\* > 1000 grams

\*\*\* S.G.A., maternal anemia, fetal macrosomia, maternal agitation, undiagnosed twins, maternal hypoxemia, maternal drug addiction, intubation of newborn, vacuum extraction, difficult c/section, maternal supine hypotension, prolonged second stage, mid forceps, maternal over-medication etc.

## Discussion

Of all the factors recognized as being associated with depression at birth, this survey has identified that complications of the umbilical cord occur most frequently. Meconium stained amniotic fluid was the second most frequent factor. Together these two factors were associated with nearly one-third of the depressed newborns. Cord complication was also the second most common factor associated with stillbirth and the seventh with neonatal death. In all instances the umbilical cord was identified to be in an abnormal position at birth, either around the neck or body or prolapsed. Cord complications could also have been unrecognized in some of the cases of meconium, as well as in some of the "unknown" group and could therefore

have been an even more frequently associated factor with depression at birth than 16.4%.

Cord complications could lead to depression at birth in a number of ways. The most likely is from hypoxia through intermittent occlusion. In addition, experiments by MING-NENG YEH and associates [14] have demonstrated that cord occlusion can cause myocardial conduction defects in the fetal baboon; similar changes with cardiac arrest have also been observed by S. C. YEH and associates in the human fetus during labor [15]. This effect appears to be separate from that of hypoxic depression, since it can be prevented by the prior administration of atropine. A third possible effect could be metabolic. DANIEL and associates have shown that intermittent hypoxia from occlusion of the umbilical cord in the fetal lamb leads to high levels of vasopressin and loss of solute, particularly sodium, in the urine [3, 4]. Another possible cause is hypovolemia. During partial cord occlusion when the vein only is likely to be occluded, blood flowing to the placenta and the umbilical arteries would not return to the fetus and would remain sequestered in the placenta.

The pattern of variable deceleration of the fetal heart rate, observed during labor, has been found to correlate with occlusion of the umbilical cord; it is also the most common abnormal heart rate pattern occurring in approximately 30% of all labors [2, 9, 10, 11, 12, 13]. This should provide the clinician with a means of recognizing a potential problem prior to birth and acid base analysis of fetal blood should permit early detection of those cases which are developing hypoxia and acidosis [1, 6, 7, 8]. Unfortunately, this is not always helpful since the most severe effect of cord occlusion may not occur until the last 15–20 minutes of the second stage of labor as the fetus descends. At this time the mother is usually in the delivery room and monitoring has been stopped. Undoubtedly, a better means of determining which cases of variable deceleration of fetal heart rate are likely to be associated with a poor outcome is needed. Closer attention to the fetal heart rate and fetal acid base state in the latter stages of labor should be helpful, particularly in the final 15–20 minutes of labor which could be the most critical time for a fetus with a cord complication. It



would seem, however, that additional diagnostic criteria should also be sought. These could include identification of the exact position of the cord by ultrasound, continuous fetal  $PO_2$  with the transcutaneous electrode, and examination of the actual

fetal electrocardiogram. At present we can offer no single solution to the problem which remains probably the most important cause of depression at birth.

### Summary

Examination of various factors contributing to perinatal mortality and morbidity has revealed that compression of the umbilical cord is the major single factor associated with depression at birth.

The fetal heart pattern of variable deceleration which has been correlated with compression of the umbilical cord [5] is also the most frequently occurring pattern, being seen in approximately 30% of labors [2, 9, 10, 11, 12, 13]. Because of a general belief that variable deceleration is benign, particularly if the heart rate does not fall below 80/min, the potential for the development of serious problems later in labor may be overlooked.

From a patient population of 8038 infants born at the Columbia-Presbyterian Medical Center, New York City, 1974–1976, all the known antepartum complications and identifiable complications at delivery were noted and tabulated for each stillbirth, neonatal death and all surviving newborns with an Apgar of 6 or less at 1 or 5 minutes over the three years under review. Malposition of the umbilical cord was visually identified either as a loop or loops around the neck or body or as a prolapsed cord. Umbilical cord complications were a leading factor associated with stillbirths during this three year review, being present 14.5% of the time. The category of "others" (15.8%) represents twelve other single factors added together. In twentyfour of the cases (31.6%), the factors associated with stillbirth were unknown.

Prematurity represents over a third of all the factors

associated with neonatal deaths, congenital anomalies 14.6%, while other causes represent the sum of forty single factors. Umbilical cord complications represent 3.1% of the factors associated with neonatal deaths.

Umbilical cord complications were most frequently associated with depression at birth, accounting for 16.4% of the factors while meconium stained amniotic fluid is the second most frequent factor. Together these two constitute almost a third of all the factors associated with morbid newborns. Cord complications could also have been unrecognized in some of the cases of meconium, as well as in some of the "unknown" group and could therefore have been an even more frequently associated factor with depression at birth than 16.4%.

Cord complications could lead to depression at birth in a number of ways. The most likely is from hypoxia through intermittent occlusion. Other causes include myocardial conduction defects [14, 15], metabolic effects from high levels of vasopressin and loss of solute, particularly sodium, in the urine [3, 4], and blood loss into the placenta if the cord is only partially occluded.

Fetal monitoring may not always be helpful if the most severe effect of cord occlusion occurs during the final 15–20 minutes of the second stage of labor, as the fetus descends. This could be the most critical time for the fetus with a cord round the neck; at this time the mother is usually in the delivery room and monitoring has been stopped.

**Keywords:** Perinatal morbidity, perinatal mortality, stillbirth, umbilical cord complications.

### Zusammenfassung

#### Perinatale Morbidität und Mortalität infolge Nabelschnurkomplikationen

Bei der Durchsicht verschiedener Faktoren, die die perinatale Mortalität und Morbidität beeinflussen, hat sich gezeigt, daß die Kompression der Nabelschnur der wichtigste einzelne Faktor für die Neugeborenen-depression ist.

Das Herzfrequenzmuster der variablen Dezeleration, welches auf Nabelschnurkompression zurückgeführt wird [5], ist zugleich das häufigste Dezelerationsmuster, das in ca. 30% sub partu beobachtet wird [2, 9, 10, 11, 12, 13]. Auf Grund der allgemeinen Annahme, daß variable Dezelerationen ungefährlich seien, besonders dann, wenn die Herzfrequenz nicht unter 80/min abfällt, kann die mögliche Gefährdung zu einem späteren Zeitpunkt der Geburt übersehen werden.

Bei einer Population von 8083 am Columbia-Presbyterian Medical Center in New York City im Zeitraum von 1974–1976 geborenen Kindern wurden alle bekannten, ante-

partualen Komplikationen und erkennbaren Geburtskomplikationen registriert; jeder neonatale Todesfall und alle überlebenden Neugeborenen mit einer APGAR-Zahl < 6 nach 1 oder 5 Minuten wurden für die drei Jahrgänge tabelliert. Die Lage der Nabelschnur wurde mit dem Auge festgestellt und eingestuft entweder als ein- oder mehrmalige Umschlingungen um den Hals, den Körper oder als Nabelschnurvorfal.

Nabelschnurkomplikationen waren während dieser Dreijahresperiode in 14,5% vorhanden und damit ein wesentlicher Faktor in Zusammenhang mit Totgeburten. Die Kategorie „andere Faktoren“ (15,8%) bestand aus zwölf weiteren Einzelfaktoren, die zusammengefaßt wurden. In 24 Fällen (31,6%) waren die mit der Totgeburt einhergehenden Ursachen nicht bekannt.

Prämaturnität machte ein Drittel aller anderer Faktoren aus, die mit der neonatalen Sterblichkeit verknüpft waren, kongenitale Mißbildungen in 14,6%, während andere