—**Short Communication**—

Time of Delivery and Perinatal Outcome

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Abstract

The purpose of this study was to examine the association between time of delivery and perinatal outcomes in singleton deliveries at Japanese Red Cross Katsushika Maternity Hospital. We performed a retrospective cohort study of all singleton deliveries at ≥22 weeks' gestation from 2002 through 2009 at our hospital. During the nighttime period (12 midnight to 8 am), although the rate of delivery of high-risk pregnancies was low, the rate of low umbilical artery pH (<7) was higher than that during the daytime periods (8 am to 4 pm) (odds ratio 1.9, 95% confidence interval 1.1–3.4, p=0.02). During the nighttime period, in addition, the rate of low umbilical artery pH in patients with emergent cesarean delivery was significantly higher than that during the daytime period (odds ratio 6.9; 95% confidence interval 2.5–19, p<0.01). In our hospital, the rate of adverse neonatal outcomes associated with cesarean birth was increased at nighttime period.

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Key words: time of delivery, perinatal outcome, umbilical artery pH, cesarean delivery

Although several studies have found that nighttime delivery increases the neonatal morbidity rate[1,2], otherstudies have found comparable neonatal outcomes between the daytime and nighttime periods[3]. In one recent large study from the Netherlands[2], hospital deliveries at night were found to be associated with an increased rate of perinatal mortality and adverse perinatal outcomes in singleton deliveries at ≥32 weeks' gestation. On the other hand, Caughey et al.[3] in the United States could not demonstrate any significant differences in the rate of neonatal morbidity or mortality by time of day among singleton neonates delivered at term. Some important limitations in these observations may be the generalizability of the differences in their hospital functions and staffs. Therefore, similar studies should be examined and replicated in various settings to clarify the perinatal outcomes of nighttime delivery. The purpose of the present study was to examine the association between time of delivery and perinatal outcomes in singleton deliveries at our institution; the Japanese Red Cross Katsushika Maternity Hospital.

Our hospital is one of main perinatal centers in Tokyo, Japan (about 2,100 deliveries per year). Five or 6 obstetricians and 3 or 4 neonatologists are on duty during the daytime on weekdays, and 2 obstetricians and 1 neonatologist are on duty on weekends and during evenings and night on weekdays. At our hospital, unfortunately there are no full-time anaesthetists or anethesiologists for emergent cearean section.

We performed a retrospective cohort study of all singleton deliveries at ≥22 weeks' gestation from

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Table 1-1 Patient and labor characteristics and complications by day, evening and night deliveries[a]

Time of delivery	Day (8 AM to 4 PM) (n=5,176)	Evening (4 PM to 12 midnight) (n=4,477)	P value[b]	Night (12 midnight to 8 AM) (n=3,763)	P value[b]
Maternal age					
<20 years	88 (1.7)	65 (1.5)	0.33	61 (1.6)	0.77
≥40 years	210 (4.1)	192 (4.3)	0.57	132 (3.5)	0.18
Nulliparity	2,795 (54)	2,662 (59%)	<0.01	1,687 (45)	<0.01
Previous Cesarean deliveries	187 (3.6)	130 (2.9)	0.05	137 (3.6)	0.94
Hypertensive disorders	311 (6.0)	241 (5.4)	0.19	90 (2.4)	<0.01
Diabetes Mellitus	33 (0.64)	23 (0.51)	0.42	21 (0.56)	0.63
Placental abruption	50 (0.97)	46 (1.0)	0.76	40 (1.1)	0.65
Gestational age at delivery					
<32 weeks	169 (3.3)	88 (2.0)	<0.01	41 (1.1)	<0.01
32–36 weeks	396 (7.7)	294 (6.6)	0.04	234 (6.2)	0.01
≥42 weeks	37 (0.71)	30 (0.67)	0.79	13 (0.35)	0.02
Oxytocin use[c]	936 (18)	960 (21)	<0.01	223 (5.9)	<0.01
Delivery mode					
Assisted deliveries	324 (6.3)	424 (9.5)	<0.01	257 (6.8)	0.28
Cesarean delivery	758 (15)	556 (12)	<0.01	150 (4.0)	<0.01
Postpartum hemorrhage					
≥1,000 mL	220 (4.3)	210 (4.7)	0.30	125 (2.4)	0.02

[a]Values are given as number (percentage).
[b]Compared with the values at daytime.
[c]Oxytocin use as augmentation of the labor.

Table 1-2 Neonatal outcomes by day, evening and night deliveries[a]

Time of delivery	Day (8 AM to 4 PM) (n=5,176)	Evening (4 PM to 12 midnight) (n=4,477)	P value[b]	Night (12 midnight to 8 AM) (n=3,763)	P value[b]
Gestational age at delivery					
<32 weeks	169 (3.3)	88 (2.0)	<0.01	41 (1.1)	<0.01
32–36 weeks	396 (7.7)	294 (6.6)	0.04	234 (6.2)	0.01
≥42 weeks	37 (0.71)	30 (0.67)	0.79	13 (0.35)	0.02
Perinatal death[c]	1 (0.019)	2 (0.045)	0.48	3 (0.080)	0.18
Birth weight					
<1,500 g	149 (2.2)	74 (1.6)	<0.01	37 (0.98)	<0.01
1,500–2,499 g	494 (9.5)	400 (9.0)	0.30	329 (8.7)	0.20
≥4,000 g	50 (0.97)	56 (1.3)	0.18	27 (0.72)	0.18
Light for gestational age	431 (8.3)	386 (8.8)	0.36	359 (9.5)	0.05
Heavy for gestational age	270 (5.2)	262 (5.9)	0.17	160 (4.3)	0.04
Apgar score at 1 minute					
<4	51 (0.99)	32 (0.71)	0.15	32 (0.85)	0.51
<7	146 (2.8)	107 (2.4)	0.19	88 (2.2)	0.07
Apgar score at 5 minutes					
<4	11 (0.22)	7 (0.16)	0.52	7 (0.19)	0.78
<7	37 (0.71)	27 (0.60)	0.50	24 (0.64)	0.66
Umnilical artery pH <7.0	19 (0.37)	20 (0.45)	0.54	26 (0.69)	0.03

[a]Values are given as number (percentage).
[b]Compared with the values at daytime.
[c]Perinatal death except intrauterine fetal death before labor.

Table 2 Incidence of umbilical artery pH <7.0 associated with the patient and labor characteristics and complications by day, evening and night deliveries[a]

Time of delivery	Day (8 AM to 4 PM) (n=5,176)	Evening (4 PM to 12 midnight) (n=4,477)	P value[b]	Night (12 midnight to 8 AM) (n=3,763)	P value[b]
Nulliparity	0.43 (12/2,795)	0.33 (12/2,662)	0.33	0.71 (12/1,687)	0.88
Hypertensive disorders	2.0 (1/50)	6.5 (3/46)	0.27	3.3 (3/90)	0.65
Gestational age at delivery					
<32 weeks	1.2 (2/169)	1.1 (1/88)	0.97	4.9 (2/41)	0.12
32–36 weeks	0.51 (2/396)	1.4 (4/294)	0.23	1.7 (4/234)	0.59
≥42 weeks	2.7 (1/37)	0 (0/30)	0.36	0 (0/13)	0.55
Oxytocin use[c]	0.43 (4/936)	0.63 (6/960)	0.55	1.3 (3/223)	0.11
Delivery mode					
Assisted delivery	0.93 (3/324)	1.2 (5/424)	0.74	0.78 (2/257)	0.84
Cesarean delivery	0.92 (7/758)	1.6 (9/556)	0.26	6.0 (9/150)	<0.01
Neonatal weight					
Light for gestational age	0.70 (3/431)	1.0 (4/396)	0.62	1.7 (6/359)	0.20
Heavy for gestational age	0.74 (2/270)	1.1 (3/262)	0.63	0.63 (1/160)	0.89

[a]Values are given as percentage (number/total number).
[b]Compared with the values at daytime.
[c]Oxytocin use as augmentation of the labor.

2002 through 2009 at Japanese Red Cross Katsushika Maternity Hospital. The protocol for this study was approved by the Ethics Committee of the Japanese Red Cross Katsushika Maternity Hospital. Exclusion criteria included pregnancies complicated by lethal congenital fetal anomalies, intrauterine fetal death before labor and planned elective cesarean deliveries. Time of day was divided into 3 intervals: 8 am to 4 pm (daytime period), 4 pm to 12 midnight (evening period) and 12 midnight to 8 am (nighttime period). Data on the following outcomes were collected from the medical record: maternal age, parity, history of previous cesarean deliveries, maternal complications such as hypertensive disorders and diabetes mellitus, placental abruption, oxytocin use for augmentation of the labor, gestational age at delivery, delivery mode, perinatal death, neonatal birth weight, 1 and 5 minute Apgar scores and umbilical artery pH.

The χ^2 and Fisher's exact tests were used to compare cross-tabulated data. Odds ratios (ORs) based on the 95% confidence interval (CI) were also calculated for the categorical data. Statistical significance was defined at $p<0.05$.

Table 1-1 shows the patient and labor characteristics and complications by daytime, evening and nighttime deliveries. During the evening, the rates of primiparous women, oxytocin use for augmentation of labor and assisted (forceps, vacuum and vaginal breech) delivery were significantly higher than those during the daytime period (primiparous women: OR 1.3, 95%CI 1.2–1.4, $p<0.01$; oxytocin use: OR 1.2; 95%CI 1.1–1.4, $p<0.01$; assisted delivery: OR 1.6, 95%CI 1.4–1.8, $p<0.01$). Similarly, the rates of premature delivery and emergency cesarean delivery during the evening period were significantly lower than those during the daytime period (premature deliveries at <32 weeks: OR 0.59, 95%CI 0.46–0.77, $p<0.01$; premature delivery at 32–36 weeks: OR 0.85, 95%CI 0.73–0.99, $p=0.04$). During the nighttime period, the rates of primiparous women, maternal hypertensive disorders, premature delivery, postterm delivery, oxytocin use and assisted delivery, cesarean delivery and postpartum hemorrhage ≥1,000 mL were significantly lower than those during the daytime period (primiparous women: OR 0.69, 95%CI 0.64–0.75, $p<0.01$; hypertensive disorders: OR 0.38, 95%CI 0.30–0.49, $p<0.01$; premature delivery at <32 weeks: OR 0.33, 95%CI 0.23–0.46, $p<0.01$; premature delivery at 32–36 weeks: OR 0.80, 95%CI 0.68–0.95, $p=0.01$; postterm delivery: OR 0.48, 95%CI 0.26–0.91, $p=0.02$; oxytocin use: OR 0.29, 95%CI 0.25–0.33, $p<0.01$; cesarean delivery: OR 0.24, 95%CI 0.20–0.29, $p<0.01$;

postpartum hemorrhage ≥1,000 mL: OR 0.77, 95%CI 0.62–0.97, p=0.02).

Table 1-2 shows neonatal outcomes by day, evening and night deliveries. During the evening period, the rate of neonatal birth weight of <1,500 g was significantly lower than that during the daytime period (birth weight of <1,500 g: OR 0.57, 95%CI 0.43–0.75, p<0.01). During the nighttime period, the rates of neonatal birth weight of <1,500 g and heavy for gestational age were significantly lower than those during the daytime period (birth weight of <1,500 g: OR 0.34, 95%CI 0.23–0.48, p<0.01; heavy for gestational age: OR 0.81; 95%CI 0.66–0.99, p<0.01). During the nighttime period, however, the rate of low umbilical artery pH (<7.0) was significantly higher than that during the daytime period (OR 1.9, 95%CI 1.1–3.4, p=0.02).

These results shown in **Table 1-1 and 1-2** indicate that the labors of high-risk pregnancies needing aggressive medical intervention has been managed to occur during the daytime period as often as possible, because the volume of medical staff during the daytime period was larger than that during the evening and nighttime periods at our hospital. In addition, augmented deliveries at term often seem to occur during the evening period. These prolonged labors seemed to be associated with an increased rate of assisted delivery but were not associated with increases in the rates of cesarean delivery or adverse perinatal outcomes. During the nighttime period, although the rate of delivery of high-risk pregnancies seemed to be low, the rate of low umbilical artery pH (<7) was higher than that during the other time periods.

In this study, using the univariate analysis showed that low umbilical artery pH (<7.0) in the singleton deliveries was seen to be associated with maternal hypertensive disorders (crude OR 2.4, 95%CI 1.1–5.3, p=0.02), premature delivery (at <32 weeks: crude OR 4.3, 95%CI 1.7–11, p<0.01; at 32–36 weeks: crude OR 2.7, 95%CI 1.4–5.3, p<0.01), assisted delivery (crude OR 3.7, 95%CI 1.8–7.5, p<0.01), cesarean delivery (crude OR 6.3, 95%CI 3.7–11, p<0.01) and neonatal birth weight of light for gestational age (crude OR 2.7, 95%CI 1.5–5.2, p<0.01). On the other hand, the low umbilical artery pH was not associated with primiparity (crude OR 1.1, 95%CI 0.67–1.8, p=0.73), oxytocin use for augmentation of the labor (crude OR 1.4, 95%CI 0.73–2.5, p=0.34), postterm delivery (crude OR 3.1, 95%CI 0.43–23, p=0.23) or neonatal birth weight of heavy for gestational age (crude OR 2.3, 95%CI 0.93–5.1, p=0.07). Multiple logistic regression analysis showed that the independent risk factors for low umbilical artery pH were cesarean delivery (adjusted OR 3.2, 95%CI 1.9–5.5, p< 0.01), premature delivery at <32 weeks (adjusted OR 2.5, 95%CI 1.0–6.4, p=0.04) and neonatal birth weight of light for gestational age (adjusted OR 1.9, 95%CI 1.0–3.5, p=0.04). These findings were consistent with those of some previous studies[4,5].

Table 2 shows the rate of low umbilical artery pH (<7.0) associated with the characteristics of the patient and of labor and complications by daytime, evening and nighttime deliveries. During the nighttime period, the rate of low umbilical artery pH in patients undergoing emergent cesarean delivery was significantly higher than that during the daytime period (OR 6.9; 95%CI 2.5–19, p<0.01).

These results suggest that the increased rate of low umbilical artery pH during nighttime period is associated with emergent cesarean delivery performed during the nighttime period.

In 2010, Caughey et al.[3] reported that neonatal outcomes do not differ between the daytime, evening and nighttime shifts in an institution with anesthesiology and obstetric staff on duty in-house 24 hours per day. In addition, Bailit et al.[6] have found in their large multicenter study of teaching hospitals in the United States that there are no important differences in maternal or neonatal morbidity rates according to work shift after unscheduled cesarean delivery. These studies[3,6] are in sharp contrast to the Gould study[1] which found that neonatal outcomes are worse at night in the state of California. Some possible explanations for these discrepancies have been proposed as follows[3,6]: (1) the presence or absence of trained physicians who mitigate the potential effects of sleep deprivation, and (2) the difference in adrenaline response to the effect of sleep deprivation associated with the differences in labor circumstances. The labor and delivery unit of our hospital has a volume of approximately 2,100 births per year. This volume is high enough to support an adequate midwifery staff throughout a 24-hour day but not too high to produce a hectic environment. In our hospital, there are 2 or more obstetricians, but no regular anaesthetists or anesthesiologists on duty in-house 24 hours per day. In our hospital, therefore, an operator (obstetrician) must often also perform anesthesia management of the patient undergoing cesarean section during nighttime period. We cannot rule out the possibilities that the circumstance of labor at our hospital puts the operator (obstetrician) under a great deal of mental stress wastes time during cesarean section, and results in an increased rate of low umbilical artery pH. Therefore, the simulation of the management of full-time anaesthetists or anesthesiologists including the medical and economic effects may be needed at our hospital.

At our hospital, the rate of adverse neonatal outcomes associated with cesarean birth increased in the nighttime period. Similar studies are needed in various settings in different parts of the world.

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