

Category 1 Caesarean Section Decision to Delivery Interval: The Causes of Delay and Impact on Neonatal Outcomes

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Abstract

Introduction: The introduction of cesarean section categorization and recommendations on decision to delivery interval was a major step forward towards standardizing clinical response to obstetric emergencies. The recommended decision to delivery interval (DDI) for category 1 cesarean sections is 30 minutes, however there is a balance to be struck to ensure that reducing fetal hypoxic risk is not at the expense of increasing maternal and fetal morbidity.

Aim of the Study: The aim of the study was to review category 1 cesarean sections, focusing on reasons for delays and neonatal outcomes.

Design: The study was conducted as a quality improvement initiative to review the performance of the institution in managing women delivered as category 1 cesarean section between January 2020 and August 2020.

Methods: The data was extracted from the operating theatre log book and patient electronic records (Cerner system) and analyzed using SPSS statistics package.

Results: There were 577 cases of category 1 Cesarean section undertaken during the study period. The recommended DDI of 30 minutes was achieved in 385/577 (67%) of cases but was exceeded in 192/577 (33%) of cases. The most common indication of category 1 cesarean section was fetal distress (58%).

It was noted that significantly more women (88.8%) in the < 30-minute group had the decision taken in the labor ward, which is in close proximity to the obstetric theatre. Significantly more women in the < 30-minute group had epidural or general anesthesia. Significant delays in the preparation time, transfer time, anesthesia time and delivery time were noted in the > 30-minute group. The neonates in the < 30-minute group had significantly lower pH and base excess measurements at birth however fewer were admitted to the neonatal intensive care unit.

Conclusion: This study has demonstrated that only two thirds of category 1 cesarean deliveries are performed within the 30-minute recommendation. The delays were evident at every stage of the process of performing the cesarean.

There are some factors which are not modifiable such as non-labor ward transfers. Continued monitoring of category 1 cesarean outcomes is recommended.

Keywords: Category 1 Cesarean Section; Delays; Neonatal Outcome; Decision to Delivery Interval; Quality Improvement

Introduction

Traditionally cesarean sections were broadly classified as elective and emergency procedures. The term ‘emergency cesarean section’ had a variety of meanings depicting level of urgency, often classified as ‘crash’ or ‘urgent’ with no definitive standardization amongst healthcare providers. The result was often a failure in communication which resulted in a dysfunctional team co-ordination and unnecessary delays, with the potential to negatively impact on perinatal outcomes [1].

The introduction of a cesarean section categorization based on the urgency of delivery was a major step forward towards standardizing clinical response to obstetric emergencies in order to improve neonatal outcome. Lucas, *et al.* (2000) proposed a new classification of cesarean section based on 4 categories, which has since been adopted universally [2]. The four categories are: Category 1: immediate threat to the life of the woman or the fetus, Category 2: maternal or fetal compromise not immediately life threatening, Category 3: needing early delivery but no maternal or fetal compromise and Category 4: delivery at a time to suit the patient and maternity team.

The recommended time from decision to delivery for Category 1 cesarean sections is still controversial, however there is a general consensus that delivery should be expedited as quickly and as safely as possible, aiming for a decision to delivery interval (DDI) of 30-minutes or less. Whilst 30 minutes is the target it is important that the team do not lose sight of the balance that needs to be struck between fetal hypoxic risk and the risk posed to the mother prior to her stabilization before surgery.

The RCOG Classification of Urgency of Cesarean Section - A Continuum of Risk Good Practice Guideline recommends that once a decision for category 1 cesarean section is made, then the aim should be to deliver the baby within 30-minutes [3]. The National Institute for Health and Care Excellence guidelines recommended that the 30-minute rule is to be used as an audit target for capabilities of an obstetric unit rather than as a strict requirement for category 1 cesarean deliveries [4].

Locally, the maternity unit a DDI of 20- minutes is used as a key performance indicator, however for the purpose of this review, the 30-minute interval was used in order to allow comparisons with international standards [5].

Aim of the Study

The aim of this study was to review the performance of the maternity unit in achieving category 1 cesarean deliveries within 30-minutes of a decision being made, focusing on organizational, manpower and surgical factors which contributed to delays, and their impact on maternal and neonatal outcomes.

Methodology

This retrospective cohort quality improvement study was performed between January 2020 and August 2020 in a large tertiary maternity center in Doha, Qatar delivering approximately 18,000 women per annum.

The electronic patient files (Cerner system) identified those women undergoing a category 1 cesarean section during the time period. The indication for the categorization, maternal characteristics and surgical and perinatal outcomes were extracted individually. In order to ensure the cases were correctly categorized the following indications: cord prolapse, category 3 CTG, fetal bradycardia, suspected uterine rupture, abruption placenta and failed instrumental delivery. Those cesarean sections initially listed as category 2 but re-classified to category 1 to expedite delivery due to delays in accessing theatre were excluded.

The maternal characteristics collected included maternal age, BMI, gravidity, parity, number of previous cesarean deliveries, previous abdominal surgery, gestational age and whether singleton or multiple pregnancy. The organizational characteristics included hospital

location where the decision was made, seniority of the decision maker and of the primary surgeon and anesthetist. The obstetric and neonatal outcomes included estimated blood loss, maternal admission to HDU/ICU, 1- and 5-minute Apgar scores, umbilical cord arterial PH and base excess.

The decision to delivery interval is defined as the time from the decision for category 1 cesarean section to the time the fetus was delivered. This period included transfer time (time from decision to arrival to operating theatre), anesthesia time (time from immediate start of anesthesia to skin incision) and delivery time (time from incision to delivery). DDI was the total time of the 4 components listed.

Comparison between the outcome variables was then made between 2 groups of women: DDI less than or more than 30 minutes. The analysis was performed using SPSS version 20 (SPSS, New York, USA) with statistical significance set at $P < 0.05$.

Ethics approval: As this is a study based on an audit done as a part of quality improvement project, ethical approval from the research committee is not applicable for this study.

Results

There were 577 cases of category 1 cesarean section undertaken during the study period. Timings were recorded by the live computer-based records (Cerner) to calculate a DDI to the nearest minute. The results were divided into a DDI of < 30 -minute ($n = 385$) and a DDI > 31 -minute ($n = 192$).

	DDI < 30 Min (n = 385) N (%)	DD > 30 min (n = 192) N (%)	Chi-sq, t test or Mann-Whitney U (Significance)
Maternal Age			2.1 (p = NS)
< 20y	9 (2.3)	5 (2.6)	
20 - 30y	215 (55.8)	95 (49.5)	
31 - 40y	150 (39)	86 (44.8)	
> 40	11 (2.9)	6 (3.1)	
Gravidity Median (range)	2 (1 - 17)	2 (1 - 13)	Mann Whitney U 0.275 (p = NS)
Parity Median (range)	1 (0 - 16)	1 (0 - 9)	Mann Whitney U 0.629 (p = NS)
BMI Mean (SD)	30.6 (5.4)	30.9 (6.6)	t = -0.56 (p = NS)
Number multiple pregnancies	10 (2.6)	11 (5.8)	3.63 (p = 0.06)

Table 1: Maternal characteristics of the 2 decision to delivery interval (DDI) groups.

The maternal demographic characteristics are shown in table 1. The ethnicity of the 2 group was not significantly different (chi-sq 10.263, $p = NS$) with 52.5% and 56.3% respectively for the Qatari and non- Qatari patients. There was no difference in primary and secondary co-morbidities between the 2 groups, as 63.1% and 62% of women had no primary and 95.6% and 92.2% of women had no secondary co-morbidity.

	DDI < 30 Min (n = 385) N (%)	DD > 30 min (n = 192) N (%)	Chi-sq (Significance)
Indication			118.749 (p < 0.0001)
Antepartum hemorrhage	54 (14)	45 (23.4)	
Fetal bradycardia	84 (21.8)	3 (1.6)	
CTG - category 3	146 (37.9)	71 (37)	
Cord prolapse	24 (6.2)	1 (0.5)	
Failed instrumental delivery	10 (2.5)	0	
Others	29 (7.5)	64 (33.3)	
Uterine rupture suspected	10 (2.6)	6 (3.1)	
Scalp pH < 7.2	28 (7.3)	2 (1)	

Table 2: Indications for category 1 cesarean section of the 2 decision to delivery interval (DDI) groups.

The indications for category 1 cesarean section is shown in table 2. The most common indication of category 1 cesarean section was fetal distress (58%) which was defined as category 3 CTG, fetal bradycardia and fetal scalp pH < 7.2. The other indications were antepartum hemorrhage (37.4%), cord prolapse (6.7%), failed instrumental delivery (2.5%) and suspected uterine rupture (5.7%). It was noted that there were significant number of women in the >30-minute group having an ‘other indications’ for category 1 cesarean sections such as severe preeclampsia and sepsis.

	DDI < 30 Min (n = 385) N (%)	DDI > 30 min (n = 192) N (%)	Chi-sq (Significance)
Where was decision taken			44.279 (p < 0.0001)
Emergency department	26 (6.8)	46 (23.9)	
High dependency unit	2 (0.5)		
Labor ward	342 (88.8)	130 (67.7)	
Antenatal ward	15 (3.9)	16 (8.3)	

Table 3: Hospital locality where the cesarean decision was made for the 2 decision to delivery interval (DDI) groups.

The impact of the location within the hospital where the decision of category 1 cesarean section was taken and DDI were analyzed (Table 3). It was noted that significantly more women (88.8%) in the < 30-minute group had the decision taken in the labor ward (close proximity to the obstetric theatre), compared to those with a delay of > 30-minutes who were much more likely to be in other areas of the hospital when the decision was taken.

	DDI < 30 min (n = 385) N (%)	DDI > 30 min (n = 192) N (%)	Chi-sq (Significance)
Anesthesia			72.634 (P < 0.0001)
Combined spinal and epidural (CSE)	1 (0.3)	11 (5.7)	
Epidural	159 (41.3)	49 (25.5)	
General	90 (23.4)	11 (5.7)	
Spinal	135 (35.1)	121 (63)	
Anesthesia conversion	9 (2.3)	8 (4.2)	1.499 (p = NS)
Consultant anesthetist	172 (44.7)	101 (52.6)	3.231 (p = 0.07)
Specialist anesthetist	213 (55.3)	91 (47.4)	

Table 4: Method of anesthesia for the 2 decision to delivery interval (DDI) groups.

Table 4 outlines the DDI of category 1 cesarean section performed under each mode of anesthesia. Significantly more women in the <30-minute group had epidural or general anesthesia, whilst there were more spinal blocks in the >30-minute group. There were no significant differences in the seniority of the administering anesthetist or the performing surgeon, and no difference in the conversion rate regional to general anesthesia between the 2 groups.

	DDI < 30 min (n = 385) N (%)	DDI > 30 min (n = 192) N (%)	Chi-sq (Significance)
Previous abdominal surgery	82 (21.3)	60 (31.3)	6.838 (p < 0.01)
Number previous Cesareans			20.126 (p < 0.001)
0	308 (80)	131 (68.6)	
1	60 (15.6)	36 (18.8)	
2	11 (2.9)	10 (5.2)	
3	3 (0.8)	11 (5.7)	
4	3 (0.8)	2 (1)	
6	0	1 (0.5)	

Table 5: Previous abdominal or cesarean surgery for the 2 decision to delivery interval (DDI) groups.

Table 5 demonstrates that those women with previous abdominal surgery and/or increasing order of repeat caesarean sections were statistically more likely to have a DDI > 30-minutes.

	DDI <30 min (n = 385) N (%)	DDI >30min (n = 192) N (%)	Chi-sq or t test (Significance)
Gestational age Mean (SD)	37.9 (3.2)	36.2 (3.7)	t = 5.79 (p < 0.0001)
Umbilical artery pH Mean (SD)	7.2181 (0.3900)	7.2765 (0.0819)	t = -2.02 (p < 0.05)
Umbilical artery pH <7.00	13 (3.5)	2 (1.1)	Chi-sq 2.832 (p = NS)
Umbilical artery base excess Mean (SD)	-2.924 (3.933)	- 1.826 (3.384)	t = -3.22 (p < 0.001)
Umbilical artery base excess >12	7 (1.9)	2 (1.1)	Chi-sq 0.54 (p = NS)
1 minute Apgar < 7	72 (18.7)	36 (18.8)	Chi-sq 0.00 (p = NS)
5 minute Apgar <7	19 (4.9)	9 (4.7)	Chi-aq = 0.017 (p = NS)
Combination of any of 5 min Apgar <7, pH <7.00 or BE <-12	28 (7.3)	11 (5.7)	Chi-sq 0.480 (p = NS)
NICU admission	107 (27.8%)	83 (43.2%)	Chi-sq 13.823 (p < 0.0001)
Maternal ICU admission	29 (7.5%)	25 (13%)	Chi-sq 4.549 (p < 0.05)

Table 6: Fetal and maternal outcomes for the 2 decision to delivery interval (DDI) groups.

Significant differences in fetal outcome measures were noted between the 2 groups (Table 6). The decision to delivery interval < 30-minute group were of a significantly greater gestational age (37.9 v 36.2 weeks) and had significantly lower mean umbilical artery pH (7.2181 v 7.2765) and base excess (-2.924 v -1.826) compared to the > 30-minute interval group. Although there were more babies with pH < 7.00 and a base excess of < 12.00 in the < 30-minute group, this was not statistically significant. A composite outcome of any one of; a 5- minute Apgar < 7, pH < 7.00 or a base excess < 12 was again more common but not significant in the < 30 -minute group. More babies from the >30- minute group were treated in the neonatal intensive care unit (NICU) (27.8% v 43.2%).

	DDI < 30min (N = 385) Median (range)	DDI >31min (N = 192) Median (range)	Mann Whitney U (Significance)
Preparation time (min)	7 (1 - 19)	14 (1 - 36)	13.2 (p < 0.0001)
Transfer time (min)	6 (0 - 18)	12 (1 - 34)	12.2 (p < 0.0001)
Anesthesia time (min)	4 (1 - 17)	7 (1 - 24)	8.9 (p < 0.0001)
Delivery time (min)	3 (1 - 13)	5 (1 - 29)	9.6 (p < 0.0001)

Table 7: Time of the steps involved in the decision to delivery interval (DDI) for the two groups.

The timings of all the steps involved in the process of performing a category 1 emergency cesarean section are demonstrated in table 7. The individual timings were not normally distributed therefore the 2 groups were analyzed using the Mann Whitney U test. The decision to delivery interval > 30-minutes group demonstrated significantly longer timings for each step of the process. The preparation of the patient time, transfer of the patient to theatre time, administration of adequate anesthesia time and the surgical delivery times all took significantly longer to perform when the DDI exceeded 30- minutes.

In summary the factors related to a DDI > 30-minutes for category 1 emergency caesarean sections were: decision made remote from labor ward, performed for “other” indications, received regional spinal anesthesia and had previous abdominal surgery or cesarean sections. More babies in this group were admitted to NICU despite better pH and base excess results.

Discussion

Categorization of cesarean sections was a positive step forward in obstetric quality and patient safety. There are 4 categories of cesarean section with category 1 considered the most urgent in nature. This categorization has enabled the urgency of the caesarean sections in terms of DDI to be standardized. Many maternity units around the world have adopted this categorization of caesarean section, and through regular audit based on the bench marks laid down by international obstetric societies [3,4,6], use DDI as a method of analyzing the performance of the maternity unit.

Category 1 cesarean section is considered the highest priority with a recommended DDI of under 30-minutes and is performed for obstetric emergencies in which fetal compromise to due hypoxia is greatest and therefore decision to delivery interval should be small. Such obstetric emergencies include cord prolapse, uterine rupture, placental abruption and profound fetal bradycardia. The DDI is therefore considered critical, and although the 30-minute DDI recommendation is by general consensus and not evidence based, there are still question marks over the ability of performing all category 1 cesarean sections under 30 minutes improving the perinatal outcome.

Adherence to DDI of 30 minutes for category 1 cesarean section is considered as a mitigation measure to prevent birth asphyxia which may result in cerebral palsy. However, various studies have suggested that intrapartum complications are not the major causative factor for cerebral palsy and many physiological mechanisms interplay to protect the fetus from acute hypoxia, allowing the fetus to survive

intact for a longer period-minutes to perhaps hours-than an adult with similar blood gas concentrations [7]. An international consensus statement concluded that research strongly suggests that the large majority of neurological pathologies causing cerebral palsy occur as a result of multifactorial and mostly unpreventable reasons during either fetal development or the neonatal period rather than due to intrapartum hypoxia [8].

When a time limit has to be adhered to for the delivery of the fetus, then the concern regarding maternal safety emerges since the rapidity at which the procedure is done can contribute to maternal injuries. Therefore, it is imperative to balance both fetal and maternal safety when a category 1 cesarean section is called and undertaken. In a retrospective review of 593 category 1 emergency cesarean sections [9], the early neonatal outcome was found to be improved without any increase in maternal complications, suggesting that urgent transfer and surgery were not resulting in surgical or anesthetic risk. Conversely, a systematic review and meta-analysis of DDI and subsequent neonatal outcomes reports that there were no differences in admission to neonatal intensive care units or special newborn units when DDI was less than or greater than 30-minutes (OR 1.23; 95% CI 0.90 - 1.68) [10].

Although there is standardization of the cesarean categories, there is no consensus on what obstetric emergencies belong in which categories. This can be influenced by institutional resources, such as theatre and staff availability, level of population risk, but more often than not is influenced by the attending decision makers. As a result, the rates of category 1 cesarean sections performed within the recommended 30-minute period differ significantly across the world. In Oman and Ethiopia for instance the rates are around 20 - 25% [11,12], whereas in Hong Kong and Singapore rates as high as 80-90% are reported [13,14].

In order to ensure only 'genuine' category 1 cesarean sections were included, case files were reviewed to ensure the indication warranted a category 1 procedure. The commonest cases removed from our cohort were women who were deemed to require a category 2 caesarean section, but due to theatre delays, were re-classified as category 1 while waiting. Our study reports that DDI within 30 minutes occurred in 67% of category 1 cesarean sections, which reflects the unit performance.

In order to complete abdominal delivery within a DDI of 30 minutes all aspects of the multidisciplinary process must be seamless. The transfer to theatre, patient preparation and administration of anesthetic, and surgical time all contribute and are potentially responsible for failing to achieve the 30-minute target.

The first step in performing a category 1 cesarean section is transferring the patient to theatre. This aspect is often cited as one of the main factors for delay in DDI [14,15]. This study has also found that transfer to theatre, particularly when from areas remote from labor ward, was associated with a delay in achieving delivery within 30-minutes. This delay is understandable when the few category 1 cesarean sections are transferred from an antenatal ward, with staff unfamiliar with the process. There is a case for ward-based simulation drills to improve efficiency.

The administration of a timely, effective anesthetic is often the source of discussion between the anesthetist, who would prefer to avoid general anesthesia, and the obstetrician who eager to commence the caesarean. Traditionally general anesthesia has been considered as the most appropriate anesthesia for an emergency caesarean section as it can be induced rapidly, however it does come with notable risks such as aspiration pneumonia, atonic postpartum hemorrhage and unexpected failed intubation. In addition to maternal complications, there are also concerns that general anesthesia can be associated with short term neonatal morbidity in an already presumably compromised baby [16].

This study confirms, that general anesthetic for category 1 cesarean sections is associated with shorter DDI when compared to regional anesthesia [17]. We are unable to report on the incidence and nature of maternal complications related to anesthesia, as that was not on objective of the study.

As obstetric anesthetists become more skilled in regional anesthetics, there has been a positive shift in the use of regional anesthesia. Category 1 cesarean sections are increasing being performed following rapid sequence spinal anesthesia or 'topping up' of existing epidural anesthetic. Eighty-two percent of women in our study had their category 1 caesarean section under a regional anesthetic, which compares favorably to other studies [12]. We also found similarities with type of anesthesia and delivery intervals previously reported [18]. Around 60% of those women taking more than 30-minutes had undergone regional anesthesia, and that a DDI < 30-minutes was achieved in cases that received general anesthesia or topping up of existing epidural prior to commencing the surgery.

The surgical element of the DDI is the final step in the process. The expectation that previous abdominal surgery or high order cesarean sections would result in surgical delays due to the technical aspects associated with previous surgery was confirmed. It has previously been reported in a prospective study that women with no previous abdominal delivery had a significantly shorter total duration of surgery than women who had one or more previous caesarean deliveries [13]. Our study supports the fact that surgery without a previous abdominal surgical history is very likely to be quicker due to the absence of the consequences of previous abdominal entry such as adhesions, fibrosis or high adherent bladder. This is reflected in this study as women with previous abdominal surgery or high order caesarean deliveries were significantly more likely to be associated with a DDI > 30-minutes.

More babies in this group were admitted to NICU despite better pH and base excess results, which is likely a reflection of the case mix. Despite more neonates being admitted to NICU in DDI > 30-minutes, there was not a significant difference in the composite neonatal outcomes between two groups. This finding has been reflected in other studies which have also shown that a DDI >30-minutes is not associated with adverse neonatal outcome [14,19].

Conclusion

This study has shown that the DDI of 30-minutes for category 1 cesarean sections is around 70%. All steps involved in the process took significantly longer to perform. The individual factors related to this delay were that the indication for the cesarean ('others') were likely not to be considered associated with acute fetal hypoxia, the patients were remote from labor ward, received spinal anesthesia and were more likely to have had previous abdominal or cesarean surgery. Despite this there were no significant differences in the composite neonatal outcomes.

The timings of each step in the process appear to be the only modifiable factor which would reduce any delays, particularly in areas remote from the labor ward. Staff training and simulation in these areas are recommended to ensure prompt transfer of the patient.

Conflict of Interests

Authors state no conflict of interest.

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