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Original Research Article

## Decision to delivery interval in cesarean delivery for suspected fetal distress: the risk factors and outcomes

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### ABSTRACT

**Background:** This study was to evaluate the differences in the neonatal outcomes after caesarean sections (CS) for suspected fetal distress in groups with decision to delivery interval (DDI) of 30 minutes or less and longer than 30 minutes. Factors associated with these intervals were also investigated.

**Methods:** Data were retrospectively collected from all emergency caesarean deliveries for fetal distress in 2021. Maternal demographic data, the procedure characteristics and the neonatal outcomes were analyzed according to the DDI groups; 30 minutes or less and more than 30 minutes. Time interval for different stages of DDI and related factors were also analyzed.

**Results:** A total of 115 cases were included for analysis with the mean DDI of 40.1 minutes. Only 24/115 (20.9%) of the cases had the DDI of 30 minutes or less. Maternal and surgical characteristics were similar between the 2 study groups, and there were no differences in the proportion of neonatal acidosis, low Apgar score, intubation, NICU admission and the mean umbilical cord pH or base excess. Regression analysis demonstrated that level of surgeon's experience, operations during the normal working hours or CS for fetal bradycardia were significantly associated shorter DDI. Experienced surgeon and unscarred uterus were associated with shorter incision to neonatal delivery interval.

**Conclusions:** The longer DDI in caesarean deliveries for suspected fetal distress is not associated with significant adverse neonatal outcomes. Despite so, identifying the factors influencing the DDI is still an important aspect in the constant work to improve the obstetric service.

**Key words:** Caesarean delivery, Delivery interval, Fetal distress

### INTRODUCTION

When an urgent delivery is planned especially for suspected fetal compromise, it is widely accepted that it should be completed within 30 minutes of the decision. This time limit originated from a study in 1980s and had been adopted across the globe.<sup>1</sup> The interval was, however, not based on robust evidence associating it with the neonatal and in some extend, the maternal outcome. The effect of prolonged DDI on the neonatal outcome was conflicting. Few studies reported that, as opposed to what previously thought, shorter DDI was in fact associated

with lesser babies with acidemia and intubation.<sup>2-4</sup> However, a metanalysis on the category 1 cesarean delivery did not show any significant difference in mean cord pH and Apgar score.<sup>5</sup> Despite these varied results, one of the more consistent findings is that the DDI of 30 minutes or less is not achievable in all cases of emergency CS except in specialized, tertiary centres in developed countries.<sup>6,7</sup> Factors associated with these achievements had also been identified, but again the findings are inconsistent. This study was conducted to investigate our center's performance in achieving the target DDI, local factors influencing the results and the neonatal outcomes.

## METHODS

This is a retrospective review in a major specialist hospital with yearly delivery of about 4000 looking at the numbers of cesarean delivery for fetal distress and the intervals between the decision for surgery and the delivery of the neonate. The data was also analyzed to determine the association between DDI and the neonatal outcomes. Factors associated with the target DDI of 30 minutes or less were also investigated. All cesarean deliveries from January to December 2021 were identified from the delivery record and the medical records of the surgeries for suspected fetal distress were reviewed. The DDI was defined as the interval when the specialist gave the approval for CS until the delivery of the neonate.<sup>8</sup> Other intervals; from the decision to patient's arrival in the operation theatre (decision to theatre interval; DTI), from the arrival in the theatre to the start of surgery (theatre to incision interval; TII) and from incision to the delivery of the baby (IDI) were also recorded. Suspected fetal distress was defined as abnormal fetal heart pattern on cardiotocography (CTG) following the Society of Obstetricians and Gynecologists of Canada guideline on intrapartum fetal monitoring.<sup>9</sup> Data on the maternal age, parity, body mass index (BMI), presence of uterine scar from previous surgery, the type of cesarean section and anesthesia, the estimated blood loss and the neonatal birth weight were extracted from the medical record. The main neonatal outcome of interest was the incidence of neonatal acidosis at birth while the umbilical artery pH, base excess, Apgar score at 5 minutes of life, admission to the neonatal intensive care unit (NICU) and intubation were also recorded and analyzed.

Neonatal acidosis is defined as umbilical artery pH <7.00 and base deficit >12 mmol/l, and the World Health Organization criteria defining obesity was used to classify patients as obese (BMI  $\geq$  30 kg/m<sup>2</sup>) or non-obese (BMI <30 kg/m<sup>2</sup>) based on the patient's height and last known weight in the pregnancy.<sup>10,11</sup> The analysis was also performed according to the surgeons' experience where those with at least 1 year residency were classified as experienced officers. Our office (or working) hours are between 8 am to 5 pm on Sunday to Wednesday and until 3.30 pm on Thursday, while weekends and public holidays are categorized as non-working hours in the analysis. The data collected were divided into 2; cases with DDI of 30 minutes or less and DDI of more than 30 minutes and the outcomes of interest were analyzed according to these 2 groups.

### Statistical analysis

Demographic data comparison was made using a Student t test, while the qualitative data were reported as percentage and analyzed using chi-square test or Fisher exact test when necessary. Multinomial logistic regression analysis was performed to determine the association between the DDIs and the associated factors. All data handling and analysis was performed using

Statistical Package for Social Science (SPSS) version 22 (SPSS Inc, Chicago, IL, USA) software with p value of less than 0.05 considered to indicate statistical significance.

## RESULTS

In 2021, there were 4087 deliveries in our hospital of which 16.2% were cesarean deliveries. A total of 115 (17.3% of total CS) were indicated for suspected fetal distress. All operations were lower segment hysterotomy where 93% were performed under spinal anesthesia (none with epidural anesthesia). The mean maternal age was 29.4 ( $\pm$ 5.5) years, and the mean gestation was 38.5 ( $\pm$ 1.8) weeks. Slightly more than half of the women were in their first pregnancy and 13% had a history of previous cesarean delivery. The most common abnormal CTG abnormality prior to the emergency delivery was bradycardia which comprise of 41.7% of the cases (Table 2). The overall mean DDI was 40.1 minutes (range from 17 to 91 minutes) and 20.9% of the infants were delivered within 30 minutes or less after the decision for delivery was made. The mean and median intervals for various stages from the decision of surgery to the delivery of the baby are shown in the (Table 1).

All stages of patient preparation prior to surgery and the interval between the start of surgery to the delivery of the baby were significantly quicker when the DDI was 30 minutes or less. It is also shown here that more than half of the DDI was the preoperative preparation in the operation theatre especially the anesthetic work TII. There was no significant difference in the maternal demographic data, the blood loss during the surgery or the neonatal birth weight. The group with DDI longer than 30 minutes had more obese women, operation on scarred uterus and delivery complicated by meconium-stained liquor, but the differences were not significant Table 2. In this study, there were only 8 (7%) babies with low Apgar score at 5 minutes of life and 6 (5.2%) had neonatal metabolic acidosis. There was no significant difference in the incidence of neonatal acidosis, low Apgar score (less than 7) at 5 minutes after birth, or admission to NICU when analyzed according to the DDI groups. The mean arterial pH was similar while the mean base excess was lower in the DDI of more than 30 minutes group but the difference was not significant. Similarly, higher proportion of babies in the second group was intubated (Table 3).

Despite these similarities, there were 2 cases of severe neonatal asphyxia leading to early neonatal deaths and both cases had DDI of more than 30 minutes (delivered after 38 and 48 minutes after decision). All but one CS, were performed by trained medical officers and 74.8% of them had more than 1 year experience in obstetrics. The results from the logistic regression show that surgeries operated by these experienced surgeons were associated with the shorter DDI (OR 12.385; 95% confidence interval, CI: 1.365-112.344). Cases operated during the normal working hours and labor complicated by fetal bradycardia were 2 other significant predictors of DDI of

30 minutes or less ( $p=0.016$  and  $0.004$  respectively). Maternal characteristics that could influence the DDI were obesity and presence of scar from previous CS, and both

were associated with reduced likelihood of having shorter interval.

**Table 1: Interval between decision to various end points (minutes).**

Time interval	Time (min)			P value
	Total	≤30 min (24)	>30 min (91)	
<b>DTI</b>				
Mean±SD	12.6±7.0	9.1±4.0	12.5±7.3	0.005
Median (IQR)	10.0 (10.0-15.0)	10.0 (5.0-10.0)	12 (10.0-15.0)	
<b>TII</b>				
Mean±SD	22.3±7.9	13.7±3.9	24.6±7.0	<0.005
Median (IQR)	21.0 (16.0-27.0)	15.0 (11.2-16.8)	24 (20.0-28.0)	
<b>IDI</b>				
Mean±SD	5.4±3.0	3.4±2.0	5.9±3.1	<0.005
Median (IQR)	5.0 (3.0-7.0)	3.0 (2.0-5.0)	6.0 (3.0-7.0)	
<b>DDI</b>				
Mean±SD	40.1±12.4	25.1±3.6	44.1±10.8	<0.005
Median (IQR)	39.0 (32.0-46.0)	26.0 (22.2-27.8)	43.0 (37.0-48.0)	

DTI, decision to theatre arrival; TII, theatre arrival to incision interval; IDI, incision to delivery interval; DDI, decision to delivery interval

**Table 2: Maternal and surgical characteristics.**

Parameters	≤30 min (24)	>30 min (91)	P value
Maternal age (years), mean (SD)	29.7 (6.8)	29.3 (5.1)	0.056
Gravidity, mean (SD)	1.3 (1.8)	1.1 (1.5)	0.123
Nulliparous, N (%)	13 (54.2)	46 (50.5)	0.752*
Gestational age at delivery (weeks), mean (SD),	38.7 (1.8)	38.5 (1.8)	0.553
BMI	28.6 (7.0)	30.1 (6.0)	0.481
Obese, N (%)	8 (34.8)	45 (51.1)	0.162*
Previous LSCS, N (%)	1 (4.2)	14 (15.4)	0.189 <sup>¥</sup>
General anesthesia, N (%)	4 (16.7)	6 (6.6)	0.213 <sup>¥</sup>
EBL (mls), mean (SD)	625.0 (456.1)	703.4 (434.2)	0.978
Fetal bradycardia, N (%)	17 (35.4)	31 (64.6)	0.001
Meconium stained amniotic liquor, N (%)	9 (37.5)	38 (41.8)	0.706

Student's t-test unless stated, \*Chi-square test, <sup>¥</sup>Fishers's exact test

**Table 3: Neonatal outcomes.**

Parameters	≤30 min (24)	>30 min (91)	P value
Birthweight, mean, gm (SD)	2941.7 (589.3)	2820.8 (582.1)	0.724
Neonatal acidemia, N (%)	1 (4.3)	5 (5.7)	0.633*
Umbilical artery pH, mean (SD)	7.17 (0.15)	7.12 (0.78)	0.459
Umbilical artery base excess, mean (SD)	-8.26 (-4.84)	-16.73 (-4.50)	0.862
Low Apgar score at 5 min, N (%)	2 (8.3)	6 (6.3)	0.672*
NICU admission, N (%)	18 (75.0)	64 (71.0)	0.706*
Intubation	2 (8.3)	12 (13.3)	0.731*

Student's t test unless stated, \*Chi-square test

The use of general anesthesia was associated with shorter DDI but the difference was not significant (Table 4). Further analysis demonstrated that the interval between the start of the surgery to the delivery of the baby (IDI) was significantly shorter when operated by experienced doctors. No difference was noted related to parity, presence of previous CS scar, maternal obesity, timing of the surgery and intrapartum fetal bradycardia (Table 5).

## DISCUSSION

The 8th edition of the American College of Obstetricians and Gynecologists and the American Academy of Pediatrics joint guideline on perinatal care no longer emphasized the 30 minutes time frame but recommends the delivery should be tailored according to the maternal and fetal risk.<sup>12</sup> On the other hand, NICE UK updated guideline on cesarean birth still recommends that neonatal

delivery to completed within 30 or 75 minutes depending on the urgency.<sup>13</sup> Most authors agreed that DDI of less than

30 minutes is not possible in all situations, with few exceptions.

**Table 4: Logistic regression analyzing factors related to DDI of 30 minutes or less.**

Variables	Model coefficient ( $\beta$ )	Standard error ( $\beta$ )	P value (t test $\beta = 0$ )	95% CI
<b>Nulliparity</b>	1.019	0.589	0.975	0.321-3.234
<b>Scarred uterus</b>	0.187	1.199	0.162	0.018-1.963
<b>Obesity</b>	0.364	0.591	0.087	0.114-1.159
<b>Experienced surgeon</b>	12.385	1.125	0.025	1.365-112.344
<b>Office hours</b>	4.020	0.576	0.016	1.300-12.433
<b>General anaesthesia</b>	2.833	0.692	0.132	0.730-10.992
<b>Fetal bradycardia</b>	5.620	0.593	0.004	1.758-17.970

**Table 5: Mean and median Incision-to-delivery interval (IDI).**

Variables	Number	Mean (minutes)	Median (minutes)	P value
<b>Nulliparity</b>				0.284
Yes	59	5.08	5.00	
No	56	5.70	5.00	
<b>Uterine scar</b>				0.005
Yes	15	3.8	7.0	
No	100	2.8	5.0	
<b>Maternal obesity</b>				0.300
Yes	53	3.2	5.0	
No	58	3.0	5.0	
<b>Office hours</b>				0.720
Yes	35	3.6	4.5	
No	80	2.8	5.0	
<b>Experienced surgeon</b>				<0.005
Yes	86	4.7	5.0	
No	29	7.5	7.0	
<b>Fetal bradycardia</b>				0.145
Yes	47	4.9	5.0	
No	67	5.8	5.0	

The target DDI was achieved in 3.5 to 20.3% of the cases in non-developed countries, while in highly specialized obstetric units in developed countries, the achievement could reach 100%.<sup>6,7,14-16</sup> In our center, only 21% of the cesarean delivery for fetal distress had the DDI of 30 minutes or less, with the median DDI of 39 (IQR=32.0-46.0) minutes. This is much longer than DDI reported in tertiary centers with focused services in Hong Kong, Singapore and Germany, which were less than 20 minutes.<sup>7,17,18</sup> We also analyzed the predelivery interval into stages and it showed that all were significantly longer when the DDI is more than 30 minutes. The DTI reflects not just the patients' preparation in the labor wards such as preoperative antibiotics, antacids, consent and indwelling urinary catheter insertion but also the readiness of the operation theatre to accept the patient. The TTI is mainly contributed by the preanesthetic work and the anesthesia itself in the operation theatre, while IDI is influenced by the speed of the surgery preceding the delivery of the baby. IDI was particularly of interest to us as the factors associated to it are mostly related to the surgeon and the patient characteristics, which can be identified earlier before the actual surgery.

An earlier study showed that surgeries performed by experienced surgeons were quicker, up to 6 minutes difference in DDI.<sup>19</sup> Our data suggested that an emergency cesarean delivery for fetal distress had 12 times the chance of shorter DDI when operated by surgeons with at least 1 year experience, with significant difference in IDI ( $p < 0.005$ ). The influence is clearly seen in IDI where these doctors were almost 3 minutes quicker in delivering the babies compared to their less experienced colleagues. The presence of scar tissues from previous cesarean delivery could slow down the surgery proper, influencing the DDI. Data from France showed that the mean DDI in a scarred uterus was 62 minutes, which was 18 minutes longer than the interval for unscarred uterus.<sup>20</sup> This difference, however, was not statically significant. Regression analysis of DDI in our study also showed the odd of having a shorter DDI in cases of scarred uterus was reduced by almost 84% although it was not statistically significant. One study did report significantly longer DDI when operating on women with scarred uterus, but it included women with more than 1 previous CS, whilst ours only included those with a single CS before the trial of labor.<sup>21</sup> We, however, did demonstrate that the IDI for women with

scarred uterus is significantly longer. The effect of the scar tissue on IDI was also reported by Morales et al who showed that delivery of the neonate was delayed by 5.6 minutes with 1 previous CS, 8.5 minutes after 2 surgeries and 18.1 minutes during the fourth operation.<sup>22</sup> Past publications had shown that delivering babies via cesarean sections during office hours were associated with shorter DDI, a similar finding to our data.<sup>18-21</sup> In our hospital, during the working hours, all cesarean deliveries are performed in a dedicated maternity operation theatre. But outside normal working hours including holidays, all surgeries are managed in an emergency theatre, located on a floor above the labor ward. This is expected to cause longer DDI especially when a second theatre is needed and the staffs required to run it are brought from their homes, a reason also echoed by Spencer and MacLennan.<sup>23</sup>

Fetal bradycardia, compared with other forms of pathological CTG patterns was associated with, not just the shorter DDI, but also shorter IDI. Although the difference was not significant. It is believed that bradycardia is more damaging to the fetus compared with other abnormal fetal heart rate patterns, resulting in quicker preoperative preparation and surgery. This perception is supported by a study on bradycardia to delivery interval which demonstrated that the umbilical artery pH drops 0.009 every minute after the diagnosis.<sup>24</sup> General anesthesia is a significant factor for quicker delivery of the neonate.<sup>25,26</sup> In our center, operating under general anesthesia was associated with shorter DDI but it was not significantly quicker compared with spinal anesthesia (6 minutes difference in mean DDI). This difference is probably related to small number of cases underwent general anesthesia in our study population (8.7%). Maternal obesity, on another aspect, could cause issue in transportation to and from the operation theatre, difficulty administering anesthesia and longer surgical time. Some had shown the relationship between increasing BMI and IDI and/or DDI but our data could not reproduce this association. Again, this is probably related to the lower prevalence of obese women in our study population, which was 46% compared to 55-70% in other publications.<sup>26,27</sup> The main reason to expedite the delivery in fetal distress is to reduce the incidence of adverse neonatal outcomes. Our data did not show any significant difference in any of the neonatal parameters when the DDI is longer than 30 minutes, results similar to another report by Roy et al.<sup>4</sup> Some other studies, however, had shown the paradoxical correlations; the shorter DDI is associated with low umbilical cord pH and base excess even in cases of suspected fetal compromised.<sup>3,18,28</sup> The authors postulated that severe fetal distress usually resulted in quicker surgery. It was also thought that longer DDI would allow resolution of reversible factor(s) that caused intrapartum fetal compromise. Even though the differences in the neonatal outcomes when the DDI is longer than previously suggested is not significant, it is still imperative to complete the delivery for suspected fetal distress as quickly as possible. National Institute for Health and Clinical Excellence (UK) still advocate the 30 minutes

DDI for urgent or category 1 CS in their latest 2021 guideline.<sup>13</sup> This is of most importance in cases of fetal bradycardia due to irreversible conditions such as abruptio placentae, cord prolapse or failed instrumental delivery, where it had been shown, the cord pH rapidly drops with time.<sup>7</sup>

To achieve a higher proportion of DDI of 30 minutes or less, effective communication, streamlined logistic issue and close teamwork between all the parties; the obstetrics staffs, the operation theatre personals and the anesthetic team are required. This is achievable by implementing various protocols or workflows. In a Singaporean hospital, the implementation of a crash cesarean delivery protocol involving the use of public announcement system saw 100% of the extremely urgent deliveries were completed within 30 minutes.<sup>6</sup> Introduction of a color coding system for different class of urgency for delivery in 26 hospitals in France, also saw a significant improvement in DDI.<sup>29</sup> Similarly, application of “code blue” protocol in a university-based hospital saw the mean DDI improved from 52 minutes to just 22 minutes.<sup>30</sup> We have recently implemented a similar protocol and are looking forward in sharing the results in the future. Our results support the findings of previous investigators that the DDI of longer than 30 minutes is not associated with significant negative neonatal outcomes even in cases of suspected intrapartum fetal distress. We had identified that surgeon’s experience, presence of abdominal scar from previous CS and operating within or outside the normal working hours as factors associated with these DDI. These findings could help in optimizing the CS for fetal distress, ensuring the best neonatal outcomes.

## CONCLUSION

The longer DDI in caesarean deliveries for suspected fetal distress is not associated with significant adverse neonatal outcomes. Despite so, identifying the factors influencing the DDI is still an important aspect in the constant work to improve the obstetric service.

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