Evaluation of decision to delivery time interval and its effect on feto-maternal outcomes and associated factors in category-1 emergency caesarean section deliveries: prospective cohort study

Mamaru Mollalign Temesgen, Amare Hailekirose Gebregzi, Habtamu Getinet Kasahun, Seid Adem Ahmed and Yophtahe Berhe Woldegerima

Abstract

Background: Category-1 emergency caesarean section delivery is the commonly performed surgical procedure in pregnant women associated with significant mortality and morbidity both in the mother and fetus. The decision to delivery time interval is recommended to be less than 30 min by the Royal College of Obstetricians and Gynecologists as well as the American College of Obstetricians and Gynecologists. This study was designed to evaluate the decision to delivery time interval and its effect on feto-maternal outcomes and the associated factors during category-1 emergency caesarean section deliveries.

Method: A prospective observational cohort study was conducted from March to May 2018 at the University of Gondar Comprehensive Specialized Hospital obstetrics Operation Theater and postnatal ward. A total of 163 clients who were undergone category-1 emergency caesarean section were included in this study. Statistical analysis was performed using SPSS version 20 (IBM Corporate). Bivariate and multivariate logistic regression with a 95% confidence interval was used to determine the association of decision to delivery time interval with predictor variables and feto-maternal outcomes.

Results: Only 19.6% of women had a decision to delivery time interval below 30 min. The average decision to delivery time interval was 42 ± 21.4 min, the average time from the decision of category-1 emergency caesarean section arrival to the operation theater was 21.58 ± 19.76 min and from theater to delivery of anesthesia was 11.5 ± 3.6 min. Factors that were associated with prolonged decision to delivery time interval were: time taken to collect surgical materials (AOR = 13.76, CI = 1.12–168.7), time taken from decision and arrival to the operation theater (AOR = 0.75, CI = 0.17–3.25) and time taken from arrival at the operation theater to the immediate start of skin incision (AOR = 0.43, CI = 0.28–0.65).

Conclusion: Delivery was not achieved within the recommended time interval in the majority of category-1 emergency caesarean sections. The average decision to delivery time interval was longer than the recommended time but it did not affect feto-maternal outcomes.

Keywords: Caesarean section, Decision to delivery interval, Feto-maternal outcome, Ethiopia
Background
Category-1 emergency caesarean section delivery is one of the commonly performed surgical procedures in pregnant women which is associated with significant mortality and morbidity worldwide both in the mother and fetus [1, 2].

Ethiopia has made significant changes to improve feto-maternal health according to the World Health Organization report in 2015 [3]. But according to the Ethiopian Demographic Health Survey in 2011, Ethiopia has one of the highest maternal mortality ratio in Africa at 676 per 100,000 live births [4] and neonatal mortality rate of 35 per 1000 live births [5].

The national C/S rate in Ethiopia is about 2% but it varies widely among administrative regions due to unequal access [6]. The rate increases worldwide beyond the recommended level of 10% and reached 30% [7].

Category 1 emergency C/S is performed when there is an immediate threat to life (mother and fetus) and need of delivery within 30 min [2]. Avoiding the adverse neonatal effects of perinatal asphyxia has been one of the common indications for C/S deliveries in current obstetric practice [8].

Antenatal care (ANC) and good communication among health care providers are vital for better maternal and fetal outcome during category-1 emergency C/S delivery [9].

When category-1 emergency C/S is indicated, the most important predictor for fetal and maternal outcome is decision to delivery interval (DDI), which is recommended to be within 30 min [10].

A retrospective cohort study done in Ghana showed that increased DDI is associated with adverse perinatal outcome [10]. The rates of maternal and neonatal complications were high in both extremes of maternal age [11].

The general objective of this study was to evaluate decision to delivery time interval, its effect on feto-maternal outcomes and associated factors during category-1 emergency cesarean section delivery.

Methods
Study design and area
A prospective cohort study was conducted from March to May 2018 among women who underwent category-1 emergency C/S at Gondar University Specialized Hospital obstetrics operation room, recovery room and wards located in Gondar town, Northwest Ethiopia.

Source and study population
Source population
All pregnant mothers who underwent C/S at the University of Gondar Comprehensive Specialized Hospital (UOCGS).

Study population
Clients who underwent category-1 emergency cesarean section under both general and regional anesthesia at GUCSH during the study period.

Inclusion and exclusion criteria
Inclusion criteria
All clients who underwent category-1 emergency C/S delivery under both general and regional anesthesia were included.

Exclusion criteria
All clients who underwent category-1 emergency C/S with preterm fetus, uterine rapture before decision, refused to give consent and fetus with gross congenital anomaly were excluded.

Variables of the study
Dependent variables
Time of decision to delivery interval (DDI) and feto-maternal outcomes were dependent variables.

Independent variable
Independent variables were socio-demographic factors (Age, weight, height, BMI, gestational age, ANC follow up, educational level, number of previous C/S), experience of the obstetrician, duration of surgery, experience of the anesthetist, duration of anesthesia, ANC follow up, hemodynamic status of the client, availability of surgical materials, client information (did the client have knowledge about the complications due to prolonged DDI), team communication (early information delivery among the surgical team), availability of surgical team, unplanned conversion to general anesthesia, and availability of operating tables.

Operational definition
Category-1 emergency caesarean section: immediate threat to the life of the woman or fetus which needs delivery of the fetus within 30 min [12].
Transfer time: the time taken from decision for C/S to arrival in the operation theater [13].
Anesthesia time: the time taken from transfer and immediate start of anesthesia to skin incision [13].
Operation time: the time taken from skin incision to delivery of the fetus [14].
DDI: The time from decision of C/S to fetal delivery [15].
Peri-natal outcome: neonatal mortality and morbidity or birth without complications [16].
Fever: the American College of Critical Care Medicine, the International Statistical Classification of Diseases, and the Infectious Diseases Society of America define fever as a core temperature of 38.3 °C or higher [17].
**Sever pre-eclampsia:** systolic blood pressure of 160 mmHg or higher or diastolic blood pressure of 110 mmHg or higher in two occasions at least 4 h apart [18].

**Eclampsia:** the occurrence of new onset of seizure in a mother with pre-eclampsia [18].

**Severe APH:** an acute blood loss > 1500 ml with cold clammy skin, tachycardia, tachypnea and hypotension [19].

**Sample size and sampling procedure**

**Sample size determination**

The sample size was estimated by taking the achievement of DDI below 30 min (12.3%) among emergency C/S deliveries from a study done in Tanzania with the assumptions of single population proportion at 5% margin of error, and at 95% of confidence interval [20]. So, it was calculated as:

\[
 n = \left( \frac{Z^2}{2} \right) \frac{p(1-p)}{\varepsilon^2} = \frac{(1.96)^2 \times 0.123(1-0.123)}{(0.05)^2} = 166
\]

A total of 166 participants were required.

**Sampling procedure**

Every consecutive women who underwent category-1 emergency C/S under both general and spinal anesthesia during the study period was included.

**Data collection procedures**

Data was collected by using a structured questionnaire. Socio-demographic variables, the time of decision of C/S, indication of C/S, time of OT transfer, time taken to deliver anesthesia, the total time taken from decision to delivery of the fetus and the time of anesthesia team informed were collected from patients’ chart and direct observation.

The time of decision for category-1 emergency C/S was recorded at the time the obstetrician decided to do caesarean section. Subsequently the time of transfer to the operation theater, type of anesthesia, time taken for administration of anesthesia and time taken for operation were also recorded.

The pre-operative and post-operative maternal vital signs (BP, PR, temperature, spo2 and urine output) and BMI were recorded. Post-operatively, mothers were evaluated for short term maternal outcomes (fever, wound infection, bladder injury, hysterectomy, need for blood transfusion, administration of anti-convulsants, administrations of diuretics, blood loss and maternal death) until the 3rd post-operative day on which they would be discharged.

Neonatal outcomes were evaluated at the 1st and 5th minutes by using the Apgar score, need of intubation, cardiopulmonary resuscitation, need of admission to neonatal intensive care unit (NICU) and neonatal death.

**Data quality control**

Two BSc degree graduate anesthetists were selected and trained how to collect the data and supervised by the investigators. Pre-test was done on 5% of the sample to ensure the quality of the data and appropriate amendments done. Data from pre-test was not included in the main study. The data was checked for completeness, accuracy, clarity and cleaned up by the principal investigator.

**Data management and analysis**

The data was coded, entered and analyzed using SPSS version 20 (IBM Corporate). Descriptive statistics was done. Categorical variables were presented in frequency and percentage. Continuous variables were presented in mean ± SD or median (IQR) according to results of Shapiro-Wilk normality test. Bivariate and multivariate binary logistic regression analyses were carried out to identify predictors. The strength of the association was assessed using odds ratio and 95% confidence intervals. A p-value less than 0.05 was considered as statistically significant. Finally, results were presented in tables and figures.

**Ethical consideration**

Ethical clearance was obtained from University of Gondar Collage of Medicine and Health Sciences, School of Medicine Ethical Review Committee. A written informed consent was taken from each study participant after detailed explanation. Every participant was allowed to discontinue participation if did not want to finish it. Also the participants were assured that their treatment and other benefits they can gain from the hospital will not be interrupted due to their withdrawal. Participants who had complication were given advice, and their respective physicians and midwives were alerted about the problem. Confidentiality was ensured by removing identifiers and locking the questionnaires in a secured area.

**Results**

**Socio-demographic and clinical characteristics**

A total of hundred and sixty-six clients were enrolled in the current study with a response rate of 98.2% and 3 of participants were excluded from the study because of incomplete data. Majority of participant’s 68 (41.7%) age was in the range of 25–29 years. Around 32(19.6%) of women had history previous C/S and almost a half of clients had college or university level of education. The mean weight, height and gestational age of participants were 66 ± 10 Kg, 1.61 ± 0.06 m and 38 ± 1 weeks, respectively. The majority of participants 85(52.1%) had BMI
between 25 and 29.9 Kg/m². The mean weight of the new born was 3.04 ± 0.19 Kg (Table 1). Most of clients were operated under spinal anesthesia. Single attempt lumbar puncture was demonstrated in 54(33.15%) participants and two, three, and four or more attempts were noted in 68(41.75%), 23(14.1%), and 2(1.2%) participants respectively.

The mean ± SD preoperative systolic blood pressure, diastolic blood pressure, pulse rate, respiratory rate, oxygen saturation, temperature and urine output were 125 ± 16 mmHg, 73.5 ± 10.9 mmHg, 97.8 ± 14.9 beats/minute, 20 ± 2.5 breaths/minute, 96 ± 2%, 36 ± 04°C and 55 ± 50.8 ml respectively. The mean ± SD post-operative systolic blood pressure, diastolic blood pressure, pulse rate, respiratory rate, oxygen saturation, temperature and urine output were 106.5 ± 16.7 mmHg, 62.65 ± 9.96 mmHg, 90 ± 11.08 beats/minute, 19 ± 1.9 breaths/minute, 96.4 ± 1.9%, 35.9 ± 9.8°C and 192 ± 95.8 ml respectively. None of the vital signs was associated with DDI or feto-maternal outcomes.

The leading indications for category-1 emergency C/S were fetal distress (52.15%), multiple previous C/S scars with ongoing labor (9.8%) and cephalopelvic disproportion (9.20%). Others are prolapsed umbilical cord, placental abruption, failed instrumental delivery, imminent uterine rupture, placenta previa, severe pre-eclampsia and eclampsia (Fig. 1). Around 5.5% of clients had combination of indications.

**Decision to delivery time interval, and other intervals**

The recommended decision to delivery time interval (DDI below 30 min) was achieved only in 32 (19.6%) of clients. The mean ± SD delivery time interval was 6.13 ± 10.37 minutes.

### Table 1

| Maternal characteristics | n (%) |
|--------------------------|-------|
| **age (years)**          |       |
| < 20                     | 7(4.3) |
| 20–24                    | 51(31.3) |
| 25–29                    | 68(41.7) |
| 30–34                    | 25(15.3) |
| 35–39                    | 11(6.7) |
| ≥ 40                     | 1(0.6) |
| **Number of previous C/S** |     |
| 0                        | 131(80.4) |
| 1                        | 14(8.6) |
| 2                        | 16(9.8) |
| ≥ 3                      | 2(1.2) |
| **Educational level**    |       |
| No formal education      | 28(17.2) |
| Primary school           | 42(25.8) |
| Secondary school         | 46(28.2) |
| Collage/university        | 47(28.8) |
| **Mean ± SD weight (kg)** | 66± (10) |
| **Mean ± SD height (meter)** | 1.61 ± (0.06) |
| **Mean ± SD gestational age (weeks)** | 38± (1) |
| **Fetal mean ± SD weight (kg)** | 3.04 ± (0.19) |

SD standard deviation
category-1 emergency C/S. The mean ± SD of DDI was 42 ± 21.4 min. The mean ± SD of time taken from decision of C/S to transfer to OT was 21.58 ± 19.76 min and from arrival at the operation theater to skin incision was 11.5 ± 3.6 min (Table 2).

**Predictors of decision to delivery time interval in category-1 emergency C/S**

Around 152 (93.3%) of clients had ANC follow up and out of those, 31 (20.4%) had DDI below 30 min. The majority of cases were operated by senior residents and out of those, 26 (20.8%) had DDI below 30 min. Most of clients 63 (82.9%) were anesthetized by BSc holder anesthetists and out of those, 13 (17.1%) had DDI below 30 min (Table 3).

Time elapsed to collect materials, time of decision of C/S, time taken from decision to the operation theater, skin incision, and delivery, anesthesia, and surgery (Table 2).

| Variables | Decision to delivery time interval | OR | COR (95%CI) |
|-----------|-----------------------------------|----|-------------|
| BMI (kg/m²) | > 30 min n (%) | ≤ 30 min n (%) | |
| 18.5–24.9 | 59(85.5) | 10(14.5) | 1 |
| 25–29.9 | 65(76.5) | 20(23.5) | 1.81(0.79–4.19) |
| ≥ 30 | 7(77.8) | 2(22.2) | 1.69(0.31–9.31) |
| Number of previous C/S | | | |
| 0 | 102(77.9) | 29(22.1) | 1 |
| 1 | 14(100) | 0(0) | 0.28(0.02–4.69) |
| 2 | 14(87.5) | 2(12.5) | 0.5(0.11–2.32) |
| ≥ 3 | 1(50) | 1(50) | 3.52(0.21–57.97) |
| ANC follow up | | | |
| Yes | 121(79.6) | 31(20.4) | 1 |
| No | 10(90.9) | 1(9.1) | 0.39(0.05–3.17) |
| Educational level | | | |
| No formal education | 23(82.1) | 5(17.9) | 1 |
| Primary school | 33(78.6) | 9(21.4) | 1.25(0.37–4.230) |
| Secondary school | 36(78.3) | 10(21.7) | 1.28(0.39–4.22) |
| Collage/university | 39(83) | 8(17) | 0.94(0.28–3.23) |
| Experience of surgeons | | | |
| Junior residents | 32(84.2) | 6(15.8) | 1 |
| Senior residents | 99(79.2) | 26(20.8) | 1.4(0.53–3.71) |
| Experience of anesthetist | | | |
| BSC students | 12(80) | 3(20) | 1 |
| BSC holders | 63(82.9) | 13(17.1) | 0.7(0.12–3.56) |
| MSC student | 42(79.2) | 11(20.8) | 0.58(0.178–1.89) |
| MSC holders | 14(73.7) | 5(26.3) | 0.73(0.17–2.48) |

SD standard deviation, IQR interquartile range (maen ± SD)*, n(%)**, and median(IQR)***

**Table 3** Bivariate logistic regression analyses results: Health professionals and clients related factors that can delay decision to delivery time interval in category-1 emergency caesarean section, at Gondar University specialized Hospital Northwest Ethiopia, March to May 2018(N = 163)

**Table 2** Decision to delivery time intervals, duration of surgery and anesthesia of category-1 emergency caesarean section at Gondar University specialized Hospital Northwest Ethiopia, March to May 2018(N = 163)

| Characters | Values |
|-----------|--------|
| Time taken from decision to theater (minute) | 21(±19.76)* |
| Time taken for delivering anesthesia (minute) | 11.5(±3.6)* |
| Decision to delivery time interval > 30 min | 131(80.4)** |
| Decision to delivery time interval ≤ 30 min | 32(19.6)** |
| Decision to delivery time interval (minute) | 42(±21.4)* |
| Duration of anesthesia (minute) | 55(50–65)*** |
| Duration of surgery (minute) | 49(43–58)*** |

C/S caesarean section, ANC antenatal care, BMI Body mass index
time taken to deliver anesthesia and operation time were associated with prolonged DDI (Table 4).

Other factors such as unavailability of clinicians (anesthetists 8(4.9%), surgeons 3(1.8%), and midwives 3(1.8%)), hesitation of the client to give consent 18(11%), unplanned conversion to general anesthesia 2(1.2%), lack of operation table 11(6.7%), difficulty of intravenous access 7(4.3%), waiting for CBC results 1(0.6%), waiting of senior surgeon 1(0.6%) and waiting for consultant anesthetist 1(0.6%) had no association with prolonged DDI.

### Table 4: Bivariate and multivariate logistic regression analyses results: Predictors of decision to delivery time interval in category-1 emergency caesarean section, Gondar University specialized Hospital Northwest Ethiopia, March to May 2018 (X-tab and OR with 95%CI) (N = 163)

| Reason for delay          | Decision to delivery time interval | OR          |
|---------------------------|------------------------------------|-------------|
|                           | > 30 min n (%) | ≤30 min n (%) | COR (95%CI) | AOR (95%CI) |
| Availability of materials |                                    |             |
| Easily available          | 101(77.1)        | 30(22.9)     | 1           | 1           |
| Tooke time to collect     | 30(93.8)         | 2(6.2)       | 4.46(1.01–19.73)* | 13.76(1.12–168.7)* |
| Time of decision          |                                    |             |
| Day                       | 87(86.1)         | 14(13.9)     | 1           | 1           |
| Night                     | 44(71)           | 18(29)       | 0.39(0.18–0.86)* | 0.73(0.17–3.25) |
| Type of anesthesia        |                                    |             |
| Reginal                   | 121(82.3)        | 26(17.7)     | 1           | 1           |
| General                   | 10(62.5)         | 6(37.5)      | 0.36(0.12–1.07) | 8           |
| Skin incision to delivery |                                    |             |
| ≤ 5 min                   | 7(50)             | 7(50)        | 1           | 1           |
| > 5 min                   | 124(83.2)        | 25(16.8)     | 0.20(0.07–0.63)* | 0.18(0.02–2.03) |

* P-value < 0.05

**Fetal outcomes in category-1 emergency C/S**
A total of 163 deliveries were included in the study. Apgar score < 7 was recorded in 52 newborns at the 1st minute and in 18 at the 5th minute. Bag and mask resuscitation was done in 45 newborns, 7 newborns were intubated, chest compression was done for 7 newborns and 17 were admitted to the neonatal intensive care unit and 4 newborns died (3 still birth and 1 after delivery) (Fig. 2). Among 131 newborns who delivered with a DDI longer than 30 min, 40 had Apgar score < 7 at the first
minute, 13 had Apgar score < 7 at the 5th minute, 38 had resuscitation via bag-mask ventilation, 5 had intubation, and 6 had chest compression (Table 5).

Maternal outcome in category-1 emergency C/S
Out of 163 mothers who delivered with category-1 emergency C/S, 16 were transfused, 10 had developed fever, 4 had wound infection, 2 had hysterectomy, 8 had lost blood which was estimated to be more than 1000 ml and 1 had died (Fig. 3). Among 32 mothers whose DDI was longer than 30 min, 12 were transfused, 8 had developed fever, 2 had developed wound infection and 1 had hysterectomy (Table 6).

Discussion
Decision to delivery time interval is a time range between decision for C/S and delivery of a newborn. This is the critical time interval that determines the feto-maternal outcome in category-1 emergency C/S [8]. The current study showed that only 19.6% of women who underwent category-1 emergency C/S were delivered within the recommended DDI of 30 min. The mean ± SD of DDI was 42 ± 21.4 min which is similar with a study done by Sunanda et al. in which the mean ± SD was 36.3 ± 17 min [21]. The difference might be due to sample size. Another study done in Oman concluded that a DDI below 30 min was achieved in 23.8% of category-1 emergency C/S [22] which is comparable with the current study. On the other hand, a study done in Benin teaching hospital has showed that a DDI below 30 min was achieved in only 5.7% of emergency C/S and the mean ± SD of DDI was 106.3 ± 79.5 min [23]. This finding is low in comparison with the current study.

In this study, time to collect surgical materials had a positive association with prolonged DDI in category-1 emergency C/S (AOR =, CI =, p=). This is consistent with a research done by Tak Yeung Leung et al. which has stated that a DDI below 30 min was achievable if the operation facilities were easily available [24]. Another study has showed that lack of surgical equipments was the main factor for prolonged DDI time [25]. A DDI below 30 min was difficult to attain in emergency C/S due to the infrastructural challenges [23].

In the current study, the mean time from decision to arrival to the operation theater was 21.58 ± 19.76 min. A research done by Wong et al. concluded that the major determinant for prolonged DDI was the time taken for transfer of clients to the OT [26]. Another study also has stated that preparation and transfer to the operation theater have significantly prolonged DDI with the average of 15.9 min [27]. The mean time taken to deliver anesthesia after the clients were arrived at the operation theater was 11.5 ± 3.6 min. A study has showed that delays in the

| Variable                  | Neonatal outcomes | OR | COR (95%CI) |
|---------------------------|-------------------|----|-------------|
| Decision to delivery time interval | < 7 n (%) ≥7 n (%) |    |             |
| > 30 min                  | 40(30.5) 91(69.5) | 1  |             |
| ≤30 min                   | 12(37.5) 20(62.5) | 1.37 | (0.61–3.06) |
| APGAR score at 5th minute | < 7 n (%) ≥7 n (%) |    |             |
| > 30 min                  | 13 (9.9) 118 (90.1) | 1  |             |
| ≤30 min                   | 5 (15.6) 27 (84.4) | 1.68 | (0.55–5.12) |
| Bag mask resuscitation    | Yes n (%) No n (%) |    |             |
| > 30 min                  | 38 (29) 93 (71) | 1  |             |
| ≤30 min                   | 7 (21.9) 25 (78.1) | 0.69 | (0.29–1.72) |
| Resuscitation via intubation| Yes n (%) No n (%) |    |             |
| > 30 min                  | 5 (3.8) 126 (96.2) | 1  |             |
| ≤30 min                   | 2(6.2) 30(93.8) | 1.68 | (0.31–9.08) |
| Chest compression         | Yes n (%) No n (%) |    |             |
| > 30 min                  | 6 (4.6) 125 (95.4) | 1  |             |
| ≤30 min                   | 2(6.2) 30(93.8) | 1.39 | (0.27–7.23) |
| NICU admission            | Yes n (%) No n (%) |    |             |
| > 30 min                  | 15 (11.5) 116 (88.5) | 1  |             |
| ≤30 min                   | 2(6.2) 30(93.8) | 0.52 | (0.11–2.38) |
| Neonatal death            | Yes n (%) No n (%) |    |             |
| > 30 min                  | 3 (2.3) 128 (97.7) | 1  |             |
| ≤30 min                   | 1 (3.1) 31 (96.9) | 1.38 | (0.14–13.69) |
preparation and administration of anesthesia were significantly associated with prolongation of DDI [28].

Category-1 emergency C/S done in the night time had generally shorter DDI when it compared with the day time which was 18(29%) vs 14(13.9%). This result was comparable with the study done in Nysamba Hospital, Uganda which has stated that C/S done during the day time had prolonged DDI than those done in the night [28]. This can be explained by; during the day time the operating tables might be occupied by elective cases.

A retrospective cohort study done in the University of Benin teaching hospital has showed that the most frequent causes for delay in emergency C/S were anesthetists delay and busy OT [29]. This finding is against with the current study and might be explained by committed anesthetists and availability of free operation tables in our setup.

The indication for more than a half of the category-1 emergency C/S was fetal distress. This was comparable with a study done by Zwuditu et al. [30] Most of the indications were also consistent with that of a research done by Dr. Ban Leong et al. [13, 28]. A DDI below 30 min was best achieved when the indication was failed instrumental delivery. Fifty-seven percent of mothers with the indication of failed instrumental delivery have delivered within 30 min during C/S. This might be due to the locations the delivery rooms which are very near to the OT and make easy to transfer the mother to the OT immediately. In contrast, another study has showed that DDI below 30 min was achieved among women with the indication of non-reassuring fetal heart rate. The 3/4th of women with this indication has delivered within the recommended DDI [31].

The most of participants (90.2%) were operated under spinal anesthesia. This result was in accordance with a previous study in which 97.2% of category-1 emergency C/S were done under spinal anesthesia [23]. General anesthesia was administered in 16 clients and the attainments of DDI below 30 min was 37.5% [26]. A prospective study done by Mackenzie IZ et al. claimed that general anesthesia was significantly associated with shorter DDI than regional anesthesia for emergency caesarean section [32].

Most category-1 emergency C/S (76.7%) in our study was performed by senior residents (R3 and R4) and 23.3% by junior resident (R2). Achievement of DDI below 30 min was 20.8 vs 15.8% respectively. Senior obstetricians were not evolved in any of cases. However, the experience of obstetric residents was not a statistically significant determinant of DDI. This is supported by a prospective study done by Mackenzie IZ et al.
which stated that the seniority of the surgeon didn’t influence the DDI [32]. In the majority of the cases (44.6%), anesthetic care was provided by BSc degree graduate anesthetists and the remaining 32.5 and 11.7% by MSc degree in anesthesia students and MSc graduates respectively. The study has denied that experience of the anesthetists had no association with DDI. In contrast to our finding, there is a study that showed lack of experience of the obstetricians, anesthetists and hesitation of the pregnant mother to give consent can be barriers to achieve shorter DDI [25].

In this study there was no association between DDI and feto-maternal outcome. Most of the literature stated that, there was no association between DDI and feto-maternal outcome during category-1 emergency C/S [13, 28, 31]. On the other hand Jane Thomas et al. stated that only delays in DDI longer than 75 min were significantly associated with worse feto-maternal outcome in category-1 emergency C/S [33]. Despite these, another study has showed that during life threatening conditions, quicker delivery can result in better feto-maternal outcomes [24].

Many newborns with adverse outcome had DDI longer than 30 min but it was not statistically significant. This result is supported by previous studies that claimed longer DDI was not significantly associated with worse neonatal outcome [27, 34]. In contrast, another study has stated that there was significant improvement in feto-maternal outcome when DDI was below 20 min [35].

Among newborns who were delivered with DDI longer than 30 min, 40 had Apgar score < 7 at the 1st minute, 13 had Apgar score < 7 at the 5th minute, 38 had resuscitation via bag-mask ventilation, 5 had intubation, 6 had chest compression, 3 had NICU admission and 3 had died. On the other hand, when DDI was below 30 min, 12 had Apgar score < 7 at 1st minute, 2 had Apgar score < 7 at the 5th minute, 7 had resuscitation via bag-mask ventilation, 2 had intubation, 2 had chest compression, 2 had NICU admission and 1 had died.

Among 131 mothers who delivered with DDI longer than 30 min, 12 had blood transfusion, 8 had developed fever, 2 had developed wound infections, 1 had hysterectomy and 7 had lost blood which was estimated to be more than 1000 ml. On the other hand, among 32 women who delivered with DDI below 30 min, 4 had blood transfusion, 2 had developed fever, 2 had developed wound infections, 1 had hysterectomy, and 1 had lost blood which was estimated to be more than 1000 ml. Despite our findings, a prospective study has showed that around 27% of women had one or more complications during caesarean section in which category-1

---

**Table 6** Bivariate logistic analyses results: Maternal outcome in category-1 emergency caesarean section, at Gondar University specialized Hospital Northwest Ethiopia, March to May (X-tab and OR with 95%CI) (N = 163)

| Variable                | Maternal outcome | OR (95%CI)      |
|-------------------------|------------------|----------------|
| Decision to delivery time interval | Blood transfusion |                |
| > 30 min                | Yes n (%) 12 (9.2) | No n (%) 119 (90.8) | 1 |
| ≤30 min                 | 4 (12.5)         | 28 (87.5)       | 1.42 (0.43–4.72) |
| Fever                   |                  |                |
| > 30 min                | Yes n (%) 8 (6.1) | No n (%) 123 (93.9) | 1 |
| ≤30 min                 | 2 (6.2)          | 30 (93.9)       | 1.03 (0.21–5.08) |
| Wound infection         |                  |                |
| > 30 min                | Yes n (%) 2 (1.5) | No n (%) 129 (98.5) | 1 |
| ≤30 min                 | 2 (6.2)          | 30 (93.8)       | 4.3 (0.58–31.77) |
| Hysterectomy            |                  |                |
| > 30 min                | Yes n (%) 1 (0.8) | No n (%) 130 (99.2) | 1 |
| ≤30 min                 | 1 (3.1)          | 31 (96.9)       | 4.19 (0.26–68.9) |
| Blood loss              |                  |                |
| > 1000 ml               | Yes n (%) 7 (5.3) | No n (%) 124 (94.7) | 1 |
| ≤1000 ml                | 1 (3.1)          | 31 (96.9)       | 0.57 (0.07–4.82) |

Temesgen et al. BMC Pregnancy and Childbirth (2020) 20:164
emergency C/S delivery significantly associated with these complications [36].

We strongly recommend that materials which are important for emergency C/S should be readily available in the supply room and obstetric pharmacy, anesthetic and surgical care for all category-1 emergency C/S should be provided by senior anesthetists, residents and consultants. Time of preparation and transfer to the OT should be reduced. It would be better if further study is done by incorporating late feto-maternal outcomes with larger sample size.

Strengths and limitations of the study
The strengths of this study is that subjects were homogeneous (category-1 emergency C/S) which could provide representative data and since it was prospective study which could make it appropriate to identify factors. This study has not evaluated late feto-maternal outcomes, immediate fetal outcome was assessed only with the Apgar score due to the unavailability of umbilical cord blood pH analysis in the hospital and even if larger sample size is needed, due to short study period we included only 163 samples and might reduce the power of the study. These are limitations of the study.

Conclusions
Decision to delivery time interval in category-1 emergency C/S at UOGCSH was longer than the recommended interval of time. Only 19.6% of women were delivered within the recommended DDI below 30 min. Time taken to collect materials, time taken for client preparation and transfer to the Operation Theater and time taken to deliver anesthesia were associated with prolonged DDI. The techniques of anesthesia, experience of anesthetists and obstetric residents, availability of clinicians were not associated with DDI. Prolonged DDI had no association with feto-maternal outcomes.

Abbreviations
ANC: Antenatal care; APGAR: Appearance, pulse, grimace, activity and respiration; APH: Ante partal hemorrhage; CS: Caesarean section; DDI: Decision to delivery interval; GA: General anesthesia; GUH: Gondar University Hospital; ICU: Intensive care unit; MNH: Maternal and newborn health; OT: Operation theater; SA: Spinal anesthesia

Acknowledgments
We would like to thank University of Gondar for giving us the chance to carry out this project. We also acknowledge the data collectors and staffs of department of anesthesia for their help and encouragement in conducting this project.

Authors’ contributions
MMT conceptualized the study and led the analysis, and write-up. AHG, HGK and SAA advised on the design and data collection. YWB advised on the analysis and how to write the paper. All authors read and approved the final manuscript.

Funding
College of Medicine and Health Sciences, University Of Gondar. The University of Gondar as a funding body had no any role in the design of the study, the collection, analysis, and interpretation of data and in writing the manuscript.

Availability of data and materials
Data and materials used in this study are available and can be presented by the corresponding author upon reasonable request: the data supporting our findings is found in the department of anesthesia and critical care at the University of Gondar data set system.

Ethics approval and consent to participate
Ethical approval was obtained from ethical review committee of college of medicine and health sciences, university of Gondar. Signed informed consent was obtained from each participant after detailed disclosure.

Consent for publication
Not applicable: the article did not include any personal or any clinical detail of any participant.

Competing interests
The authors declare that they have no competing interests.

Received: 21 March 2019 Accepted: 20 February 2020
Published online: 17 March 2020

References
1. Shabila NP. Rates and trends in cesarean sections between 2008 and 2012 in Iraq. BMC Pregnancy Childbirth. 2017;17(1):22.
2. Grace L, Greer RM, Kumar S. Perinatal consequences of a category 1 caesarean section at term. BMJ Open. 2015;5(7):e007248.
3. Ethiopia MoH, Ethiopia. Success factors for women and children’s health. WHO library cataloguing-in-publication data. 2015.
4. Demographic E. Health survey 2011 central statistical agency Addis Ababa. Maryland: Ethiopia ICF International Calverton; 2012.
5. Alkema L, Chou D, Hogan D, Zhang S, Moller A-B, Gemmill A, et al. Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN maternal mortality estimation inter-agency group. Lancet. 2016;387(10017):462–74.
6. Yisma E, Smithers LG, Lynch JW, Mol BW. Cesarean section in Ethiopia: prevalence and sociodemographic characteristics. J Matern Fetal Neonatal Med. 2017;32(7):1–6.
7. Gynaecologists Rcooa. classification of urgency of caesarearisk section a continuum the royal college of anesthetists; 2010. p. 11.
8. Nallah S. Understanding the decision-delivery interval in cesarean births. 2017.
9. Permijn J, Moran A, Rahman M, Razzaque A, Sibley L, Sneathfield PK, et al. Association of antenatal care with facility delivery and perinatal survival—a population-based study in Bangladesh. BMC Pregnancy Childbirth. 2012;12(1):111.
10. Oppong S, Tuuli M, Seffah J, Adanu R. Is there a safe limit of delay for emergency caesarean section in Ghana? Results of analysis of early perinatal outcome. Ghana Med J. 2014;48(1):24–30.
11. Timfoeiv J, Reddy UM, Huang C-C, Driggers RW, Landy HJ, Laughon SK. Obstetric complications, neonatal morbidity, and indications for cesarean delivery by maternal age. Obstet Gynecol. 2013;122(6):1184.
12. Excellence nifac. Performing caesarean section. ManchesterM1 4BT www.nice.org.uk nice@nice.org.uk. 2017.
13. Dunn CN, Zhang Q, Sta JT, Assam PN, Tagore S, Sng BL. Evaluation of timings and outcomes in category-one caesarean sections: a retrospective cohort study. Indian J Anaesth. 2016;60(8):546.
14. Puia DM. The cesarean decision survey. J Perinat Educ. 2013;23(4):212.
15. Wong TCT. Decision to delivery intervals and total duration of surgery for caesarean section in tertiary government hospital Singap Med J. 2017;58(6):332.
16. Li Y, Townsend J, Rowe R, Brocklehurst P, Knight M, Linsell L, et al. Perinatal and maternal outcomes in planned home and obstetric unit births in women at ‘higher risk’ of complications: secondary analysis of the birthplace national prospective cohort study. BLOOD J Obstet Gynaecol. 2015;12(5):741–53.
17. Walter EJ, Hanna-Jumma S, Carraretto M, Forni L. The pathophysiological basis and consequences of fever. Crit Care. 2016;20(1):200.

18. Obstetricians ACo, Gynecologists. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists’ task force on hypertension in pregnancy. Obstet Gynecol. 2013;122(5):122.

19. Wolffish M, Neuman A, Wlody D. Maternal haemorrhage. Br J Anaesth. 2009; 103(suppl_1):147–56.

20. Hirani BA, Mchome BL, Mazuguni NS, Mahande MJ. The decision delivery interval in emergency caesarean section and its associated maternal and fetal outcomes at a referral hospital in northern Tanzania: a cross-sectional study. BMC Pregnancy Childbirth. 2012;17(1):411.

21. Gupta S, Naithani U, Madhanamohan C, Singh A, Reddy P, Gupta A. Evaluation of decision-to-delivery interval in emergency cesarean section: a 1-year prospective audit in a tertiary care hospital. J Anaesthesiol Clin Pharmacol. 2017;33(1):64.

22. Tashfeen K, Patel M, Hamdi M, Al-Busaidi IHA, Al-Yarubi MN. Decision-to-delivery time intervals in emergency caesarean section cases: repeated cross-sectional study from Oman. Sultan Qaboos Univ Med J. 2017;17(1):38–42.

23. Onah H, Ibeziako N, Umezulike A, Effetie E, Ogbuoki C. Decision-delivery interval and perinatal outcome in emergency caesarean sections. J Obstet Gynaecol. 2005;25(4):342–6.

24. Leung TY, et al. Timing of caesarean section according to urgency. Elsevier. 2013;27:251–67.

25. Melman S, Schreurs RHP, Dirksen CD, Kwee A, Nijhuis JG, Smeets NAC, et al. Identification of barriers and facilitators for optimal cesarean section care: perspective of professionals. BMC Pregnancy Childbirth. 2017;17(1):230.

26. Wong TCT, Lau CQH, Tan EL, Kanagalingam D. Decision-to-delivery intervals and total duration of surgery for caesarean sections in a tertiary general hospital. Singap Med J. 2017;58(6):332.

27. MAK S-L, FHKCOG FO. Maternal and fetal outcomes in extremely urgent caesarean delivery in relation to the decision-to-delivery interval. J Gynaecol Obstet Midwifery. 2015;15(1):16–22.

28. Nakintu E, Murokora D. Emergency caesarean sections: decision to delivery interval and obstetric outcomes in Nsambya hospital, Uganda-a cross sectional study. Medwin J Gynaecol. 2016;1(4):122.

29. Chukwudi OE, Okonkwo CA. Decision-delivery interval and perinatal outcome of emergency caesarean sections at a tertiary institution. Pak J Med Sci. 2014;30(5):946.

30. Abdiillsa Z, Awoke T, Belayneh T, Tefera Y. Birth outcome after caesarean section among mothers who delivered by caesarean section under general and spinal anesthesia at Gondar University teaching hospital north-west Ethiopia. J Anesther Clin Res. 2013;4:435.

31. Khemworapong K, Somphaddeed N, Borboorhnirunsarn D. Decision-to-delivery interval in emergency cesarean delivery in tertiary care hospital in Thailand. Obstet Gynecol Sci. 2018;61(1):48–55.

32. Mackenzie I, Cooke I. What is a reasonable time from decision-to-delivery by caesarean section? Evidence from 415 deliveries. BJOG Int J Obstet Gynaecol. 2002;109(5):498–504.

33. Thomas J, Paranjotthy S, James D. National cross sectional survey to determine whether the decision to delivery interval is critical in emergency caesarean section. BMJ. 2004;328(7441):665.

34. Hein A, Thalen D, Eriksson Y, Jakobsson XG. The decision to delivery interval in emergency caesarean sections: Impact of anaesthetic technique and work shift. F1000Research. 2017;6:1977.

35. Heller G, Bauer E, Schill S, Thomas T, Louwen F, Wolff F, et al. Decision-to-delivery time and perinatal complications in emergency cesarean section. Dtsch Arztebl Int. 2017;114:35–36:589.

36. Pallarmaa N. Cesarean section-short term maternal complications related to the mode of delivery; 2014.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.