

Original articles

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State of acidity as an indicator of quality care in obstetrics

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Increasingly, excellence in obstetric care is not just measured by perinatal mortality but also by the ratio of the infants born with acidosis [5, 6, 7]. The values published by SALING and WULF [21] according to which pH values below 7.20 are termed "acidotic", have been generally accepted and permit comparisons. The value of determining the degree of acidity has been confirmed among others by LITSCHGI and coworkers [12], even though the severity of acidosis and clinical depression may differ [9] and the pH in the umbilical artery blood may not inform adequately about the correction of the acidosis [10].

Since the introduction of cardiotocography (CTG) and fetal blood gas analysis as routines the risk for acidosis has become estimable. Thus the rate of infants with acidosis may be influenced by including operative deliveries which assess the actual fetal condition in maternal as well as fetal distress.

In combination with the degree of prematurity, acidosis is an important indicator because neonatal adaptation and the development of respiratory distress syndrome show a correlation with the degree of acidosis [18, 24].

1 Material and methods

We analyzed 10,816 unselected births from 1976 through 1979. The obstetric management included: Admission CTG (during 1976 and 1977 in part, since 1978 in all patients), invasive CTG

Curriculum vitae

ECKHARD KOEPCKE was born 1939 in Güstrow following graduation from the medical faculty of the University of Rostock in 1966. He underwent Obstetric/Gynecology training until 1977 at the Obstetric/Gynecology Department of the District Hospital in Rostock with Professor Dr. SEIDENSCHNUR. He has been Director of the Obstetric Section since 1977. He qualified for his advanced degree in 1982 with a thesis on „The Influence of Intensive Obstetrics on the Criteria of Perinatal Performance.” His areas of principal interest are fetal diagnosis and pathologic pregnancy and deliveries.



monitoring as a routine, selective determination of fetal scalp pH, and routine determination of the state of acidity in the newborns. We analyzed:

1. Distribution of state of acidity in the entire population
2. Distribution of state of acidity in prematures (\leq 37th week gestation), small for dates infants ($<$ 5th percentile according to KYANK et al. [11]), and breech presentations. Only singletons were included in the analysis
3. Correlation between CTG findings and the state of acidity
4. Distribution of acidosis in correlation to method of delivery

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5. Acidosis morbidity in correlation to acute tocolysis by CTG indication.

The CTG was rated globally separately for first and second stages of labor [3]. The following codes were used: (0) not monitored; (1) normal; (2) early warning symptoms; e.g., arrhythmia, extrasystoles, "physiologic bradycardia" (i.e., exclusion of an hypoxic cause) and mild tachycardia; (3) early deceleration; (4) and (5) mild and severe signs respectively of a disturbed umbilico-placental circulation; (6) reflex bradycardia (i.e., bradycardia as a consequence of an acute hemodynamic disturbance in the extracorporeal fetal circulation of various etiology); (7) signs of hypoxia, and (8) pre-terminal findings. Forceps deliveries were segregated into forceps-assisted deliveries (prophylactic shortening of the second stage or elimination of final contractions with normal CTG and normal labor activity and low fetal head), and forceps extractions (abnormal CTGs, maternal and/or fetal indications with normal labor activity). Statistical analysis utilized the Chi Square-Test.

2 Results

Admission CTGs were obtained in 61.4% (standard deviation ± 33.1) of the women in labor.

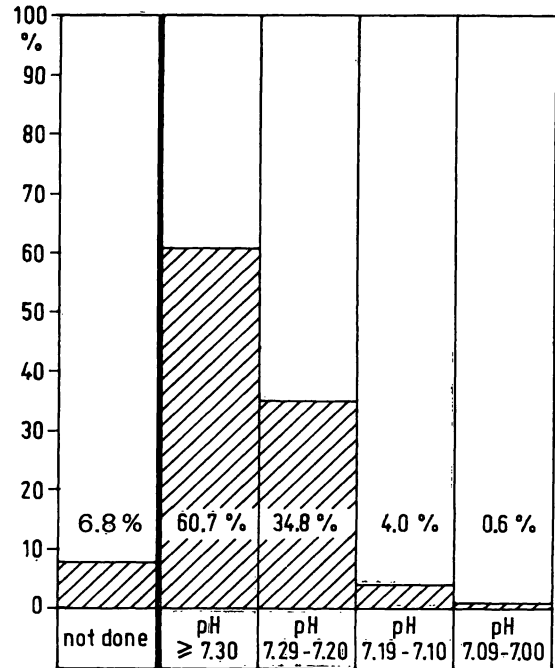


Fig. 1. Distribution of the state of acidity in 10,816 deliveries during 1976-1977.

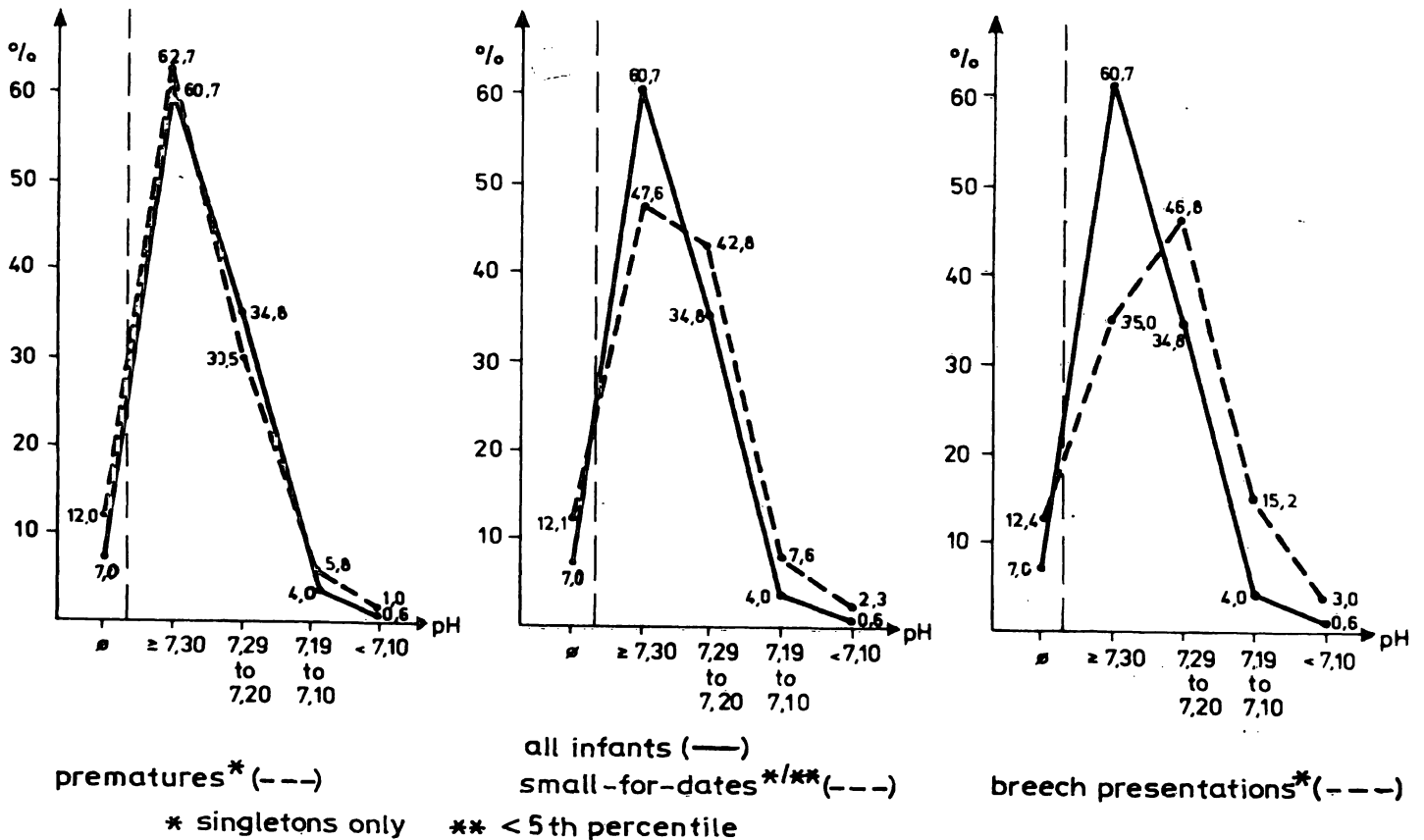


Fig. 2. Comparison of the state of acidity in the entire population with that of prematures ($\alpha < 0.05$), small for dates ($\alpha < 0.01$) and breech presentations ($\alpha < 0.01$).

Cardiotocography monitoring was used in 90.9% ± 0.97%. In 3.5 ± 1.7% the fetal pH was determined. State of acidity was assessed in 93.2 ± 2.0%. A normal acidity (pH ≥ 7.30) was found in 60.7% of the newborns. Slightly to moderately increased acidity (pH 7.20–7.29) was seen in 34.8%. Definite acidosis (pH < 7.20) prevailed in 4.6%, with 4.0% having pH values between 7.10 and 7.19, i.e. slight to moderate acidosis. A advanced to severe acidosis (pH < 7.10) was seen in 0.6% of the newborns (Fig. 1).

Prematures, small for dates infants and infants from breech deliveries varied significantly from this distribution (Fig. 2).

The state of acidity data correlated with the distribution of heart rates during the two stages of delivery ($\alpha < 0.01$) (Fig. 3).

When comparing the various degrees of the state of acidity and correlating the distribution of the CTG findings during the first stage of labor there were significant differences when both the infants with increased as well as the infants with slightly to

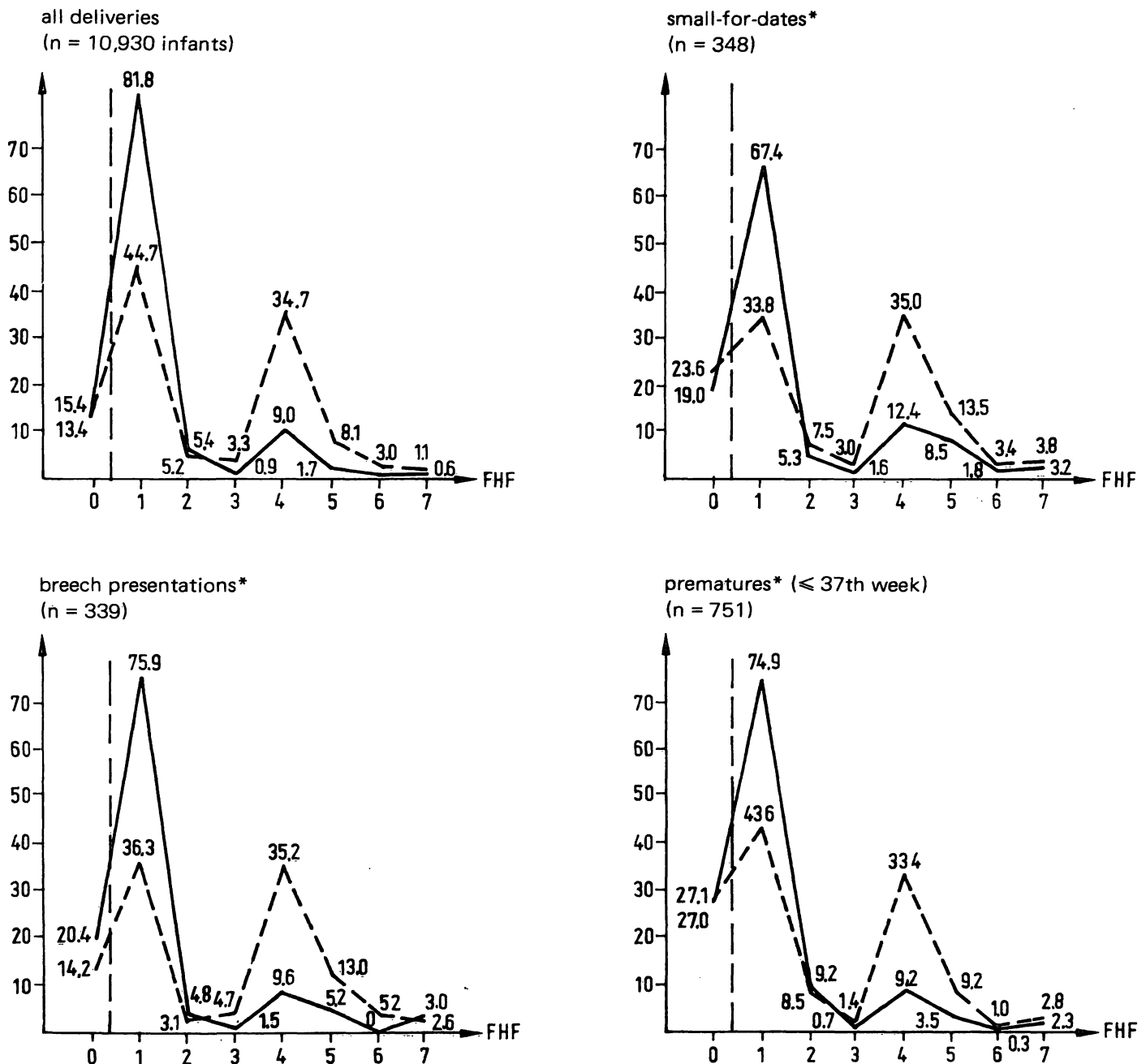


Fig. 3. Comparison of the distribution of the fetal CTG findings during first and second stages of labor between the entire study population and small for dates infants, breech deliveries and prematures, * singletons only.

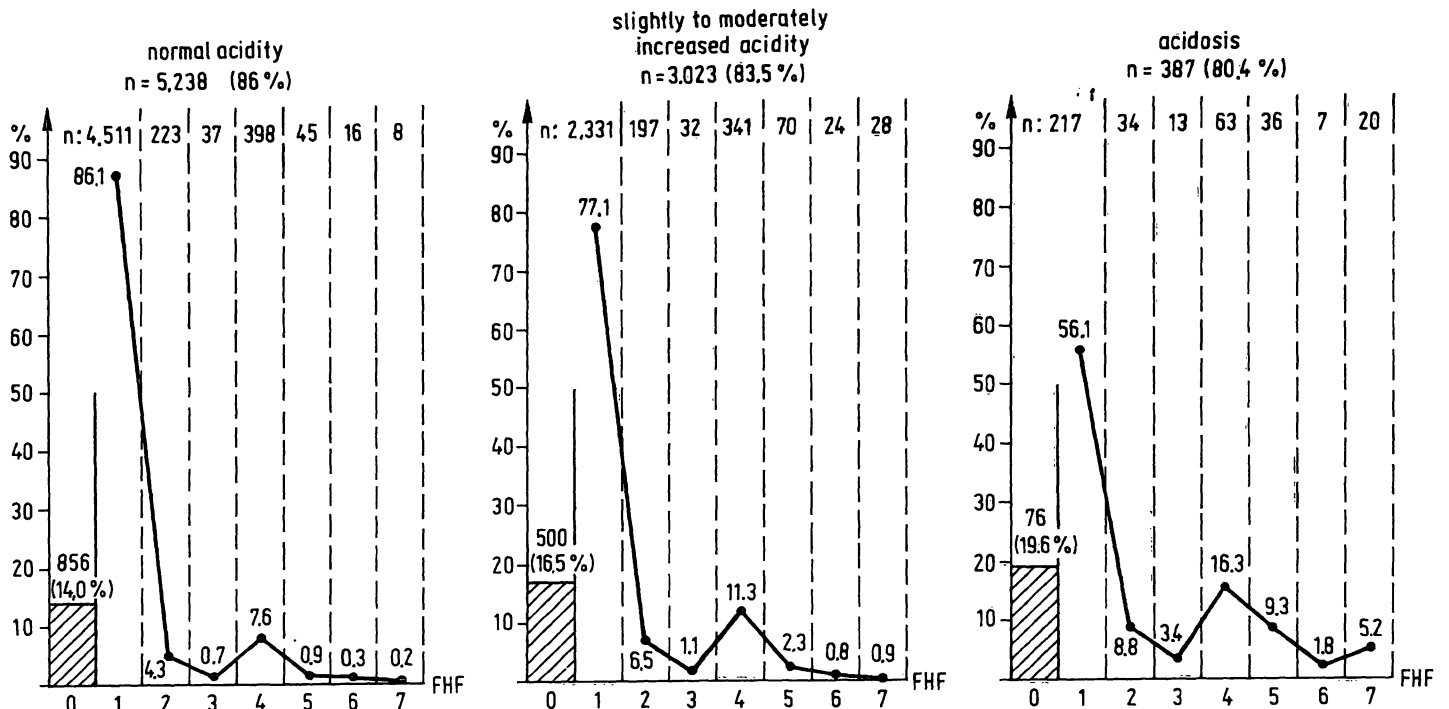


Fig. 4. Distribution of CTG findings during the first stage of labor for defined states of acidity whereby normal acidity: pH \geq 7.30, slightly to moderately increased acidity: pH 7.20–7.29, acidosis: pH $<$ 7.20. CTG findings are coded along the abscissa as follows: 0 = no monitoring; 1 = normal; 2 = early warning symptoms (arrhythmia, extrasystoles, physiologic bradycardia, mild tachycardia); 3 = early deceleration; 4 = mild signs of disturbed umbilico-placental circulation; 5 = severe signs of disturbed umbilico-placental circulation; 6 = reflex bradycardia; 7 = signs of hypoxia.

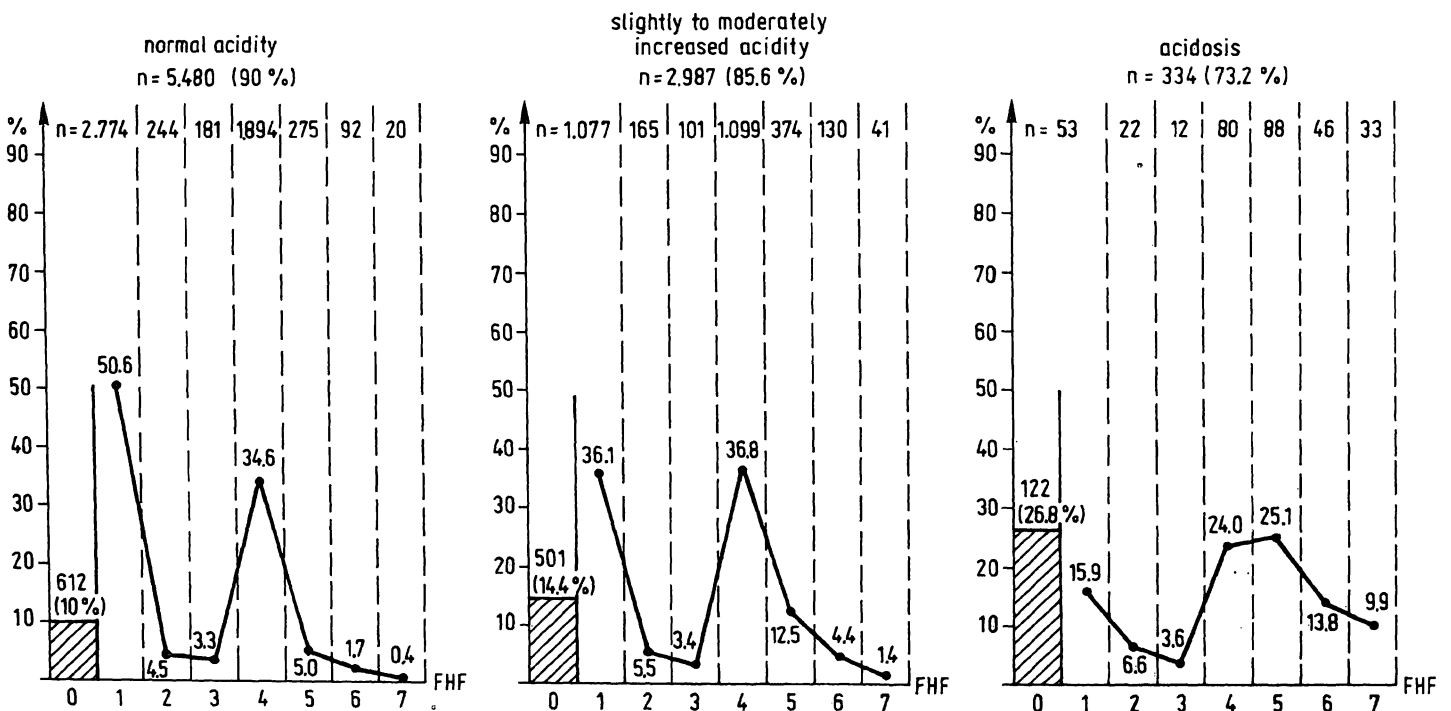


Fig. 5. Distribution of fetal CTG findings during the second stage of labor (see Fig. 4).

moderately increased acidity ($X^2 = 134.90$) and acidosis ($X^2 = 493.55$) were compared with those with normal acidity (Fig. 4).

This difference was even more pronounced for the distribution of CTG findings during the second stage. Significant differences were seen again for the comparison between normal acidity and slightly to moderately increased acidity ($X^2 = 319.34$) and definite acidosis ($X^2 = 827.89$) (Fig. 5).

By far the majority of the acidotic infants were born spontaneously. Among 175 infants with acidosis following spontaneous delivery 158 showed moderate acidosis, with advanced to severe acidosis (pH < 7.10) in 17 cases.

Forceps extractions and secondary Cesarean deliveries resulted in 95 and 92 acidotic infants respectively. The proportion of more severe

degrees of acidosis was relatively higher with 16 and 21 respectively. All other routes of delivery occurred far less often (Fig. 6).

The relative distribution of acidotic infants for each mode of delivery showed an acidosis morbidity for spontaneous deliveries of 2.1%. Slight to moderate acidosis predominated (1.9%), only 0.2% showed advanced to severe acidosis. Similarly favorable was the incidence of acidosis for forceps assistance (2.9 and 0.3% respectively). The values for forceps extractions (8.5 and 1.8%), uncomplicated vaginal breech deliveries (9.6 and 2.6%), primary Cesarean section (15.5 and 2.7%) and secondary Cesarean section (15.1 and 4.5%) indicate the increased risk for acidosis for these groups (Fig. 7).

A particular risk for acidosis existed in the group where tocolysis as indicated by the CTG was used.

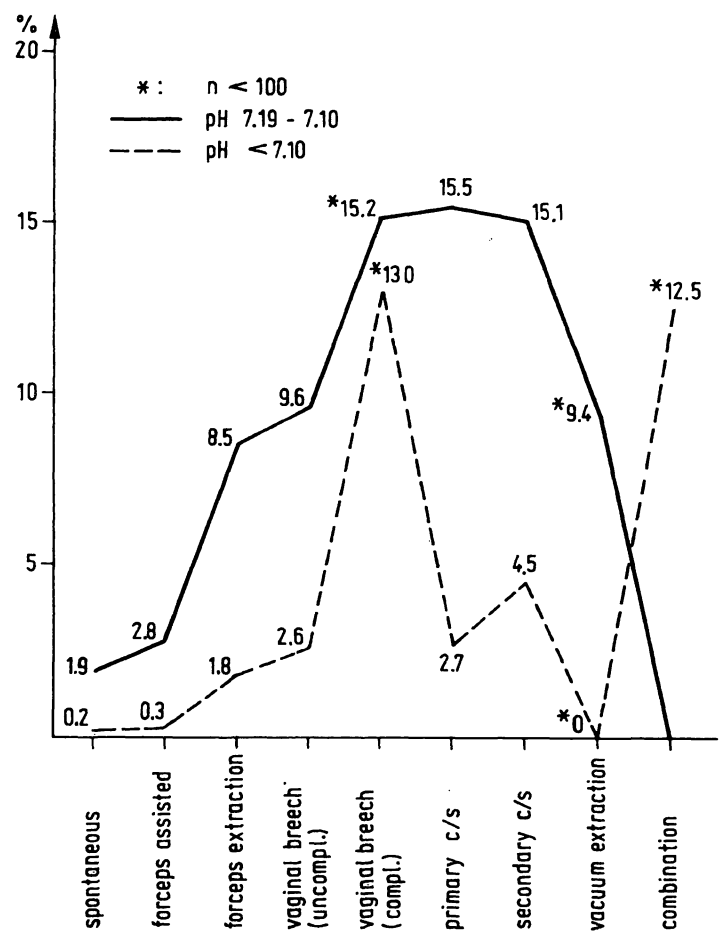
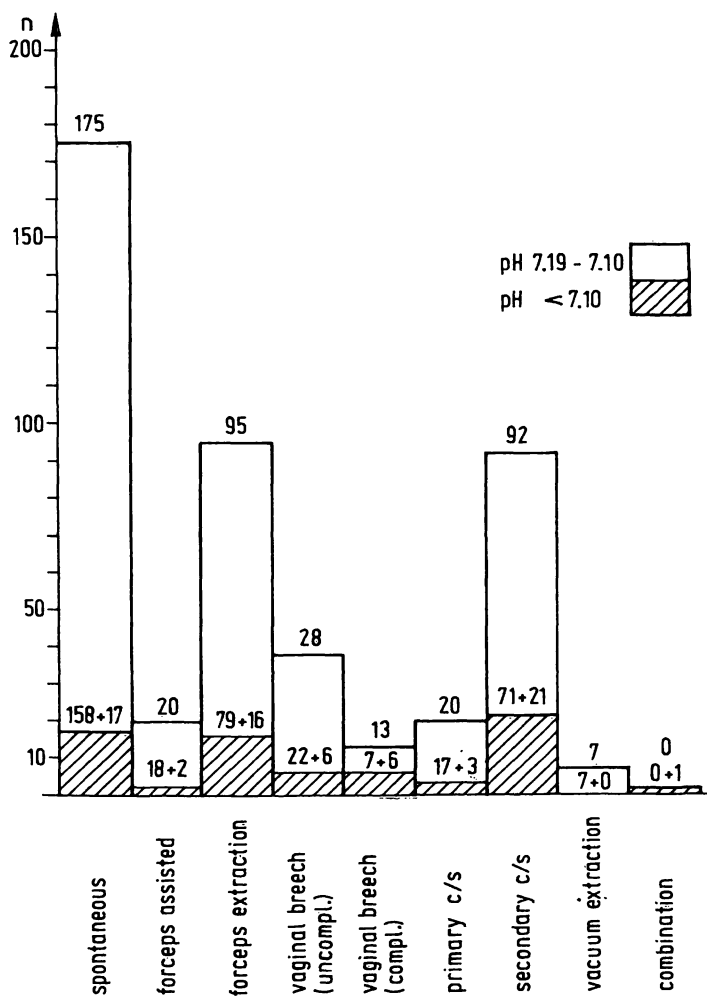


Fig. 6. Distribution of neonatal acidosis according to mode of delivery.

Fig. 7. Acidosis rates of various modes of delivery.

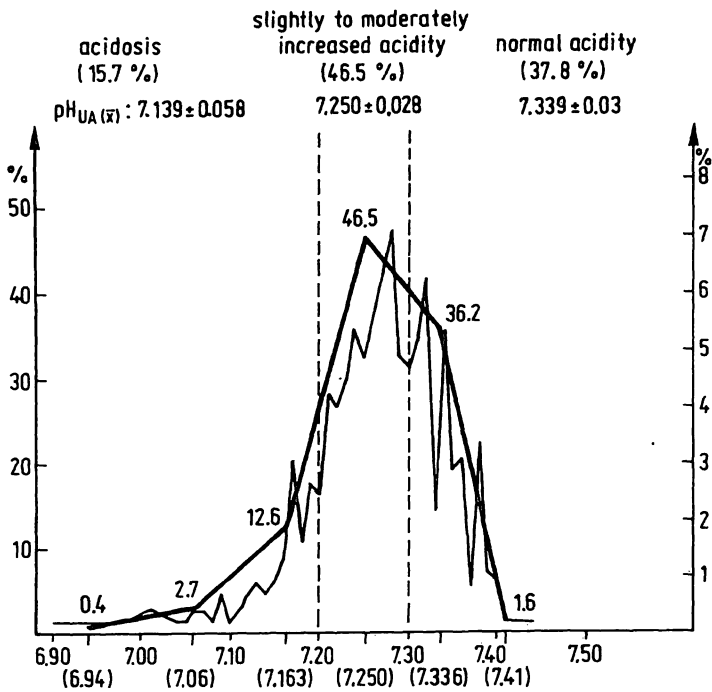


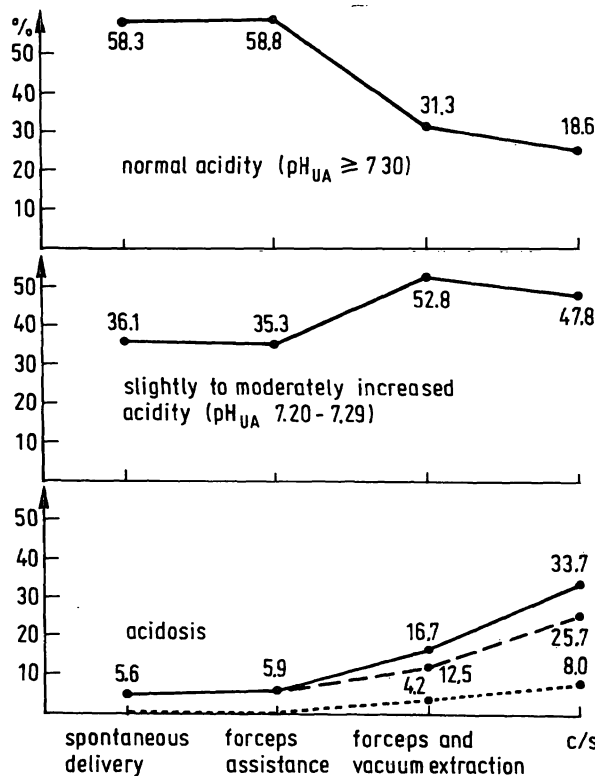
Fig. 8. Mean pH values in the umbilical artery, acidosis rate and relative pH distribution in CTG-indicated acute tocolysis (n = 465, i.e., 4.3 %) in 10,816 deliveries.

In 465 deliveries requiring acute tocolysis the acidosis rate was 15.7 % with an average pH value of 7.266 ± 0.077 (Fig. 8).¹

Spontaneous deliveries including vaginal breech deliveries occurred in only 35.3 %. The high prevalence of vaginal forceps extractions (38.7 %) and abdominal deliveries (26.0 %) correlated with a high incidence of acidosis (Fig. 9).

3 Discussion

Data about the incidence of the early acidosis morbidity vary widely. Our own data of 4.0 % for pH values of 7.10 to 7.19, and 0.6 % for pH values < 7.10 were surpassed by HEINRICH [4] with an acidosis rate of under 3.0 % for pH < 7.20. Published data about acidosis morbidity range from 8 to above 15 %. NAGL et al. [16] show an acidosis rate of 15.7 % for pH 7.10–7.19 and



mode of delivery	n	%	
spontaneous	157	33.8	35.3 %
vaginal breech	7	1.5	
forceps assistance	34	7.3	38.7 %
forceps extraction	132	28.4	
vacuum extraction	14	3.0	
cesarian section	121	26.0	26.0 %
total	465	100 %	

Fig. 9. Mode of delivery and relative distribution of the state of acidity after CTG-indicated acute tocolysis (n = 465 or 4.3 %) in 10,816 deliveries.

2.03 % for pH < 7.10. ROEMER et al. [19] indicate for Basel and Tübingen an acidosis rate of 13.6 % and 12.4 % respectively for pH < 7.20. More severe degrees of acidosis, i.e., pH < 7.10 was found to be 1.6 and 2.1 % respectively. LITSCHGI and TSCHUMI [13] reported a rate of 10.7 % (pH < 7.20) and 1.3 % for pH less than 7.10.

In order to set as a specific goal the reduction in the number of acidotic infants certain conditions must be met and obstetric management must be changed. In order to achieve this the general routine monitoring of the fetal conditions by CTG must be recommended. Invasive methods offer unequivocal advantages (freedom of noise in the signals; more exact determination of uterine activity). The correlation between CTG findings and the acidosis status confirms that the acidosis is in principle estimable. This correlation is emphasized by the significant increase of pathological CTG findings in subsets of patients with fetal indications such as prematurity, growth retardation and breech presentation, all of which show a statistically significantly higher degree of acidosis. The prediction of neonatal acidosis increases with advancing progress of labor. Formal descriptions and classifications of CTGs according to the methods published by MELCHIOR et al. [14], FISCHER et al. [2], and THIERY et al. [23] are clinically not very satisfactory. This is also true for the cardiotocographic definition of fetal distress by YOUNG [26]. In contrast a differentiated interpretation according to the various etiologies and pathogenesis of CTG changes is very valuable. It has been shown that the duration of the birth correlates with the degree of acidosis [20], especially for the second stage of labor. The dynamics and extent of this effect is modified by uterine activity and its influence on the placental perfusion and the umbilical circulation. Obstetric management for the purpose of preventing acidosis should consider the following principles:

An abdominal delivery indicated by CTG and/or blood gas findings should be performed after the

fetal oxygenation has been normalized by reducing uterine activity (discontinuation of uterine stimulants and commencement of tocolysis). This normalization should be documented with a CTG. Vaginal deliveries should proceed accordingly. The CTG should be rated prognostically, vaginal procedures should be used generously and uterine activity should be regulated optimally in order to prevent early acidosis morbidity.

Advanced and severe degrees of acidosis appear to be increasingly avoidable when these concepts are applied and have lead to a further decrease in the incidence of acidosis. Thus we saw 3.8 % acidosis in 3,066 births in 1980, 2.8 % in 2660 deliveries in 1981 and the cases with a pH of less than 7.10 decreased further to 0.6 and 0.2 % in 1980 and 1981. It must be individually determined whether a spontaneous vaginal delivery of an acidotic infant is an acceptable procedure by initially assessing CTG findings and the length of the second stage of labor. The high proportion of spontaneous deliveries within the acidosis group points to the possibility of a further reduction of acidotic infants. The mechanical stress in vaginal operative deliveries [15, 17] depends largely on the correct indication and procedural skill [22]. Intracranial hemorrhages, especially in immature infants, are the consequence of hypoxemia, hypoxia and acidosis [25].

It has not yet been determined exactly what pathological importance accrue to slight to moderate acidosis (pH 7.19 to 7.10). Advanced and severe acidosis modify neonatal adaptative behavior and may correlate to later morbidity [8].

Despite the good predictive determination of the acidosis risk from the CTG, especially during the second stage, predictions about the degree of severity are not very reliable. In a non-selected delivery population a prevalence of vaginal operative deliveries of 10–15 % might be accomplished. Incidence of Cesarean sections may be kept low at 4–6 %. Further increases in the incidence of operative deliveries [1] appear not justified.

Summary

The state of acidity as an indicator for quality in obstetric care was studied by analyzing 10,816 unselected deliveries in 1976–1979 with a uniform obstetric management

protocol including admission cardiotocography in $61.4 \pm 33.1\%$ invasive monitoring until delivery in $90.9 \pm 0.97\%$, selective fetal pH determinations in

3.5 ± 1.7% and determination of the state of acidity (93.2 ± 2.0%). We studied incidence, severity and potential preventability.

A normal acidity was seen in 60.7% of the infants and 34.8% had a slightly to moderately increased acidity. Acidosis (pH < 7.20) was seen in 4.6%, and values of < 7.10 in 0.6%. Clinical CTG and obstetric factors determine the risk for acidosis as follows:

1. Prematures, growth retarded and breech infants had a significantly different distribution of the state of acidity as well as the CTG findings during first and second stages of labor when compared to the entire population.
2. The distribution of CTG findings in a slightly to moderately increased acidity and acidosis was significantly different from that in normal acidity. This was seen in the first and especially the second stage.
3. Acidotic infants were seen most commonly in spontaneous deliveries followed by forcep extractions and secondary Cesarean sections. When classified by mode of delivery the greatest relative incidence was seen in

Cesarean deliveries, vaginal breech deliveries, and forceps extractions.

4. Intrapartum acute tocolysis after CTG criteria formed a group with a particularly high risk for acidosis (15.7%) as well as a high rate of forceps deliveries (38.7%) and Cesarean sections (26.0%).

Suitable measures to avoid that neonatal acidosis which can be estimated during delivery might include:

1. Rating of CTG's according to etiology and pathogenesis rather than by formal descriptive interpretations.
2. Timely diagnosis and avoidance of disturbed fetal oxygenation (uterine and/or umbilical) and consideration of fetal tolerance and time until vaginal delivery.
3. Selective timely acute tocolysis and avoidance of iatrogenic and spontaneous uterine hyperactivity.
4. A generous disposition towards vaginal operations (we consider as realistic goals for an unselected population acidosis (pH < 7.20) in 3 to 5%, among which there would be < 0.5% cases with pH < 7.10.
5. Frequency of Cesarean sections 4–6%
6. Frequency of operative vaginal deliveries 10–15%

Keywords: Acute tocolysis, breech presentation, frequency of operations, growth retarded infants, intrapartum cardiotocogram, obstetric management, prematures, state of acidity.

Zusammenfassung

Der Aziditätsstatus als Qualitätskriterium der Geburtsleitung

Der Aziditätsstatus als Qualitätskriterium der Geburtsleitung wurde in einer Analyse von 10 816 unselektierten Geburten (1976–1979) bei einheitlicher Betreuungskonzeption wie generelle Aufnahmekardiotokographie (61,4% ± 33,1), generelle Überwachung mittels invasiver Technik bis zur Geburt (90,9% ± 0,97), selektive fetale pH-Wert-Messung (3,5% ± 1,7) und generelle Aziditätsstatusbestimmung (93,2% ± 2,0) hinsichtlich Häufigkeit, Schweregrad und Modifizierbarkeit untersucht.

Im Gesamtkollektiv waren 60,7% Kinder normazide, eine gesteigerte Azidität hatten 34,8%. Die Azidoserate betrug 4,6% einschließlich 0,6% mit einem pH-Wert < 7,10.

Die Kalkulierbarkeit des Azidoserisikos an Hand klinischer, kardiotokeographischer und geburtsdynamischer Befunde konnte belegt werden:

1. Frühgeborene, Hypotrophe und Kinder in Beckenendlage hatten eine gegenüber dem Gesamtkollektiv signifikante unterschiedliche Verteilung des Aziditätsstatus sowie des Kardiotokeogrammbefundes in der Eröffnungs- und Austreibungsperiode.
2. Die Kardiotokeogramm-Befundverteilung bei gesteigerter Azidität und Azidose unterschied sich signifikant von der bei Normazidität. Das betraf die Eröffnungs- und besonders die Austreibungsperiode.
3. Azidotische Kinder rekrutierten sich am häufigsten aus Spontangeburt, gefolgt von Zangenextraktionen und sekundären Schnittentbindungen. Bezogen auf den

Entbindungsmodus wiesen Schnittentbindungen, vaginale Beckenendlagen-Geburten und Zangenextraktionen die größte relative Häufigkeit auf.

4. Die nach kardiotokeographischen Kriterien vorgenommene intrapartale Akuttokolyse stellte eine Gruppe mit hohem Azidoserisiko (15,7%) sowie hoher Zangen- (38,7%) und Sectiofrequenz (26,0%) dar.

Geeignet zur Vermeidung einer intrapartal kalkulierbaren Neonatalazidose erscheinen:

1. Kardiotokeogramminterpretation nach ätiopathogenetischen Gesichtspunkten; keine formal-descriptive Beurteilung.
2. Rechtzeitige Diagnostik und Vermeidung einer gestörten fetalen Oxygenation (uterin und/oder umbilikal) unter Berücksichtigung von fetaler Toleranz und Zeitfaktor bis zur vaginalen Entbindung.
3. Gezielte rechtzeitige Akuttokolyse und Vermeidung von iatrogenen und spontanen uterinen Hyperaktivität.
4. Großzügige Herstellung der vaginalen Operationsbereitschaft.

Bei einem nicht selektierten Geburtsgut erscheinen realistisch:

1. Azidoserate: 3,0 bis 5,0% einschließlich ≤ 0,5% pH < 7,10
2. Sectiorate: 4,0 bis 6,0%
3. Vaginal-operative Entbindungsfrequenz: 10,0 bis 15,0%.

Schlüsselwörter: Akuttokolyse, Aziditätsstatus, Beckenendlage, Frühgeborene, Geburtsleitung, Hypotrophe, intrapartales Kardiotokeogramm, Operationsfrequenz.

Résumé

Niveau d'acidose comme indicateur de la qualité des soins en obstétrique

Le degré d'acidose en tant qu'indicateur de la qualité des soins obstétricaux a été étudié par l'analyse de 10 816 naissances non sélectionnées entre 1976 et 1979 avec un protocole d'attitudes obstétricales uniformes comportant un enregistrement cardiotocographique à l'admission dans 61,4% ± 33,1% des cas, un monitoring invasif jusqu'à l'accouchement dans 90,9 ± 0,97% des cas, des dosages du pH foetal sélectif dans 3,5 ± 1,7% des cas, et une détermination du degré d'acidose néonatale (93,2 ± 2,0%). Les auteurs ont étudié l'incidence, la gravité et la prévention potentielle.

Un équilibre acidotique normal est observé chez 60,7% des enfants et 34,8% ont un pH augmenté. L'acidose (pH < 7,20) est observée chez 4,6% et des valeurs inférieures à 7,10 chez 0,6%. Les risques d'acidose suivants sont déterminés par l'étude cardiotocographique et les facteurs obstétricaux:

1. Les prématurés, les hypotrophiques et les sièges ont une répartition de l'équilibre acido-basique significativement différente de celle de la population globale; il en est de même pour les enregistrements cardiotocographiques en début et en cours de travail.
2. En cas d'acidose ou d'acidose modérée les enregistrements cardiotocographiques sont significativement différents des enregistrements lorsque l'équilibre acido-basique est normal; cela en début et plus particulièrement en fin de travail.
3. C'est lors des accouchements spontanés terminés par un forceps ou une césarienne que l'on observe habituellement des enfants en état d'acidose. Si l'on

s'en tient au mode d'accouchement, l'incidence relative la plus grande s'observe lors des césariennes, des accouchements du siège par voie basse et des extractions par forceps.

4. La tocolyse d'urgence en cours de travail fondée sur des critères CTG représente un groupe à risque particulièrement élevé d'acidose (15,7%) de même qu'un fort pourcentage de forceps (38,7%) et de césariennes (26,0%).

Les mesures appropriées pour éviter cette acidose néonatale qui peut être prévue en cours de travail comprennent:

1. L'interprétation des anomalies du RCF en fonction de l'étiologie et de la pathologie plutôt que des interprétations descriptives formelles.
2. Le diagnostic approprié et la suppression des troubles de l'oxygénation foetale (utérins et/ou ombilicaux), de même qu'une appréciation de la tolérance foetale et du délai jusqu'à l'accouchement par voie basse.
3. La tocolyse en urgence sélective et appropriée et la suppression de l'hyperactivité utérine iatrogénique et spontanée.
4. La tendance généreuse vers les interventions par voie basse (les auteurs considèrent comme un but réaliste dans une population non sélectionnée l'obtention d'un pH entre 7,10 et 7,19 dans 3 à 5% des cas, avec moins de 0,5% des cas avec un pH < 7,10).
5. Une prévalence des césariennes de 4 à 6%.
6. Une fréquence des interventions instrumentales par voie basse de 10 à 15%.

Mots-clés: Cardiotocographie en cours de travail, enfants hypotrophiques, équilibre acido-basique, fréquence des interventions, management obstétrical, prématurés, présentation du siège, tocolyse en urgence.

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