Evaluation of Decision-to-Delivery Interval and Its Effect on Maternal and Neonatal Outcomes in Category-1 and Category-2 Emergency Caesarean Section Deliveries: A Systematic Review

Jimmy Sakti Nanda Berguna¹, Masyitoh Basabih²

¹Correspondence Author: jimmy.sakti@ui.ac.id
²Faculty of Public Health Universitas Indonesia, Jakarta, Indonesia

ABSTRACT

Emergency cesarean section is a surgery delivery through the abdomen that must be carried out immediately within a decision-to-delivery interval (DDI) <30 minutes because it threatens the maternal and neonatal. This study prevents prolonged DDI response time for emergency cesarean section categories 1 and 2. This study aims to determine the causes of prolonged DDI for maternal and neonatal outcomes so that hospital management becomes standardized with the standard of care for emergency cesarean sections and the quality of care for patients increases. A literature search was conducted through four databases, SpringerLink, ScienceDirect, Google Scholar, and PubMed, using keywords that matched the clinical questions. Article selection was carried out based on exclusion and inclusion criteria. The selected literature was reviewed and assessed for validity, importance, and applicability based on the Oxford Center of Evidence-Based Medicine guidelines. Nineteen (19) studies examined category 1 or category 2 emergency cesarean sections from publications from 2018 to 2022. Of the 19 studies, only 3 achieved a response time of 30 minutes for emergency cesarean section category 1 and 75 minutes for category 2. However, 17 studies explained that DDI did not affect maternal and neonatal outcomes. Factors that influence not achieving the DDI target are the unavailability of operating rooms, anesthesiologists, pediatricians, and insufficient nurses. On the other hand, lack of special training, no standard emergency cesarean section service, and limited places and facilities impact maternal and neonatal outcomes.

Kata kunci:
Seksio sesarea emergensi kategori 1 dan 2; maternal; neonatal; response time


Article history: Received 2023-05-29; Revised 2023-07-28; Accepted 2023-07-28
INTRODUCTION

According to World Health Organization (WHO), the maternal mortality rate in low-income countries in 2020 was 430 per 100,000 live births, while in high-income countries was 12 per 100,000 live births. Based on the 2015 Inter-Census Population Survey of the Ministry of Health of the Republic of Indonesia, the total Maternal Mortality Rate (MMR) in Indonesia in 2015 was 305 per 100,000 live births, with the highest incidence occurring in Southeast Asia at 78%. In addition, according to the Indonesia Basic Health Research Report in 2018, deliveries in Indonesia were 17.6% by cesarean section and 81.5% by expected delivery. The total number of cesarean section deliveries has exceeded the maximum ideal limit of WHO recommendations. This high number led to the need to improve the management and quality of antenatal care and delivery services so that indicators are also needed to facilitate the speed of the cesarean section service process (Menteri Kesehatan RI, 2022; WHO, 2020; Badan Kebijakan Pembangunan Kesehatan, 2018).

According to the Indonesian Ministry of Health, an emergency cesarean section aims to save the mother and baby and cannot be delayed. Emergency cesarean section category 1 is a cesarean section in circumstances where there is a direct threat to the mother’s or fetus’s survival. Emergency cesarean section has an operating response time, which is the time the patient takes to get an emergency cesarean section from deciding to operate until the start of the operating incision in the operating room, which is ≤30 minutes. (Menteri Kesehatan RI, 2022).

Indications for emergency cesarean section include persistent fetal distress, prolapse of the umbilical cord or protruding umbilical cord, failure of vacuum/forceps, imminent uterine rupture, uterine rupture, and antepartum hemorrhage with active bleeding. The classification of the degree of urgency of a cesarean section generally consists of 4 types: category 1 is an immediate threat to life (fetal or maternal), category 2 is a compromise of the mother or fetus that is not immediately life-threatening, category 3 is the need for early intervention. Delivery but no maternal or fetal compromise, and category 4 is delivery at the convenience of the patient or the obstetric team. The most significant risk with higher complication rates is category 1 CS, particularly in fetal compromise (Menteri Kesehatan RI, 2022; Zhang et al., 2014; Pallasmaa et al., 2010).

The National Institute of Clinical Excellence (NICE) 2011 guidelines also suggested that to measure the overall performance of obstetric units, the decision interval for delivery (DDI) and emergency cesarean section is less than 30 minutes in emergency cesarean section category 1 and < 75 minutes for category 2 CS. Additionally, the American College of Obstetricians and Gynecologists (ACOG) Committee on professional standards stated in 1989 that a hospital with obstetric services should be able to initiate a cesarean delivery within 30 minutes of the decision to perform the procedure (ACOG, 1989; Thomas et al., 2004).

In developing countries, it is generally recommended that the target for emergency cesarean section is 30 minutes from the set time for delivery. However, this target can only be used in some countries with limited facilities. To prevent unwanted incidents, the decision-to-delivery time should be as short as possible (Thomas et al., 2004; NICE, 2011; Khumalo et al., 2022).
The quality of health services is the level of health services for individuals and communities that can improve optimal health outcomes, are provided by service standards and the latest scientific developments, and fulfill patients’ rights and obligations. According to WHO, the framework for the quality of health services is through the dimensions of the quality of health services; health services that are effective, efficient, easily accessible, acceptable/focused on patients, fair and safe. The quality of health services then develops into seven dimensions: effective, safe, patient-oriented/service user, efficient, equitable, and integrated (Menteri Kesehatan RI, 2022).

Several quality indicators in the hospital include hand hygiene compliance, adherence to personal protective equipment, adherence to patient willingness, emergency cesarean section response time, outpatient waiting time, delayed elective surgery, adherence to the doctor visit time, reporting of critical laboratory results, adherence to using national formulary, adherence to clinical pathways, adherence to efforts to prevent patient falls, speed of response to complaints, and patient satisfaction (Menteri Kesehatan RI, 2022).

Yeni et al. and Gunawan T et al. explained that the response time for emergency cesarean section affected maternal and neonatal outcomes. However, the Pratama RE et al. study stated that the results were insignificant, so they did not affect outcomes (Pratama et al., 2021; Yeni et al., 2021; Gunawan et al., 2018). Therefore, whether response time affects outcomes in Indonesia is still uncertain.

This research design has never been done before in Indonesia. Thus, this study was designed to analyze the factors and impact of DDI on mothers and newborns, determine the decision time interval to deliver (DDI) for emergency cesarean section, and determine whether the current standard of 30 minutes can be achieved routinely. Many factors can influence, such as obstetricians, anesthesiologists, staff, and resource constraints, contribute to delays in DDI.

**RESEARCH METHOD**

**Design**

This research used a systematic review method. The reference lists of related studies from 2018 to 2022 followed PRISMA guidelines. The articles were conducted through searching databases, including manual search using PubMed, ScienceDirect, SpringerLink, and Google Scholar. Publications were collected within the last 5 years to reduce bias due to similar research methods, abilities and distribution of doctors and techniques.

**Search Strategy**

The keywords of this study were based on the PICO (Population, Intervention, Comparison, and Outcome) model; the population was the third-trimester women with indications for category 1 and 2 emergency cesarean section, the intervention or exposure was the response time fulfilled the criteria for category 1 and 2 emergency cesarean section. The comparison is unfulfilled category 1 and 2 emergency cesarean section, and the outcome is maternal and neonatal outcomes.

The combinations of search keywords and subject headings are around the terms “response time”, “emergency cesarean section”, “emergency cesarean section”, “surgical birth”, “surgical delivery”, “abdominal delivery”, “C-section”, “third-trimester pregnant
women”, “decision-to-delivery interval”, “maternal outcome”, “perinatal outcome”, “neonatal outcome”.

Search strategy in PubMed: ((emergency cesarean section) OR (emergency cesarean section)) AND (decision to delivery interval (DDI)). Full text and free full text, date of publication, and last 5 years were included in the filter. In ScienceDirect: emergency cesarean section OR emergency cesarean section AND decision-to-delivery interval as a keyword. The filter includes 2018-2022 years of publication, review articles and research articles for the type. The publication title includes the European Journal of Obstetrics & Gynecology and Reproductive Biology, and the access type is open. In SpringerLink: response time AND emergency cesarean section category 1 and 2 OR surgical birth OR surgical delivery OR abdominal delivery OR C-section AND third-trimester pregnant women AND decision-to-delivery interval AND maternal AND perinatal OR neonatal as a keyword. The filter includes the English language. The discipline was medicine & public health, general, and the content type article. In Google Scholar, the author used keywords response time, emergency cesarean section, emergency cesarean section, decision-to-delivery interval, maternal, perinatal, and neonatal outcomes. The filter included publications from 2018-2023.

Study Selection and Eligibility Criteria

This study was selected based on the article’s title, abstract, and the feasibility of the full text for review. One reviewer independently screened the titles and abstracts of all potentially relevant articles by emergency cesarean section response time and outcome of feto-maternal articles and exclusion based on criteria. Those deemed potentially relevant are included in the full-text review, with the same review process applied to full-text screening. Any articles that did not meet the requirements or did not meet the requirements for inclusion after evaluation by the second reviewer were brought to the researcher for discussion.

Inclusion and Exclusion Criteria

Inclusion criteria in this study were original articles in English or Indonesian, accessible in full text, academic or research articles, and studies assessing response time to emergency cesarean section categories 1 (immediate threat to life (fetal or maternal)) and 2 (compromise of the mother or fetus that is not immediately life-threatening) for maternal or perinatal outcomes. The study exclusion criteria were women with categories 3 (the need for early intervention), and 4 (delivery at the convenience of the patient or the obstetric team), pregnant women who underwent elective cesarean section, women who gave birth to babies with any congenital anomaly, preterm delivery, data that were not correctly recorded, intrauterine death before the decision of cesarean delivery were excluded from the study.

Data Collection

Relevant data were taken based on the study period, the year of publication, the research design and research method, and the correlation response time decision-to-delivery with emergency cesarean section categories 1 and 2.
Quality Assessment Tool

Assessment of the quality of the critical review methodology of articles based on the Oxford Center of Evidence-Based Medicine. One independent reviewer conducted critical reviews, with a second review resolving conflicts. The tools used were divided into levels A, B, C, and D according to the Oxford Center of Evidence-Based Medicine (CEBM) provisions. (CEBM, 2009).

Data Synthesis

Data synthesis in the systematic review used narrative analysis that provided qualitative approach information on the response time of emergency cesarean section categories 1 and 2 for maternal and perinatal outcomes.

![PRISMA Flow Diagram of Search and Selection Process](Diagram.png)

Picture 1. PRISMA Flow Diagram of Search and Selection Process

The studies examined were research studies, with literature reviews omitted, but reference lists were searched for additional studies. The studies that are considered to analyze are the studies that measure the response time of emergency cesarean section categories 1 and 2 for maternal and perinatal outcomes.
The initial search identified 233 studies conducted through searching databases, including PubMed, ScienceDirect, SpringerLink, and Google Scholar. After removing duplicate articles, titles and abstracts were screened, bringing out 27 potentially relevant to the topic response time of emergency cesarean section and outcomes feto-maternal. The full-text studies assessed eligibility and resulted in 19 studies included in the final review. The literature selection process was resumed in Picture 1.

The 3 studies were from India, 2 studies were from South Africa, 1 study was from the United Kingdom, 2 studies were from Pakistan, 3 studies were from Indonesia, 3 studies were from Ethiopia, 2 studies were from Nigeria, 1 study was from Thailand, 1 study was from Germany, and 1 study was from Japan. The results resumed in Table 1. The 18 articles were rated B quality, and 1 was rated C quality. The sample size was in the range of 6-572. The research study of 19 studies consisted of a cross-sectional, retrospective cohort, and prospective cohort. Response time analysis has varied groups. The type of emergency cesarean section used was category 1, category 2, and there was 1 study that added category 3. Three studies could achieve response time decision-to-delivery interval (DDI) emergency cesarean section category 1 (30 minutes) and category 2 (75 minutes). Moreover, two studies affected maternal and neonatal outcomes.

<table>
<thead>
<tr>
<th>Author, Year of Publish, Country</th>
<th>Sample Size of Emergency Cesarean Section</th>
<th>Setting of Studies</th>
<th>Response Time Emergency Cesarean Section</th>
<th>Type of Emergency Cesarean Section</th>
<th>DDI Achieved?</th>
<th>Maternal or Neonatal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radhika K, et al., India, 2021</td>
<td>200</td>
<td>A cross-sectional observational study</td>
<td>≤30 minutes and &gt;30 minutes</td>
<td>category 1, category 2, and category 3</td>
<td>No</td>
<td>The mean DDI in the study participants was 79.28 ± 28.66 mins. Mean DDI for category 1, 2, and 3 cesarean deliveries were 47.23 ± 13.35 mins, 64.83 ± 11.83 mins, and 110.1 ± 13 mins, respectively. Neonatal outcomes did not differ significantly between those cesarean deliveries with DDI ≤ 30 mins and those with DDI &gt; 30 mins.</td>
</tr>
<tr>
<td>Author, Year of Publish, Country</td>
<td>Sample Size of Emergency Cesarean Section</td>
<td>Setting of Studies</td>
<td>Response Time Emergency Cesarean Section</td>
<td>Type of Emergency Cesarean Section</td>
<td>DDI Achieved?</td>
<td>Maternal or Neonatal Outcome</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>-------------------------------------------</td>
<td>-------------------</td>
<td>------------------------------------------</td>
<td>----------------------------------</td>
<td>---------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Khumalo M, et al., South Africa, 2022</td>
<td>572</td>
<td>A retrospective, contextual, descriptive study</td>
<td>≤30 minutes, 31-60 minutes, 61-90 minutes, 91-120 minutes, 121-150 minutes, 151-180 minutes, 181-210 minutes, 211-240 minutes, ≥240 minutes</td>
<td>no specific classification is used to categorize the emergency cesarean delivery, but indications lead to emergency cesarean section categories 1 and 2</td>
<td>No</td>
<td>The mean (SD) DDI was 411 (291) minutes. 2.3% of the emergency cesarean section deliveries were due to an immediate threat to the life of the mothers who have babies with good Apgar scores, even though their DDIs were prolonged.</td>
</tr>
<tr>
<td>Kinsella S.M, et al., United Kingdom, 2021</td>
<td>405</td>
<td>A prospective study</td>
<td>≤30 minutes and &gt;30 minutes</td>
<td>category 1</td>
<td>No</td>
<td>Poor neonatal outcomes may occur if DDI is prolonged.</td>
</tr>
<tr>
<td>Shahwar DE et al., Pakistan, 2018</td>
<td>375</td>
<td>A retrospective study</td>
<td>&lt;30 minutes and &gt;30 minutes</td>
<td>category 1 and non-category (category 2 and 3)</td>
<td>-</td>
<td>There was no statistically significant association between different indications of emergency cesarean section and neonatal outcome.</td>
</tr>
<tr>
<td>*Pratama RE, et al., Indonesia, 2021</td>
<td>103</td>
<td>An observational analytic study with cross-sectional</td>
<td>&lt;30 minutes and &gt;30 minutes</td>
<td>category 1 and category 2</td>
<td>No</td>
<td>Response time of the cesarean section indicates a significant relationship between cesarean section response time and fetal outcome.</td>
</tr>
</tbody>
</table>
Table 1. Summary of Study Characteristics (cont’)

<table>
<thead>
<tr>
<th>Author, Year of Publish, Country</th>
<th>Sample Size of Emergency Cesarean Section</th>
<th>Setting of Studies</th>
<th>Response Time Emergency Cesarean Section</th>
<th>Type of Emergency Cesarean Section</th>
<th>DDI Achieved?</th>
<th>Maternal or Neonatal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hussain M, et al., Pakistan, 2020</td>
<td>300</td>
<td>A prospective study</td>
<td>&lt;30 minutes, &gt;30 minutes</td>
<td>category 1 and category 2</td>
<td>No</td>
<td>There was no significant difference between DDI and perinatal outcome.</td>
</tr>
<tr>
<td>Mishra N, et al., India, 2018</td>
<td>480</td>
<td>An observational study</td>
<td>&lt;30 minutes, 31-60 minutes, 61-90 minutes, 90-120 minutes, &gt;120 minutes</td>
<td>category 1 and category 2</td>
<td>No</td>
<td>The composite neonatal outcomes were not significantly increased up to DDI of 60 minutes for category 1 and up to 90 minutes for category 2 cesarean section.</td>
</tr>
<tr>
<td>Kitaw TM, et al., Ethiopia, 2021</td>
<td>327</td>
<td>A cross-sectional study</td>
<td>&lt;30 minutes</td>
<td>no specific classification is used to categorize the emergency cesarean delivery, but indications lead to emergency cesarean section categories 1 and 2</td>
<td>No</td>
<td>Decision-to-delivery intervals were not achieved within the recommended time intervals (within 30 minutes). DDI does not address the short-term and long-term effects on the feto-maternal.</td>
</tr>
<tr>
<td>Avidime AR, et al., Nigeria, 2020</td>
<td>333</td>
<td>A retrospective study</td>
<td>&lt;30 minutes</td>
<td>category 1</td>
<td>No</td>
<td>There was no significant association between the DDI and adverse perinatal outcomes, but a significant association was found between the indication for the crash cesarean section and adverse perinatal outcomes.</td>
</tr>
<tr>
<td>Author, Year of Publish, Country</td>
<td>Sample Size of Emergency Cesarean Section</td>
<td>Setting of Studies</td>
<td>Response Time Emergency Cesarean Section</td>
<td>Type of Emergency Cesarean Section</td>
<td>DDI Achieved?</td>
<td>Maternal or Neonatal Outcome</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------</td>
<td>-------------------</td>
<td>----------------------------------------</td>
<td>----------------------------------</td>
<td>-------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Ayele AD, et al., Ethiopia, 2021</td>
<td>510</td>
<td>A quantitative retrospective cross-sectional study</td>
<td>≤30 minutes and &gt;30 minutes</td>
<td>category 1</td>
<td>No</td>
<td>In most cases, delivery was not completed within the prescribed ≤30-minute interval. DDI has not shown a statistically significant impact on fetal outcomes.</td>
</tr>
<tr>
<td>Khemwрапонг K, et al., Thailand, 2018</td>
<td>431</td>
<td>A retrospective cohort study</td>
<td>≤30 minutes, 31-75 minutes, &gt;75 minutes</td>
<td>category 1 and category 2</td>
<td>Yes</td>
<td>DDI of ≤30 minutes was achieved in 4.9% of cases after five hours compared to only 0.7% during regular office hours (P=0.001), and DDI of &gt;75 minutes was also significantly lower (45.8% vs. 64.3%). No significant differences in perinatal outcomes between various DDI were observed in this study.</td>
</tr>
<tr>
<td>Khatoon F, et al., India, 2021</td>
<td>90</td>
<td>A prospective study</td>
<td>&lt;30 minutes, 30-75 minutes</td>
<td>category 1 and category 2</td>
<td>No</td>
<td>In the present study, achieving the 30-minute DDI for category 1 cesarean section was not feasible. The DDI of 30-75 minutes for category 2 could be achieved. There was no difference in perinatal outcome between the groups.</td>
</tr>
<tr>
<td>Author, Year of Publish, Country</td>
<td>Sample Size of Emergency Cesarean Section</td>
<td>Setting of Studies</td>
<td>Response Time Emergency Cesarean Section</td>
<td>Type of Emergency Cesarean Section</td>
<td>DDI Achieved?</td>
<td>Maternal or Neonatal Outcome</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------------------------</td>
<td>--------------------</td>
<td>------------------------------------------</td>
<td>-----------------------------------</td>
<td>--------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>Ayeni OM, et al., Nigeria, 2021</td>
<td>205</td>
<td>A prospective cross-sectional study</td>
<td>≤45 minutes, 46-60 minutes, 61-90 minutes, &gt;90 minutes</td>
<td>category 1 and category 2</td>
<td>No</td>
<td>The mean DDI was 233.99±132.61 minutes (range 44-725 minutes). Logistic regression revealed no statistically significant correlation between the DDI and adverse perinatal outcomes. Perinatal morbidity and mortality increased with DDI relative to the clinical urgency, but perinatal deaths increased with DDI greater than 90 minutes.</td>
</tr>
<tr>
<td>*Yeni CM, et al., Indonesia, 2021</td>
<td>19</td>
<td>A prospective cohort study</td>
<td>&lt;30 menit and &gt;30 menit</td>
<td>category 1</td>
<td>No</td>
<td>The average response time for SC emergency category 1 is 36.29±59 (28-50 minutes). Response time emergency cesarean section &lt;30 minutes significantly differs in maternal and perinatal outcomes.</td>
</tr>
<tr>
<td>Andisha E, et al. South Africa, 2019</td>
<td>153</td>
<td>A retrospective descriptive observational study</td>
<td>≤30 minutes</td>
<td>category 1</td>
<td>No</td>
<td>Only 1 in 20 parturients 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. There was no significant difference in the median DDI between neonates with a 5-minute Apgar ≥7 or 7.</td>
</tr>
</tbody>
</table>
### Table 1. Summary of Study Characteristics (cont’)

<table>
<thead>
<tr>
<th>Author, Year of Publish, Country</th>
<th>Sample Size of Emergency Cesarean Section</th>
<th>Setting of Studies</th>
<th>Response Time Emergency Cesarean Section</th>
<th>Type of Emergency Cesarean Section</th>
<th>DDI Achieved?</th>
<th>Maternal or Neonatal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brandt JA, et al., Germany, 2020</td>
<td>437</td>
<td>A retrospective study</td>
<td>≤20 minutes</td>
<td>category 1</td>
<td>Yes</td>
<td>Delivery within 20 min after the decision for ECS was achieved in the great majority (98.9%) of cases. With a mean DDI of 7.66 min (SD=4.389), it was also performed perspicuously faster than recommended. Duration of DD had no significant impact on the incidence of adverse neonatal outcomes.</td>
</tr>
<tr>
<td>Temesgen MM, et al., Ethiopia, 2020</td>
<td>163</td>
<td>A prospective observational cohort study</td>
<td>&lt;30 minutes, &gt;30 minutes</td>
<td>category 1</td>
<td>No</td>
<td>The recommended decision to a delivery time interval (DDI below 30 min) was achieved only in 32 (19.6%) of category-1 emergency C/S. The mean ± SD of DDI was 42 ± 21.4 min. Delivery was not achieved within the recommended time interval in most category-1 emergency cesarean sections. The average decision-to-delivery interval was more prolonged than recommended but did not affect feto-maternal outcomes.</td>
</tr>
</tbody>
</table>
Table 1. Summary of Study Characteristics (cont')

<table>
<thead>
<tr>
<th>Author, Year of Publish, Country</th>
<th>Sample Size of Emergency Cesarean Section</th>
<th>Setting of Studies</th>
<th>Response Time Emergency Cesarean Section</th>
<th>Type of Emergency Cesarean Section</th>
<th>DDI Achieved?</th>
<th>Maternal or Neonatal Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gunawan T, et al., Indonesia, 2018</td>
<td>155</td>
<td>A retrospective cohort study</td>
<td>30-90 minutes, 91-150 minutes, 151-210 minutes, 211-270 minutes, &gt;270 minutes</td>
<td>category 1</td>
<td>No</td>
<td>The average response time for category 1 emergency SC was 115±52 minutes (35-360 minutes), with the highest proportion of significant response times of 91-150 minutes (41.9%). In this study, response time category 1 emergency cesarean section did not affect perinatal outcomes.</td>
</tr>
<tr>
<td>Kotera A, Japan, 2022</td>
<td>6</td>
<td>A prospective study</td>
<td>&lt;30 minute</td>
<td>category 1</td>
<td>Yes</td>
<td>DDI was achieved within 30 minutes in all the patients, and the mortality of neonates might depend on gestational age.</td>
</tr>
</tbody>
</table>

Discussion

This systematic review identified 19 studies that found emergency cesarean section category 1 and 2 response times for maternal and neonatal outcomes. Most research standards, 30 minutes category 1 and 75 minutes category 2, were not achieved as recommended DDI emergency cesarean section. However, many factors influence the prolongation of the decision to delivery interval, so the other 16 studies have no significant value. This systematic review found that most of the response time did not affect maternal and neonatal outcomes. On the other hand, Jane Thomas et al. stated that a delay in DDI >75 minutes had a significant value and is associated with poor feto-maternal outcomes in category 1 emergency cesarean section (Thomas et al., 2004). In addition, other studies have shown that life-threatening conditions and faster delivery lead to better feto-maternal outcomes (Leung et al., 2013). Many newborns are born with DDI >30 minutes, but this finding is not statistically significant. These results are supported by previous studies, stating that a greater DDI is not associated with poor neonatal outcomes (Chow et al., 2016; Heller et al., 2017). Dunn et al. found that the average DDI was 9.4 minutes in emergency cesarean section category 1 but was not associated with increased neonatal outcomes (Dunn et al., 2016). In contrast, other studies also revealed significant results on feto-maternal outcomes when the DDI is <20 minutes (Hein et al., 2017).
Comparison of Achieved and Unachieved Outcomes

Maternal outcomes in emergency cesarean section <30 minutes had less bleeding, no postoperative fever symptoms, and the average postoperative hemoglobin was higher when compared to emergency cesarean section >30 minutes with the opposite value. In addition, emergency cesarean section <30 minutes did not require postoperative ICU care, did not require a hysterectomy, and there were no maternal deaths, whereas emergency cesarean section <30 minutes required postoperative ICU care, there was a hysterectomy, and there were maternal deaths. Neonatal outcomes in emergency cesarean section <30 minutes had normal APGAR scores, did not require CPAP breathing apparatus and intubation, did not require NICU care, no meconium aspiration, and no neonatal deaths, whereas emergency cesarean section >30 minutes had mild asphyxia events, moderate, to severe, requires CPAP breathing apparatus and intubation, requires NICU, have meconium aspiration, has neonatal death (Yeni et al., 2022).

If viewed in terms of the patient’s location, in the <30 minutes emergency cesarean section group, 5 patients each came from villages and cities, while in emergency cesarean sections >30 minutes, 5 patients came from villages, and 4 patients came from cities. Long distances to live, such as in a village, make access to a hospital with adequate facilities difficult to reach earlier, and the patient’s symptoms upon arrival are in severe condition. Another factor was the education status of the mother in the <30 minutes emergency cesarean section group consisting of 4 high school graduates and 6 strata 1 patient, whereas in the >30 minutes emergency cesarean section group, 8 high school graduates and only 1 stratum 1 patient, related to the lower the mother’s educational status, the worse the maternal and neonatal outcomes are. In addition, regarding patient work, in the emergency cesarean section <30 minutes, 4 patients were working, and 6 patients were not working, while in the emergency cesarean section >30 minutes, 9 patients were not working. Occupational status patients who are not working are more at risk of having an emergency cesarean section (Yeni et al., 2022).

Decision-to-Delivery Interval and Maternal-Neonatal Outcomes

According to the American College of Obstetricians and Gynecologists (ACOG) and National Institute of Clinical Excellence (NICE) 2011 guidelines, to improve all performance of obstetric units, the decision interval for delivery (DDI) and emergency cesarean section should not exceed 30 minutes for CS category 1 because the immediate threat to life woman or fetus and 75 minutes for CS category 2 because compromise of mother and fetus that is not necessarily life-threatening (ACOG, 1989; Thomas et al., 2004). Based on Table 1, most of the literature that has achieved DDI results does not have significant maternal and neonatal outcomes, so the relationship between DDI and outcomes is not directly proportional. Moreover, most studies showed that an emergency cesarean section response time of 30 minutes in category 1 and 75 minutes in category 2 did not affect maternal and neonatal outcomes.

How to Improve Decision-to-Delivery Interval (DDI) and Maternal-Neonatal Outcomes

There are several ways to achieve emergency cesarean section to improve. In clinical factors, such as reviewing patients multidiscipline when they arrive at the operating room,
having good communication in every team or different team, adequate human resources and competence, implementing multidiscipline protocols in section cesarean emergency, better staffing, workflow, and levels, and every healthcare stand by in hospital. In non-clinical factors, they quickly transfer patients to the operating room, give general anesthesia, and always follow up with pregnant women through antenatal care (ANC). Moreover, hospital factors are adequate operating room, surgical equipment, blood products, drugs, health insurance, and payment methods after surgery.

According to the research study by Bank CT et al., a more influential factor for increasing DDI and neonatal-maternal outcomes is developing and increasing the evidence base rather than shortening and speeding up the DDI time. The evidence-based form of improvement is improving strategies and educational simulations for fetal utero resuscitation, such as positional cord compression, maternal hypotension, prompt recognition and treatment of tachysystole, or other causes of fetal hypoxia, which can provide better neonatal outcomes than accelerated labor. In addition, for fetuses that still have a chance of recovery, close monitoring of vital signs and signs of well-being can be carried out during resuscitation. However, in cases of a fetus with complicated recoveries, such as in the event of uterine rupture, severe placental abruption, or umbilical cord prolapse, the fetus must be delivered right away using the preparation of an operating room, patient counseling, and mobilization of a delivery team regarding possible cesarean or operative vaginal delivery (Bank et al., 2023).

Another thing that can improve neonatal-outcome outcomes is to make clinical practice guidelines by professional organizations such as POGI so that there is an understanding of standardization in emergency cesarean section, making particular emergency criteria that are more specific in terms of signs and symptoms, time, neonatal management, outcome cardiotocography, ultrasound results, and also making emergency scoring.

Factors Contribute to Decision-to-Delivery Interval (DDI)

The study by Khemworapong et al. states that many factors play an essential role in achieving the 30-minute goal: operating room availability, patient transfer process, team communication, and the clinician’s perception of delivery urgency and obstetric care unit setting (Leung et al., 2013; Chauleur et al., 2009). This study divides the factors influencing prolonged DDI into non-clinical, clinical, and hospital factors.

A. Non-Clinical Factors

Healthcare Team

The study by Lucas et al. stated that the degree of urgency for cesarean section should be carried out when deciding on the type of delivery (Lucas et al., 2000). It should be reviewed by a multidisciplinary team when the patient arrives at the operating room (RCOG, 2010). Lucas et al. explained that good clinical practice is reviewing the patient’s clinical status and having good communication among each team member using standard terminology (RCOG, 2017). Research by Mishra et al. found that the average DDI for emergency cesarean section in their study was 65.87 minutes, influenced by differences in the number of resources such as doctors, nurses and paramedical staff; the workload was too heavy (Mishra et al., 2018). Fuhrmann and Weiner’s study states that to improve delivery times by implementing multidisciplinary protocols to deal with emergency cases, team training, better staffing,
workflow and levels, improving communication between different teams (Fuhrmann et al., 2015; Weiner et al., 2014). Research by Spencer et al. explains that waiting for the healthcare team (obstetrician, anesthetist, pediatrician, and theatre staff) is one of the reasons for delays in emergency cesarean section (Spencer et al., 2001). Melman et al. stated that the lack of experience of obstetricians, anesthetists and patients’ doubts about giving consent are obstacles to shortening DDI (Melman et al., 2017). Therefore, it is crucial to determine the type of labor based on the degree of urgency. Doctors, midwives, nurses, paramedics, and theatre staff, as a unit of a multidisciplinary team, must arrive on time at the operating room, be competent and adequate, and have the proper emergency cesarean section health protocol because they can achieve the DDI target.

**Anesthesia**

Temesgen MM et al. found that the average time to deliver anesthesia to patients after the anesthetist arrived at the operating room was 11.5 ± 3.6 minutes (Nakintu et al., 2016). In a retrospective cohort study, the University of Benin stated that the most common causes of emergency cesarean section were delayed anesthetists and an operating room that was busy or unavailable (Chukwudi et al., 2014). In that study, Onah et al. said that most patients (90.2%) were operated on with spinal anesthesia. These results are the same as the previous study of 97.2% emergency cesarean section category 1 with spinal anesthesia (Onah et al., 2005). Wong et al. stated that 16 patients with general anesthesia achieved a DDI of <30 minutes by 37.5% (Wong et al., 2017). Mackenzie IZ et al. showed that general anesthesia had a significant and associated DDI is smaller than regional anesthesia in emergency cesarean section (MacKenzie et al., 2002). The incident of the anesthesiologist upon arrival at the operating room and the administration of rapid anesthesia and general anesthesia can shorten and achieve the DDI target.

**B. Clinical Factor**

**Mother’s condition**

According to Temesgen MM et al., the average time to deliver anesthesia to patients after the anesthetist arrived at the operating room was 11.5 ± 3.6 minutes (Nakintu et al., 2016). In a retrospective cohort study, the University of Benin stated that the most common causes of emergency cesarean section were delayed anesthetists and an operating room that was busy or unavailable (Chukwudi et al., 2014). In that study, Onah et al. said that most patients (90.2%) were operated on with spinal anesthesia. These results are the same as the previous study of 97.2% emergency cesarean section category 1 with spinal anesthesia (Onah et al., 2005). Wong’s study et al. stated that 16 patients with general anesthesia achieved a DDI of <30 minutes by 37.5% (Wong et al., 2017). A prospective study by Mackenzie IZ et al. stated that general anesthesia had a significant and associated DDI was smaller than regional anesthesia in emergency cesarean section (MacKenzie et al., 2002). The incident of the anesthesiologist upon arrival at the operating room and the administration of rapid anesthesia and general anesthesia can shorten and achieve the DDI target.
C. Hospital Factors  
Operating Room and Infrastructure

Temesgen MM et al. research stated that the time to collect surgical equipment was significantly valuable and was associated with prolonged DDI in emergency cesarean section category 1 (Temesgen et al., 2020). These results are consistent with the study of Tak Yeung Leung et al., finding that DDI <30 minutes is achieved if operating facilities are readily available (Leung et al., 2013). Other studies have explained that the unavailability of surgical equipment is a significant factor in DDI prolongation time (Melmann et al., 2017). Due to infrastructure constraints, Onah et al. stated that DDI <30 minutes is difficult to achieve in an emergency cesarean section (Onah et al., 2005).

Radhika K et al. stated that 51% of the main factors for prolonging DDI for emergency cesarean section in category 1 were the preparation of the operating room table during surgery (40%) and 46.15% were due to delays in arranging for cross-matched blood products in patients with placenta previa, placental abruption, or in patients requiring blood transfusions for severe anemia, fever, hypotension, DIC and patients requiring resuscitation. Similarly, Gita et al. revealed that 72% of DDI lengthening for emergency cesarean section categories 1 and 2 was due to the unavailability of an operating room (Gohou et al., 2004). In emergency cesarean section category 2, the main factor was the delay in waiting for arranged drugs, which is 47.56% (Radhika et al., 2021).

Inyang-Etoh et al. showed institutional and regional variations; that is, services in some facilities can subsidize and allow payment on discharge, while others require payment before treatment (Inyang-Etoh et al., 2010). In addition, there is a need to purchase surgical equipment (Chukwudi et al., 2014; Gohou et al., 2004). Preparation of surgical instruments, adequate and available facilities, and availability of blood products for transfusion and medicines have made the DDI achievement targets achievable.

Patient Transport

Wong et al. stated that the significant factor determining prolonged DDI is transferring the patient to the operating room (Wong et al., 2017). Other studies also found that the preparation and transfer of patients to the operating room had a significant value causing the DDI to lengthen with an average value average 15.9 minutes (Chow et al., 2015). Sayegh study et al. reported that the main factor for the delay was when transferring patients to the operating room (Sayegh et al., 2004). Patient preparation and transfer affect DDI timing.

Limitations of Study

This study is a qualitative study, which may limit its validity. This study only has 19 studies collected with varying sample ranges. All studies, on average, came from developing countries, and even so, the variables assessed are the same as those assessed in research in developed countries. There is bias because the categories and criteria for the emergency cesarean section can vary and may differ from one study to another.

CONCLUSION

This study found no relation between the decision-to-delivery interval and maternal-neonatal outcomes. The solution to improving maternal outcomes is identifying maternal
comorbidities during antenatal care, ensuring a smooth flow of referrals for handling risky deliveries in hospitals with more comprehensive facilities (hospital type A or type B). To enhance neonatal outcomes, it is crucial to standardize category 1 or category 2 criteria and provide neonatal resuscitation team training for pediatricians, general practitioners, and midwives to ensure their competence. Additionally, hospitals must have adequate resuscitation equipment, including NICU facilities such as incubators.

Given the complexity and multidisciplinary approach required to achieve DDI and, consequently, improved maternal and fetal outcomes, collaboration among the government, in this case, the Ministry of Health, professional organizations (POGI, IDAI, Perdatin, HIPKABI, IPAI, IDI, and IBI), and hospital management associations, is essential. Hopefully, this collaboration will lead to the development of guidelines and training programs regarding emergency cesarean section deliveries.

REFERENCES


