Introduction

Measurement of umbilical cord pH is an objective measure for perinatal morbidity at birth and can be used for audit on prenatal care and management of labour (Vandenbussche et al., 1999). Umbilical artery pH < 7.05 is a marker for neonatal acidosis and is associated with an increased risk for neonatal complications, as compared to normal cord blood pH. Respiratory acidosis, associated with base-excess ≥ 10 mmol/L, is less severe than metabolic acidosis with a deviating base-excess (Uzan et al., 2003). The incidence of serious neonatal morbidity and post-asphyctic encephalopathy increases significantly with umbilical artery cord pH < 7.00 (Gilstrap et al., 1989; Goldaber et al., 1991; Malin et al., 2010). In the criteria for the diagnosis of intrapartum hypoxia related neonatal brain damage, a base excess of ≤ -12 mmol/L is set as the cut-off value for definition of asphyxia (ACOG Committee Opinion, 2006; Andres et al., 1999; Goodwin et al., 1992; Low et al., 1997; Sehdev et al., 1997; Zupan, 2008).
As labour is the time span in which there is a substantial risk for asphyxia and asphyxia related mortality and morbidity, it is often questioned which particular aspects of labour management might enhance or prevent birth asphyxia. Some typical examples generally well known are uterine hyperactivity following administration of oxytocine, or hypotension related cardiocographic fetal distress at installation of epidural anaesthesia (Verspyck et al., 2008). This study is a single center 1-year perinatal audit of neonatal metabolic acidosis at birth with postnatal follow up of neonatal outcome, in order to identify preventable aspects of labour management which are associated with birth-related neonatal morbidity.

Methods

Population and data collection

At birth of each baby, born in ziekenhuis Oost Limburg Genk Belgium between 1/1/2010 and 31/12/2010, umbilical cord blood was sampled for blood gas analysis according to reported methodology (Sundström et al., 2000). The Sundström criteria for metabolic acidosis are more stringent than the criteria for perinatal asphyxia, as defined by the American College of Obstetricians and Gynecologists (ACOG, 2006) and allow for identification of a higher number of index cases with potential suboptimal care. Both venous and arterial blood was collected. The samples were collected within minutes after birth and sent to the lab instantly for analysis.

Analysis

All cases of metabolic acidosis were identified by blood gas analysis. Criteria for established metabolic acidosis were arterial pH < 7,05 or venous pH < 7,17, in association with base excess ≤ -10 mmol/L. In cases of sampling- or analysis-error, neonates with persistently low Apgar score of ≤ 6 after 5 minutes were considered clinically at risk for metabolic acidosis (Sundström et al., 2000; Uzan et al., 2003; Zupan, 2008) and were also included for further analysis.

For all cases of neonatal metabolic acidosis or persistently low Apgar score, patient’s labour ward notes, fetal monitoring traces and neonatologist’s records were evaluated retrospectively by three independent observers for identification of indicators of suboptimal peripartal care. After this, all cases were discussed with a group of obstetricians and neonatologists of Ziekenhuis Oost Limburg Genk to obtain overall consent for classification into 1 of five categories: (a) failure to detect or misinterpretation of signs of fetal distress was labelled as “non-conformity with guidelines for fetal monitoring” (Sundström et al., 2000), (b) abstaining from or overdosage of oxytocin for augmentation of uterine contractility was labeled as “non-conformity with the protocol for active management of labour” (Boylan et al., 2004), (c) early second stage intervention with instrumental vaginal delivery for fetal distress within 2h after full dilatation, (d) complications from non-obstetric interventions, such as anesthesia, and (e) preterm births or accidental and unavoidable cases at term such as placental abruption, chorio-amnionitis,…

Results

There was a total of 2056 deliveries with birth of 2117 babies. In this population, there were 11 cases of in utero fetal demise, 1 intrapartum death and 3 early neonatal deaths, bringing the total rate of early perinatal mortality to 7.1 per thousand births (15/2117).

As shown in Figure 1, 92.5% (1959/2117) of babies had normal pH values, whereas 3.5% (74/2117) were born with acidosis. Of these, 23 (1.1%) babies suffered metabolic acidosis and 51 (2.4%) had respiratory acidosis. There were 73 (3.3%) babies with unknown pH values, of which one showed a persistently low Apgar score of ≤ 6 after 5 minutes.

Figure 2 shows the clinical classification of 23 babies with metabolic acidosis or persistently low Apgar score, excluding 1 intrapartum death following maternal incompliance to labour support. For thirteen (54%) babies, no recognizable pattern of preventable measures during labour was identified, whereas ten others were classified as follows: 4 (16.7%) cases of violation of fetal monitoring guidelines, 1 (4.2%) case of violation of the protocol for active management of labour, 1 (4.2%) total spinal block after epidural anesthesia and 5 (20.8%) cases of instrumental vaginal delivery for fetal distress within 2 h of second stage. Apart from the premature births (n = 5), all babies left hospital within a week after birth, and 21 babies (91.3%) were in good clinical condition at discharge. Two babies (0.9% of the total population) showed persistence of neurologic symptoms for at least 6 months after birth and therefore were in long term neonatal follow up. Both babies were classified in the group of instrumental vaginal delivery for fetal distress within 2 h of second stage. One of these neonates had umbilical artery pH less than 7.0 with base-excess < -12 mmol/l and the other one had 5 minute Apgar score ≤ 6, for which both had criteria of perinatal asphyxia fulfilled.
Discussion

Reported incidence of neonatal metabolic acidosis and birth asphyxia depends on the definitions used. An umbilical artery pH < 7.05 combined with base-excess $\leq -10$ mmol/L is recorded in approximately 2.5% of the population (Sundström et al., 2000). Perinatal asphyxia with pH < 7.0 and base-excess $\leq -12$ mmol/L is observed in approximately 0.5-1% of term deliveries (Richardson et al., 2005; Wayenberg et al., 1998; Zupan, 2008). Many other definitions and criteria are used today. In our study, neonatal metabolic acidosis and perinatal asphyxia was found in 1.1% (24/2105) and 0.9‰ (2/2105) of live births respectively.

Two babies born with metabolic acidosis showed signs of persistent neurologic symptoms after birth, and met criteria of birth asphyxia. Both babies were born with instrument vaginal delivery for fetal distress within 2 h of second stage. Guidelines on management of second stage of labour show increased rates of spontaneous vaginal delivery in prolonged second stage with delayed pushing, as compared with early pushing at diagnosis of full dilatation, without associated differences in other parameters of maternal or neonatal outcome (Berghella, 2007; Roberts et al., 2004). Fetal distress after full dilatation is often anticipated with assisted birth techniques, such as instrument vaginal delivery (de Jonge, 1991). However, in case of insufficient descend or incomplete adaptation of the fetal head to the shape of the birth canal, cesarean section is to be preferred over difficult instrumental delivery, specifically for an already compromised baby. Intra-uterine resuscitation in the early second stage of labour can be considered an alternative for immediate operative delivery, on the condition that fetal monitoring shows complete and reassuring recovery. Reports on intra-uterine resuscitation in the second stage are scarce. Obstetric interventions with successful effect on intra-uterine fetal recovery from distress include interruption of IV administration of oxytocin, acute tocolysis in case of uterine hypertonia, maternal repositioning and amnio-infusion for oligoamnion (Verspyck et al., 2008). Maternal oxygen administration is not recommended since it has been associated with lower cord blood pH values compared to controls (Fawole et al., 2007). The use of betamimetics in the second stage has been linked to increased risk for forceps deliveries (Campbell et al., 1978). Increased risk for postpartum hemorrhage and for urinary incontinence 3 months postpartum (Brown et al., 2011) after prolonged second stage have also been reported. From the audit results presented in this paper, we have introduced in our local protocol for management of labour the consideration of intra-uterine resuscitation in the second stage of labour as an alternative to operative delivery for fetal distress, after discussing harms and benefits with the parents. Results of this adaptation of our protocol are to be assessed prospectively in forthcoming years.

Programs of perinatal audit usually include data on maternal mortality, near-miss maternal morbidity, stillbirths and neonatal mortality (Drife, 2006). In Belgium and other well-developed countries, low rates of < 1/10.000 for maternal mortality and < 1%
for perinatal mortality are reported (Study Centre for Perinatal Epidemiology, Brussels). Even with low maternal and neonatal mortality rates, guidelines towards further improvement of perinatal care are reported (Flenady et al., 2011), however, changing obstetric and perinatal management based on mortality rates only, without using figures on morbidity, may overlook those strategies causing a paradoxical shift from mortality to severe morbidity (Wilson et al., 2007). Currently, registration of neonatal near-miss cases based on abnormal cord blood gas analysis, are usually not part of any audit program and no accepted definition of neonatal near-miss currently exists (Avenant, 2009). It has been shown that the neonatal near-miss approach provides data useful to evaluate and improve the quality of perinatal care (Pileggi et al., 2010). Assessment of cord blood pH is enlisted in the RCOG recommendations towards improvement of patient safety (RCOG, 2009). Our study illustrates that the assessment of neonatal metabolic status at birth has been helpful to identify indicators of care with increased risk for persistent perinatal morbidity and to define strategies towards improvement of perinatal outcome. In our audit, by adding the cases of neonatal metabolic acidosis to those of perinatal mortality, the number of events eligible for analysing quality of perinatal care increased from 15 to 38, or from 0.7% of all births to 1.8%, which reflects a 2.5 fold increase. The near-miss principle of perinatal audit thus adds cases to evaluate and optimize intrapartum care. From this, we recommend that programs of perinatal audit should include figures on perinatal morbidity next to those of perinatal mortality, maternal morbidity and maternal mortality.

We conclude from our data that systematic screening for neonatal metabolic acidosis at birth helps to identify indicators of prenatal and obstetric management with potentially increased risk for adverse outcome, in addition to those identified with audit of perinatal mortality. Therefore, we suggest that audit programs towards improvement of perinatal care should include data on perinatal near-miss morbidity, next to those on perinatal mortality, maternal morbidity and maternal mortality.

References

Andres RL, Saade G, Gilstrap LC et al. Association between umbilical blood gas parameters and neonatal morbidity and


