# Evaluating the decision-to-delivery interval in category 1 emergency caesarean sections at a tertiary referral hospital

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**Background.** Caesarean sections (CS) in low- and middle-income countries are still afflicted with high complication rates for both mothers and neonates. A target decision-to-delivery (DDI) interval ≤30 minutes in category 1 emergency CS is the recommended standard of care, although the impact of this target on perinatal outcomes and its practicality is unclear.

**Objectives.** The purpose of this retrospective study was to evaluate whether a DDI ≤30 minutes was achieved in daily practice and to describe the indications for category 1 emergency CS.

**Methods.** We conducted a retrospective descriptive study at King Edward VIII Hospital, KwaZulu-Natal, Durban, South Africa, between 1 January and 30 June 2017. Alternate Category 1 cases were selected from an existing departmental database. Relevant data were extracted from standardised institutional booking forms and entered onto a data collection tool.

**Results.** A total of 153 patients were enrolled in this study; no stillbirths were recorded. Only 5.2% ($n$=8/153) of the parturients achieved a DDI ≤30 minutes. The overall median (IQR) DDI was 75.0 (58 - 97) minutes with a range of 13 - 341 minutes. There was no significant difference in the median DDI between neonates with a 5-minute Apgar ≥7 or <7. Fetal distress (81.0%) and placental abruption causing significant antepartum haemorrhage (13.7%) were the most common indications for CS.

**Conclusion.** The study demonstrated that achieving a DDI of 30 minutes within the current organisational structure, institutional policies and staffing pattern is very rare. However, units should still benchmark against the internationally recommended 30-minute target as an indicator of unit efficiency and to improve quality of care. Despite absence of correlation between the DDI and the 5-minute Apgar score, unjustified delay from the decision-making to delivery of the baby is not acceptable.

*S Afr J ObstetGynaecol* 2019;25(3):95-99. https://doi.org/10.1796/SAJOG.2019.v25i3.1510

The caesarean section (CS) is an integral component of global maternal healthcare.[1] Recent evidence suggests that the World Health Organization's vision for safe access and quality of care (QoC) for pregnant women and neonates has not yet been attained in Africa.[2,3]

Categorising CS may assist in prioritising patients so as to improve outcomes but, although numerous classification systems have been proposed, all have limitations.[4] The four-grade classification system proposed by Lucas *et al*.[5] is based on grading the urgency of the CS and has been shown to be both consistent and clinically useful. The classification has been endorsed by many professional bodies, including the Royal College of Obstetricians and Gynaecologists (RCOG).[6,7]

The time interval from the decision for a CS to be carried out to delivery of the neonate is known as the decision-to-delivery interval (DDI). The RCOG, the National Institute of Clinical Excellence and many other professional organisations recommend a DDI of ≤30 minutes for a category 1 emergency CS.[6-9] DDI is a valuable audit tool, allowing units to test the co-ordination and efficiency of the whole delivery team, especially in those patients who require rapid access to CS if the life of the mother or baby is threatened.[6,10]

The main aim of the present study was to evaluate compliance at a tertiary referral hospital in Durban, KwaZulu-Natal, South Africa (SA) with the international standard of care of a DDI in a category 1 (i.e. emergency) CS ≤30 minutes. The secondary objectives were to characterise the primary indications for emergency CS and to document neonatal outcomes; this allowed us to evaluate the efficiency of performance of different teams simultaneously involved in the management of a critical group of patients.

## Methods

We conducted a retrospective descriptive observational study between 1 January and 30 June 2017 at King Edward VIII Hospital, KwaZulu-Natal, Durban, SA. Ethical approval was obtained from the University of KwaZulu-Natal Biomedical Research Ethics Committee (BREC no. BE614/16), with additional hospital and Department of Health (DoH) gatekeeper permissions.

The study included cases of category 1 CS performed for parturients with live babies at term or preterm gestational age. All other categories of CS were excluded, including urgent (category 2), scheduled (category 3) and elective (category 4) CS cases. Cases were selected from an existing departmental database which prospectively recorded booking and outcome details for all CSs performed at the institution. The unit adopted Lucas' four-grade classification[5] in 2016 and instituted a standardised CS booking form completed by both the attending obstetrician and anaesthetist.

### Outcome variables and data collection

Category 1 CS was defined as an emergency CS requiring delivery within 30 minutes for any indication that posed an immediate threat to the life of the woman or her fetus, including: fetal distress (FD); placenta praevia causing a significant antepartum haemorrhage

(APH); cord prolapse; uterine rupture; placental abruption with a live baby causing a significant APH; and maternal cardiac arrest. Fetal condition was assessed by the obstetric team, based on the cardiotocograph (CTG) as 'good', 'non-reassuring' or 'poor' and recorded on the standardised CS booking form. A 'poor' CTG trace was considered as 'fetal distress'.

Data describing the participants were collected over a period of 6 months. Out of an existing departmental database of 306 category 1 cases, patients included in our study were selected on an alternate basis (i.e. every second case); this resulted in a sample size of 153 cases which was considered a representative sample. The collected data included age, gestational age and the indication for CS. The date and time of decision for CS and date and time of delivery of the baby were recorded and the DDI was defined as the interval between decision and delivery of the baby. Neonatal Apgar scores at 1and 5 minutes were documented for all neonates, but only the 5-minute scores were used for analysis. Although type of anaesthesia used was recorded, this study did not aim to investigate maternal outcomes or complications relevant to the mode of anaesthesia. All data were extracted by EA, and data entry was verified by LC.

## Statistical analysis

Data were captured and subsequently analysed using SPSS (IBM Corp., USA). The DDI was derived and a 30-minute decision-to-delivery cut-off used to count the percentage of parturients who achieved a DDI ≤30 minutes. Descriptive statistics such as frequencies (*n*) and percentages (%) were used to summarise the data, and are presented in tables. Measures of central tendency such as median and measures of dispersion such as interquartile range (IQR) were calculated for numerical variables. For comparisons, the Kruskal-Wallis and Mann-Whitney *U* test were used as appropriate. A probability level ≤0.05 was considered statistically significant.

# Results

A total 153 patients were enrolled in the study, and no stillbirths were recorded. Approximately half the patients (52.9%) were aged 20 - 29 years, and 13.1% of the parturients were teenagers (Table1). The majority of parturients (69.3%) were at term.

The most common indication for CS was fetal distress (81%), followed by placental abruption with a live baby, causing significant antepartum haemorrhage (13.7%). All cases of fetal distress had a 'poor' CTG trace documented.

The overall median (IQR) age of patients was 26 (22 - 32) years and median (IQR) gestational age was 38 (36 - 40) weeks. Of the cases enrolled in this study, we found that 94.8% had DDI intervals exceeding 30 minutes; only 5.2% (*n*=8/153) of cases achieved a DDI of 30 minutes or less. Owing to the small number of cases that had achieved the ≤30-minute target, and in order to allow comparisons between subgroups, a decision was made to regroup the cases into a target DDI ≤ or >45 minutes (Table 2). There was no significant difference between the median age ($p$=0.3) or median gestational age ($p$=0.4) between patients in the > or ≤45-minute DDI subgroups. We still found the majority of cases (86.9%) exceeded a DDI of 45 minutes, with only 20/153 patients being delivered in ≤45 minutes. The majority of cases (85.6%) were done under spinal anaesthesia (SA) and the remainder under general anaesthesia (GA).

The median DDI according to the indication for CS and by neonatal 5-minute Apgar is displayed in Table 3. The overall median (IQR) DDI was 75.0 (58 - 97) minutes with a range of 13 - 341 minutes. Cord prolapse had the shortest median DDI, followed by placental abruption and placenta praevia. The 2 cases of uterine rupture had the longest median (IQR) DDI of 84.5 (29 - 140) minutes. The differences in DDI according to the indications were not significant. When considering the DDI by neonatal outcome, the overall median (IQR) DDI was 74.0 (55 - 93). There was no significant difference in the median DDI between neonates with a 5-minute Apgar ≥7 or <7. Analysis of the distribution of 5-minute Apgar scores according to different DDI cut-off limits (30 minutes, 45 minutes, 75 minutes) also did not show any significant difference.

**Table 1. Characteristics of the study population and indications for emergency caesarean section (*N*=153)**

| Variable | *n* (%) |
|---|---|
| Age, years | |
| <20 | 20 (13.1) |
| 20 - 29 | 81 (52.9) |
| ≥30 | 52 (34.0) |
| Gestational age, weeks | |
| 27 - 36 | 47 (30.7) |
| 37 - 42 | 106 (69.3) |
| Indication | |
| Fetal distress | 124 (81.0) |
| Placenta praevia (causing significant APH) | 3 (2.0) |
| Cord prolapse | 3 (2.0) |
| Uterine rupture | 2 (1.3) |
| Placental abruption | 21 (13.7) |
| Maternal cardiac arrest | 0 |

APH = antepartum haemorrhage.

The DDI according to type of anaesthesia is shown in Table 4. Parturients who underwent GA had a median (IQR) DDI of 61 (37 - 72) minutes which was statistically shorter than the DDI of 77 (59 - 100) minutes of those who underwent SA ($p$=0.006). When we compared neonatal outcomes according to type of anaesthesia, we found that the SA group had statistically better 5-minute Apgars ($p$=0.004).

Although it was not a primary outcome to compare indications for emergency CS between patients done under spinal and patients done under GA, this study has shown that only 2/124 of fetal distress patients had GA. The indications for CS in the other 20 patients done under GA were: 2/2 cord prolapse, 3/3 placenta praevia, 14/21 placental abruption and 1/2 uterine rupture. These figures may indicate a potentially poorer-condition maternal and fetal population in the GA group.

# Discussion

The main finding of our study was that only 1 in 20 parturients who were booked for an emergency category 1 CS achieved a target DDI ≤30 minutes. The median DDI was 75 minutes, with a range of 13 - 341 minutes. Both these findings differ significantly from current international standards.

In 1989, the American College of Obstetricians and Gynecologists Committee on Professional Standards recommended that in the case of emergency CS, the DDI should not exceed 30 minutes, and similar recommendations have been issued by other international professional bodies.[6,8,9,11] The former recommendation was based on the premise that maternal and neonatal outcomes will be worse

**Table2. Characteristics of the study population according to DDI subgroups**

| Variable | DDI≤45 minutes (*N*=20), *n* (%)* | DDI>45 minutes (*N*=133), *n* (%) |
|---|---|---|
| Age (years), median(IQR)† | 24.5 (21.1 - 29.5) | 27.0 (22 - 32) |
| Gestational age (weeks), median (IQR)‡ | 37.0 (34 - 40) | 38.0 (36 - 40) |
| Indication | | |
| Fetal distress | 10 (8.1) | 114 (91.9) |
| Placenta praevia (causing significant APH) | 0 | 3 (100) |
| Cord prolapse | 2 (66.7) | 1 (33.3) |
| Uterine rupture | 1 (50.0) | 1 (50.0) |
| Placental abruption | 7 (33.3) | 14 (66.7) |
| Maternal cardiac arrest | 0 | 0 |
| Total | 20 (13.1) | 133 (86.9) |
| 5-minute Apgar score (for term babies ≥37 weeks) (*n*=106) | | |
| ≥7 | 10 (10.3) | 88 (89.8) |
| <7 | 2 (25.0) | 6 (75.0) |
| Total | 12 (11.4) | 94 (88.6) |
| Type of anaesthesia | | |
| GA | 8 (36.4) | 14 (63.6) |
| SA | 12 (9.2) | 119 (90.8) |
| Epidural | 0 | 0 |
| Total | 20 (13.1) | 133 (86.9) |
| Type of operation | | |
| Emergency CS | 19 (13.0) | 127 (87.0) |
| Emergency CS and BTL | 1 (14.3) | 6 (85.7) |
| Total | 20 (13.1) | 133 (86.9) |

DDI = decision-to-delivery interval; IQR = interquartile range; APH = antepartum haemorrhage; GA = general aneastesia; SA = spinal anaesthesia; CS = caesarian section; BTL = bilateral tubal ligation.
*Unless otherwise stated.
†Age: two-sample Wilcoxon rank-sum (Mann-Whitney) test (*p*=0.3).
‡Gestational age: two-sample Wilcoxon rank-sum (Mann-Whitney) test (*p*=0.4).

**Table 3. Median DDI according to indications and 5-minute Apgar score**

| Variable | *n* (%) | Median DDI (min) | IQR |
|---|---|---|---|
| Indication* | | | |
| Fetal distress | 124 (81.0) | 77.0 | 59.5 - 98 |
| Placenta praevia (causing significant APH) | 3 (2.0) | 67.0 | 67 - 77 |
| Cord prolapse | 3 (2.0) | 36.0 | 13 - 100 |
| Uterine rupture | 2 (1.3) | 84.5 | 29 - 140 |
| Placental abruption | 21 (13.0) | 62.0 | 37 - 85 |
| Maternal cardiac arrest | 0 | - | - |
| Overall | 153 (100) | 75.0 | 58 - 97 |
| 5-minute Apgar score (for term babies ≥37)† | | | |
| <7 | 8 (7.5) | 73.0 | 31.5 |
| ≥7 | 98 (92.5) | 74.0 | 40.0 |
| Total | 106 (100) | 74.0 | 38.0 |

DDI = decision-to-delivery interval; IQR = interquartile range; APH = antepartum haemorrhage.
*Indication: Kruskal-Wallis equality-of-populations rank test (*p*=0.2).
†Apgar score at 5 minutes: two-sample Wilcoxon rank-sum (Mann-Whitney) test (*p*=0.7).

should this time be exceeded.[12,13] Despite these recommendations, there is little evidence for this benchmark and there is considerable debate as to whether a DDI ≤30 minutes is a realistic and feasible target to aim for in daily practice or whether outcomes would be improved if this DDI is achieved.[10,14-17]

Evidence from high-income countries (HICs) suggests that the 30-minute DDI in emergency CS is achievable.[18,19] However, this is not a universal finding and an overall success rate of 79% may be a more more realistic assessment[17] and, even in HICs, targeting a DDI of 30 minutes in category 1 patients is difficult to achieve in clinical practice.[14,20] A prospective study from SA by le Riche *et al.*[21] found that only 20% of patients delivered by CS at a tertiary centre within the 30-minute timeframe. In the present study, it was shown that only 5.2% of patients delivered within the benchmark time; this finding is similar to other low- and middle-income countries (LMICs), suggesting that compliance with the current standard of care is rarely achievable in daily practice.[21-26]

If a target of ≤30 minutes is not feasible, is there another DDI target which is more achievable, but does not adversely affect maternal and fetal outcomes? Studies have suggested ≤45 minutes

**Table 4. Type of anaesthesia and type of operation v. median DDI**

| Variable | *n* (%) | Median DDI (minutes) | IQR |
|---|---|---|---|
| Type of anaesthesia* | | | |
| GA | 22 (14.4) | 61.0 | 37 - 72 |
| SA | 131 (85.6) | 77.0 | 59 - 100 |
| Epidural | 0 | | |
| Type of operation† | | | |
| Emergency CS | 146 (95.4) | 75.0 | 58 - 98 |
| Emergency CS and BTL | 7 (4.6) | 69.0 | 50 - 96 |

DDI = decision-to-delivery interval; IQR = interquartile range; GA = general anaesthesia; SA = spinal anaesthesia; CS = caesarean section; BTL = bilateral tubal ligation.
*Type of anaesthesia: two-sample Wilcoxon rank-sum (Mann-Whitney) test, $p$=0.006.
†Operation: two-sample Wilcoxon rank-sum (Mann-Whitney), $p$=0.7.

is acceptable;[27] however, even with this more lenient target, we still found only 1 in 7 parturients who delivered within that timeframe. There are studies that have found that a DDI ≤75 minutes is an achievable target and neonatal outcomes are not significantly worse if 75 minutes are not exceeded.[7,16,28] The study by le Riche *et al.*[21] found a median DDI of 48 minutes for Category 1 CS, within the 75-minute benchmark. The median DDI achieved in our study was 75 minutes, i.e. 50% of cases exceeded the 75-minute threshold. Our findings are worse than those of le Riche, but many LMICs show DDIs far in excess of 75 minutes.[22,26]

Irrespective of the ongoing debate about whether achieving a DDI ≤30 minutes is practical and appropriate or not, it is still recommended to follow and to benchmark against the international regulations issued by professional bodies, respected authorities and medicolegal bodies. Unacceptable reasons for delay should be documented and quality improvements be undertaken. Furthermore, unless there is a clear reason, the delivery of babies in cases of emergency CS should not be delayed to the extent reflected in our results.

There are certain clinical situations which will require a much quicker DDI than in others while, in other situations, undue haste to achieve a short DDI may introduce its own risks with the potential for maternal and neonatal harm.[6] In two separate studies performed in Europe, Mackenzie *et al.*[13] and Kolas *et al.*[29] found that the indication for emergency CS had a significant influence on the DDI; this could be explained by prioritisation of certain emergency cases over others, depending on indications, i.e. not all Category 1 cases are equally urgent. Some influence on DDI was seen in our present study, depending on the indications for the emergency CS, but findings were inconsistent and not significant, implying a lack of true prioritisation.

The results of our study showed that GA compared with SA for emergency CS was associated with a significantly shorter median DDI (of ~15 minutes). It is very hard to ascribe cause and effect, as we do not have sufficient data, but we surmise that cases labelled as very high risk were transferred to theatre more quickly and were therefore also more likely to receive GA, i.e. a quicker transfer rather than the GA *per se* were contributory to a shorter DDI. Findings from studies by Dunphy *et al.*,[30] Tuffnell *et al.*,[31] Hein *et al.*[19] and Mackenzie *et al.*[13] showed a similar influence on DDI by a chosen type of anaesthesia. Although the present study demonstrated a shorter DDI in the GA group, neonatal outcomes were better in the SA group. This finding is similar to those in the literature and may reflect either that a GA is chosen in situations where the parturient or fetus is more compromised or that SA is beneficial.[13] Although it was not the primary focus of the study, and having small numbers, the finding that the majority of GAs were performed for sicker patients may support these speculative reasons.

There is currently little scientific evidence confirming preference of GA over spinal anaesthetic, or that the delay from performing the spinal anaesthetic causes a worse neonatal condition at birth. Further research is required to answer these questions and, until clear guidance is found, we emphasise the importance of communication between the anaesthetic team and the obstetric team to identify the true degree of urgency of the operation and making a case-by-case decision on *inter alia* the mode of anaesthesia to choose.

The present study assessed neonatal outcome at birth as a function of DDI. Cord blood analysis was not available for the neonates, and therefore the 5-minute Apgar was used as a surrogate measure of neonatal outcome. This approach also allowed comparison with other similar studies. We found it very difficult to draw conclusions on the impact of the DDI on neonatal outcome, owing to the scanty number of cases performed within the international standard of ≥30 minutes. Furthermore, we found no difference in the distribution of 5-minute Apgar scores at 45-minute or 75-minute DDI cut-offs, and no difference in median DDI in relation to an Apgar ≥7 or <7 at 5 minutes. These findings suggest minimal impact of DDI on neonatal outcomes in our study; this is contrary to the findings of Thomas *et al.*[16] and Radhakrishnan *et al.*[26] who found neonatal outcomes were worse at a longer DDI, but were in keeping with the results from other studies.[13,14,22] Prospective trials lacking confounders and using cord blood analysis are necessary to confirm the relation between DDI and neonatal outcome.

Based on results from studies conducted in HICs, factors that enhance the ability of units to achieve a target DDI ≤30 minutes are: improving the communication between the different teams; establishing protocols to deal with emergency cases; better staffing workflow and levels; and improving unit facilities.[12,18,19] The present study did not investigate the causes of delay; therefore it is difficult to comment on this subject. However, in the hospital where our study was conducted, factors such as the availability of only one operating room for non-elective CSs, a large volume of complex referred cases, a long waiting list for CS and a high CS rate may have contributed to not achieving the international recommended DDI.

## Study strengths and limitations

The present study is retrospective in its nature, which may limit validity. The data were collected from only one centre, moreover a tertiary referral hospital, from which it follows that results may not be generalisable to other facilities in the province.

The 5-minute Apgar score used for evaluation of neonatal outcome is a subjective tool and a crude measure of outcome and may therefore not be a reliable indicator of neonatal clinical status at delivery nor a predictor for long-term neurological outcome.[23] On the other hand, the 5-minute Apgar score has been used in several comparable studies, therefore allowing comparisons to be drawn with our study.

King Edward VIII Hospital is a tertiary referral hospital receiving a complex spectrum of pathology and has a CS rate of close to 50% (departmental statistics) and it is also a student and registrar training centre linked to the University of KwaZulu-Natal. Conclusions and

potential remedial actions from the study could therefore positively affect a large community of patients and trainees.

## Conclusion

This study demonstrated that achieving a DDI of 30 minutes within the current organisational structure, institutional policies and staffing patterns is very rare. However, units should still benchmark against the internationally recommended 30-minute target as an indicator of unit efficiency and to improve quality of care. Despite absence of correlation between DDI and the 5-minute Apgar score, unjustified delay from decision-making to delivery of the baby is not acceptable. The present study could be considered as an initiative for other large and comprehensive studies to provide information specifically on causes of delay and thus strategies that improve standards of care, and further to evaluate a more exact distinction of urgency to establish the correct DDI.

**Acknowledgements.** We thank Prof. Thomas (Ted) Sommerville and Dr Pragasan Gopalan for their invaluable assistance and guidance.

**Author contributions.** EA and LC designed the study and jointly wrote the manuscript. Data collection was done by EA.

**Funding.** None.

**Conflict of interest.** None.

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*Accepted 8 February 2020.*