Original Article

Evaluation of Surgical and Anaesthesia Response Times for Crash Caesarean Sections – An Audit of a Singapore Hospital

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Abstract

Introduction: The Royal College of Obstetricians and Gynaecologists published the "Organisational Standards for Maternity Services" in 1995, in which they proposed that there be a maximum decision-to-delivery time of 30 minutes for urgent caesarean sections (CS). In 1997, our institution established a protocol for extremely urgent ("crash") CS to expedite delivery time and to conform to this standard. Materials and Methods: The objective of this prospective audit was to determine the surgical and anaesthesia response times in our institution after the protocol had been implemented. The audit was conducted in KK Women's and Children's Hospital from February 2003 to January 2004, over a 12-month period. Upon activation of a "crash" CS, the attending anaesthetist was required to record the decision-to-anaesthesia time, decision-to-delivery time and the perinatal outcome. Results: Ninety-eight cases of "crash" CS were identified from a total of 3629 elective and non-elective CS, with 80 cases having complete data. The mean decision-to-delivery interval was 7.7 min ± 3.0 (SD) with 100% of deliveries made within 17 minutes. The mean decision-to-anaesthesia time was 3.5 min ± 2.0 (SD) with all the patients anaesthetised within 10 minutes. The majority (88.8%) of the patients had general anaesthesia for "crash" CS while the rest had successful epidural block extension. There was no significant difference in the decision-to-delivery interval or mean cord blood pH with respect to the type of anaesthesia given. Conclusions: We achieved 100% deliveries within the proposed 30-minute decision-to-delivery time interval by implementing a protocol for "crash" CS. Both general anaesthesia and extension of existing epidural block are acceptable modes of anaesthesia and do not delay delivery of the fetus.

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Key words: Anaesthesia, Epidural, Response times

Introduction

In 1995, the Royal College of Obstetricians and Gynaecologists published the "Organisational Standards for Maternity Services" in which it was proposed that there be a maximum decision-to-delivery interval (DDI) of 30 minutes for urgent caesarean sections (CS).[1] This time standard was arbitrary and not supported by any trials or observational studies.

Various teaching and general hospitals have carried out audits on their response time for emergency CS to assess if the proposed standards could be met in their institutions.[2-4] In an audit at a local general hospital, 76% of their "crash" lower segment CS (for cord prolapse) were delivered within 30 minutes of the decision to operate.[4] Among the emergency CS performed for fetal distress, delivery within 30 minutes was achieved in only 39% to 66% of cases.[2,3] Furthermore, the Confidential Enquiry into Stillbirths and Deaths in Infancy in 2000 identified the late arrival of anaesthesia personnel (an anaesthetist and skilled assistants) and delays in the provision of anaesthesia as the main anaesthetic factors contributing to the delay in the delivery of the baby.[5]

As a tertiary maternity hospital, we established a protocol in 1997 for extremely urgent ("crash") CS to expedite delivery time and meet the standards set by the Royal College of Obstetricians and Gynaecologists. In order to evaluate the effectiveness of the "crash" CS protocol implemented in our institution, we set out to determine the DDI, anaesthetists' response time, the incidence of anaesthetic complications and perinatal outcome, for all

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"crash" CS over a one-year period from February 2003 to January 2004.

Materials and Methods

This prospective audit was conducted in KK Women's and Children's Hospital (KKWCH), a tertiary centre specialising in the fields of obstetrics, gynaecology and paediatrics in Singapore with approximately 15,000 deliveries annually.

In our protocol, once a decision for "crash" CS was made, the hospital's operator would be informed to activate the team using the public announcement (PA) system. Once activated over the PA system, the obstetrician, the anaesthetist, the neonatologist and the operating theatre (OT) staff would respond appropriately to their designated roles and proceed immediately to the specially designated OT assigned for "crash" CS. The delivery suite and the OT are located on the same floor, less than 50 metres apart, which facilitates the transfer of the patients. The protocol also included a 24-hour stay-in obstetrician, anaesthetist and neonatologist, supported by a full set of OT staff (scrub, circulating and anaesthetic nurses) and a dedicated OT reserved only for emergency CS. The paramedical staff members were also educated on the importance of adhering strictly to the protocol. Following the establishment and refinement of this protocol, we conducted an audit over a one-year period to evaluate the effectiveness of the protocol. In this audit, we assessed the DDI, anaesthesia response time, anaesthetic technique used, its effect on the DDI and the incidence of anaesthetic complications and side effects.

An audit form that included a structured time sheet was made available in all the obstetric OTs. All the anaesthetists were informed of the ongoing audit and were required to complete an audit time sheet when a "crash" CS was activated over the PA system. The data collected included the following:

1. Time the decision for "crash" CS was made: time the "crash" CS was activated over the PA system.
2. Decision-to-anaesthesia time: time the decision for "crash" CS was made to the time anaesthesia was instituted. [For general anaesthesia (GA): when intravenous induction agent was given; for epidural anaesthesia: when epidural local anaesthetic was given.]
3. Decision-to-incision interval: time the decision for "crash" CS was made to the time skin incision was made.
4. Decision-to-delivery time: time the decision for "crash" CS was made to the time the fetus was delivered.
5. Duration of the CS.
6. The indication for the "crash" CS.
7. The Apgar score at 5 minutes and arterial cord pH of the neonate.
8. The type of anaesthesia instituted, its effect on the decision-to-anaesthesia interval, decision-to-incision interval, DDI, perinatal outcome (5-minute Apgar score, cord pH) and anaesthetic complications.
9. The number of "crash" CS done during and after office hours.
10. The seniority of the obstetricians and anaesthetists attending to the "crash" CS.

Audit forms with incomplete entry on the time charts were excluded from our analysis. However, we reviewed the medical records of patients whose forms had incomplete data entry with respect to the indications for CS, status of neonate and type of anaesthesia given and these data were entered retrospectively.

The data were entered and analysed using Statistical Package for Social Sciences (SPSS) 11.5 (SPSS Inc., Chicago, IL, USA). The Student unpaired *t*-test was used to analyse parametric data (DDI, anaesthesia response time, decision-to-incision interval and arterial cord pH) and the Mann-Whitney U test was used for the analysis of non-parametric data (5-minute Apgar score). The χ^2 test was used to analyse the incidence of complications and side effects of anaesthesia. ANOVA was used to compare DDI and cord pH for the 3 types of anaesthesia. A P value of <0.05 was considered statistically significant.

Results

There were 98 "crash" CS over the 12-month period from February 2003 to January 2004. There were 3629 CS over this period; thus, "crash" CS constituted approximately 2.7% of the total number of CS carried out in our institution. There were 18 audit forms which did not indicate the time of activation of "crash" CS, and since it was not possible to assess their DDI, these data were excluded from our analysis. However, we compared the cord pH of these 18 patients with the group that we analysed and found them to be similar [mean 7.234 ± 0.084 (SD) versus 7.231 ± 0.103 (SD) respectively, $P > 0.05$].

Of these 98 "crash" CS, the 3 most common indications for "crash" CS were fetal distress (68.4%), cord prolapse (20.4%), placental abruption (6.1%) and a further 5.1% comprising 2 cases of uterine rupture and 3 cases of severe antepartum haemorrhage. The patients' mean age was 31 years ± 6 (SD). Of all the "crash" CS, 42.5% were activated during office hours (0830 to 1700) and 57.5% after office hours. The mean surgical duration was 38 min ± 11 (SD).

Of the 80 "crash" CS analysed, the mean DDI was 7.7 min ± 3.0 (SD). All the "crash" CS managed to achieve delivery of the neonate within 17 minutes from the time decision for delivery was made. The decision-to-anaesthesia time was 3.5 min ± 2.0 (SD) with all the patients anaesthetised within 10 minutes. There was no significant difference in DDI with respect to the seniority of the surgeon [specialists 8.3 min ± 2.8 (SD) versus trainees 7.0 min ± 2.8 (SD), $P > 0.05$], seniority of the anaesthetist [specialists 8.1 min ± 2.6 (SD) versus trainees 7.4 min ± 3.0 (SD), $P > 0.05$] or if the crash CS was activated during or after office hours [8.0 min ± 2.9 (SD) versus 7.5 min ± 2.9 (SD), $P > 0.05$].

The majority of the parturients (88.8%) had GA for "crash" CS. Labour epidurals were in situ in 25 of the parturients who arrived in the OT (sited in early labour for analgesia). The attending anaesthetist attempted to extend the epidural block in 13 of these parturients with 9 of them having successful epidural extension for CS. In the other 4 cases, there was insufficient time for an adequate block and conversion to general anaesthesia was chosen in order to expedite delivery. The DDI was 7.5 min ± 3.0 (SD) for the group which received immediate general anaesthesia on arrival to the OT; 8.3 min ± 2.2 (SD) for the group which had successful epidural extension and 9.0 min ± 2.5 (SD) for the group which first had epidural extension attempted by the anaesthetist and subsequently converted to general anaesthesia due to insufficient time to achieve adequate sensory block. Although there was a trend towards longer DDI, the difference in DDI was not statistically significant and neonatal arterial cord pH were not significantly different (Table 1).

Table 1. Decision-to-delivery Interval and Cord pH with Respect to the Anaesthetic Technique

	Immediate GA (n = 67)	EA (n = 9)	EA with conversion to GA (n = 4)	*P* value
DDI (min)	7.5 ± 3.0	8.3 ± 2.2	9.0 ± 2.5	0.48
Cord pH	7.23 ± 0.10	7.23 ± 0.06	7.23 ± 0.05	0.97

DDI: decision-to-delivery interval; EA: epidural anaesthesia; GA: general anaesthesia; NS: not significant

Values in mean ± SD. No significant differences were noted between the 3 groups.

There was no difference in the decision-to-anaesthesia interval, decision-to-incision interval, DDI and the incidence of side effects or complications with respect to the type of anaesthetic instituted. Perinatal outcome (5-minute Apgar score and cord pH) were similar for both groups (Table 2).

Discussion

An earlier audit was carried out in our hospital in 1999, soon after the protocol was in place, and the mean time interval from decision to delivery was 14.9 minutes, with the time standard of 30 minutes achieved in 99% (112/113) of the cases.[6] With refinement of the "crash" CS protocol as well as familiarity of roles and duties by each member involved in a "crash" CS, the DDI has improved over the years and this current audit of the surgical response time for "crash" CS revealed an impressive mean DDI of 7.7 min ± 3.0 (SD). We believe this is one of the fastest response times published to date, a testament to the success of the protocol established to expedite extremely urgent or "crash" CS and meet the benchmark set by the Royal College of Obstetricians and Gynaecologists. Many similar audits have been done in the past which revealed that the proposed 30-minute DDI was not being routinely achieved by many centres.[2,4,7]

However, the significance of the proposed 30-minute DDI has been questioned by several authors. Tuffnell et al[3] reported, in their audit conducted over 32 months, that delivery within 30 minutes was achieved in only 2 out of 3 cases, but the delay in delivery made no difference to the rate of neonatal special care unit admission. Another group from Oxford postulated that the undue anxiety generated in patients while preparing them for emergency CS may provoke catecholamine release and reduce perfusion to the placental bed.[8] These studies suggested that maternal and fetal outcome may not always correlate with the DDI.[9]

Despite the above evidence, we believe that in certain clinical situations where there is immediate threat to the life of woman or fetus (e.g., complete placental abruption), more expeditious delivery is necessary to prevent perinatal

Table 2. Type of Anaesthesia and its Effect on the Decision-to-anaesthesia Interval, Decision-to-incision Interval, Decision-to-delivery Interval, Perinatal Outcome and Anaesthetic Complications

	GA (n = 71)	EA (n = 9)	All cases (n = 80)	*P* value (GA vs EA)
Decision-to-anaesthesia interval (min)*	3.6 ± 2.1	3.2 ± 0.8	3.5 ± 2.0	0.63
Decision-to-incision interval (min)*	5.1 ± 2.4	5.7 ± 1.1	5.2 ± 2.3	0.55
Decision-to-delivery interval (min)*	7.6 ± 2.9	8.3 ± 2.2	7.7 ± 3.0	0.49
Cord pH*	7.23 ± 0.10	7.23 ± 0.06	7.23 ± 0.09	0.84
5-minute Apgar score [median (range)]	9 (2-9)	9 (8-9)	9 (2-9)	0.10
Nausea/vomiting	11 (15.5%)	2 (22.2%)	13 (16.3%)	0.63
Hypotension	6 (8.5%)	2 (22.2%)	8 (10%)	0.22
Difficult airway	1 (1.4%)	0	1 (1.3%)	0.88

EA: epidural anaesthesia; GA: general anaesthesia; NS: not significant

*Values in mean ± SD. No significant difference detected.

and maternal morbidity and mortality, and the target DDI of 30 minutes should remain as the benchmark for institutions.[9,10] In a prospective study evaluating emergency CS, delivery time and neonatal morbidity and mortality, the investigators found that the mean umbilical arterial PaO_2 was lower and risk of fetal loss was significantly increased when the DDI exceeded 20 minutes.[11] In another small study of severe placental abruption complicated by fetal bradycardia, a DDI of 20 minutes or less was associated with substantially reduced neonatal morbidity and mortality.[12] In an audit of the response time for umbilical cord prolapse carried out in another tertiary centre in Singapore, 76% (19/30) were delivered within 30 minutes. Of the16 neonates that had cord pH performed, 62% had an umbilical cord pH of $\leq$7.20.[4] In the subgroup analysis of our audit, 19 patients had "crash" CS for cord prolapse and 47% (9/19) had umbilical cord pH of $\leq$7.20. Thus, implementation of a protocol that facilitates expeditious delivery of extremely urgent CS may be able to improve outcome in these patients. Many hospitals have thus set up protocols to achieve a shorter DDI and audit of these practices have been shown to improve patient care.[13]

The PA system used as a means to activate the team for a "crash" CS reduced the delay frequently associated with individually activating the obstetrician, neonatologist, anaesthetist and other OT personnel. The response time of the team was almost immediate without the delay associated with waiting for team members to respond to their page. A dedicated OT reserved for emergency CS ensured that the unavailability of an OT would not be a cause for delay. The similar DDI times achieved during and after office hours demonstrated that a uniform and good standard of care was maintained throughout the day. A recent audit of emergency CS performed in maternity hospitals with differing levels of facilities showed that the median (10th to 90th percentile) DDIs were 69 (37 to 114), 54 (28 to 94) and 42 (17 to 86) minutes in Levels 1, 2 and 3 maternity hospitals, respectively.[14] The main perceived reasons for delay in DDI were staff unavailability in Level 1 hospitals (primarily midwifery-based and suitable for parturients with normal pregnancy requiring minimal investigations), theatre access in Level 2 hospitals (consultant-based care, suitable for parturients with low- and high-risk pregnancy) and anaesthetic complications in Level 3 hospitals (specialist consultant-based care and equipped to manage parturients with complex or high-risk pregnancy).[14] We overcame these potential delays by incorporating a strict protocol, good labour ward and OT designs and providing adequate manpower during and after office hours with each team member being trained and made familiar with their roles.

The delay in DDI has been attributed to many factors. One of these includes the delay in transfer of the parturient from the delivery suite to the OT.[14] Of the anaesthetic incidents, the late arrival of anaesthetic personnel and delay in the provision of anaesthesia were blamed for the delay in delivery in the United Kingdom's Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) report for 1994-1995.[5] When we analysed our data, the mean time interval from decision to anaesthesia was 3.5 min ± 2.0 (SD), with all the patients anaesthetised within 10 minutes from the time the decision for "crash" CS was made. We were able to achieve these results regardless of the seniority of the attending anaesthetist or if the "crash" CS was activated after office hours. During office hours, a specialist and a trainee anaesthetist were exclusively rostered to attend to non-elective as well as "crash" CS and were immediately available to provide anaesthesia for all "crash" CS. After office hours, there were 3 anaesthetists (a specialist and 2 trainees) on duty to attend to labour epidurals in the delivery suite as well as attend to emergency CS. Their priority, however, was to attend to "crash" CS whenever it was activated. This provided adequate manpower to cope with "crash" CS at all times so that there was no delay in the institution of anaesthesia.

The majority of patients had CS under GA. Extension of epidural block was usually initiated in the labour ward using lignocaine 1.5% by the attending anaesthetist. Adrenaline 1 in 200,000 and 2 mL of sodium bicarbonate 8.4% were added to the local anaesthetic to allow rapid development of block and did not appear to cause a significant delay in the commencement of CS or DDI. When GA was needed after the epidural extension proved to be insufficient for CS, this did not significantly increase the DDI. In the OT designated for "crash" CS, there is a GA tray with anaesthetic drugs drawn up and prepared daily. Our practice had always been to prepare all patients for GA and pre-oxygenate them immediately on arrival in the OT, regardless of whether there was an attempt to extend the epidural block. If epidural block was inadequate when the obstetrician was ready to commence the operation, GA was initiated without any delay. Time constraint was the primary reason many anaesthetists cited for opting for general anaesthesia despite the presence of an epidural catheter. Given adequate time, failure to extend epidural analgesia for anaesthesia in CS occurred in approximately 2.6% of patients in one study.[15] Our audit showed that 69.2% (9/13) of epidural extension were successful, avoiding institution of GA and its complications. This suggests that epidural extension should be attempted more frequently, especially when the attending anaesthetist anticipates a difficult airway in the patient. However, the rapid extension of the epidural block for "crash" CS must be done cautiously and in the presence of an anaesthetist who is equipped to manage the rare but serious complications of epidural anaesthesia, e.g., local anaesthetic toxicity and total spinal blockade.

There are several pitfalls to our audit. Firstly, this was a prospective audit and the anesthetists involved in reporting the data were aware that their response time were being audited. We recognise that this could have biased or improved their reaction times. Secondly, the majority of the anaesthetists chose to administer GA for their patients, thus the number of patients being given EA was small. Finally, 18.4% of the audit forms were incomplete and this may have also contributed to reporting bias. We thus retrospectively reviewed the medical records of these 18 patients to show that their perinatal outcome (cord blood pH) were comparable to the group that had been analysed.

With a protocol in place for managing "crash" CS and a multidisciplinary team familiar with their roles and duties, we managed to achieve 100% deliveries within the proposed 30-minute DDI. Although the 30-minute DDI is difficult to achieve and may not be relevant in most cases of emergency CS, expeditious delivery is still crucial in selected indications, and maternity units should seek to improve their DDI whenever possible.

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