Infant's safety in cesarean section surgery: a meta-synthesis

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Research article

Keywords: Infants, Cesarean Section Surgery, Safety

Posted Date: August 11th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-39983/v2>

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Abstract

Background: Patient safety is the most important clinical priority, especially in high-risk groups such as infants. Neonatal safety after a C-section is more challenging because despite all efforts and guidelines, patient safety is still a major challenge in the operating room. This meta-synthesis study aimed to investigate the factors affecting neonatal safety during a C-section and to provide improved strategies.

Methods: This systematic review was carried out through meta-synthesis. A total of 112 articles were found and finally, 37 articles were selected for research after review. The articles were first reviewed by title and abstract and those which met the inclusion criteria were entered into the study. The inclusion criteria were papers in English and Persian, relevance to neonatal safety and being published before 2019. Exclusion criteria were papers that were not relevant to safety or neonate. In the next step, the quality of the articles was reviewed simultaneously by two separate researchers using the Strengthening the Reporting of Observational studies in Epidemiology "STROBE" and consolidated standards of reporting trials "CONSORT" Review Guidelines. Data were analyzed using content analysis.

Results: The most important risk factors of neonatal safety during a C-section included anemia due to early cord clamping, jaundice due to delayed cord clamping, nosocomial infection, hypothermia and hyperthermia, inappropriate positioning of the infant, fall, medication error, operative damage and error in registering infants identity.

Conclusion: For improvement of neonatal safety during C-section, it is important to consider teamwork, team and interdisciplinary continuous training through simulation, accurate identification of mothers and accurate registration of mothers and infants' identity on the identification band, accurate medication and right dosage, safely carrying and sleeping, observing infection control tips, maintaining operating room temperature and humidity, cord clamping after 30 seconds before birth and 2 minutes after birth.

Background

Patient safety and reduced unwanted side effects are the most important clinical priority [1], especially in high-risk groups such as infants. Adverse events may occur unintentionally during medical procedures [2]. Today, finding a way to prevent and ensure care recipients' safety has been emphasized [3]. Adverse events such as Nosocomial infection affects nearly 1 in 6 infants, doubling the risk of mortality, lengthening the hospital stay and readmission [4]. The rate of death from medical errors exceeds death following accidents and cancer [5].

According to studies, medical errors occur in 1.2% to 1.4% of hospitalized neonates [3], Medical Errors are eight times more likely to occur in neonates as compared with adults [6], the prevalence rate of iatrogenic events in them was 18.0 per 100 hospitalized days and 7.9% of the incidence was classified as life threatening and 45.1% as harmful [7], and relative physiological immaturity in neonates caused that they have less capacity in being able to defense unintended consequences of errors [8], indicating the

importance of further studies in promoting neonatal safety in C section surgery [5, 9]; unfortunately, there are few studies conducted in this regard [3]. Neonatal safety is associated with more challenges at birth by C-section because, despite all efforts and guidelines, patient safety is still a major challenge in the operating room [10], emphasizing further studies for safety promotion [11]. In addition, infant care is of high concern at birth [4]. High stress at work by healthcare worker, specialized equipment, and surgical sensitivity are factors that increase the likelihood of unintended events [5, 10]. Given the neonatal conditions during C-section such as fetal bradycardia, fetal distress or other emergency condition, safety threatening factors may lead to unwanted complications in neonates or even in the process of their development such as hypoxia, anemia [9], [10] and encephalopathy [12], which exacerbates safety challenges during C-section leading to critical complications [12] such as fall [13], hypothermia [12], wrong patient, wrong drug and wrong drug dose [14] that could result in encephalopathy and even infant death [12]. Therefore, improving safety in the operating room and during recovery should be considered [15]. In this regard, this meta-synthesis study aimed to investigate factors affecting neonatal safety during C-section and to provide improvement strategies.

Methods

Study design: This systematic review was carried out through a comparative approach and systematic review with meta-synthesis method. This method was used for obtaining comprehensive information and intergrade knowledge [16, 17].

Setting: An adapted strategy according to the University of York, Center for Reviews and Dissemination Guidance was used to perform this meta-synthesis study [18].

Sampling: The objective of the present study was to obtain information about infants' safety during C-section via systematic review with meta-synthesis method. According to the objective, the primary general question was to find factors affecting neonatal safety; to this aim, the keywords of neonatal safety in the operating room, infants, and neonatal risks in C-section were searched in ProQuest, Science Direct, Ovid, and PubMed databases. Inclusion criteria were articles in English and Persian, relevance to neonatal safety, and being published between 2000 and 2019.

Data Collection: A total of 112 articles were found which reduced to 97 after excluding duplicate articles. Then the abstract of the selected articles were reviewed for compliance with the inclusion and exclusion criteria and were analyzed using the STROBE (Strengthening the Reporting of Observational studies in Epidemiology) and CONSORT (consolidated standards of reporting trials) Review Guidelines. In this stage 19 articles were removed because of Finally, 37 articles were selected for research. Figure 1 illustrates the article selection process. In the review phase of the study [17, 19], two separate researchers simultaneously reviewed the articles using the mentioned instruments and articles found appropriate by both researchers were included in the study.

Data analysis: Data were analyzed using thematic analysis. The research audit method was used to improve data accuracy, and data were analyzed simultaneously by two researchers. They were also

combined and confirmed by two researchers [17, 19].

Results

The most important risk factors for neonatal safety during C-section included anemia due to early cord clamping, jaundice due to delayed cord clamping, nosocomial infection, hypothermia and hyperthermia, fall, safe sleep, medication error, perioperative damage, and error in registering infants' identity. Table 1 shows the articles used for extraction of the risk factors for neonatal safety during C-section.

Table 1: The list of articles used for extraction of the risk factors for neonatal safety during C-section

risk factors for neonatal safety	Articles
anemia due to early cord clamping	[17-32]
jaundice due to delayed cord clamping	[22, 25, 33]
nosocomial infection	[3, 34-38]
hypothermia and hyperthermia	[9, 39, 40]
Fall	[9, 10]
safe sleep	[9, 41-44]
medication error	[3, 45]
perioperative damage	[3]
error in registering infants' identity	[8, 46]

Discussion

Timely Cord Clamping

Early cord clamping (prior to 30 seconds before birth) has been discouraged in the last decade, instead, the umbilical cord is recommended to be clamped in the first 60 to 180 seconds after birth and preferably before the first 2 minutes of life [20]. Delayed cord clamping (after the cord still has a pulse) is about 3 minutes [21] and delayed cord clamping for 2-3 minutes increases neonatal blood by 30-40% or 25-30 mL/kg. With the onset of physiological hemolysis, iron is stored in the infant's body, which is sufficient for at least 3-11 months [22].

Although delayed cord clamping is effective in infants' health and reduces their mortality, prolonged delay may result in polycythemia [23] and hyperbilirubinemia [23, 24]. It should be noted that hyperbilirubinemia requiring phototherapy and polycythemia are not significant when the umbilical cord is clamped during the first 180 seconds after birth and may lead to complications such as hyperbilirubinemia and [neonatal icterus](#) if it is clamped up to 3 minutes and more [25]. Therefore, the best cord clamping time is reported

to be between 30 seconds to 2 minutes after birth. Cord clamping between 30 second and 2 min allows for most of the blood transfer from the placenta to the infant.

Infection Control Practices

Nosocomial infections are common adverse events that can have irreparable consequences for care recipients in the operating room [3, 26]. Infants are more vulnerable to infection and hence much care should be taken to prevent infection transmission [27], and infection control standards should be strictly observed [28, 29]. This is especially important in premature infants with low birth weight [27, 29, 30].

Adequate Operating Room Temperature and Humidity

Hypothermia can cause cardiac arrhythmias and cardiovascular collapse in infants [31], and it can lead to dehydration or even burns [32, 33]. Hypothermia can result in cerebral hypoxia and encephalopathy and even infant death [12]. The WHO recommends a room temperature of 24-26 °C that can reduce cold stress in infants [34]. It has been emphasized that infants should be dried and their back should be covered to prevent hypothermia during skin to skin contact [12]. On the other hand, hyperthermia and placing infants in front of a high temperature source with no control may lead to their dehydration or even burns [32, 33]. Adequate Operating Room Temperature is essential for prevention of hypothermia and hyperthermia in infants during C-section surgery [35].

Fall

Falls can cause irreparable injuries and even death due to brain hemorrhage [13]. Infants should be transported in special beds with safety bed rails, and when they are carried in the arms by everyone, such as nurse or parent, their head and neck should be securely supported and their body should be firmly attached to the nurse or parent body to minimize the risk of falling. Education on proper carrying of an infant should be taught to parents, family members, and all caregivers of the infant. Skin to skin contact (SSC) should not be performed when the mother is unconscious or sleepy and infants should be placed in their bed; in case of SSC, infants should be fully supported by the nurse or another person and be watched at all times [12].

Safe Sleep

Safe position results in hemodynamic, physiological and neurological stability in neonates [36]. Inappropriate positioning and improper sleeping can lead to irreparable injuries; therefore, correct sleeping position of infants has been emphasized [37]. Infants should preferably be in the supine position on firm and secure beds with non-saggy mattress without a pillow. Unprotected and unsuitable beds should not be used [38]. Under special conditions, infants can be positioned in lateral or prone positions. Their neck should be supported and their body should be aligned [36]. In the prone position, food remains less in the stomach and it is suggested to place infants in the prone position in the first half hour after feeding [39].

However, it is emphasized that infants should not be in the prone position when sleeping because this increases the incidence of sudden death during sleep [38]. During SSC, infants should be positioned safely while their shoulder and chest are in front of the mother's face, their head should be properly positioned and turned to one side, their face should be visible all the time, their nose and mouth should be uncovered, and their legs should be slightly flexed [12].

Medication Error

The choice of medication and the right dosage of medication are significantly important in infants [40]. Medication error and wrong dosage and infusion are preventable adverse events [3]. In order to avoid the possibility of errors in stressful conditions during neonatal surgeries and C-section, updating the knowledge of medication selection and right dosage by physicians [40], employing experienced and committed staff [4, 41], continuous group training [42] and interdisciplinary training [13] through simulation [5] are necessary, and the staff should be prepared for real situations in high-risk infants requiring mechanical resuscitation and ventilation [5]. Other considerations for reducing the possibility of medication error include the use of intact equipment [14].

Perioperative Injuries in Infants

The possibility of perioperative injuries, such as unwanted incisions during opening of the uterus [3], can be reduced through teamwork [43, 44], employing experienced and dedicated staff [4, 41], continuous team training [42] as well as interdisciplinary training [13] through simulation [5], and using proper and intact equipment and checking equipment before use to ensure their proper functioning [14].

Error in Registering Infants' Identity

Error in registering infants' identity should be a never event. Stavroudis, Miller et al (2008) reported that 11% of NICU errors involved misidentification [14]. Patient misidentification can occur among neonates given the high rate of multiple births and the practice of using "BB" (baby boy) or "BG" (baby girl) instead of her or his mother name. With correct registration of the mother and infant identities on the newborn identification band and using safe surgical checklist could prevent infants' misidentification and a decrease in medication errors [11, 45].

Implications for Practice

Neonates are at further risk for harm from medication errors because of inability to communicate with providers; and changing developmental systems affecting drug absorption, distribution, metabolism, and excretion. So for improvement in infant's safety during C-section, it is important that teamwork and additional measures such as operating interdisciplinary training through simulation and employing experienced and committed staff for prevention of nosocomial infection and Perioperative Injuries. Safety measures such as consider cord time clamping to decrease hyperbilirubinemia and anemia. Additional measures such as operating room temperature for prevention hyperthermia and hypothermia

as well as neonatal transport, safe sleep and caregiver education for prevention of falls and sudden death. Error in registering infants' identity should be a never event for prevention of medication error.

Conclusion

The most important risk factors for neonatal safety during C-section included anemia due to early cord clamping, jaundice due to delayed cord clamping, nosocomial infection, hypothermia and hyperthermia, fall, safe sleep, medication error, perioperative damage, and error in registering infants' identity. The most important measures to improve neonatal safety during C-section identified in the meta-synthesis review were accurate identification of mothers and accurate registration of mothers and infants' identity on the identification band, accurate medication and right dosage, safely carrying and sleeping of the infant, observing infection control tips, maintaining operating room temperature and humidity, cord clamping after 30 seconds before birth and 2 minutes after birth. The safety of infants during and after a C-section is of utmost importance. By implementing the measures found in the meta-synthesis it could improve the quality and safety of infants and mothers and decrease readmission rates, reduce hospital stay and mortality in neonates and provide a steppingstone toward a healthy infant development.

Abbreviations

C-section: cesarean section

SSC: skin to skin contact

Declarations

- **Ethics approval and Consent to participate**

“Not applicable” Because our manuscript does not contain any individual person's data.

- **Consent to publish**

“Not applicable” Because our manuscript does not contain any individual person's data.

- **Availability of data and materials**

“Not applicable” Because our manuscript does not contain any individual person's data.

- **Competing interest**

All of authors read and approved the final version of the manuscript and declare that they have no competing interests.

- **Funding**

We did not receive external funding for this research.

- **Limitation of the study**

We have not any limitation.

- **Authors' Contributions**

- All authors (R G, M Y and S K) formulate the research question that represents the systematic review objective.
- R G: Selecting studies, Selecting studies based on inclusion criteria, and evaluating the quality of selected studies and audit them (simultaneously and separately S K). Extracting textual data and analysis (thematic analysis), and thematic analysis (simultaneously and separately M Y) and Combining textual data.
- S K: Selecting studies, Selecting studies based on inclusion criteria, and Evaluating the quality of selected studies (simultaneously and separately R G).
- M Y: Audit trial of thematic analysis and Combining textual data (simultaneously and separately R G).

Acknowledgements

“Not applicable”

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Figures

Figure 1

article selection process