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ACTA PÆDIATRICA NURTURING THE CHILD WILEY

REVIEW ARTICLE

Stabilisation and resuscitation with intact cord circulation is feasible using a wide variety of approaches; a scoping review

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Abstract

Aim: This scoping review identified studies on approaches to intact cord resuscitation and/or stabilisation (ICR/S) for neonates delivered by Caesarean section (C-section).

Methods: A systematic literature search was carried out using the PubMed, Web of Science, Scopus, Cochrane and CINAHL databases to identify papers published in English from inception to 14 November 2022.

Results: We assessed 2613 studies and included 18 from 10 countries, covering 1–125 C-sections: the United States, the United Kingdom, Australia, India, Italy, China, France, The Netherlands, New Zealand and Taiwan. The papers were published from 2014 to 2023, and the majority were randomised controlled trials and observational studies. Different platforms, equipment and staff positions in relation to the operating table were described. Options for resuscitation and stabilisation included different bedding and trolley approaches, and maintaining aseptic conditions was mainly addressed by the neonatal team scrubbing in. Hypothermia was prevented by using warm surfaces, polythene bags and radiant heaters. Equipment was kept easily accessible by mounting it on a trolley or a separate mobile pole.

Conclusion: We could not reach definitive conclusions on the optimal method for performing ICR/S during a C-section, due to study variations. However, a number of equipment and management options appeared to be feasible approaches.

KEYWORDS
caesarean section, cord clamping, neonatal resuscitation, neonatal stabilisation, preterm infants, scoping review

Abbreviations: C-section, caesarean section; ICR/S, intact cord resuscitation and/or stabilisation; PRISMA, Preferred Reporting Items for Systematic reviews and Meta-Analyses.

1 | BACKGROUND

Extensive evidence supports delayed cord clamping after birth. It has been shown to provide multiple benefits for term neonates, such as reduced neonatal anaemia, improved iron status and positive effects on long-term neurodevelopment.[1] Furthermore, the placental transfusion provides additional benefits as it promotes physiological postpartum adaptation through improved respiratory and haemodynamic stability.[2–4] Positive effects of delayed cord clamping have also been shown in several studies of preterm neonates, namely a consistent reduction in the mortality rate of approximately 30%.[5,6] Evidence of the effects on other complications, such as severe intraventricular haemorrhages and necrotising enterocolitis, has been more diverse.[5–7]

The European Resuscitation Council Guidelines issued in 2021 now recommend delayed cord clamping when feasible.[8] On a global level, up to 10% of neonates require interventions to facilitate their transition after birth, while 1% need more extensive resuscitation to stabilise them.[9] It has been hypothesised that delayed cord clamping is even more important for neonates who require resuscitative efforts after birth than for vigorous neonates.[10] Feasibility studies of intact cord resuscitation and/or stabilisation (ICR/S) of preterm and term neonates have shown promising results. There are ongoing clinical trials that are exploring strategies for optimising cardiopulmonary resuscitation during delayed cord clamping.[11–14]

Some logistical issues need to be addressed in order to provide ICR/S. In the first instance, it is crucial to have a mobile bed or trolley readily available near the mother during the resuscitation process. Resuscitation tools are also vital, including positive pressure ventilation and supplemental oxygen, temperature support and monitoring equipment. Guidelines and training are also needed to ensure that the approach is accepted by professional teams.[8,9]

Providing ICR/S after a Caesarean section (C-section) is of concern. Data from 169 countries, representing 98.4% of global births, has showed the C-sections nearly doubled between 2000 and 2015, to reach 29.7 million per year. The use of C-sections varies from region to region, and higher rates have been observed among wealthier quintiles, educated women and in private healthcare facilities.[15]

Clinicians face further challenges when they introduce ICR/S into operating theatres, where the integrity of the sterile field needs to be maintained. At least some of the neonatal resuscitation team and equipment need to be within the sterile field without interrupting the work of the obstetric team. Multidisciplinary collaboration is needed in this area to determine optimal and acceptable approaches for clinicians and parents alike.

Some clinical settings are now introducing ICR/S after vaginal births as well as C-sections as a result of the known and hypothesised beneficial effects. There are clearly challenges to doing this after C-sections, as discussed above. Our research has identified a knowledge gap regarding the optimal care of neonates who need resuscitation after a C-section, while medical, hygienic and logistical considerations are also taken into account.

Key notes

- This scoping review explored the management of intact cord circulation at stabilisation and resuscitation during Caesarean sections.
- Options for resuscitation and stabilisation included different bedding and trolley approaches and maintaining aseptic conditions was mainly addressed by the neonatal team scrubbing in.
- Hypothermia was prevented by using warm surfaces, polythene bags and radiant heaters and equipment was kept easily accessible by mounting it on the trolley or a separate mobile pole.

The aim of this study was to synthesise the existing literature regarding the management of and procedures for providing ICR/S in neonates during a C-section.

2 | METHODS

A scoping review was undertaken to comprehensively analyse pertinent literature, following the methodology proposed by Peters et al. This involved formulating a research question, identifying suitable studies, selecting relevant studies, extracting data, summarising findings and reporting outcomes.[16]

We identified literature that described practical approaches for managing ICR/S in neonates born by C-section. This included the equipment used for monitoring and performing resuscitation and placing the neonate on bedding or trolleys. It also covered where the healthcare professionals involved in stabilising the infant were positioned in relation to the operating table and how they managed the resuscitation procedure.

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) extension for Scoping Reviews checklist was used to guide the writing of this paper.[17]

2.1 | Study characteristics

Study characteristics were identified using the Patient/Problem, Intervention, Comparison and Outcome framework.[18] We included studies on neonates born by C-sections where resuscitation or stabilisation was performed with an intact cord.

2.2 | Eligibility criteria

The search focused on peer-reviewed papers published in English from inception until 14 November 2022. Original studies and case reports, were included. We excluded study protocols, systematic

reviews, non-systematic reviews, conference abstracts, unpublished papers and papers that had not been peer reviewed.

2.3 | Information sources

We consulted a librarian from Lund University to develop and implement an effective search strategy. The librarian then conducted the search across the following databases to identify relevant publications: PubMed, the interdisciplinary Web of Science database, Scopus and the Cochrane database, which includes meta-analyses and systematic reviews. We also included the Cumulative Index to Nursing and Allied Health Literature (CINAHL) as this covers literature on nursing, physical therapy, occupational therapy, speech and language pathology and biomedicine. The initial search of all the databases was carried out on 29 March 2022. This was complemented by an updated PubMed search on 14 November 2022.

2.4 | Search strategy

There were no restrictions regarding the date or geographical location of the studies in the search strategy. The following keywords were used to search the databases: umbilical cord, cord clamping, intact cord, immediate neonatal care, resuscitation, stabilisation, cord cutting, ventilation, neonate, newborn, preterm, caesarean/cesarean, post-caesarean/cesarean and caesarean/cesarean section. A complete list of the search algorithms used for each database is presented in Appendix S1.

2.5 | Study selection and data charting process

Studies that included ICR/S and C-sections were considered relevant and included. The abstracts were imported into the Covidence platform (Covidence). Covidence is an online review management tool that was developed to facilitate the systematic screening, data abstraction and quality assessment of papers for literature reviews. Titles and abstracts of articles were screened by the review group, which comprised all of the authors of this scoping review. Each abstract was screened independently and randomly by two of the authors in the review group, who were blinded each other's results. The abstracts were categorised as relevant or not relevant. Any conflicts between the two reviewers were resolved by a third reviewer, who was blinded to the screening results. Full-text review and data extraction were performed by two independent reviewers for each of the 18 papers in the study. The authors developed a piloted data extraction form, which was used for data collection (Appendix S2).

2.6 | Synthesis of results

The review group exported the data from Covidence as a comma-separated values CSV file into SPSS, version 27 (IBM Corp) where data were analysed. The tables were structured in Microsoft Excel for Mac, version 2021 (Microsoft Corp) to describe the details of the included studies.

3 | RESULTS

3.1 | Database search

The research team identified 2613 studies, removed 38 duplicates and screened the titles and abstracts of 2575 studies based on the eligibility criteria. We decided that 2502 studies were irrelevant to this scoping review, and they were excluded. The remaining 73 studies were assessed for full-text eligibility, and 55 of these were excluded, leaving 18 studies in this scoping review. The reasons for excluding the papers are shown in the PRISMA flow diagram (Figure 1).

3.2 | Characteristics of the included studies

The 18 studies were published in journal issues between 2014 and 2023. However, some papers appeared online before their formal publication date, and that is how we included them in our review up to 14 November 2022.[12–14,19–33] We searched for all papers published since the inception of the databases we used, but the two earliest articles identified in this scoping review were published in 2014. The studies were all quantitative, peer-reviewed, single-country studies, which were published in English and conducted in 10 different countries. There were four studies from the United States, three from the United Kingdom, two each from Australia, India and Italy and one each from China, France, the Netherlands, New Zealand and Taiwan. Seven studies were randomised controlled trials,[12,13,19–23] one was a quality improvement/method development study,[24] seven were observational studies[14,25–30] and three were case reports[31–33] (Table 1).

3.3 | Characteristics of the included neonates

The 18 studies covered 1089 C-sections, and the number in each study ranged from 1 to 125. Three studies only included neonates born by C-section,[28] while the other 15 studies comprised a combination of vaginal births and C-sections. Only the results related to the C-section deliveries were retrieved and included in this scoping review. Eight studies only included neonates born at ≤31 + 6 weeks/days of gestation,[12,13,19,21,22,26,27,32] seven studies covered those born at >32 + 0 weeks/days,[20,23,25,28,30,31,33] and three studies focused on those born at 23–41 weeks.[14,24,29] A total of 395/823 (48%) neonates received ICR/S during a C-section in those three age ranges: 207, 112 and 76, respectively (Table 1). The neonates weighed between 470 and 4080 grams in the 16 studies that reported birth weight.

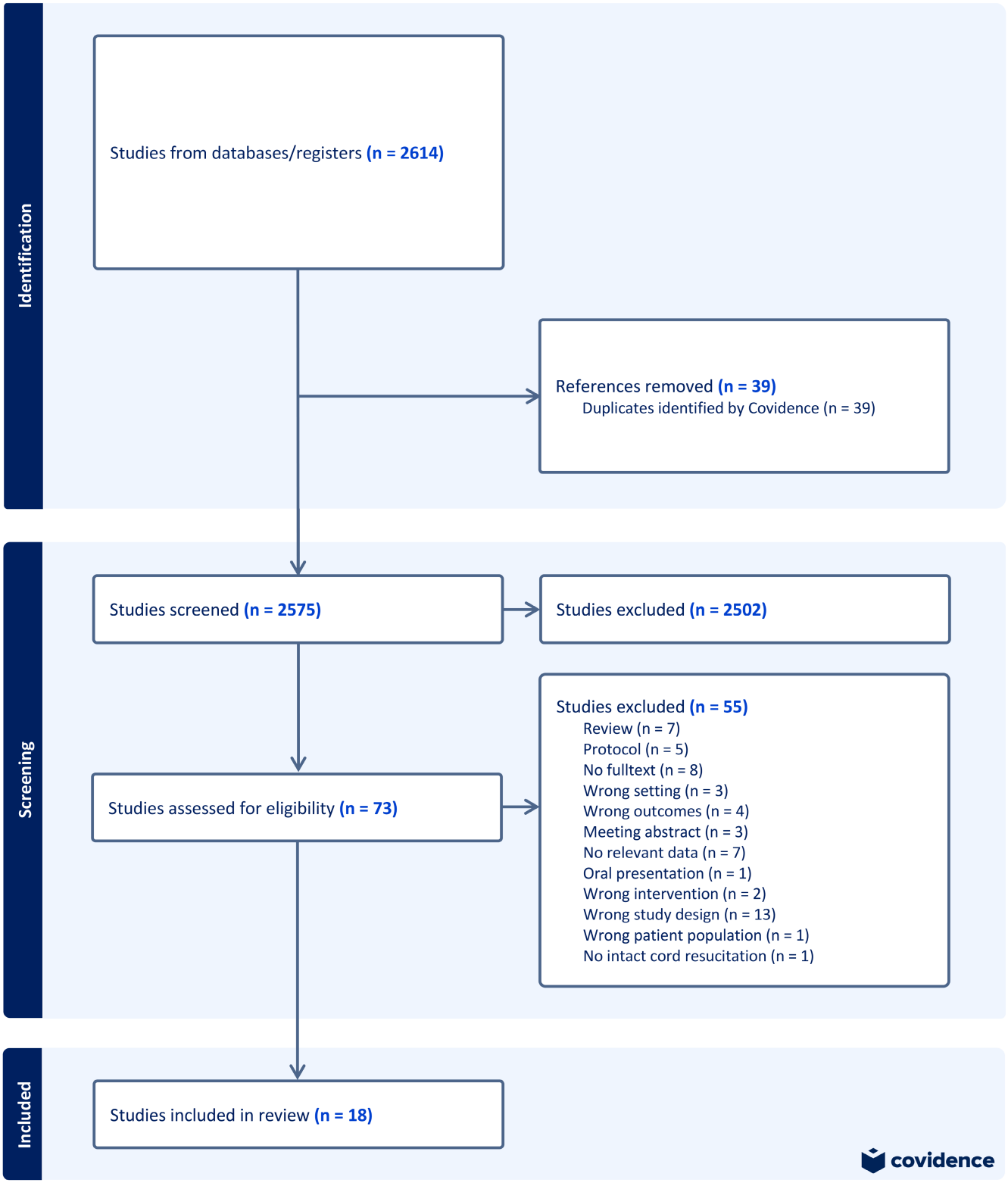

FIGURE 1 PRISMA flow chart.

3.4 | Platforms used

Different platforms were used to perform ICR/S on neonates born by C-section. We found that 164 neonates in five studies were stabilised or resuscitated on commercially available Lifestart trolleys (Inspiration Healthcare),[19,21,24,27,33] while 134 neonates in seven studies were placed on bedding, such as mattresses, drapes or towels.[13,14,20,22,26,30,31] Five papers reported that they used locally developed and assembled trolleys for a total of 88 neonates.[23,25,28,29,32] The commercial Concord trolley (Concord

TABLE 1 Characteristics of included studies.

Author, year	Country	Journal	Study design	Aim	Prospective/retrospective	Mode of birth
Pivetti, 2014[31]	Italy	J Neonatal Perinatal Med	Case report/series	Management of congenital birth defects	Prospective	Only CS
Thomas, 2014[24]	UK	BMC Pediatr	Method development study	Feasibility	Prospective	Both vag and CS
Katheria, 2016[19]	United States	J Pediatr	RCT	Physiologic	Prospective	Both vag and CS
Hung, 2017[32]	Taiwan	Taiwan J Obstet Gynecol	Case report/series	Physiologic	Retrospective	Only CS
Lefebvre, 2017[25]	France	Resuscitation	Observation case–control	Feasibility	Prospective	Both vag and CS
Winter, 2017[14]	United States	Am J Perinatol	Observation unspecified	Feasibility	Prospective	Both vag and CS
Blank, 2018[20]	Australia	Resuscitation	Observation case–control	Feasibility	Prospective	Both vag and CS
Pratesi, 2018[21]	Italy	Front Pediatr	RCT	Feasibility	Prospective	Both vag and CS
Bates, 2019[26]	UK	Eur J Obstet Gynecol Reprod biol	Observation unspecified	Feasibility	Retrospective	Both vag and CS
Foglia, 2020[33]	United States	Arch Dis Child Foetal Neonatal Ed	Case report/series	Management of congenital birth defects	Prospective	Both vag and CS
Hoyle, 2020[27]	UK	Arch Dis Child Foetal Neonatal Ed	Observation unspecified	Feasibility	Prospective	Both vag and CS
Knol, 2020[12]	Netherlands	Front Pediatr	RCT	Physiologic	Prospective	Both vag and CS
Joshi, 2021[28]	United States	Children	Observation unspecified	Feasibility	Prospective	Only CS
UshaDevi, 2021[29]	India	J Perinatol	Observation unspecified	Feasibility	Prospective	Both vag and CS
Badurdeen, 2022[30]	Australia	PLOS Med	RCT	Physiologic	Prospective	Both vag and CS
Deng 2022[22]	China	Front Pediatr	RCT	Physiologic	Prospective	Both vag and CS
Nevill 2023[13]	New Zealand	J Pediatr	RCT	Physiologic	Prospective	Both vag and CS
Raina 2023[23]	India	J Pediatr	RCT	Physiologic	Prospective	Both vag and CS

Abbreviations: CS, caesarean section; RCT, randomised control trial; vag, vaginal.

Neonatal B.V.) was used for nine neonates in one study[12] (Table 2). Some form of bedding was described in six of the seven studies where ICR/S was performed on the mothers´ thighs.[13,14,20,26,30,31] In the 11 studies that used a trolley, the platform was positioned alongside the table in the operating theatre in eight studies[19,21,23–25,27,29,33] and above the mother in two studies.[28,32] In the eleventh case, there was no data on position.

3.5 | Where healthcare professionals were positioned

Most papers did provide clear descriptions of the position of the professionals around the operating theatre table, including the neonatal team. Some papers described the neonatal team being positioned alongside the mothers' thighs, seven papers included a figure or photo of their set-up[12,14,21,26,28,29,33] and three referred to supplementary videos.[20,27,30]

3.6 | Sterility

Nine studies said that the neonatal teams were scrubbed in References.[13,14,19,20,22,23,26,30,33] A total of 14 studies said the platform was wrapped in sterile drapes, but four studies did not provide specific information on the sterility of the platform.[12,22,25,31] Three studies described the resuscitation equipment as clean but not sterile,[22,26,33] and two studies said that the resuscitation equipment, including the mask and electrocardiogram, were actively sterilised.[20,30] The remaining studies did not describe the monitoring equipment, T-piece and masks as sterile.

3.7 | Equipment to support breathing and monitor neonates

Respiratory support was provided by a T-piece and mask in 11 studies, intubation in three and nasal continuous positive airway pressure in one. No information was provided in the other three (Table 2). The authors of one study stated they provided standard postnatal respiratory management and did not specify what equipment was used.[12] Two of the studies that reported using intubation handled congenital defects: congenital diaphragmatic hernias and congenital high airway obstruction syndrome.[31,33]

We studied data on the initial monitoring of the neonates. The most frequently used equipment were an electrocardiogram combined with pulse oximetry in six of the 18 studies and just pulse oximetry in a further two. This meant that 10 (56%) studies did not use pulse oximetry or an electrocardiogram to monitor the neonates (Table 2). One study stated that it was difficult to monitor heart rates during ICR/S, especially during a C-section.[13] In the VentFirst pilot trial, the heart rate was assessed at 60 s by gentle cord palpation.[14]

We also extracted data on temperature control, namely measuring temperature, methods to maintain temperature control and the outcome of temperature control. The most commonly used methods to deliver temperature support were warm bedding and plastic wraps (Table 2). Of the 12 studies that used warm bedding, nine used warm mattresses and three described warm towels or sheets. Neonates were wrapped or placed in plastic suits or bags in seven studies. Overhead heating was used in three studies, alone or in combination with other measures.

One study described using warm surfaces, plastic wrap and overhead heating.[29] Four studies either did not use any temperature support or just did not mention it in their papers (Table 2).

All studies reported the neonates' temperature outcomes. Six studies reported comparative analyses of the difference in temperature between ICR/S and early cord clamping and found no differences in temperature between the groups.[12,19,23–25,33]

3.8 | Criteria and time to clamp the cord after C-sections

There was heterogeneity in how the timing of cord clamping was reported. In the ICR/S groups, the time from birth to cord clamping varied from 50 to 540 s, with a median of 2 min and 8 s. The time to cord clamping was slightly shorter among neonates born at ≤31 + 6 weeks/days (median 128 s, range 50–349 s) than those born at 32 + 0 weeks/days (median 162 s, range 60–540 s; Table 2).

3.9 | Reasons for protocol deviations

Early cord clamping occurred in 422 cases across the 18 studies. There was heterogeneity in how the studies reported protocol deviations, including those for vaginal births and C-sections. The most common reasons for early cord clamping in the ICR/S intervention groups were a short umbilical cord (8%) followed by early placental detachment (7%). Less frequently cited reasons included maternal haemorrhage, the unavailability of the team or equipment and obstetricians' concerns about maternal health (all 2% each). There were indications that protocol deviations occurred less frequently when using simple bedding 14/134 (10%) than a trolley 84/261 (32%). This could be explained by a relatively lower incidence of short cords and early placental detachment in the group who were placed on simple bedding (2% versus 11% and 9%, Table S1).

3.10 | Maternal blood loss and uterotonics

Maternal blood loss was reported by five of the 18 studies and ranged from 50 to 2450 mL.[12,13,25,30,33] There was no difference in blood loss between the early cord clamping and ICR/S groups. Four studies administered uterotonics after cord clamping.[12,20,25,30]

TABLE 2 Overview of included neonates and methods used during ICR/S at CS.

Author, year	Total neonates at CS	Neonates receiving ICR/S at CS	Time to cord clamping	GA at birth (weeks + days)	Platform used	Resuscitation team sterile	Mode of temperature support*	Respiratory support	Neonatal monitoring
Pivetti, 2014[31]	1	1	180 s	32 + 1	Bedding			Intubation	
Thomas, 2014[24]	45	45		24–41	Lifestart		M P	T-piece + mask	
Katheria, 2016[19]	125	63	65.9 ± 8.8 s	23 + 0 to 31 + 6	Lifestart	Sterile	M	T-piece + mask	
Hung, 2017[32]	2	2	after establishing a secured airway	26 + 2 and 26 + 4	Non-labelled platform			Intubation	
Lefebvre, 2017[25]	11	5	7.0 ± 3.4 min	≥ 32 + 0	Non-labelled platform		M	Intubation	ECG + Pulsoxymetri
Winter, 2017[14]	21	21	90 s	24 + 0 to 31 + 6	Bedding	Sterile	M P	T-piece + mask	Cord palpation
Blank, 2018[20]	23	7	162 (158–174) s	≥32 + 0	Bedding	Sterile		T-piece + mask	ECG + Pulsoxymetri
Pratesi, 2018[21]	19	6	3 min	23 + 0 to 29 + 6	Lifestart		M P	T-piece + mask	Pulsoxymetri
Bates, 2019[26]	47	25	>60 s 92% (23/25)	≤31 + 6	Bedding	Sterile	M P	T-piece + mask	ECG + Pulsoxymetri
Foglia, 2020[33]	23	12	2 min (IQR 1.15, 2.32)	≥36 + 0	Lifestart	Sterile	M	T-piece + mask	
Hoyle, 2020[27]	112	38		≤31 + 6	Lifestart		M P		
Knol, 2020[12]	18	9	5.49 ± 2.37 min	≤31 + 6	Concord		O		ECG + Pulsoxymetri
Joshi, 2021[28]	20	20	60 s	36–39	Non-labelled platform				
UshaDevi, 2021[29]	10	10	3 min	≥24 + 0	Non-labelled platform		M P O	T-piece + mask	
Badurdeen, 2022[30]	29	16	136 s [126–150]	≥32 + 0	Bedding	Sterile		T-piece + mask	ECG + Pulsoxymetri
Deng, 2022[22]	124	64	60 s (IQR 60–60)	≤31 + 6	Bedding	Sterile	M	PPV device + CPAP	ECG + Pulsoxymetri
Nevill, 2023[13]	78		50 s, 95% (n = 54)	≤30 + 6	Bedding	Sterile	M P	T-piece + mask	Stethoscope
Raina, 2023[23]	109	51	180 s (76,1%)	≥34 + 0	Non-labelled platform	Sterile	M O	T-piece + mask	Pulsoxymetri

Abbreviations: *M, mattress/sheet; =, not specified; Bedding, mattress, sheet or towel; CS, Caesarean section; ECG, electrocardiogram; GA, gestational age; ICR/S, Intact cord resuscitation/stabilisation; IQR, intra quartile range; O, overhead heating; P, plastic wrap/suit.

This meant that 14 studies did not provide any data on the use of uterotonics.

4 | DISCUSSION

To the best of our knowledge, this was the first scoping review to identify studies on the management of initial resuscitation and/or stabilisation with intact cord circulation (ICR/S) for neonates delivered by C-sections. The 18 papers we studied demonstrated diverse management approaches and reported a range of practical issues that need to be considered when implementing ICR/S during a C-section.

Various papers have suggested fundamental characteristics that need to be considered when implementing ICR/S during a C-section.[10,34,35] It is important to have a stable, flat and soft, but firm surface where the neonate can be safely placed during resuscitation.[34] The surface must fulfil the requirements for aseptic conditions in the operating theatre. In addition, specific measures must be taken to ensure normothermia, especially in very preterm neonates, due to the typically low room temperature in this environment. Our review identified two main solutions: mattresses or blankets placed on the mother's lap and placing the neonate on a trolley. Both solutions were adapted in large studies, and a preferred solution could not be identified as the two solutions seemed to perform equally. Given that the vast majority of neonatal resuscitation and stabilisation occurs in low-resource settings, it is essential to consider cost-effective solutions that can be adapted worldwide.

Sterility and aseptic management are important during C-sections. Maternal wound complications have been described in 3%–15% of C-sections and these contributed to prolonged hospital stays, readmissions and increased healthcare costs.[36] As the number of C-section is increasing globally, more neonates will need ICR/S and it is important to identify how to minimise the risk of wound complications. The papers we reviewed showed large heterogeneity with regard to whether the neonatal team was scrubbed in, the neonate was placed on a sterile surface and whether the equipment used to monitor and resuscitate the neonate was sterilised. No references to maternal wound complications or maternal infections were identified by our analysis, emphasising the need for future studies to address this topic and provide comprehensive reporting.

Another important consideration when implementing ICR/S is hypothermia during ICR/S.[34,35] Three methods were described: putting the neonate on pre-warmed blankets or a chemical mattress, placing the preterm neonate in a polythene bag and adding a radiant heater. Several studies were able to demonstrate a comparable temperature at admission to the ward when practicing ICR/S and early cord clamping and using a warm surface and polythene bag/wrap to manage preterm neonates. When it comes to term neonates, our scoping review suggests that drying the skin and putting the neonate on a warm surface is enough for initial stabilisation and resuscitation.

Using a radiant warmer is recommended in the European guidelines for resuscitating neonates. A review by Trevisanuto et al. indicated that radiant warmer heterogeneity potentially increased the risk of hypothermia and hyperthermia in exposed neonates.[8,37] Interestingly, an animal study of term-born lambs by Blank et al. demonstrated that sustained cord circulation during physiological-based cord clamping stabilised the core temperature at delivery better than immediate cord clamping. They hypothesised that the neonate used the placenta that was still in the uterus as a heat source.[38] This may explain the findings of comparable temperatures in this review.

It is also essential to have easily accessible resuscitation and monitoring equipment close to the neonate. All the studies in this review solved this by having the necessary equipment on a trolley or a separate mobile pole on wheels that could be brought close to the operating table. None of the studies reported any difficulties with the resuscitation equipment when they provided ICR/S. Challenges have been described in relation to the use of equipment or trolleys when performing ICR/S during C-sections. Clinicians expressed concerns about a smaller work surface and the baby's safety on a trolley[24] and parents witnessed ICR/S being performed.[39] It is important to find the best possible and easiest-to-use equipment to provide the best care for neonates during C-sections.

Finally, it is essential to have easily accessible monitoring equipment close to the neonate. The current European and American guidelines recommend that heart rate and oxygen saturation be monitored for 60 s after delivery.[8,9] In the studies we reviewed, less than half were able to use a pulse oximeter or electrocardiogram electrodes to monitor the neonate. Notably, one paper stated that sterilised equipment was specifically used for the study.[30] In other studies, the initial assessment was performed by manual palpation of the umbilical cord or by using a stethoscope. Although the studies reviewed did not incorporate the use of the NeoBeat heart rate monitoring device (Laerdal Global Health, Stavanger, Norway), it is currently employed in clinical practice and may offer advantages during resuscitation.[40] The feasibility and applicability of the NeoBeat during ICR/S after C-sections warrant research.

4.1 | Strengths and limitations

This scoping review has several strengths. First, it is a comprehensive review that condenses existing data on the procedures and management of ICR/S for neonates born by C-sections. That means it provides a workable model of care. Scoping reviews can answer broader questions, such as the one posed by the present study, by describing the nature and diversity of the available evidence. They can also provide important insights into the body of evidence.[17,41] We made sure that our systematic review process was aligned with the review question, results and discussion, by adhering to the guidance of the PRISMA extension for scoping reviews. Our review also used Covidence, which is an established review platform.[17]

A possible limitation of this scoping review was the variable design of the included studies, which made it difficult to extract any

specific recommendations. The studies we included had inconsistent outcome definitions and some did not report procedures and important information regarding sterility and temperature support when neonates born by C-section received ICR/S. The review specifically focused on C-sections, but many of the studies also included vaginal births, which may have biased the outcomes of the neonates they included.

5 | CONCLUSION

ICR/S during C-sections has been progressively introduced into various clinical settings and may become routine care in the future. We could not draw any definite conclusions about the optimal due to the differences in the study designs and outcomes in the papers included in this scoping review. Several approaches seemed feasible. However, it is important to identify optimal procedures and resuscitation equipment that is acceptable, reliable and easy to use. Large studies are needed that implement ICR/S in structured ways, with clearly defined outcome settings, details of how equipment and staff are positioned and structured sterilisation procedures. We also need thorough, well-performed implementation studies that provide the best care for neonates who need to be stabilised during a C-section.[42,43]

Proper practice and team training are also essential to ensure that resuscitation at the mother's side, with intact placental circulation, provides the same quality of care for neonates, while allowing the obstetrical team to provide uninterrupted care for the mother. These efforts should conform to neonatal and obstetric standards and be adaptable as new evidence emerges.

AUTHOR CONTRIBUTIONS

Vesta Seyed Alikhani: Conceptualization; data curation; formal analysis; investigation; validation; visualization; writing – original draft; writing – review and editing. **Li Thies-Lagergren:** Conceptualization; data curation; formal analysis; investigation; methodology; project administration; supervision; validation; visualization; writing – original draft; writing – review and editing. **Jenny Svedenkrans:** Conceptualization; funding acquisition; investigation; validation; writing – review and editing. **Anders Elfvin:** Conceptualization; formal analysis; investigation; validation; writing – review and editing. **Jenny Bolk:** Conceptualization; data curation; formal analysis; investigation; methodology; validation; visualization; writing – original draft; writing – review and editing. **Ola Andersson:** Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; supervision; validation; visualization; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to declare.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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