# Original Article

# Factors Associated with Adverse Neonatal Outcomes in Category II Intrapartum Fetal Heart Rate Tracings

Ninlapa Pruksanusak MD[1],
Rattanawadee Duangchan MD[1], Chitkasaem Suwanrath MD, M.Med.Sci[1]

[1] Department of Obstetrics and Gynecology, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla, Thailand

***Objective:*** To evaluate the risk factors associated with adverse neonatal outcomes in category II intrapartum fetal heart rate (FHR) tracing

***Materials and Methods:*** This was a retrospective study, conducted at Songklanagarind Hospital from April 2014 to December 2015. All pregnant women with gestational aged 35 to 42 weeks and category II intrapartum FHR tracing were included to determine adverse neonatal outcomes and their associated risk factors. Statistical analysis was performed using the R software program, utilizing the Chi square test, Fisher exact test to compare between the groups. Multiple logistic regression was used to investigate the independent factors associated with adverse neonatal outcomes.

***Results:*** A total of 248 pregnant women were enrolled. The cesarean section rate was 88.7%. Seven-teen (6.8 %) neonates had adverse neonatal outcomes, but no neonatal death. The independent factors associated with adverse neonatal outcomes were maternal infection (OR, 54.04; 95%CI 4.29-680.74), thick meconium stained amniotic fluid (OR, 6.63; 95%CI 1.9-23.13) and moderate to severe late deceleration (OR, 3.95; 95%CI 1.13-13.79).

***Conclusion:*** Category II intrapartum FHR tracings, combined with maternal infection or meconium stained amniotic fluid had significant effect on adverse neonatal outcomes.

***Keywords:*** Intrapartum fetal heart rate, Tracing, Category II

Intrapartum electronic fetal monitoring (EFM) has been widely used in delivery units at various hospitals. The goal of EFM is to identify the high risk groups of peripartum asphyxiated fetuses, so as to allow time for intervention in the prevention of fetal injury. In the past, we interpreted the intrapartum fetal heart rate (FHR) patterns as reassuring or non-reassuring, but this interpretation had poor agreement among physicians, and did not represent high-risk fetuses[1]. Therefore, in 2008 the National Institute of Child Health and Human Development (NICHD), the Society for Maternal-Fetal Medicine (SMFM) along with the American College of Obstetricians and Gynecologists (ACOG) came to a consensus on a intrapartum FHR interpretation system (the NICHD 3-tier system)[2]. They then recommended using this interpretation system within all delivery units. The NICHD 3-tier system has 3 categories of FHR patterns: Category I is a normal pattern with very low-risk of fetuses having peripartum asphyxiation, whereas, at the other end of the scale, category III is contrary having significant risk for neonatal acidosis coupled with long term risks of encephalopathy if unresolved during the intrapartum period[3]. The Category II pattern accounted for 80 percent of intrapartum fetal heart rate tracing[4], which had various neonatal outcomes, with pregnancy management depended on individual decision making.

In Songklanakarind Hospital, a tertiary care and referral center in Southern Thailand, we have used the intrapartum EFM and its 3-tier system for interpretation FHR patterns since 2014. We found the incidence of category II intrapartum FHR patterns to be 36.4 percent. Most of these, in the category II FHR pattern, were variable decelerations, however, there were some cases of category II FHR patterns that had adverse perinatal outcomes. Hence, our study aimed to evaluate the associated risk factors of adverse neonatal outcomes within category II FHR tracing. This was done with the aim of establishing better and more appropriate intrapartum management in these pregnant women.

**Correspondence to:**

Pruksanusak N. Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.
**Phone:** +66-74-451201-2, **Fax:** +66-74-429617
**Email:** nin056@hotmail.com

## Materials and Methods

### Study population

A retrospective study was conducted at Songklanagarind Hospital between from April 2014 to December 2015, after approval by the Institutions' Ethics Committee. Pregnant women gestational aged 35 to 42 weeks with intrapartum category II FHR tracing for at least 20 minutes during the last 2 hours before delivery were included. Those with fetal growth restriction, congenital anomalies, abnormal presentations, and had previous maternal cesarean delivery were excluded. All category II FHR tracings were reviewed, then interpreted for FHR baseline, variability, accelerations, types and degrees of decelerations by Pruksanusak N (maternal-fetal-medicine staff). The degrees of decelerations were categorized according to the criteria by Parer JT in 2007[5]. The sample size calculation was from the formula using the rate of adverse neonatal outcome reported by Holmgren CM[6], 0.11 %, with level of significance 0.05. The total sample size was 235 patients.

Baseline maternal characteristics, antenatal and intrapartum complications were recorded. The adverse neonatal outcomes were defined using of the following criteria: the need for admission into the newborn intensive care unit (NICU), intubation in the delivery room, inotropic drug support required, Apgar score at 5 minutes less than 7, resuscitation continued for 10 minutes, time to spontaneous respiration longer than 10 minutes, seizure, and encephalopathy[7].

Patients were categorized into two groups: 1. Pregnant women, who had adverse neonatal outcomes. 2. Patients with no adverse neonatal outcomes. Then, we compared the two groups to establish the risk factors associated with adverse neonatal outcomes and management of the two groups.

### Data analysis

The statistical analysis was performed by the use of the R software program using the Chi square test, Fisher exact test to make comparisons between the two groups. A probability value of <0.05 was considered statistically significant. Multiple logistic regression was used to investigate the independent factors that were associated with adverse neonatal outcomes. Odds ratios (OR) as well as their 95% confidence interval (CI) were calculated from the regression coefficients.

### Results

A total of 248 pregnant women and infants were enrolled. Maternal characteristics, pregnancy complications, and neonatal outcomes were shown in Table 1. The three most common antepartum complications were: premature rupture of membranes (PROM), gestational diabetes mellitus (GDM), and hypertensive related pregnancy (Table 1). A high cesarean section rate (88.7 %) was observed in the category II intrapartum FHR tracings patients. The other routes of delivery were vacuum and forceps extractions, with no normal delivery in this group of patients. Category II intrapartum FHR tracings showed prolonged decelerations, variable decelerations, late decelerations at 57.6, 50.8, and 20.6 percent, respectively. The minimal variability was 5.2 percent. Overall, the mean neonatal birth-weight was 3,109 grams, whilst hospital length of stay was 4.8 days. The adverse neonatal outcomes were 6.8 percent, but only 0.4 percent were neonatal seizures. No perinatal deaths were observed (Table 1).

Table 2. showed obstetric risk factors of category II intrapartum FHR tracings for patients with and without adverse neonatal outcomes during the first stage of labor. The maternal infections (2 cases of chorioamnionitis and 2 cases of urinary tract infections), thick meconium stained amniotic fluid (AF), minimal FHR variability and presence of moderate to severe late deceleration were significantly associated with adverse neonatal outcomes. Overall, the decision to delivery time more than 60 minutes between the two groups was not significantly different.

After multivariable logistic regression was used (Table 3), the model then included the following variables: maternal infections, thick meconium stained AF, FHR variability and presence of late decelerations. Maternal infections, thick meconium stained AF and moderate to severe degrees of late decelerations were statistically significant factors associated with the occurrence of adverse neonatal outcomes. Mean decision to delivery time of pregnant women, who had adverse neonatal outcomes, with moderate to severe late decelerations, thick meconium stained AF, and both were 32.8, 39.3, and 24 minutes, respectively.

### Discussion

The present study showed that most pregnant women, with normal fetal growth and intrapartum category II FHR tracings, had good neonatal outcomes (93.2 percent) with no perinatal death, but there was high rate of obstetrical operative procedures found along with no normal deliveries conducted within this group of patients. Although, there was high

rate of operative procedures observed, the maternal morbidities were low, additionally, there were no maternal death.

Pregnant women with moderate to severe degrees of late decelerations coupled with infections, or thick meconium stained AF had highly significant adverse neonatal outcomes, although the mean decision to delivery time was less than 30 minutes. However,

**Table 1.** Maternal characteristics and complications of pregnancy with adverse neonatal outcomes

| | Frequency (%) |
|---|---|
| Maternal characteristics and complications | |
| Maternal Age (years) Mean (SD) | 30.2 (5.3) |
| Gestational Age (weeks) Mean (SD) | 38.8 (1.2) |
| Nulliparous | 167 (67.3) |
| Syntocinon use | 121 (48.8) |
| Premature rupture of membranes | 44 (17.7) |
| Gestational diabetes mellitus | 18 (7.3) |
| Overt diabetes mellitus | 2 (0.8%) |
| Hypertension | 13 (5.2) |
| Anemia | 11 (4.4) |
| Infection | 4 (1.6) |
| Thyroid disease | 4 (1.6) |
| Neonatal characteristics and adverse neonatal Outcome | |
| Birthweight (grams) Mean (SD) | 3109 (365.3) |
| Hospital length stay (days) Mean (SD) | 4.8 (7.7) |
| Thick meconium stained amniotic fluid | 21 (8.5) |
| NICU admission | 16 (6.5) |
| Intubation in delivery room | 9 (3.6) |
| Inotropic drug support | 9 (3.6) |
| Apgar score at 5 minute < 7 | 4 (1.6) |
| Resuscitation continued for 10 minutes | 2 (0.8) |
| Time to spontaneous respiratory ≥ 10 minutes | 1 (0.4) |
| Seizure | 1 (0.4) |

**Table 2.** Factors associated with adverse neonatal outcomes

| | Adverse neonatal outcomes frequency (%) n = 17 | No adverse neonatal outcomes frequency (%) n = 231 | p-value |
|---|---|---|---|
| Nulliparous | 11 (64.7) | 156 (67.5) | 1 |
| PROM | 2 (11.8) | 42 (18.2) | 0.745 |
| GDM | 0 (0) | 18 (7.8) | 0.620 |
| Overt DM | 0 (0) | 2 (0.9) | 1 |
| Hypertension | 0 (0) | 13 (5.6) | 0.609 |
| Anemia | 1 (5.9) | 10 (4.3) | 0.550 |
| Infection | 3 (17.6) | 1 (0.4) | 0.001 |
| Thyroid | 0 (0) | 4 (1.7) | 1 |
| Abnormal fetal heart rate (<110, >160) | 1 (5.9) | 7 (3) | 0.438 |
| No acceleration | 11 (64.7) | 134 (58) | 0.775 |
| Fetal heart rate variability | | | |
| Minimal | 3 (17.6) | 10 (4.3) | 0.050 |
| Moderate | 14 (82.4) | 221 (95.7) | |
| Presence of late deceleration | | | |
| None or mild | 12 (70.6) | 205 (88.7) | 0.046 |
| Moderate or severe | 5 (29.4) | 26 (11.3) | |
| Presence of variable deceleration | | | |
| None or mild | 17 (100) | 224 (97) | 1 |
| Moderate or severe | 0 (0) | 7 (3) | |
| Presence of prolonged deceleration | | | |
| None or mild | 14 (82.4) | 199 (86.1) | 0.716 |
| Moderate or severe | 3 (17.6) | 32 (13.9) | |
| Thick meconium stained amniotic fluid | 6 (35.3) | 15 (6.5) | 0.001 |
| Decision to delivery time > 60 minutes | 5 (33.3) | 47 (23.2) | 0.359 |

**Table 3.** Multivariable logistic regression analysis of risk factors associated with adverse neonatal outcomes

| | Adjusted ORs (95% CI) | p-value LR test |
|---|---|---|
| Infections | 54.04 | 0.002 |
| | (4.29,680.74) | |
| Thick meconium stained amniotic fluid | 6.63 | 0.006 |
| | (1.9,23.13) | |
| Variability | 2.35 | 0.419 |
| Minimal VS moderate | (0.33,16.66) | |
| Late deceleration | 3.95 | 0.042 |
| Moderate or severe VS none or mild | (1.13,13.79) | |

other types of abnormal decelerations (prolonged and variable decelerations) had no significant association with adverse neonatal outcomes.

Even though, intrapartum FHR monitoring is widely used for fetal surveillance, the abnormal FHR tracings are not specific indicators for fetal status. Well-grown term fetuses, with clear amniotic fluid will develop acidosis at a time of 115 minutes with late decelerations and 145 minutes with variable decelerations[8]. As shown in our study, variable decelerations FHR patterns were not significantly associated with adverse neonatal outcomes. This may, however, be due to the mean decision to delivery time of our patients was not long. Another reason was the nature of variable decelerations which occurred from umbilical cord compression during delivery was an acute or short event. So, it may not interfere with oxygenation of the well-grown fetuses. These factors may very well be the reasons in most fetuses having normal perinatal outcomes. Amnon et al found that late decelerations as well as severe variable decelerations, (<70 beat/minutes) during the first stage of labor, were associated with fetal acidosis in addition to a high rate of operative deliveries[9]. Therefore, the degree of decelerations was an important factor that affected the neonatal outcomes as the authors have shown in our study. This being that variable decelerations in the present patients were not associated with adverse neonatal outcomes because almost all of the variable decelerations in the present study were of a mild degree. The late decelerations were also similar to the variable decelerations in moderate to severe degrees were associated with adverse neonatal outcomes.

Meconium stained AF was found to be a statistically significant factor affected the occurrence of abnormal FHR tracings in several studies[9-11]. Hairong et al reported that term pregnancy complicated with thick meconium-stained AF and presence of abnormal FHR tracing patterns (prolonged or severe variable decelerations) were associated with increased risk of adverse perinatal outcomes[10]. Baker et al also reported 10 percent of fetuses with thick meconium stained AF and presence of an abnormal FHR tracing had a scalp pH of less than 7.20; only 2.8 percent of fetuses with no FHR abnormalities had a pH of less than 7[11]. So, in the context of well-grown term fetuses with thick meconium stained AF and abnormal FHR tracings, (especially with the presence of moderate to severe late decelerations) have been significantly associated with adverse neonatal outcomes and the decision to delivery time should be less than 30 minutes.

The present study found the maternal infections (chorioamnionitis and urinary tract infection) were the highest risk factors associated with adverse neonatal outcomes (adjusted OR 54.04). The FHR tracing patterns in this group of patients were mild degrees of prolonged decelerations and/or minimal variability and/or no FHR accelerations with no late or variable decelerations being observed. Chorioamnionitis is an intrauterine inflammation condition that has adverse effects on both mother and fetus. The majority of fetuses exposed to chorioamnionitis developed a systemic inflammatory response known as: fetal inflammatory response syndrome (FIRS). The inflammation of fetal organs can be secondary to both infection and ischemia from abnormal fetal cardiac functions resulting from exposure to the intrauterine inflammation condition[12]. As a consequence of the FIRS, neonates born from mothers with chorioamnionitis usually have adverse neonatal outcomes such as respiratory distress syndrome, necrotizing enterocolitis, and worse case neonatal death[13].

The present study reported the high rate of operative deliveries, with no normal delivery in this group of patients similar to the previous studies[10,14]. A recent report by Clark et al showed that the category II intrapartum FHR tracings reviewed and managed by experts or used as a published algorithm developed and endorsed by a large group of national experts, has the potential to improve the standard clinical performance[15]. By facilitating significant earlier recognition of some tracings that are associated with metabolic acidemia will decrease the rate of operative intervention. Therefore, pregnant women with category II intrapartum FHR tracings need to undergo careful interpretation and evaluations, to reduce unnecessary interventions, which would in turn result in the prevention of neonatal acidemia.

In summary, the category II intrapartum FHR tracings combined with maternal infection or meconium stained amniotic fluid have significantly affected on adverse neonatal outcomes. The decision as well as management of pregnant women with category II intrapartum FHR tracings needs to be carefully performed in addition to extensity reviewed by experts, so as to reduce unnecessary cesarean section, and for the early detection of perinatal asphyxia fetuses. The findings of the present study can be used to set an appropriate algorithm in our context endorsed by the experts and staff doctors in order to reduce unnecessary cesarean section without harm to fetuses.

## Conclusion

The category II intrapartum FHR tracings combined with maternal infection or meconium stained amniotic fluid have significantly affected on adverse neonatal outcomes. The decision as well as management of pregnant women with category II intrapartum FHR tracings needs to be carefully performed in addition to extensity reviewed by experts, so as to reduce unnecessary cesarean section, and for the early detection of perinatal asphyxia fetuses. The findings of the present study can be used to set an appropriate algorithm in the context endorsed by the experts and staff doctors in order to reduce unnecessary cesarean section without harm to fetuses.

## What is already known on this topic?

The category II fetal heart rate pattern had various neonatal outcomes, with pregnancy man-agement depended on individual decision making.

## What is this study added?

The category II intrapartum FHR tracings combined with maternal infection or meconium stained amniotic fluid have significantly affected on adverse neonatal outcomes.

## Acknowledgment

## Potential conflicts of interest

The authors declare no conflict of interest.

## References

1. Chauhan SP, Klauser CK, Woodring TC, Sanderson M, Magann EF, Morrison JC. Intrapartum nonreassuring fetal heart rate tracing and prediction of adverse outcomes: interobserver variability. Am J Obstet Gynecol 2008; 199: 623-5.
2. Macones GA, Hankins GD, Spong CY, Hauth J, Moore T. The 2008 National Institute of Child Health and Human Development workshop report on electronic fetal monitoring: update on definitions, interpretation, and research guidelines. Obstet Gynecol 2008; 112: 661-6.
3. American College of Obstetricians and Gynecologists. Practice bulletin no. 116: Management of intrapartum fetal heart rate tracings. Obstet Gynecol 2010; 116: 1232-40.
4. Timmins AE, Clark SL. How to approach intrapartum category II tracings. Obstet Gynecol Clin North Am 2015; 42: 363-75.
5. Parer JT, Ikeda T. A framework for standardized management of intrapartum fetal heart rate patterns. Am J Obstet Gynecol 2007; 197: 26.
6. Holmgren CM, Esplin MS, Jackson M, Porter TF, Henry E, Horne BD, et al. A risk stratification model to predict adverse neonatal outcome in labor. J Perinatol 2013; 33: 914-8.
7. Shankaran S, Laptook AR, Ehrenkranz RA, Tyson JE, McDonald SA, Donovan EF, et al. Whole-body hypothermia for neonates with hypoxic-ischemic encephalopathy. N Engl J Med 2005; 353: 1574-84.
8. Ugwumadu A. Are we (mis)guided by current guidelines on intrapartum fetal heart rate monitoring? Case for a more physiological approach to interpretation. BJOG 2014; 121: 1063-70.
9. Hadar A, Sheiner E, Hallak M, Katz M, Mazor M, Shoham-Vardi I. Abnormal fetal heart rate tracing patterns during the first stage of labor: effect on perinatal outcome. Am J Obstet Gynecol 2001; 185: 863-8.
10. Xu H, Mas-Calvet M, Wei SQ, Luo ZC, Fraser WD. Abnormal fetal heart rate tracing patterns in patients with thick meconium staining of the amniotic fluid: association with perinatal outcomes. Am J Obstet Gynecol 2009; 200: 283.e1-7.
11. Baker PN, Kilby MD, Murray H. An assessment of the use of meconium alone as an indication for fetal blood sampling. Obstet Gynecol 1992; 80: 792-6.
12. Galinsky R, Polglase GR, Hooper SB, Black MJ, Moss TJ. The consequences of chorioamnionitis: preterm birth and effects on development. J Pregnancy 2013; 2013: 412831.
13. Patrick D. Maternal and fetal infections. In: Creasy RK, Resnik R, Iams JD, Lockwood CJ, Moore TR, Greene MF, editors. Creasy and Resnik's maternal-fetal medicine principles and practice. 7th ed. Philadelphia: Saunders Elsevier; 2014: 802-51.
14. Sarno AP Jr, Ahn MO, Phelan JP. Intrapartum amniotic fluid volume at term. Association of ruptured membranes, oligohydramnios and increased fetal risk. J Reprod Med 1990; 35: 719-23.
15. Clark SL, Hamilton EF, Garite TJ, Timmins A, Warrick PA, Smith S. The limits of electronic fetal heart rate monitoring in the prevention of neonatal metabolic acidemia. Am J Obstet Gynecol 2017; 216: 163.e1-6.