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Neonatal outcome of infants with 1-minute Apgar score ≤ 7

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Background : *Apgar score describes the condition of newborn infants immediately after birth. Although, a low score alone is not correlated with the infant's future outcome, it may remain meaningful for prediction of the infant's survival and complication, such as hypoxic-ischemic encephalopathy (HIE).*

Objective : *To compare the incidence of HIE and death between preterm (GA ≤ 36 weeks) and term infants (GA ≥ 37 weeks) who had 1-minute Apgar score ≤ 7.*

Method : *Medical records of all infants with 1-minute Apgar score ≤ 7 at King Chulalongkorn Memorial Hospital during 2003-2005 were reviewed. HIE was diagnosed in the infants who had clinical finding of conscious change and seizures during the first 24 hours of age with or without abnormal EEG or abnormal computerized brain scan. Death incidence included all deaths that occurred during hospitalization regardless of their postnatal age.*

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Result : *There were 1,470 out of 25,909 infants (5.56%) who had 1-minute Apgar score ≤ 7. The incidence was significantly higher in preterm group (19.33% vs. 4.31%), (OR = 5.33, 95% CI, 4.72, 6.0, p - value <0.0001). The incidence of neonatal death in the preterm group was also higher, (8.99 % vs. 1.38 %), (OR = 7.06, 95% CI, 3.81, 13.08, p - value < 0.0001). The incidence of HIE was however lower in preterm infant than those of term group, especially among those infants with score ≤ 3, (2.75% vs. 20.56 %), (OR = 0.13, 95% CI, 0.04, 0.43, p-value <0.0001). Term infants with score ≤ 3 developed HIE more often than those with higher score (20.56 % vs. 1.87%), (OR = 13.55, 95% CI6.93, 26.50, p<0.0001). This association was not different in the preterm group. However, the mortality rate of both the preterm and term with score ≤ 3 were higher compared with those with score of 4 - 7.*

Conclusion : *Preterm infants were at higher risk to have low 1-minute Apgar score, but they were less likely to develop HIE than term infants. 1-minute Apgar score ≤ 3 can be used for prediction of HIE and death in term infants.*

Keywords : *Apgar score, Preterm infant, Term infant, HIE, Death.*

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ปัญหา : *คะแนนแอปการ์บ่งบอกสภาพทารกทันทีหลังคลอด แม้ว่าคะแนนต่ำจะไม่สัมพันธ์กับผลกระทบที่เกิดขึ้นในอนาคต แต่อาจช่วยทำนายโอกาสรอดชีวิตและภาวะแทรกซ้อนชนิดสมองขาดออกซิเจน (Hypoxic ischemic encephalopathy, HIE) ได้*

วัตถุประสงค์ : *เพื่อเปรียบเทียบอุบัติการณ์เกิด ภาวะ HIE และการเสียชีวิตระหว่างทารกเกิดก่อนกำหนด (อายุครรภ์ ≤ 36 สัปดาห์) กับทารกเกิดครบกำหนด (อายุครรภ์ ≥ 37 สัปดาห์) ที่มีคะแนนแอปการ์ที่1นาที ≤ 7*

วิธีการ : *ทำการวิเคราะห์เวชระเบียนทารกแรกเกิดในโรงพยาบาลจุฬาลงกรณ์ ในปี พ.ศ. 2546 - 2548 ทารกได้รับการวินิจฉัยว่าเป็น HIE ถ้ามีอาการผิดปกติทางสมองและชักภายในอายุ 24 ชั่วโมง ไม่ว่าจะมีผลการตรวจคลื่นสมองหรือคอมพิวเตอร์สมองผิดปกติหรือไม่ ทารกเสียชีวิตทุกรายขณะอยู่โรงพยาบาลไม่ว่าจะมีอายุเท่าใดนับเป็นอุบัติการณ์เสียชีวิต*

ผลการศึกษา : *พบว่าจากจำนวนทารกแรกเกิดทั้งหมด 25,909 คน มีทารก 1,470 คน (ร้อยละ 5.56) ได้คะแนนแอปการ์ที่ 1 นาที ≤ 7 อุบัติการเกิดขึ้นในทารกเกิดก่อนกำหนดมากกว่าทารกครบกำหนด (19.33 % vs 4.31 %), (OR = 5.33, 95% CI, 4.72, 6.0, p-value <0.0001) ทารกเกิดก่อนกำหนดเสียชีวิตมากกว่า (8.99 % vs 1.38 %), (OR=7.06, 95% CI, 3.81, 13.08, p-value <0.0001) แต่เกิด HIE น้อยกว่าทารกครบกำหนด โดยเฉพาะทารกที่มีคะแนน ≤ 3 (2.75 % vs 20.56%), (OR = 0.13,95 % CI,0.04, 0.43, p-value <0.0001) สำหรับทารกครบกำหนดที่มีคะแนน ≤ 3 เกิด HIE มากกว่าทารกที่มีคะแนนสูงกว่าอย่างมีนัยสำคัญทางสถิติ (20.56%vs 1.87%), (OR = 13.55, 95% CI 6.93, 26.50, p<0.0001). อย่างไรก็ตามไม่ว่าจะเป็นทารกเกิดก่อนกำหนดหรือครบกำหนดถ้ามีคะแนน ≤ 3 จะมีอัตราเสียชีวิตมากกว่าทารกที่มีคะแนนสูงกว่า*

สรุป : *การศึกษานี้แสดงให้เห็นว่าทารกเกิดก่อนกำหนดเสี่ยงที่จะมีคะแนนแอปการ์ที่ 1 นาที ≤ 7 สูงกว่าแต่เกิด HIE น้อยกว่าทารกครบกำหนด คะแนนแอปการ์ที่ 1 นาที ≤ 3 น่าจะใช้ทำนายโอกาสเกิดHIE และเสียชีวิตในทารกครบกำหนดได้*

คำสำคัญ : *คะแนนแอปการ์, ทารกเกิดก่อนกำหนด, ทารกเกิดครบกำหนด, ภาวะสมองขาดออกซิเจน, การเสียชีวิต.*

Apgar score comprises five clinical variables: heart rate, respiratory effort, reflex irritability, muscle tone and color. Each of which is given a score of 0, 1, or 2. It describes the condition of a newborn infant immediately after birth.[1] This scoring system was developed by Dr. Virginia Apgar which initially was used to estimate the probability of survival of a newborn infant and to appraise the need for resuscitation.[2] When properly applied, it is also a method of convenient standardized assessment for newborn infants. The World Health Organization defines the problem in newborn infants with 1 - minute Apgar score $\leq$ 7 as perinatal asphyxia, i.e. severe (score 0-3) and mild to moderate (score 4 - 7).[3] A population-based cohort study in term infants has shown that the Apgar score at both 1 and 5 minute of $\leq$ 3 were associated with increased risk of neonatal death and cerebral palsy when compared with score of $\geq$ 7.[4] When newborn resuscitation effort is carried out by a skilled team, it has been demonstrated that infants with Apgar score of $\leq$ 3 at five minutes of age had the highest risk of neonatal death.[5] Apgar score can be affected by many factors such as gestational age, congenital anomalies, infection, maternal medication, resuscitation, inter-observer variation and cardio-respiratory and neurological conditions.[6] Although low Apgar score alone is not correlated with the infant's future outcome, it may remain meaningful for prediction of neonatal survival and neonatal complication. Therefore, we evaluate the value of 1-minute Apgar score $\leq$ 7 in order to compare the incidence of a perinatal morbidity and neonatal death between the preterm ($\leq$ 37 week) and term infants ($\geq$ 37 weeks).

Material and Method

Medical records of all newborn infants with 1-minute Apgar score $\leq$ 7 at King Chulalongkorn Memorial Hospital from 2003 - 2005 were reviewed. Majority of the infants' Apgar score at 1 and 5 minutes were assigned by pediatric residents who attended deliveries. We selected the incidence of hypoxic-ischemic encephalopathy (HIE) and neonatal death as the outcomes of infants with 1-minute Apgar score $\leq$ 7. HIE was defined clinically on the basis of abnormal consciousness, muscle tone and reflexes, and seizures, according to the Sarnat and Sarnart clinical grading of HIE.[7] These abnormal clinical findings were noted shortly after birth or within 12 to 24 hours. Electroencephalogram (EEG) was performed in every infant who developed seizures during interictal stage within the first few days of life. The EEG findings were interpreted by a certified pediatric neurologist. Computerized brain scan was performed only on the infants with seizures or coma. The diagnosis of HIE can be made with or without abnormal EEG or abnormal computerized brain scan.[8] Other potential causes of these abnormalities such as meningitis, inborn errors of metabolism, focal cerebral infarction and traumatic brain injury were excluded. Deaths that occurred during admission to the neonatal unit regardless of their post-natal age were counted as neonatal death rate. Chi square tests were used to compare the event rate between preterm and term infants. Odd ratio and 95 percent confidence intervals were also calculated. P-value of <0.05 was considered significant.

Results

During this three years period, there were 25,909 infants delivered in the hospital. Gestational age ranged between 23 and 42 weeks. Birth weight was between 390 and 4,850 grams. 1,470 infants (5.67%) had 1-minute Apgar score ≤ 7, or 456 infants out of 2,359 preterm infants (19.33%) and 1014 infants out of 23,550 term infants (4.31%). Incidence of birth asphyxia in preterm infants was significantly higher than term infants (OR = 5.33, 95% CI, 4.72, 6.0), p-value <0.0001. Neonatal mortality in preterm infants was also significantly higher (8.99% *vs.* 1.38 %), (OR = 7.06, 95% CI, 3.81, 13.08). However the incidence of HIE in preterm infants was less (1.31% *vs.* 3.85%), (OR=0.33, 95% CI, 0.14, 0.79), (Table 1). Among infants with Apgar score ≤ 3, preterm infants had lower incidence of HIE than term infants (table 2). It was found that term infants with score 0-3 developed HIE more often than those with higher score (20.56% *vs.* 1.87%), (OR=13.55, 95% CI, 6.93, 26.50). But this association was not statistically different in preterm infants, (2.75% *vs.* 0.86 %), (OR = 3.24, 95% CI, 0.64, 16.32). However, the mortality rate of both preterm and term infants with score 0-3 were significantly higher compared with those with score 4-7, [(23.85% *vs.* 4.32 %, (OR=6.93, 95% CI, 3.51, 13.68)] and [(6.54% *vs.* 0.77%), (OR = 4.90, 95% CI, 3.09, 26.18)], respectively (Table 3, 4).

Table 1. Number and percent of infants with 1 - minute Apgar score ≤ 7 and their outcomes.

	Preterm infants, (n = 456)	**Term infants, (n = 1,014)**	**OR (95%CI)**	**p-value**
HIE, n (%)	6 (1.31)	39 (3.85)	0.33 (0.14,0.79)	0.005
Neonatal death, n (%)	41 (8.99)	14 (1.38)	7.06 (3.81,13.08)	<0.0001

Table 2. Comparison of the incidence of HIE and neonatal death in relation to Apgar score between preterm and term infants.

	Preterm infants	**Term infants**	**OR (95%CI)**	**p-value**
HIE, n (%)				
Apgar score 0 - 3	3/109 (2.75)	22/107 (20.56)	0.13 (0.04,0.43)	<0.0001
Apgar score 4 - 7	3/347 (0.86)	17/907 (1.87)	0.46 (0.14,1.56)	0.17
Neonatal death, n (%)				
Apgar score 0 - 3	26/109 (23.85)	7/107 (6.54)	3.65 (1.65,8.04)	<0.001
Apgar score 4 - 7	15/347 (4.32)	7/907 (0.77)	5.6 0 (2.3,13.62)	<0.0001

Table 3. Number and percent of HIE and neonatal death in preterm infants in relation to 1- minute Apgar score.

	Apgar score ≤ 3, n = 109	Apgar score 4 - 7, N = 347	OR (95% CI)	p-value
HIE, n (%)	3 (2.75)	3 (0.86)	3.24 (0.64, 16.32)	0.16
Neonatal death, n (%)	26 (23.85)	15 (4.32)	6.93 (3.51,13.68)	<0.0001

Table 4. Number and percent of HIE and neonatal death in term infants in relation to 1- minute Apgar score.

	Apgar score ≤ 3, n =107	Apgar score 4 - 7, n = 907	OR (95% CI)	p-value
HIE, n (%)	22 (20.56)	17 (1.87)	13.55 (6.93, 26.50)	<0.0001
Neonatal death, n (%)	7 (6.54)	7 (0.77)	4.90 (3.09, 26.18)	0.0001

Discussion

Our study shows that the 1-minute Apgar score is still relevant for prediction of short-term neonatal outcome and neonatal death in both preterm and term infants. Their survival increased as Apgar score increased. In term infants, the risk of neonatal death was 6.54% for those with Apgar core of 0 - 3, as compared with 0.77% for those with score of 4 - 7. Mortality rate of preterm infant was significantly higher than term infants with similar Apgar score. Approximately, 50% of the very immature infants (gestational age ≤ 25 weeks) with 1- minute Apgar score ≤ 3 died shortly after birth. This finding is consistent with a previous report. [5] Lower 1- minute Apgar score (0 - 3) in term infants was associated with higher rate of HIE. Although, low Apgar scores reflected immaturity in preterm infants, very low scores (0 - 3) were still associated with an increased risk of neonatal death but not the risk of HIE. It is unclear to determine the extent of clinical mani festation of HIE in preterm infants. An immature central nervous system may respond differently from that of term infants. It is rather difficult to diagnose HIE in the preterm infants based on clinical findings alone, so the incidence of HIE in these infants may be inaccurate. Since preterm infants are also at risk of many concurrent illnesses, including infection, respiratory distress, etc, these disorders may mask the clinical mani festations of HIE in such infants. Thus, the prevalence of HIE in preterm infants in our study may be lower than it should be. We think low 1-minute Apgar scores should not be the only associated cause of death of the infants, especially the preterm ones. Apgar score assigned to the premature infants can be lower than term infants. Since the assessment of Apgar score may vary among the observers and several components of Apgar score, such as reflex irritability, muscle tone, and respiratory effort. They are affected by the maturity of the infants. [2] Both the American Academy of Pediatrics

and the American College of Obstetricians and Gynecologists have emphasized that the diagnosis of encephalopathic perinatal asphyxia requires an evidence of neonatal neurological abnormalities and multi-system organ dysfunction in addition to both a low 5-minute Apgar score and neonatal acidosis. [9] Measurements of umbilical arterial blood gases provide the most accurate assessment of neonatal acidosis, but it is not feasible to perform such test at birth in our infants. Also decision to resuscitate the infant must be made before getting immediately blood gases. We do not intend to analyze 5-minute Apgar scores, since every infant with low Apgar score, regardless of their gestational age or birth weight, will receive intensive resuscitation which can alter the score assigned during the resuscitation. The limitations of our study included absence of data on the underlying diseases which might influence the risk of neonatal death. Although, a low 1-minute Apgar score alone is not correlated with the infant's future outcome[5], we found that it still remains meaningful for the identification of infants at risk and prediction of neonatal survival and neonatal complications. In addition with a small number of infants, the association of lower Apgar score (≤ 3) with HIE in our preterm infants are not statistically significant as it is found in term infants.

Conclusion

This study shows that preterm infants were at higher risk of having a low 1-minute Apgar score. But they developed HIE less often than term infants. 1-minute Apgar score of 0-3 can be used for prediction of HIE in term infants and prediction of death in both preterm and term infants.

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