Original Research

Determinants of the decision-to-delivery interval and the effect on perinatal outcome after emergency caesarean delivery: a cross-sectional study

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Abstract

Background
Preventing prolongation of the decision-to-delivery interval (DDI) for emergency caesarean delivery (CD) remains central to improving perinatal health. This study evaluated the effects of the DDI on perinatal outcome following emergency CD.
Methods
A prospective cross-sectional study involving 205 consenting women who had emergency CD at a tertiary hospital in Nigeria was conducted. The time–motion documentation of events from decision to delivery was documented; the outcome measures were perinatal morbidity (neonatal resuscitation, 5-minute Apgar score, neonatal intensive admission) and mortality. Data analysis was performed with IBM SPSS Statistics version 20.0, and $P<0.05$ was considered significant.
Results
The overall mean DDI was 233.99±132.61 minutes (range 44–725 minutes); the mean DDI was shortest for cord prolapse (86.25±86.25 minutes) and was shorter for booked participants compared with unbooked participants (207.19±13.88 minutes vs 249.25±12.05 minutes; $P=0.030$) and for general anaesthesia compared with spinal anaesthesia (219.48±128.60 minutes vs 236.19±133.42 minutes; $P=0.543$). All neonatal parameters were significantly worse for unbooked women compared with booked women, including perinatal mortality (10.8% vs 1.3%; $P=0.012$). Neonatal morbidity increased with DDI for clinical indications, UK National Institute of Health and Care Excellence (NICE) and Robson classification for CDs; perinatal mortality was 73.2 per 1000 live births, all were category 1 CDs and all except one occurred with DDI greater than 90 minutes. Severe preeclampsia/eclampsia, obstructed labour and placenta praevia tolerated DDI greater than 90 minutes compared with abruptio placentae and umbilical cord prolapse. However, logistic regression showed no statistical correlation between the DDI and neonatal outcomes.
Conclusion
Perinatal morbidity and mortality increased with DDI relative to the clinical urgency but perinatal deaths were increased with DDI greater than 90 minutes. For no category of emergency CD should the DDI exceed 90 minutes, while patient and institutional factors should be addressed to reduce the DDI.

Key Words: Decision-to-delivery interval, perinatal mortality, phase 3 delay, caesarean delivery, emergency delivery

Introduction

Prevention of the adverse effects of perinatal asphyxia is an important indication for caesarean deliveries (CDs) in current obstetric practice, and prompt delivery is recommended[1]. The decision-to-delivery interval (DDI) is the time between the decision to perform CD and the delivery of the newborn[2]. In recent years, emergency CDs performed in most cases to prevent birth asphyxia have outnumbered elective cases, and most obstetric malpractice allegations following delivery are linked to the severity of neonatal complications rather than the quality of care provided[2]. This prompted the recommendation of a 30-minute threshold DDI for emergency CD[2]. However, the DDI is determined by the various intervening time intervals for obtaining consent, availability of blood and surgical materials, transportation to the operating theatre and induction of anaesthesia, among other factors. Other factors, including the facility type, availability of skilled personnel, status of the surgeon, type of incision, power supply, laboratory facilities, including blood transfusion services, patient preparedness for payments and access to operating theatre facilities[2], are equally important. Prolonged DDI for emergency CDs has been associated with poor perinatal outcome, including perinatal asphyxia, admission to the neonatal intensive care unit, neonatal and perinatal death and long-term neurodevelopment sequelae such as cerebral palsy[1-4]. However, in many African countries, the prevailing poverty and poor health care systems contribute to prolongation of the DDI, while the intervening time–motion of the determinants is poorly documented.

This study aimed to evaluate the effect of the time–motion record for the various time intervals as well as other associated factors on the DDI and invariably of the perinatal outcome among women who underwent emergency CD in a tertiary facility in Ilorin, Nigeria.

Methods

The study was a prospective cross-sectional study conducted at a tertiary centre in Ilorin, Nigeria, over a 7-month period from 1 July 2015 to 31 January 2016. The participants were

women requiring an emergency primary CD during the study period; the inclusion criteria were singleton fetus with an estimated gestational age of 37 weeks or more, a decision for emergency CD and consent for participation. Women who had had multiple gestations, preterm delivery, intrauterine fetal demise, previous abdominal surgery, vaginal deliveries or elective CD were excluded from the study. Recruitment was at the obstetric emergency, antenatal and labour wards of the hospital; eligible women were informed about the study, and informed consent was obtained. The sampling method was purposive sampling, and all participants were monitored from recruitment until 5 days after delivery with a record of the timing of all events relating to the CD.

The sample size was calculated with the following formula for a cross-sectional study[5]:

$$n = \frac{z^2 pq}{d^2},$$

where n is the minimum sample size, z is the normal standard deviation, which is 1.96 for a 95% confidence interval, p is the incidence of emergency CD at the study site, which was 90.0%[6] (or 0.9), $q = 1.0 - p$ (i.e. 0.1), and d is the observed difference of 5% (or 0.05) or tolerable margin, giving

$$n = \frac{1.96^2 \times 0.9 \times 0.1}{0.05^2} = 138.$$

We assumed an attrition rate of 10%, which corresponds to 14 participants, and thus the minimum sample size for the study was 138+14=152.

The study site is a publicly funded tertiary health facility using a pack system for surgery. Deferment of payment for emergency surgical procedures is allowed until after the procedure but patients are required to provide some additional materials (antibiotics, analgesics and paediatric nasogastric tube for resuscitation), which are not included in the operation pack. Routinely, a pack is prepared for each surgical procedure, including CD; it is expected to contain most of the items required for the surgery (sutures, intravenous fluid, surgical drapes, gowns, etc.) Resuscitation (oxygen administration, intravenous fluid, regular vital sign and fetal heart rate monitoring, etc.) was continued for women requiring CD during the waiting time before surgery. Blood was loaned out during emergencies depending on the stock at the blood bank, and the patient's relatives replace used blood afterwards.

The DDI was defined in this study as the time between the decision to perform the emergency CD and the delivery of the newborn[2]. For participants with more than one indication for CD, the indication with immediate risk to the life of either the mother or the fetus was used.

The UK National Institute for Health and Care Excellence (NICE)[7] classification of CD was used to categorize the CD cases as follows:

- Category 1: Immediate threat to the life of the woman or fetus.

- Category 2: Maternal or fetal compromise which is not immediately life-threatening.

- Category 3: No maternal or fetal compromise but early delivery is needed.

Table 1. Sociodemographic characteristics, indications for caesarean delivery and causes of prolonged decision-to-delivery interval (DDI) among participants.

Characteristics	Number	Percentage
Age group		
<20 years	4	2.0
20–35 years	167	81.4
>35 years	34	16.6
Parity		
Primipara	94	45.9
Multipara	109	53.2
Grandmultipara	2	1.0
Booking status		
Booked	75	36.6
Unbooked	130	63.4
Indication for surgery		
Cephalopelvic disproportion	86	42.0
Fetal distress	33	16.1
Bleeding placenta praevia	26	12.7
Obstructed labour	24	11.7
Abnormal presentation	20	9.8
Eclampsia	9	4.4
Umbilical cord prolapse	4	2.0
Abruptio placenta with live fetus	3	1.5
Cause of prolonged DDI (n=200)		
Extra material for surgery	71	35.5
Blood availability	64	32.0
No operating theatre space	40	20.0
Delayed consent	18	9.0
Anaesthesia delay	6	3.0
Surgeon not available	1	0.5

- Category 4: Delivery timed to suit the woman or staff.

However, because of the study design, participants were eligible for categorization as category 1 or 2.

The Robson classification used was according to the recommended 10 groups:[8]

Table 2. Mean decision-to-delivery interval (DDI) for the clinical indications and time–motion intervals for emergency caesarean delivery.

Clinical indication	DDI range (minutes)	Mean DDI ± SD (minutes)	Time–motion interval	Range (minutes)	Mean DDI ± SD (minutes)
Abruptio placentae with live fetus (n=3)	100–275	210.0±95.79	DDI	44–725	233.99±132.61
Umbilical cord prolapse (n=4)	60–130	86.25±56.25	Decision-to-consent interval	5–480	36.90±62.15
Severe preeclampsia/ eclampsia (n=9)	150–415	237.67±99.70	Decision to blood availability interval	0–420	95.50±77.63
Fetopelvic disproportion (n=20)	97–725	282.10±186.00	Operating theatre arrival to surgery interval	10–140	55.94±28.53
Obstructed labour (n=24)	110–438	204.75±77.42	Decision-to-surgery interval	30–700	214.24±128.18
Bleeding placenta praevia (n=26)	55–618	305.38±305.38	Operating theatre arrival to anaesthesia induction interval	5–135	45.03±27.96
Fetal distress (n=33)	44–565	198.12±102.63	Skin incision to delivery interval	3–20	5.52±2.54
Cephalopelvic disproportion (n=86)	48–580	230.47±125.49			

SD, standard deviation.

Group 1: Nulliparous women with a single cephalic pregnancy at ≥37 weeks' gestation in spontaneous labour.

Group 2: Nulliparous women with a single cephalic pregnancy at ≥37 weeks' gestation who had labour induced or whose newborn was delivered by CD before labour.

Group 3: Multiparous women without a previous uterine scar with a single cephalic pregnancy at ≥37 weeks' gestation in spontaneous labour.

Group 4: Multiparous women without a previous uterine scar with a single cephalic pregnancy at ≥37 weeks' gestation who had labour induced or whose newborn was delivered by CD.

Group 5: All multiparous women with at least one previous uterine scar and a single cephalic pregnancy at ≥37 weeks' gestation.

Group 6: All nulliparous women with a single breech pregnancy.

Group 7: All multiparous women with a single breech pregnancy, including women with previous uterine scars.

Group 8: All women with multiple pregnancies, including women with previous uterine scars.

Group 9: All women with a single pregnancy with a transverse or oblique lie, including women with previous uterine scars.

Group 10: All women with a single cephalic pregnancy at ≤36 weeks' gestation, including women with previous scars.

Ethics approval was obtained from the ethics committee of the University of Ilorin Teaching Hospital, Ilorin, Nigeria (ERC/PAN/2013/01/1186), before commencement, and all participants gave written informed consent. Data management was performed with IBM SPSS Statistics version 20.0 (IBM, Armonk, NY, USA); the results were expressed in tables with percentages and the mean, and $P<0.05$ was considered significant.

Results

A total of 205 parturient women were recruited for the study; the mean age of participants was 28.87±5.42 years (range 17–49 years); 109 (53.2%) were multipara and 75 (36.6%) were booked. The indications for CD included cephalopelvic disproportion (86; 42.0%), fetal distress (33; 16.1%) and bleeding placenta praevia (26; 12.7%). Common causes of prolonged DDI included the time to purchase extra materials (71; 35.5%), unavailability of blood (64; 32.0%) and unavailable operating theatre space (40; 20.0%), as shown in Table 1. From Table 2, the mean DDIs were 86.25±56.25 minutes for umbilical cord prolapse, 198.12±102.63 minutes for fetal distress and 204.75±77.42 minutes for obstructed labour; bleeding placenta praevia had the longest mean DDI (305.38±305.38 minutes). The time–motion interval shows that the mean DDI was 233.99±132.61 minutes (range 44–725 minutes); it was 5.52±2.54 minutes (range 3–20 minutes) for skin incision to delivery of the newborn, 36.90±62.15 minutes (range 5–480 minutes) for decision to consent, 45.03±27.96 minutes (range 5–135 minutes) for operating theatre arrival to anaesthesia and 95.50±77.63 minutes (range 0–420 minutes) for decision to blood availability. From Table 3, the mean DDI was shorter for booked participants compared with unbooked participants (207.19±13.88 minutes vs 249.25±12.05 minutes; $P=0.030$), general anaesthesia compared with spinal anaesthesia (219.48±128.60 minutes vs 236.19±133.42 minutes; $P=0.543$), consultant obstetrician compared with trainees ($P=0.399$) and midline infraumbilical incision compared with Pfannenstiel incision (208.83±127.85 minutes vs 237.33±133.21 minutes; $P=0.324$). The operating theatre arrival to anaesthesia interval was statistically reduced for general anaesthesia compared with spinal anaesthesia (35.19±26.69 minutes vs. 46.53±27.92 minutes; $P=0.049$).

Table 4 shows that perinatal mortality for the study was

Table 3. Mean values of time–motion intervals for selected parameters.

Characteristics	Mean interval ± SD (minutes)	t/F	p
	Decision-to-delivery interval		
Booked	207.19±13.88		
Unbooked	249.25±12.05	−2.189	0.030
Anaesthesia			
Spinal	236.19±133.42		
General	219.48±128.60	0.609	0.543
Status of anaesthetist			
Registrar	225.39±126.62		
Senior registrar	279.00±156.33		
Consultant	233.99±0.0	2.295	0.103
Status of surgeon			
Registrar	230.42±127.36		
Senior registrar	240.71±139.15		
Consultant	118.00±73.54	0.924	0.399
Anterior abdominal wall incision			
Pfannenstiel	237.33±133.21		
Midline	208.83±127.85	0.989	0.324
	Operating theatre arrival to surgery interval		
Anaesthesia			
Spinal	57.40±28.64		
General	46.30±26.23	1.897	0.059
	Operating theatre arrival to anaesthesia interval		
Anaesthesia			
Spinal	46.53±27.92		
General	35.19±26.69	1.978	0.049

7.3% (15/205; 73.2 per 1000 live births). All neonatal parameters were significantly worse for unbooked women compared with booked women, including perinatal mortality (10.8% vs 1.3%; P=0.012). Across all clinical indications for CD, neonatal morbidity increased with DDI although all perinatal deaths occurred with a DDI greater than 90 minutes. However, DDI greater than 90 minutes resulted in lower perinatal mortality associated with severe preeclampsia/eclampsia (1/8), cephalopelvic disproportion (3/76), fetopelvic disproportion (1/18), obstructed labour (2/22) and bleeding placenta praevia (1/25) compared with abruptio placentae (2/2).

Table 5 shows that perinatal morbidity and mortality increased with increasing DDI. With the NICE classification for CD, all perinatal deaths occurred for NICE category 1 CD and most of these (14/15) occurred with DDI greater than 90 minutes. With the Robson classification for CD, perinatal deaths were recorded for Robson groups 1 (5 deaths), 3 (6 deaths) and 4 (4 deaths); 14 of the 15 deaths occurred with DDI greater than 90 minutes. Table 6 shows logistic regression for correlation between neonatal outcomes relative to DDIs of 60, 75, 90 and 120 minutes. Logistic regression revealed that there was no statistical significant correlation between the DDI and adverse perinatal outcomes.

Discussion

This study reported an overall mean DDI of 233.99±132.61 minutes (range 44–725 minutes); shorter DDIs were recorded for umbilical cord prolapse, booked participants, use of general anaesthesia and midline infraumbilical incision. Across all clinical indications, as well as NICE and Robson classifications of CD, perinatal morbidity and mortality increased with prolongation of the DDI, with perinatal mortality of 73.2 per 1000 live births. All perinatal deaths occurred with DDI greater than 90 minutes for clinical indications, and 14 of 15 deaths occurred with DDI greater than 90 minutes with the NICE classification (category 1) and with the Robson classification. The urgency for faster delivery was heightened for umbilical cord prolapse, abruptio placentae with a live fetus, and NICE category 1 CD as well as Robson group 1, 3 and 4 CDs, while severe preeclampsia/ eclampsia, obstructed labour and bleeding placenta praevia had better tolerance for DDI greater than 90 minutes.

The mean DDI in this study was prolonged; although it compares with 266.8 minutes[7] and 192 minutes[4] from Nigeria, 4.8 hours[10] from Côte d'Ivoire and 5.5 hours from Uganda[11] it was longer than 106 minutes[12], 119 minutes[13] and 147 minutes[3] from similar studies in Nigeria. No participant had a delivery within a 30-minute interval in this study, similar to other reports from sub-Saharan Africa[4,9-11]. However, a 30-minute DDI was reported in 39.7% of participants in Croatia[2] and 70% or participants in Britain[14]. This may be attributed to the disparity in individual preparedness, health-seeking behaviour, health facility capacity and health system preparedness for emergencies in these countries. However, in addition to variations across continents and regions, institutional factors apply within the same country. A recent nationwide survey of severe maternal outcome in Nigeria showed that getting to the health facility may not be enough to prevent adverse outcomes[15]. The survey reported a median time of 60 minutes between diagnosis and critical interventions and an overall mortality index of 40.8% for life-threatening conditions. Other reported constraints were late presentation, lack of health insurance and unavailability of blood/blood products. In Nigeria, institutional and regional variations exist; services at some facilities are highly subsidized, some allow payment at discharge while other facilities require payment and arrangement of blood donation for transfusion before treatment[4]. The need to purchase surgical items, challenges of availability of blood for transfusion[10,12] and delay in anaesthesia[3,4] are common

Table 4. Perinatal outcome based on clinical indications for caesarean delivery and the booking status.

Clinical indication/ DDI	Neonatal resuscitation		5 minute Apgar score		NICU admission		Perinatal death	
	Yes	No	<6	>6	Yes	No	Yes	No
Fetal distress (n=33)								
≤60 minutes	1 (3.0%)	0	0	1 (3.0%)	1 (3.0%)	0	0	1 (3.0%)
61–90 minutes	1 (3.0%)	2 (6.1%)	0	3 (9.1%)	0	3 (9.1%)	0	3 (9.1%)
>90 minutes	18 (54.6%)	11 (33.3%)	7 (21.2%)	22 (66.7%)	7 (21.2%)	22 (66.7%)	3 (9.1%)	26 (78.8%)
Obstructed labour (n=24)								
>90 minutes	12 (50%)	12 (50%)	19 (79.2%)	5 (20.8%)	8 (33.3%)	16 (66.7%)	2 (8.3%)	22 (91.7%)
Cephalopelvic disproportion (n=86)								
≤45 minutes	0	1 (1.2%)	1 (1.2%)	0	0	1 (1.2%)	0	1 (1.2%)
46–60 minutes	3 (3.5%)	0	2 (2.3%)	1 (1.2%)	1 (1.2%)	2 (2.3%)	0	3 (3.5%)
61–90 minutes	2 (2.3%)	1 (1.2%)	3 (3.5%)	0	3 (3.5%)	0	0	3 (3.5%)
>90 minutes	47 (54.7%)	32 (37.2%)	63 (73.3%)	16 (18.6%)	17 (19.8%$)	62 (72.1%)	3 (3.5%)	76 (88.4%)
Fetopelvic disproportion (n=20)								
≤90 minutes	1 (5%)	0	1 (5%)	0	1 (5%)	0	0	1 (5%)
>90 minutes	14 (70%)	5 (25%)	18 (90%)	1 (5%)	6 (30%)	13 (65%)	1 (5%)	18 (90%)
Severe preeclampsia/eclampsia (n=9)								
>90 minutes	4 (44.4%)	5 (55.6%)	6 (66.7%)	3 (33.3%)	3 (33.3%)	6 (66.7%))	1 (11.1%)	8 (88.9%)
Bleeding placenta praevia (n=26)								
>90 minutes	16 (61.5%)	10 (38.5%)	22 (84.6%)	4 (15.4%)	4 (15.4%)	22 (84.6%)	1 (3.9%)	25 (96.1%)
Umbilical cord prolapse (n=4)								
>90 minutes	2 (50%)	2 (50%)	4 (100%)	0	3 (75%)	1 (25%)	2 (50%)	2 (50%)
Abruptio placentae (n=3)								
≤90 minutes	1 (33.3%)	0	0	1 (33.3%)	1 (33.3%)	0	0	1 (33.3%)
>90 minutes	2 (66.7%)	0	2 (66.7%)	0	2 (66.7%)	0	2 (66.7%)	0
Booking status Booked (n=75) Unbooked (n=130)	42 (56%) 39 (30%) χ^2=13.452	33 (44%) 91 (70%) P<0.001	4 (5.3%) 34 (26.2%) χ^2=13.630	71 (94.7%) 96 (73.8%) P<0.001	10 (13.3%) 41 (31.5%) χ^2=8.434	65 (86.7%) 89 (68.5%) P=0.004	1 (1.3%) 14 (10.8%) χ^2=6.244	74 (98.7%) 116 (89.2%) P=0.012

DDI, decision-to-delivery interval; NICU, neonatal intensive care unit.

Table 5. Perinatal outcome based on the UK National Institute for Health and Care Excellence (NICE) and Robson classifications of caesarean delivery relative to the decision-to-delivery interval (DDI).

Classification/ DDI	Neonatal resuscitation		5-minute Apgar score		NICU admission		Perinatal death	
	Yes	No	<6	>6	Yes	No	Yes	No
NICE category 1 (n=90)								
≤45 minutes	1 (1.1%)	0	0	1 (1.1%)	0	1 (1.1%)	0	1 (1.1%)
46–60 minutes	1 (1.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)	1 (1.1%)
61–90 minutes	1 (1.1%)	3 (3.3%)	1 (1.1%)	3 (3.3%)	2 (2.2%)	2 (2.2%)	0	4 (4.4%)
>90 minutes	19 (21.1%)	64 (71.1%)	25 (27.8%)	58 (64.4%)	28 (31.1%)	55 (61.1%)	14 (15.6%)	69 (76.7%)
NICE category 2 (n=115)								
≤60 minutes	0	2 (1.7%)	0	2 (1.7%)	1 (0.9%)	1 (0.9%)	0	2 (1.7%)
61–90 minutes	2 (1.7%)	2 (1.7%)	0	4 (3.5%)	0	4 (3.5%)	0	4 (3.5%)
>90 minutes	58 (50.4%)	51 (44.4%)	11 (9.6%)	98 (85.2%)	19 (16.5%)	90 (78.3%)	0	109 (94.8%)
Robson group 1 (n=76)								
≤60 minutes	1 (1.3%)	0	0	1 (1.3%)	1 (1.3%)	0	0	1 (1.3%)
61–90 minutes	1 (1.3%)	2 (2.6%)	0	3 (4.0%)	0	3 (4.0%)	0	3 (4.0%)
>90 minutes	44 (57.9%)	28 (36.8%)	13 (17.1%)	59 (77.6%)	21 (27.6%)	51 (67.1%)	5 (6.6%)	67 (88.2%)
Robson group 2 (n=11)								
≤90 minutes	1 (9.1%)	0	0	1 (9.1%)	1 (9.1%)	0	0	1 (9.1%)
>90 minutes	8 (72.7%)	2 (18.2%)	2 (18.2%)	8 (72.7%)	3 (27.3%)	7 (63.6%)	0	10 (90.9%)
Robson group 3 (n=70)								
≤45 minutes	0	1 (1.4%)	0	1 (1.4%)	0	1 (1.4%)	0	1 (1.4%)
46–60 minutes	2 (2.9%)	0	1 (1.4%)	1 (1.4%)	1 (1.4%)	1 (1.4%)	1 (1.4%)	1 (1.4%)
61–90 minutes	1 (1.4%)	1 (1.4%)	0	2 (2.9%)	0	2 (2.9%)	0	2 (2.9%)
>90 minutes	36 (51.4%)	29 (41.4%)	14 (20.0%)	51 (72.9%)	14 (20.0%)	51 (72.9%)	5 (7.1%)	60 (85.7%)
Robson group 4 (n=26)								
≤60 minutes	1 (3.9%)	0	0	1 (3.9%)	0	1 (3.9%)	0	1 (3.9%)
61–90 minutes	1 (3.9%)	0	0	1 (3.9%)	0	1 (3.9%)	0	1 (3.9%)
>90 minutes	15 (57.7%)	9 (34.6%)	7 (26.9%)	17 (65.4%)	7 (26.9%)	17 (65.4%)	4 (15.4%)	20 (76.9%)
Robson group 6 (n=12)								
>90 minutes	3 (25%)	9 (75%)	2 (16.7$)	10 (83.3%)	2 (16.7%)	10 (83.3%)	0	12 (100%)
Robson group 7 (n=10)								
>90 minutes	8 (80%)	2 (20%)	0	10 (100%)	2 (20%)	8 (80%)	0	10 (100%)

NICU, neonatal intensive care unit.

Table 6. Correlation between the mean decision-to-delivery interval (DDI) and perinatal outcome.

Parameter	DDI 60 minutes		DDI 75 minutes		DDI 90 minutes		DDI 120 minutes	
	r	P	r	P	r	P	r	P
Need for neonatal resuscitation	0.227	0.369	0.090	0.197	0.032	0.654	0.019	0.788
Need for NICU admission	0.055	0.431	0.079	0.259	0.001	0.992	0.032	0.646
Low 5-minute Apgar score	0.213	0.341	0.105	0.501	0.041	0.614	0.009	0.879
Perinatal death	0.077	0.272	0.023	0.740	0.010	0.890	0.027	0.703

NICU, neonatal intensive care unit; r, Spearman correlation coefficient.

reasons for delays in sub-Saharan Africa. At the study site, although blood is available on loan and payment is deferred for emergency CD, the expected benefits are negated by the noninclusion of some items in the pack which the patient's relatives are required to purchase as an addition to the pack. This was the commonest cause of delay, and it is intended that this report will provide evidence to amend the protocol. In addition, the decision-to-consent interval range of 5–480 minutes reported in this study contributed to the prolonged DDI. The delay may be related to the aversion for CD in some African communities[10,16], while patients and partners routinely consult in-laws, religious leaders and sometimes other relatives before consent for surgery is given[14]. The methodological differences in the individual studies on DDI limit comparison of results; differences range from prospective versus retrospective designs to study definitions of time intervals. In a study which reported a lower mean DDI[3], the timing was from obtaining consent unlike the timing from decision for surgery in this study.

There are other contributors to the overall DDI for CD. In this study, the mean DDI was significantly lower for booked participants and was comparable to the DDI of 193 minutes[4] for booked women in a similar study. This underscores the role of antenatal care in birth preparedness and complication readiness by providing education on identification of labour, benefits of early presentation in labour, probable labour complications and treatment modalities. In another report, unbooked women delayed adherence to management options in labour, thereby prolonging the DDI[17]. In many African countries, a tertiary institution serves a wide geographical area, which is similar to the situation at the study site; thus, a high influx of women requiring emergency CD often overwhelms the available human resources and infrastructure. In such instances, operating theatre suites may not be immediately available, the surgeons may be busy with other procedures and blood may be exhausted in the blood bank[3,4,7,10,12], as recorded in this study.

The operating theatre arrival to anaesthesia interval, operating theatre arrival to surgery interval and overall DDI were lower for general anaesthesia compared with spinal anaesthesia in this study, which is similar to the findings in previous reports[18,19]. This can be understood on the basis of the urgency, although the time spent in preloading patients with intravenous fluid to prevent hypotension may have contributed to the longer DDI for spinal anaesthesia. Although Holcroft et al.[18] observed significantly higher 5-minute Apgar scores in babies delivered with general anaesthesia compared with regional anaesthesia, there

was no significant difference in the umbilical pH values in the babies. However, Hein et al.[19] reported a significantly low 5-minute Apgar score and greater need for neonatal ventilation, intubation and neonatal intensive care admission in newborns delivered with general anaesthesia. This may be related to the depressive effects of the anaesthetic agent on the newborn and the severity of the underlying indication for the CD. In this study, the DDIs for senior clinicians were shorter than those for trainees, in agreement with previous reports[2,9]. This may be because the study site is a residency training institution where the obstetricians and anaesthetists are highly skilled. In emergency situations, older obstetric tradition favoured a midline vertical skin incision because it is thought to save time; however, this study reports that the reduced incision-to-delivery interval was not significant. In another study, there was no significant difference in the incision-to-delivery interval or duration of surgery for midline incision compared with Pfannenstiel incision; rather, wound infection, prolonged hospital stay, delayed commencement of oral intake and ambulation were associated with midline incision[20]. This study therefore supports the need to discourage midline incision for CD because the presumed benefit is not significant and it is overshadowed by the potential side effects.

This study observed that perinatal morbidity and mortality increased with increasing DDI for clinical indications and the NICE and Robson classifications of CDs and perinatal mortality was increased for DDI greater than 90 minutes. This observation stimulates important clinical correlation for clinical practice. On the basis of the clinical indication, it was unexpected that many fetuses in which fetal distress was diagnosed clinically survived until DDI greater than 90 minutes when delivery should have been expedited within 30 minutes. A possible explanation could be a probable misclassification of the diagnosis of fetal distress based solely on clinical parameters. In a retrospective review of CDs performed for nonreassuring fetal status, Holcroft et al.[18] in an attempt to classify the CDs as emergent or urgent observed variations among specialists in the interpretation of the cardiotocograph tracing used in making the diagnosis, while the blood gas analysis did not support some of the diagnoses. This explained the similarity in the 1-minute and 5-minute Apgar scores among the newborns reported in that study, unlike in this study with a wider difference in the Apgar scores. This emphasizes the need to validate clinical suspicion of fetal distress with blood gas analysis from fetal scalp blood sampling in order to identify false positive cases as well as false negative cases to avoid unnecessary CDs.

This study's result suggests immediate delivery for abruptio placentae with live fetuses and umbilical cord prolapse,

while women with severe preeclampsia/eclampsia, bleeding placenta praevia and obstructed labour can be safely resuscitated and delivery can be expedited before 90 minutes. It is recommended that NICE category 1 CD be performed within 30 minutes, while up to 75 minutes is allowed for NICE category 2 CDs[7]. In this study, all perinatal deaths occurred for NICE category 1 CD with DDI greater than 90 minutes; although most of the newborns survived after 90 minutes, perinatal morbidities were heightened increased after the 90-minute mark. In a report from India, Mishra et al.[21] reported that the composite neonatal outcomes were not significantly increased for up to 60 minutes for category 1 CD or up to 90 minutes for category 2 CD. In another report, Radhakrishnan et al.[22] concluded that a 30-minute DDI is difficult to achieve for urgent (category 2) CD in government-based hospitals in developing countries, and suggested that a 60–75-minute time frame may be justified. The higher perinatal mortality in this study is comparable to the perinatal mortality in other reports[3,4,9,12] from developing countries with prolonged DDI and an attendant suboptimal preoperative fetal assessment due to lack of necessary equipment. On logistic regression, there was no statistical correlation between the DDI and the main perinatal outcome measures. This compares with other reports[3,4,13], and appears to suggest that the DDI is not the sole determinant of perinatal outcome. According to another report, the DDI is less important in determining perinatal outcome when compared with the urgency demanded by the indication for the CD as well as the level of institutional delay and effectiveness[13]. Therefore, current evidence from developing countries seems to suggest the need to address the factors that are associated with the DDI, including the degree of fetal compromise before surgery and patient, healthcare worker and institutional factors, to ensure an effective response towards improving the perinatal outcome.

The prospective design enabled this study to provide a time–motion record of the time intervals which add up to form the DDI. We opine that this will reveal the contributions of each step and allow objective interventions towards reducing the time intervals and invariably the DDI. Also, the inclusion of both booked and unbooked parturient women provides a holistic and practical field experience unlike studies that included booked participants only.

Conclusion
We conclude that the DDI for the study was prolonged, neonatal morbidity and mortality increased with increasing DDI, and almost all perinatal deaths occurred with DDI greater than 90 minutes. The study emphasizes the need for immediate delivery in women with umbilical cord prolapse and abruptio placentae with a live fetus, while the fetuses of women with severe preeclampsia/eclampsia, obstructed labour and bleeding placenta praevia can tolerate the time spent to stabilize the mother before CD. However, delivery should be expedited before the 90-minute mark to prevent perinatal death. Diagnosis of fetal distress should be validated with fetal blood gas analysis to avoid misclassification and unnecessary CD. Midline infraumbilical incision does not contribute significantly to reducing the DDI and should be discouraged in favour of Pfannenstiel incision. Institutional policies in developing countries should prioritize ensuring there is a pack system which contains all materials needed for the surgery, health education to reduce the decision-to-

consent time and promotion of blood donation to equip blood banks for emergency maternity services.

Conflict of interest

Funds

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