

Guidelines on Deferred Cord Clamping and Cord Milking: A Systematic Review

Sugee Korale Liyanage, MSc,^{a,*} Kiran Ninan, BHSc,^{a,*} Sarah D. McDonald, MD, MSc^{a,b,c,d}

abstract

CONTEXT: Deferred cord clamping (DCC) saves lives. It reduces extremely preterm infants' mortality by 30%, yet a minority of eligible infants receive it. This may in part be due to lack of awareness or confidence in evidence, or conflicting or vague guidelines.

OBJECTIVE: To systematically review clinical practice guidelines and other statements on DCC and cord milking.

DATA SOURCES: Ten academic and guideline databases were searched.

STUDY SELECTION: Clinical practice guidelines and other statements (position statements and consensus statements) providing at least 1 recommendation on DCC or umbilical cord milking among preterm or term infants were included.

DATA EXTRACTION: Data from included statements were extracted by 2 independent reviewers, and discrepancies were resolved through consensus. Guideline quality was appraised with modified Appraisal of Guidelines for Research and Evaluation II and Appraisal of Guidelines for Research and Evaluation Recommendation Excellence tools.

RESULTS: Forty-four statements from 35 organizations were included. All endorsed DCC for uncompromised preterm infants, and 11 cautiously stated that cord milking may be considered when DCC is infeasible. Only half (49%) of the recommendations on the optimal duration of DCC were supported by high-quality evidence. Only 8% of statements cited a mortality benefit of DCC for preterm infants.

LIMITATIONS: Because systematic reviews of guidelines are relatively novel, there are few tools to inform study execution; however, we used the Appraisal of Guidelines for Research and Evaluation II and the Appraisal of Guidelines for Research and Evaluation Recommendation Excellence to assess quality and were methodologically informed by previous systematic reviews of guidelines.

CONCLUSIONS: Statements worldwide clearly encouraged DCC. Their implementability would benefit from noting the preterm mortality benefit of DCC and more granularity.



^bDivision of Maternal-Fetal Medicine and ^aDepartments of Obstetrics and Gynecology, ^cHealth Research Methods, Evidence, and Impact, and ^dRadiology, McMaster University, Hamilton, Ontario, Canada

*Contributed equally as co-first authors

Ms Liyanage and Mr Ninan designed the data collection instruments, collected data, conducted the analyses, drafted the manuscript, and reviewed and revised the manuscript; Dr McDonald coordinated and supervised data collection and critically reviewed and revised the manuscript for important intellectual content; and all authors conceptualized and designed the study and approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

This trial has been registered with PROSPERO (<https://www.crd.york.ac.uk/prospero/>) (identifier CRD42019143332).

To cite: Liyanage SK, Ninan K, McDonald SD. Guidelines on Deferred Cord Clamping and Cord Milking: A Systematic Review. *Pediatrics*. 2020;146(5):e20201429

Cutting the umbilical cord is inevitable; but should it be rushed?

Deferred cord clamping (DCC) facilitates the newborn infant's transition to extrauterine life by allowing fetoplacental circulation to continue as the lungs expand after birth.¹ Umbilical cord milking (UCM) is when blood in the cut or uncut cord is squeezed toward the infant.²

DCC reduces neonatal morbidity and mortality, especially among preterm infants. In a systematic review of 18 randomized controlled trials (RCTs), DCC (defined as ≥ 30 seconds) reduced the risk of mortality by 32% in preterm infants.³ RCTs revealed that DCC reduced the risks of intraventricular hemorrhage (IVH), necrotizing enterocolitis, and sepsis among preterm infants; reduced the need for blood transfusions and respiratory support; improved iron stores at 3 to 6 months; and improved neurodevelopmental outcomes at 2 years.³⁻⁶

In a systematic review of 7 RCTs, UCM reduced the risks of IVH and oxygen requirement and improved hemoglobin levels among preterm infants.⁷ However, a recent large RCT raised concerns about the risks of IVH with UCM.⁸

DCC is a simple and inexpensive practice,^{9,10} yet many health providers are reluctant to defer clamping.^{11,12} In California, at least 42% of preterm infants (gestational age <32 weeks or birth weight <1500 g) admitted to neonatal intensive care in 2016 did not receive DCC.¹³ In Canada, 40% of preterm infants and 53% of extremely preterm infants admitted to a NICU in 2018 did not receive DCC.¹⁴ **This may be, in part, because of the persistence of custom, lack of awareness or confidence in evidence, and conflicting or vague guidelines.¹⁵** To address the latter three issues, we systematically described the clinical

guidance on placental transfusion to identify gaps in guidance, concordance with evidence available at the time (including benefits for preterm mortality),³ and recommendation quality.

METHODS

We conducted this systematic review (PROSPERO identifier CRD42019143332) according to available methodological guidance on conducting a systematic review of guidelines.^{16,17}

Data Sources

We searched the following 10 academic and guideline databases from January 1, 2010, to July 17, 2019 (Supplemental Table 2): Ovid Medline, Ovid Embase, Cumulative Index to Nursing and Allied Health Literature, Cochrane Central Register of Controlled Trials, Web of Science, Clinical Practice Guideline (CPG) Infobase, Guidelines International Network, National Institute for Health and Care Excellence (NICE) Evidence, Royal College of Obstetricians and Gynaecologists Guidance, and Trip Medical Database. We hand searched the Web sites of members of the International Federation of Gynaecology and Obstetrics that had Web sites with recommendation statements (Supplemental Table 3).

Inclusion Criteria

With no language restrictions, we included the most recent versions of CPGs and other recommendation statements published after 2010 that provide at least 1 recommendation on DCC or UCM among preterm or term infants. On the basis of the definition provided by the Institute of Medicine, we defined CPGs as statements developed by a dedicated multidisciplinary panel, after a thorough review of the evidence, to optimize patient and practitioner decisions.¹⁸ We also reported on other statements that could not be described as CPGs (position statements and consensus statements) in

order to comprehensively summarize all recommendations that inform health providers' cord management practices.

Data Extraction

Two reviewers (S.K.L. and K.N.) independently screened the titles and abstracts and full texts. Data from included full texts regarding guideline authorship, guideline development methodology, DCC and UCM recommendations, and sources of evidence supporting the recommendations were abstracted by using a piloted data extraction form. Discrepancies were discussed between reviewers to reach consensus, and a third reviewer (S.D.M) was consulted, as necessary.

Quality Assessment

Two reviewers independently appraised the quality of included statements using the modified Appraisal of Guidelines for Research and Evaluation II (AGREE II) instrument (Supplemental Table 4).¹⁹ AGREE II was modified to only include 3 of the 6 domains (scope and purpose, clarity of presentation, and editorial independence). The remaining 3 domains (stakeholder involvement, rigor of development, and applicability) were removed for 3 key reasons. First, only 3 domains were scored so that the AGREE II appraisal highlights the quality of cord management recommendations specifically (rather than the quality of recommendations on other topics as well), thus more accurately reflecting our research topic. Second, we wanted to prevent bias toward assessing the few guidelines dedicated to cord management as higher quality than the majority of guidelines, which had a broader or different focus (eg, preterm labor) and, thus, less comprehensive recommendations on cord management. Finally, because the reviewers were not experienced in all topics addressed by the guidelines (eg, neonatal resuscitation), we wanted to avoid arbitrary scoring

of areas in which we lacked knowledge.

The clinical credibility and implementability of the relevant recommendations on cord management were appraised by using Appraisal of Guidelines for Research and Evaluation Recommendation Excellence (AGREE-REX) (Supplemental Table 4), which comprises 3 domains (clinical applicability, values and preferences, and implementability).²⁰ We also applied AGREE II and AGREE-REX to position papers and consensus statements. Although it is important to note that these statements will inherently receive lower-quality assessments because they do not follow the rigorous CPG development methodology that Appraisal of Guidelines for Research and Evaluation (AGREE) is designed to assess, we wanted to appraise all statements using a consistent framework.

AGREE advises users to determine their own thresholds to interpret scores according to the context of their study. Hence, in line with a number of other systematic reviews of CPGs,^{21,22} we considered domain scores $\geq 50\%$ to be consistent with higher quality and domain scores $< 50\%$ to be consistent with lower quality. Because different domains were not equally relevant in our study, we did not pool together domain scores, and instead we reported individual domain scores.

Data Analysis

We calculated the proportion of statements that recommended DCC and UCM for preterm or term infants. We reported on the details of the recommendations and their concordance with the highest level of evidence available at the time of publication regarding the mortality benefit of DCC among preterm infants because we hypothesized that physicians would be more likely to employ DCC if it is supported by this type of evidence.

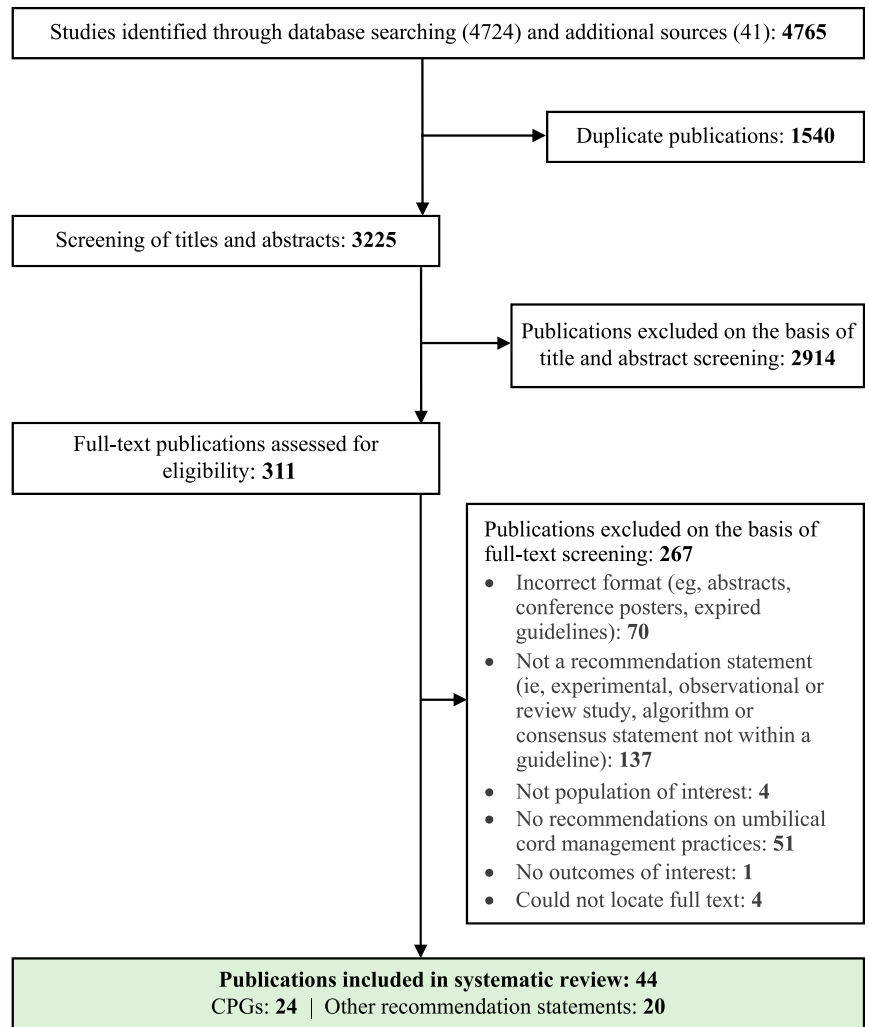


FIGURE 1

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of a systematic review of CPGs and other recommendation statements on DCC and UCM. The flow of studies is summarized through the following stages in the systematic review: database searching, title and abstract screening, and full-text screening.

RESULTS

The searches retrieved 4765 records (Fig 1). After excluding 1540 duplicates, we screened 3225 titles and abstracts and selected 311 records for full-text screening. Before resolving discrepancies, the reviewers had 97% agreement for inclusion and exclusion of full texts. We included 44 statements,²³⁻⁶⁶ of which 24 met the criteria for a CPG because they were developed by a dedicated national or international panel after a systematic search and synthesis of the evidence to inform practitioner and patient decisions.¹⁸ Twenty statements were

described as position papers or consensus statements or could not be confirmed to be a CPG because of a lack of detail on guideline development methodology or lack of a comprehensive evidence search (Supplemental Table 5). The included statements represented the views of 35 national and international professional societies, commonly in the fields of obstetrics, midwifery, neonatology, pediatrics, and resuscitation. Statements addressed a global audience but predominantly high-income countries: 33 of 44 addressed 17 different high-income

Year	Organization	Type of Statement (Sources of Evidence ^a)	Cord Management Guidance Summary	AGREE II ^b			AGREE-REX ^b		
				D1	D4	D6	D1	D2	D3
Umbilical Cord Management (DCC and Cord Milking)									
2018	Italian Task Force for the Management of Umbilical Cord Clamping ²³	CPG (Literature search in Medline and Cochrane Library + guidelines)	✓ PT (GA <34 wk, GA 34–36 ⁶ wk; twin); ✓ T (VD, CD; twin) ≈ PT (GA <34 wk, GA 34–36 ⁶ wk; twin); ✓ T (VD, CD; twin)	●	●	●	●	●	●
2017	American College of Obstetricians and Gynecologists ²⁴	Committee opinion (Not stated)	✓ PT, T; ✗ Multiple gestations ≈ ✗ PT, T	●	●	●	●	●	●
2014	American College of Nurse-Midwives ²⁵	Position statement (Not stated)	✓ PT, T ≈ ✓ PT (particularly), T	●	●	●	●	●	●
2014	WHO ²⁶	CPG (Literature search in Cochrane Library)	✓ PT, T ≈ ✗ PT, T	●	●	●	●	●	●
Managing Preterm Labor and Birth									
2019	Romanian Society of Obstetrics and Gynecology ²⁷	Cannot confirm if CPG (Literature search + stakeholder opinion)	✓ PT (GA <37 wk)	●	●	●	●	●	●
2018	European Association of Perinatal Medicine ²⁸	Not a CPG (Literature search)	✓ PT	●	●	●	●	●	●
2017	SOGC (infants on the border of viability [<29 ⁶ wk]) ²⁹	CPG (Literature search on Medline, Embase, Cochrane Library)	≈ ✓ Extremely PT	●	●	●	●	●	●
2016	Saudi Neonatology Society (VLBW infants in the first hour of life) ³⁰	Not a CPG (Literature search)	✓ PT (BW <1500 g, GA ≤32 wk)	●	●	●	●	●	●
2016	Confalonieri Ragonese Foundation (Italy) ³¹	CPG (Literature search + international guidelines + stakeholder opinion)	✓ PT (GA <37 wk, singleton); ✗ PT twin ≈ ✓ PT (Singleton)	●	●	●	●	●	●
2015	NICE (England, Wales) ³²	CPG (Literature search in multiple databases + stakeholder opinion)	✓ PT (GA <37 wk) ≈ PT: Consider if significant maternal bleeding or resuscitation	●	●	●	●	●	●
2014	Swedish National Board of Health and Welfare (extremely preterm infants <28 wk) ³³	CPG (Literature search)	✓ PT (GA <28 wk)	●	●	●	●	●	●
Neonatal Resuscitation and Supporting Perinatal Transition									
2017	National Resuscitation Council (Singapore) ³⁴	Not a CPG (Literature search + ILCOR international recommendations)	✓ PT, T ≈ ✗ routine practice	●	●	●	●	●	●
2017	Australian and New Zealand Committee on Resuscitation ³⁵	Not a CPG (ILCOR and ERC recommendations)	✓ PT ≈ ✗ PT/ T routine practice	●	●	●	●	●	●

FIGURE 2

Characteristics of Included CPG and Other Recommendation Statements on DCC and Cord Milking. The hourglass represents DCC. The scissors represent UCM. AMTSL, active management of the third stage of labor; BW, birth weight; CD, cesarean delivery; CENTRAL, Central Register of Controlled Trials; CINAHL, Cumulative Index to Nursing and Allied Health Literature; ERC, European Resuscitation Council; GA, gestational age; ILCOR, International Liaison Committee on Resuscitation; RDS, respiratory distress syndrome; SOGC, Society of Obstetricians and Gynaecologists of Canada; VD, vaginal delivery; VLBW, very low birth weight; red x, not recommended; green checkmark, recommended. ^aEach guideline also supplemented the literature searches with expert opinion, which includes clinicians within the guideline development group or external experts. ^bThe modified AGREE II domains (D) are as follows: D1, scope and purpose; D4, clarity of presentation; and D6, editorial independence. The AGREE-REX domains are as follows: D1, clinical applicability; D2, values and preferences; and D3, implementability. Green circles indicate high quality (domain score ≥50%), and red circles indicate low quality (domain score <50%). ^cMembers of the ILCOR include the American Heart Association, the European Resuscitation Council, the Heart and Stroke Foundation of Canada, the Australian and New Zealand Committee on Resuscitation, the Australian Resuscitation Council, the New Zealand Resuscitation Council, the Resuscitation Councils of Southern Africa, the InterAmerican Heart Foundation, and the Resuscitation Council of Asia.

countries, 4 specifically addressed Europe, 5 addressed 5 different middle-income countries, and 3 had a global focus (Fig 2). The available clinical guidelines on DCC and UCM are summarized in Figure 3 and described in detail below.

Quality of Statements

Detailed and summarized AGREE II and AGREE-REX scores are listed in Supplemental Table 4 and Figure 2, respectively. On the modified AGREE II instrument to assess methodologic rigor, 18 of the 44

(41%) statements had high quality in all 3 domains (scope and purpose, clarity of presentation, and editorial independence). On the AGREE-REX instrument to assess the quality of recommendations, 11 statements (25%) were high quality in all 3 domains (clinical applicability, values and preferences, and implementability). Eight statements (18%) had high quality in all domains of AGREE II and AGREE-REX, with statements by NICE³² and the World Health Organization

(WHO)⁴¹ having the highest scores overall.

On AGREE-REX, clinical applicability is used to assess the quality of the evidence review and applicability to clinicians and patients: 31 statements scored high quality in this domain. Values and preferences was the weakest domain overall (only 11 statements scoring high quality); it is used to assess efforts taken to make recommendations and outcomes important to clinicians, patients, and policy- and decision-makers.

Year	Organization	Type of Statement (Sources of Evidence ^a)	Cord Management Guidance Summary	AGREE II ^b			AGREE-REX ^b		
				D1	D4	D6	D1	D2	D3
2017	Swiss Society of Neonatology (GA >34 wk and BW >2000 g) ³⁶	Cannot confirm whether a CPG (Literature search + international guidelines + stakeholder opinion)	✓ PT (VD), T ✗ PT (CD)	●	●	●	●	●	●
2016	Queensland Clinical Guidelines (Australia) ³⁷	CPG (Literature search on multiple databases + national and international guidelines)	✓ PT, T ✗ PT, T	●	●	●	●	●	●
2015	Dutch Resuscitation Council (adults, children, and newborns) ³⁸	Inferred to be a CPG, cannot confirm (Literature search + stakeholder opinion)	✓ “Unthreatened” PT	●	●	●	●	●	●
2015	European Resuscitation Council ⁶⁵	Cannot confirm whether CPG (National and international guidelines (including ILCOR) + Previously evaluated evidence)	✓ PT, T ✗ Potential DCC alternative if urgent resuscitation; ✗ routine practice	●	●	●	●	●	●
2015	ILCOR (multinational) ⁶⁴	Not a CPG (Systematic review in PubMed, Embase, Cochrane Library + stakeholder opinion)	✓ PT ✗ routine practice GA ≤28 wk	●	●	●	●	●	●
2015	Japanese Resuscitation Council ⁴⁰	CPG (Literature search on multiple databases + ILCOR meeting discussion)	✓ PT ✗ PT (<28 wk) routine practice	●	●	●	●	●	●
2015	Resuscitation Council UK ³⁹	CPG (Literature search + stakeholder opinion)	✓ PT, T ✗ PT and/or T routine practice	●	●	●	●	●	●
2012	WHO ⁴¹	CPG (Literature search and systematic review in multiple databases)	✓ PT, T	●	●	●	●	●	●
Preventing and Managing Postpartum Hemorrhage and AMTSL									
2019	Queensland Clinical Guidelines (Australia) ⁴²	CPG (Literature search on multiple databases + national and international guidelines)	✓ PT, T: in AMTSL	●	●	●	●	●	●
2018	SOGC ⁴³	CPG (Literature search on multiple databases)	✓ PT (GA <37 wk); T (weigh risk of jaundice with benefits of DCC)	●	●	●	●	●	●
2016	Association of Ontario Midwives (Canada) ⁴⁴	CPG (Literature search on Medline, CINAHL, Cochrane Library)	✓ PT, T: in AMTSL	●	●	●	●	●	●
2014	Chinese Association of Obstetrics and Gynecology ⁴⁵	Not a CPG (International guidelines)	✓ PT, T	●	●	●	●	●	●
2012b	WHO ⁴⁶	CPG (Literature search in Cochrane Library + stakeholder opinion)	✓ PT, T	●	●	●	●	●	●
2012	Federation of Obstetric and Gynaecological Societies of India ⁴⁷	Consensus statement (Clinical experience of authors)	✓ PT, T	●	●	●	●	●	●
Normal Birth (Spontaneous, Vertex, Term, Healthy Mother and Newborn) and Care of the Healthy Newborn									
2018	Austrian Society of Pediatrics and Adolescent Medicine ⁴⁸	Position paper (Not stated)	✓ T ✗ PT	●	●	●	●	●	●
2017	Queensland Clinical Guidelines (Australia) ⁴⁹	CPG (Literature search in multiple databases + stakeholder opinion)	✓ T (VD)	●	●	●	●	●	●
2016	SOGC ⁶³	CPG (Literature search in PubMed, Cochrane Library)	✓ PT, T	●	●	●	●	●	●

FIGURE 2
(Continued).

Recommendations on DCC

Summary of DCC Recommendations

Forty-four statements contained a total of 70 recommendations on DCC for subpopulations (Supplemental Fig 5); 24 recommendations were specific to preterm infants, with 3 for extremely preterm infants (≤ 28 weeks),^{29,33,62} and 3 addressing extremely preterm and moderately preterm infants.^{23,30,55} Thirty-one applied to both preterm and term infants, and 15 applied only to term infants (>37 weeks). Two recommendations were specific for multiple gestations.^{23,24} Three statements identified monochorionic twins or multiples as a contraindication to DCC.^{23,31,34}

Recommendations on DCC provided by CPGs are summarized in Figure 4, whereas those provided by non-CPGs are summarized in Supplemental Fig 6.

Three recommendations did not explicitly endorse DCC in certain instances. First, a committee opinion by the American College of Obstetricians and Gynecologists (ACOG) Committee on Obstetric Practice stated that there is insufficient evidence to recommend for or against DCC in multiple gestations.²⁴ Second, a CPG by the Society of Obstetricians and Gynaecologists of Canada stated that in term infants, the benefits of DCC must be balanced with the risks of neonatal jaundice requiring phototherapy.⁴³ Finally, a CPG by the Italian Task Force

for the Management of Umbilical Cord Clamping recommended immediate clamping in directed cord blood collection for at-risk families.²³

Regarding mode of delivery, 3 recommendations on preterm infants,^{23,57} 3 on term infants,^{23,25,57} and 1 on both preterm or term infants provided recommendations specific to DCC after cesarean delivery (CD).⁵⁷

Optimal Timing To Defer Clamping

Fifty-one of 67 (76%) recommendations endorsing DCC made a recommendation regarding the optimal duration to defer clamping (Fig 4, Supplemental Fig 5). The shortest evidence-based

Year	Organization	Type of Statement (Sources of Evidence ^a)	Cord Management Guidance Summary	AGREE II ^b			AGREE-REX ^b		
				D1	D4	D6	D1	D2	D3
2014	Estonian Society of Gynecologists ⁵⁰	Cannot confirm whether a CPG (Not stated)	☒✓ T (VD)	●	●	●	●	●	●
2014	NICE (England, Wales) ⁵¹	CPG (Literature search on multiple databases + stakeholder opinion)	☒✓ T	●	●	●	●	●	●
2010	National Directorate of Maternity and Infancy, Ministry of Health (Argentina) ⁵²	Cannot confirm if CPG (Literature search + stakeholder opinion)	☒✓ T (37–41 wk, normal delivery)	●	●	●	●	●	●
Blood Transfusion									
2016	British Committee for Standards in Haematology (England) ⁵³	CPG (Literature search + international guidelines + stakeholder opinion)	☒✓ PT, T	●	●	●	●	●	●
2015	Canadian Paediatric Society (very preterm infants) ⁶²	Position statement (Literature search in Medline, Embase, Cochrane CENTRAL, grey literature)	☒✓ Extremely PT ☒✓ Extremely PT (X routine practice)	●	●	●	●	●	●
2014	High Authority of Health (France) ⁵⁴	CPG (Systematic literature search + peer review)	☒✓ PT, T	●	●	●	●	●	●
Other Topics of Focus									
2019	Canadian Paediatric Society (preventing acute brain injury in PT infants) ⁵⁵	Position statement (Literature search on Medline)	☒✓ PT (GA ≤32 ⁶ wk) ☒✓ PT	●	●	●	●	●	●
2019	European Society for Paediatric Research (managing RDS) ⁵⁶	Consensus guideline (Literature search)	☒✓ PT infants with RDS	●	●	●	●	●	●
2018	Enhanced Recovery After Surgery Society (global) (intraoperative care in CD) ⁵⁷	CPG (Literature search in Embase and PubMed)	☒✓ PT, T (CD)	●	●	●	●	●	●
2018	The Royal College of Midwives (UK) (midwifery care in labor) ⁵⁸	Inferred to be a CPG on the basis of summary of methods, because technical manual could not be found (Literature search)	☒✓ PT, T	●	●	●	●	●	●
2018	Turkish Neonatal Society (managing RDS) ⁵⁹	Not a CPG (Evidence sources not stated)	☒✓ PT ☒✓ PT (in emergency situations)	●	●	●	●	●	●
2015	SOGC (cord blood counselling, collection, and banking) ⁶⁰	CPG (Literature search in Medline, PubMed, grey literature)	☒✓ PT, T	●	●	●	●	●	●
2014	Royal College of Obstetricians and Gynaecologists (UK) (cord prolapse) ⁶¹	CPG (Literature search on multiple databases)	☒✓ PT (GA ≥23 wk), T	●	●	●	●	●	●

FIGURE 2
(Continued).

durations included 30 to 60 seconds in preterm infants, 30 to 60 seconds in term infants, and ≤30 seconds in preterm and term infants. The longest evidence-based durations included 30 to 180 seconds in preterm infants, until cord pulsation ceases in term infants, and ≥60 seconds in preterm and term infants. The most commonly recommended lower limit of optimal duration was at least a minute (20 recommendations), whereas 10 recommendations suggested an upper limit of at most a minute.

Among the 51 recommendations that included an optimal timing, we reviewed the sources of evidence that the authors cited to support the suggested time (Supplemental Fig 5). For 11 timings (22%), a source of evidence was not cited. In 25 (50%), primary studies or systematic reviews were cited. In 6 (12%), the authors cited other guidelines rather than primary research. For the remaining 9 (18%) recommended timings, the authors did cite evidence

to support the recommendation; however, there was a mismatch between either the upper or lower limit of the durations recommended in the evidence sources and the durations recommended in the statements. Hence, we could not confidently determine if and how these recommendations were informed by the cited evidence, expert opinion, and authors' consensus decisions (Supplemental Table 6).

Contraindications to DCC

Common maternal and infant contraindications to DCC included significant maternal bleeding and unstable maternal conditions (6 statements), the need for immediate neonatal resuscitation (29 statements), an infant heart rate <60 beats per minute (2 statements), and suspected fetal asphyxia (1 statement). Common uteroplacental contraindications included concerns about the integrity of the cord

and placental circulation and placental abruption or previa (7 statements).

Recommendations on UCM

The 23 recommendations on UCM in 20 statements were more cautious and less detailed than those on DCC (Supplemental Table 7). Fifteen recommendations suggested that UCM may be considered when DCC is infeasible and when there is significant maternal bleeding, when there is a need for immediate neonatal support, or in emergency situations. Only 4 recommendations provided suggestions on the numbers of times to milk the cord, ranging from 2 to 5 times. Thirteen statements discouraged the routine use of UCM because of insufficient evidence of its benefits and harms.

Concordance With Evidence on the Mortality Benefit of Umbilical Cord Management

Given our hypothesis that clinicians would be more likely to change

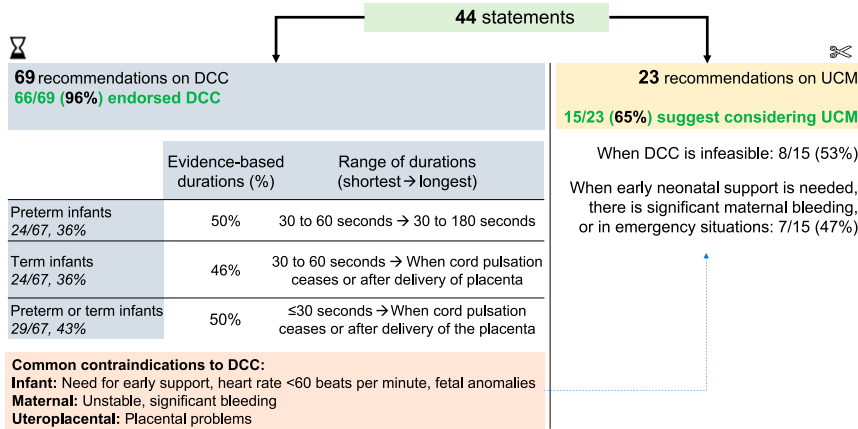


FIGURE 3

Summary of recommendations on DCC and cord milking in included statements. The proportions of recommendations on DCC (including the recommended optimal durations to defer clamping) and UCM are summarized.

practice on the basis of evidence revealing benefit in compelling outcomes, such as reductions in infant death, we examined the number of statements that used mortality data to justify DCC. Among the 39 statements that provided recommendations relevant to preterm infants (recommendations for preterm or both preterm and term infants), only 3 (8% of statements) reported a mortality benefit of DCC for preterm infants. Guidelines by the Italian Task Force for the Management of Umbilical Cord Clamping²³ and the European Society for Paediatric Research⁵⁶ both reported the findings of the systematic review by Fogarty et al,³ which found that DCC (mainly ≥60 seconds) significantly reduced hospital mortality in preterm infants compared with immediate cord clamping. Additionally, the 2016 guideline by the Confalonieri Ragonese Foundation³¹ cited the results of a systematic review by Backes et al,⁶⁷ which found that DCC and UCM reduced mortality among preterm infants <32 weeks' gestation (relative risk 0.42; 95% confidence interval 0.19–0.95).

In concordance with meta-analytic evidence, a mortality benefit for preterm infants was reported in none of the statements that provided recommendations on UCM.^{7,68,69}

DISCUSSION

In this systematic review, we included 24 CPGs and 20 other statements, which together contained 70 recommendations on DCC and 23 recommendations on UCM for preterm and term infants. There was significant variation between statements on the specific details of performing DCC and UCM, despite all endorsing placental transfusion. Statements frequently failed to cite the most compelling evidence of reductions in mortality in preterm infants.

Strengths and Limitations

Motivated by the clinical goal of improving DCC rates by improving guideline quality,¹⁵ we comprehensively searched in multiple academic and gray literature sources without language or country restrictions. We included CPGs, consensus statements, and position papers; hence, we synthesized all retrieved recommendations that may shape health providers' practices. In addition, we reviewed the concordance of recommendations with cited evidence regarding the duration of DCC and the availability of high-quality evidence on the mortality benefits of placental transfusion for preterm infants. Finally, we used a modified AGREE II

and the AGREE-REX to appraise the methodologic quality and applicability of all recommendations.

Our study also has limitations. First, given that using guidelines as the study type is relatively new in the world of systematic reviews (although increasing^{22,70}), there is a lack of tools to inform study design and execution. To mediate this limitation, we closely followed methodologic guidance for systematic reviews of CPGs by Johnston et al¹⁷ and referred to published systematic reviews of CPGs. Second, we could not ascertain the level of authority possessed by each authoring organization, which would allow us to comment on the degree to which particular recommendations influence practitioners. Third, for feasibility, we used Google Translate to interpret guidelines not written in English, when local translation was not available, for the following languages: Estonian, French, German, Italian, Japanese, Romanian, and Spanish. Finally, because our search strategy was designed to capture guidelines that mention terms describing placental transfusion, we are unable to calculate the proportion of all perinatal guidelines that comment on cord management.

Interpretation of Findings

CPGs and other recommendation statements published within the past decade agree that DCC should be offered to stable preterm and term infants. Furthermore, several guidelines on preventing postpartum hemorrhage included DCC as a component of the active management of the third stage of labor, in line with evidence that DCC does not increase the risk of severe postpartum hemorrhage at term.⁷¹

There is significant heterogeneity among recommendations about the methods of performing DCC, especially regarding the timing of cord clamping. Indeed, even recent systematic reviews and meta-analyses among preterm infants

Year	Organization	Population	Contraindications	Recommendations on DCC
Preterm infants				
2018	Enhanced Recovery After Surgery Society ⁵⁷	Preterm	I: Need for immediate resuscitation UP: Placental circulation not intact	⌚ CD: ≥30 s
2018	Confalonieri Ragonese Foundation with the Italian Society of Obstetrics and Gynecology ³¹	Preterm singleton	M: Unstable conditions; multiple pregnancy I: Neonatal resuscitation required; congenital anomalies; hydrops development with pathological fetus flowmetry; alloimmunization UP: Placental abnormalities; adnexal pathologies (placenta previa, vasa previa or abruption, dyed amniotic fluid)	⌚ ≥60 s and after the newborn has taken the first breath
2018	Italian Task Force for the Management of Umbilical Cord Clamping ²³	GA 34–36 ⁶ wk	M: Massive uterine bleeding; CD under general anesthesia; collapse; cardiac arrest I: Need for immediate resuscitation; birth asphyxia secondary to hypoxic-ischemic events; shoulder dystocia; twin-twin syndrome; rhesus disease; fetal hydrops; monozygotic twins UP: Doubts about integrity of umbilical cord; cord prolapse; uterine rupture; vasa previa; placental detachment; amniotic embolism	Vaginal delivery: 60–180 seconds ⌚ Position: At or below the perineal level for the first 30 s, then on the maternal abdomen CD: 30–60 s In infants not breathing at birth, dry and stimulate by rubbing the back 2–3 times; encourage spontaneous breathing before clamping and clamp cord if persistent apnea. Ensure presence of neonatal resuscitation skills to evaluate newborn in transition phase. At least 30 seconds (maintain body temperature, perform tactile stimulation, and ensure airway patency and aspiration. At 30 s, evaluate tone, breathing activity, and heart rate. If bradycardic (<100 bpm), apneic or gasping, clamp cord and begin ventilatory assistance. At 30 seconds, if heart rate is >100 beats per minute and active breathing or efforts to breathe, clamp at 60 s.) ⌚ Vaginal delivery; GA 29–33 ⁶ wk and not requiring ventilatory assistance: 90–120 s Position in vaginal delivery: At or below the perineal plane
		GA <34 wk		
2018	SOGC ⁴³	Preterm		⌚ ≥60 s
2017	SOGC ²⁹	Extremely preterm		DCC is suggested but an optimal timing is not provided.
2015	Japanese Resuscitation Council ⁴⁰	Preterm	I: Need for immediate resuscitation	DCC is suggested but an optimal timing is not provided.
2015	NICE ³²	Preterm	M: Significant hemorrhage I: Needs to move from mother for resuscitation	⌚ 30–180 s, if the mother and infant are stable Position: at or below the level of the placenta
2014	High Authority of Health (France) ⁵⁴	Preterm		⌚ ≥30 s, do not delay management of an emergency
2014	Swedish National Board of Health and Welfare ³³	GA <28 wk	I: Need for immediate resuscitation	⌚ After 45–60 s
Term Infants				
2018	Enhanced Recovery After Surgery Society ⁵⁷	Term	I: Need for immediate resuscitation UP: Placental circulation not intact	⌚ CD: ≥60 s

FIGURE 4

Recommendations on DCC by Included CPGs. AMTSL, active management of the third stage of labor; BW, birth weight; CD, cesarean delivery; CHD, congenital heart disease; GA, gestational age; I, infant contraindications; ILCOR, International Liaison Committee on Resuscitation; M, maternal contraindications; PMTSL, physiologic management of the third stage of labor; PPH, postpartum hemorrhage; SOGC, Society of Obstetricians and Gynaecologists of Canada; UP, uteroplacental contraindications; clock symbol, the recommended optimal timing for DCC. ^aThe statement by the Royal College of Midwives⁵⁸ includes a technical manual, which could not be found online. We inferred that it is a CPG using the summary of guideline methodology provided in the main guideline document. ^bThis statement is a compilation of 2 other WHO statements.^{41,46}

suggest deferring ≥30 seconds⁷² or ≥60 seconds³ but do not suggest an upper limit at which time to clamp the cord. One reason for this may be that because most preterm infants require early support, an optimal time to clamp the cord has not yet been established. We identified a few statements recommending clamping the cord at times that are not yet verified by robust evidence (eg, 5 minutes, after delivery of the placenta). To maximize the benefits of DCC and prevent adverse effects, recommended durations should reflect high-quality evidence.

Nearly two-thirds of the statements exclude nonvigorous infants who require immediate neonatal

resuscitation from receiving DCC in order to move the infant away from the mother to perform resuscitation. Unfortunately, this means that the sickest infants, who might benefit from DCC the most, are excluded from this intervention. Innovative technological solutions that may address this issue are being studied: prototypes of mobile trolleys that allow neonatal resuscitation to be performed with an intact cord have revealed safety, feasibility, and acceptability among health providers (eg, Bedside Assessment, Stabilization and Initial Cardiorespiratory Support, LifeStart).^{73,74} If proven to be beneficial, bringing resuscitation to the mother's bedside will require changes to hospital policy and ergonomics and collaboration between care providers, including

pediatricians, obstetricians, and midwives.⁷⁵

Beyond DCC, UCM is a potential simple alternative that can allow placental transfusion to be quickly performed in infants who need immediate resuscitation.^{69,75} Statements recommended UCM less frequently compared with DCC. Because milking disrupts the normal fetoplacental circulation to increase blood flow to the infant more rapidly than DCC, there are concerns that UCM may have adverse effects.⁷⁶ Guidelines echoed the need for more research on UCM, some of which has recently emerged. A trial by Katheria et al⁸ was prematurely terminated because of concerns about severe IVH

Year	Organization	Population	Contraindications	Recommendations on DCC
2018	Italian Task Force for the Management of Umbilical Cord Clamping ²³	Term	M: Massive uterine bleeding; CD under general anesthesia; collapse; cardiac arrest I: Need for immediate resuscitation; birth asphyxia secondary to hypoxic-ischemic events; shoulder dystocia; twin-twin syndrome; rhesus disease; fetal hydrops; mono chorionic twins UP: Doubts about integrity of umbilical cord; cord prolapse; uterine rupture; vasa previa; placental detachment; amniotic embolism	Vaginal delivery: ≥60 s, clamp by 3–5 min or until pulsation stops if requested by the mother ⊖ Position: On mother's abdomen or chest or below perineal plane CD 30–60 s (if >60 s, ensure presence of neonatal resuscitation skills to evaluate fetoneonatal transition) Dry and stimulate nonbreathing infants by rubbing back 2–3 times to encourage spontaneous breathing before clamping, and clamp cord if persistent apnea.
2018	SOGC ⁴³	Term		Weigh the risks of neonatal jaundice requiring phototherapy against the benefits of DCC.
2017	Queensland Clinical Guidelines ⁴⁹	Term (GA 37–42 wk) born spontaneously in vertex position, and the mother and child in good condition	I: Heart rate <60 beats per minute UP: Concern with cord integrity	Vaginal delivery: AMTSL: 1–3 min or until cord pulsation ceases; within 5 min if controlled cord traction anticipated PMTSL: After cord pulsation ceased or after birth of the placenta
2014	High Authority of Health (France) ⁵⁴	Term		⊖ ≥60s, do not delay management of an emergency
2014	NICE ⁵¹	Term (GA 37–42 wk)	I: Heart rate <60 beats per minute, not getting faster UP: Concern with cord integrity	AMTSL: 1–5 min (clamp before 5 min to perform controlled cord traction. If the mother requests clamping later than 5 min, support her choice.) ⊖ PMTSL: When cord pulsation has stopped
Preterm and Term Infants of GA Unspecified				
2019	Queensland Clinical Guidelines ⁴²	Preventing and managing primary PPH		⊖ AMTSL: At least 1–3 min while initiating simultaneous essential newborn care (routine early clamping not recommended)
2018	Italian Task Force for the Management of Umbilical Cord Clamping ²³	GA ≥34 wk		Dry and stimulate apneic infants before clamping by rubbing the back 2–3 times to encourage spontaneous breathing, and clamp the cord if persistent apnea.
		Dichorionic twins	M: Massive uterine bleeding; cesarean delivery under general anesthesia; collapse; cardiac arrest I: Need for immediate resuscitation; birth asphyxia secondary to hypoxic-ischemic events; shoulder dystocia; twin-twin syndrome; rhesus disease; fetal hydrops; mono chorionic twins UP: Doubts about integrity of umbilical cord; cord prolapse; uterine rupture; vasa previa; placental detachment; amniotic embolism	⊖ 30–60 s At risk of anemia due to fetomaternal alloimmunization: ≤30 s from birth, after first breaths if they are before 30 s
		Other populations		⊖ HIV-positive mother with adequate antiretroviral therapy during pregnancy and HIV-RNA ≤1000 copies per mL at or near delivery with scheduled CD: 30–60 s CHD: vaginal delivery: 1–2 min CD: 1 min; if severe CHD (group 3), discuss DCC in prenatal multidisciplinary team Altruistic cord blood donation: 1–2 min Directed cord blood donation for at-risk families: immediate clamping

FIGURE 4
(Continued).

in infants born at 23 to 27⁶ weeks' gestation who received UCM. In their systematic review, Balasubramanian et al⁶⁹ also found significantly increased risk of severe IVH (grades 3 or higher) among preterm infants <34 weeks who received UCM compared with DCC in 4 RCTs.

Importantly, the RCT by Katheria et al,⁸ which was the only included trial that found significantly increased risk, contributed nearly half the sample size of the UCM versus DCC comparison in this systematic review.⁶⁹ Ongoing trials among infants of older gestational ages and follow-up studies on long-term neurodevelopmental outcomes will be important to support future recommendations on UCM.^{77,78}

Additionally, high-quality evidence on various cord milking techniques (eg, the number of milkings, speed of milking, and position of the infant) and studies on the outcomes of cord milking among infants needing resuscitation are needed.

Increased granularity of recommendations may improve health providers' ability and confidence in performing DCC. Only 4 statements were dedicated to DCC; all others embedded recommendations about DCC within broader topics. Guidelines focused on cord management would allow for specific recommendations for subpopulations (eg, various preterm gestational ages, modes of delivery). Further guidance is required on the position to hold the

infant, the sequence of administration of uterotonic medications, temperature control, and other details. Additionally, DCC's life-saving benefits to extremely preterm and preterm infants³ should be noted as the basis of recommendations.

The language we use to discuss DCC may also encourage its practice and assist patients in understanding it as being a positive rather than a negative intervention. Among the 33 English-language statements, only 1 used the term "deferred cord clamping"⁵¹; all others referred to "delayed" or "late" cord clamping, which connote negativity and that immediate cord clamping is the norm.¹² Hence, we recommend that

Year	Organization	Population	Contraindications	Recommendations on DCC
2018	The Royal College of Midwives ^{58,a}			DCC is suggested but an optimal timing is not provided. Discuss DCC options with the mother in situations other than a vaginal delivery (instrumental, cesarean).
2016	Association of Ontario Midwives ⁴⁴	Preventing and managing PPH		⊖ AMTSL: Until cord pulsation ceases ⊖ PMTSL: Until cord pulsation ceases or delivery of the placenta
2016	British Committee for Standards in Haematology ⁵³		I: Requiring resuscitation	DCC is recommended but an optimal timing is not provided.
2016	SOGC ⁶³	Term and preterm	I: Need for immediate resuscitation	⊖ Vaginal or CD: 60 s
2016	Queensland Clinical Guidelines ³⁷	Uncompromised infants	I: Need for resuscitation takes precedence	There is insufficient evidence to recommend an optimal timing.
2015	Resuscitation Council UK ³⁹	Uncompromised infants	I: Need for immediate resuscitation (there is insufficient evidence to recommend an optimal timing for severely compromised infants.)	⊖ ≥60 s
2015	SOGC ⁶⁰	Cord blood counseling, collection, banking		Cord blood collection should not interfere with DCC. Inform women and partners about the benefits of DCC and its impact on cord blood collection and banking.
2014	Royal College of Obstetricians and Gynaecologists ⁶¹	GA >23 ⁹ wk, uncompromised infants after cord prolapse	I: Need for immediate resuscitation	DCC is recommended but an optimal timing not provided.
2014	WHO ^{26,b}		I: Asphyxiated and needs to be moved immediately for resuscitation (If there is experience providing effective positive pressure ventilation without cutting the cord, initiate ventilation before cutting the cord.)	⊖ ≥60 s DCC is recommended among women with HIV or women with unknown HIV status. Determine HIV status at birth and provide appropriate anti retroviral therapy.
2012	WHO ⁴¹		I: Requiring positive pressure ventilation	⊖ ≥60 s Stimulate infants who do not breathe spontaneously after drying by rubbing the back 2–3 times before clamping the cord and initiating positive pressure ventilation.
2012	WHO ⁴⁶	Preventing PPH	I: Asphyxiated and needs to be moved immediately for resuscitation	⊖ Vaginal and CD: Approximately 1–3 min after birth while providing essential newborn care; recommended among women with HIV or with unknown HIV status as well

FIGURE 4
(Continued).

future guidelines and studies use the more neutral term, “deferred.”

Although many professional societies advocate DCC for preterm and term infants, improved clarity and granularity can improve the quality of guidance on this issue. In this systematic review, we found that guidelines representing different professions within the same country provided different recommendations. For example, although the ACOG recommended deferring clamping for at least 30 to 60 seconds for term infants,²⁴ the American College of Nurse-Midwives recommended deferring for up to 5 minutes for vaginally delivered term infants positioned skin to skin.²⁵ Before its closure in 2018, the National Guideline Clearinghouse, an initiative of the US Department of Health and Human Services, allowed health providers to succinctly synthesize and compare guidelines on topics of interest to identify recommendations that are most suitable to their clinical setting and population. Our study provides this knowledge synthesis with the methodologic rigor of a systematic

review and with quality appraisal of guidelines and recommendations. The abundance and heterogeneity of guidelines on placental transfusion emphasize the need for an updated resource for health providers that compiles and compares the content and quality of relevant statements.

To improve rates of DCC for infants born worldwide, strong guidelines should be amenable to adoption in everyday clinical settings. Among our included CPGs and other recommendation documents, 42% satisfactorily (domain score $\geq 50\%$) met the criteria within the AGREE-REX domain of implementability, which is used to assess the suitability of the recommendations for local adoption.²⁰ In their systematic review of 18 studies conducted in high- and middle-income countries, Anton et al⁷⁹ describe barriers to implementing placental transfusion in hospital settings. General challenges included staff unawareness and resistance to change, and pediatrician-specific concerns included uncertainty about the role of placental transfusion when neonatal

resuscitation is needed and concerns about potential adverse outcomes, such as jaundice.⁷⁹ Strategies to overcome barriers to implementation included education, creating protocols, auditing, providing constructive feedback, and improving multidisciplinary collaboration.⁷⁹ For example, the CPG by NICE provides a modifiable clinical auditing tool for the third stage of labor.⁵¹ Additionally, joint guidelines by obstetrical and pediatric care providers and establishing of opportunities for multidisciplinary communication, such as a predelivery surgical pause and team debriefing, may facilitate improved rates of DCC. Beyond revealing the evidence-informed nature of DCC, efforts to address resistance to change and make DCC acceptable to policy-makers, health workers, and families will improve the rates of its adoption to practice.²⁶ Although we found no country-specific recommendation statements produced in low-income countries, the WHO promotes the integration of DCC to national childbirth and postnatal care programming worldwide by employing strategies such as culturally

appropriate education on DCC, linking of implementation with other interventions (eg, improving women's health literacy), and robust monitoring and evaluation.²⁶

Birth brings together many disciplines; it is thus important that organizations guiding various disciplines are unified in their messages and use the current best evidence to provide detailed, comprehensive, and locally applicable recommendations so that change at the level of the birth can be implemented in a collaborative and sustainable way.¹⁰

CONCLUSIONS

In our systematic review of 44 CPGs and other recommendation statements, we found that professional maternal and infant health societies endorsed DCC to prevent neonatal

morbidity and mortality among stable preterm and term infants. Only half the recommendations on the optional duration of DCC were supported by primary research or systematic review evidence, and in only 8% of statements was a mortality benefit of DCC for preterm infants reported. The current implementation of DCC may be increased with the provision of more unified, detailed, and evidence-based guidance on cord management.

ACKNOWLEDGMENTS

We thank Ms Kaitlin Fuller, liaison and education librarian at Gerstein Science Information Centre, University of Toronto, for her assistance in developing the search strategies. We value the contributions of Ms Rifaa Fatima Ali and Ms Angel Gao in the administrative aspects of the study.

ABBREVIATIONS

ACOG: American College of Obstetricians and Gynecologists
AGREE: Appraisal of Guidelines for Research and Evaluation
AGREE II: Appraisal of Guidelines for Research and Evaluation II
AGREE-REX: Appraisal of Guidelines for Research and Evaluation Recommendation Excellence
CD: cesarean delivery
CPG: clinical practice guideline
DCC: deferred cord clamping
IVH: intraventricular hemorrhage
NICE: National Institute for Health and Care Excellence
RCT: randomized controlled trial
UCM: umbilical cord milking
WHO: World Health Organization

DOI: <https://doi.org/10.1542/peds.2020-1429>

Accepted for publication Jul 17, 2020

Address correspondence to Sarah D. McDonald, MD, MSc, Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology and Departments of Radiology and Health Research Methods, Evidence, and Impact, McMaster University, 1280 Main St West, Room 3N52G, Hamilton, ON, Canada L8S 4L8.
E-mail: mcdonalds@mcmaster.ca

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2020 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: Dr McDonald is supported by a Canadian Institutes of Health Research Tier II Canada Research Chair sponsor award (950-229920). The Canadian Institutes of Health Research had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication; and Ms Liyanage and Mr Ninan have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have no conflicts of interest relevant to this article to disclose.

REFERENCES

- Downey CL, Bewley S. Historical perspectives on umbilical cord clamping and neonatal transition. *J R Soc Med*. 2012;105(8):325–329
- Katheria AC, Lakshminrusimha S, Rabe H, McAdams R, Mercer JS. Placental transfusion: a review. *J Perinatol*. 2017; 37(2):105–111
- Fogarty M, Osborn DA, Askie L, et al. Delayed vs early umbilical cord clamping for preterm infants: a systematic review and meta-analysis. *Am J Obstet Gynecol*. 2018;218(1):1–18
- Raju TN. Timing of umbilical cord clamping after birth for optimizing placental transfusion. *Curr Opin Pediatr*. 2013;25(2):180–187
- Rabe H, Gyte GM, Diaz-Rossello JL, Duley L. Effect of timing of umbilical cord clamping and other strategies to influence placental transfusion at preterm birth on maternal and infant outcomes. *Cochrane Database Syst Rev*. 2019;(9):CD003248
- Armstrong-Buisseret L, Powers K, Dorling J, et al. Randomised trial of cord clamping at very preterm birth: outcomes at 2 years. *Arch Dis Child Fetal Neonatal Ed*. 2020;105(3):292–298
- Al-Wassia H, Shah PS. Efficacy and safety of umbilical cord milking at birth: a systematic review and meta-analysis. *JAMA Pediatr*. 2015;169(1):18–25

8. Katheria A, Reister F, Essers J, et al. Association of umbilical cord milking vs delayed umbilical cord clamping with death or severe intraventricular hemorrhage among preterm infants. *JAMA*. 2019;322(19):1877–1886
9. Blouin B, Penny ME, Maheu-Giroux M, et al. Timing of umbilical cord-clamping and infant anaemia: the role of maternal anaemia. *Paediatr Int Child Health*. 2013;33(2):79–85
10. Mercer JS, Erickson-Owens DA. Rethinking placental transfusion and cord clamping issues. *J Perinat Neonatal Nurs*. 2012;26(3):202–217; quiz 218–219
11. Ononeze AB, Hutchon DJ. Attitude of obstetricians towards delayed cord clamping: a questionnaire-based study. *J Obstet Gynaecol*. 2009;29(3):223–224
12. Jelin AC, Kuppermann M, Erickson K, Clyman R, Schulkin J. Obstetricians' attitudes and beliefs regarding umbilical cord clamping. *J Matern Fetal Neonatal Med*. 2014;27(14):1457–1461
13. Tran CL, Parucha JM, Jegatheesan P, Lee HC. Delayed cord clamping and umbilical cord milking among infants in California neonatal intensive care units. *Am J Perinatol*. 2020;37(2):151–157
14. Canadian Neonatal Network. *The Canadian Neonatal Network Annual Report 2018*. Toronto, Canada: Canadian Neonatal Network; 2019
15. Hutchon DJ. Why do obstetricians and midwives still rush to clamp the cord? *BMJ*. 2010;341:c5447
16. Higgins JPT, Thomas J, Chandler J, eds, et al. *Cochrane Handbook for Systematic Reviews of Interventions*. 2nd ed. Chichester, United Kingdom: John Wiley & Sons; 2019
17. Johnston A, Kelly SE, Hsieh SC, Skidmore B, Wells GA. Systematic reviews of clinical practice guidelines: a methodological guide. *J Clin Epidemiol*. 2019;108:64–76
18. Graham R, Mancher M, Wolman DM, Greenfield S, Steinberg E, eds; Institute of Medicine Committee on Standards for Developing Trustworthy Clinical Practice Guidelines. *Clinical Practice Guidelines We Can Trust*. Washington, DC: National Academies Press; 2011
19. Brouwers MC, Kho ME, Browman GP, et al; AGREE Next Steps Consortium. AGREE II: advancing guideline development, reporting and evaluation in health care. *CMAJ*. 2010;182(18):E839–E842
20. AGREE-REX Research Team. The Appraisal of Guidelines Research & Evaluation—Recommendation EXcellence (AGREE-REX). 2019. Available at: <https://www.agreetrust.org/wp-content/uploads/2019/04/AGREE-REX-2019.pdf>. Accessed June 25, 2019
21. Bragge P, Guy S, Boulet M, Ghafoori E, Goodwin D, Wright B. A systematic review of the content and quality of clinical practice guidelines for management of the neurogenic bladder following spinal cord injury. *Spinal Cord*. 2019;57(7):540–549
22. Grammatikopoulou MG, Theodoridis X, Gkiouras K, et al. Methodological quality of clinical practice guidelines for nutrition and weight gain during pregnancy: a systematic review. *Nutr Rev*. 2020;78(7):546–562
23. Ghirardello S, Di Tommaso M, Fiocchi S, et al. Italian recommendations for placental transfusion strategies. *Front Pediatr*. 2018;6:372
24. Committee on Obstetric Practice. Committee opinion No. 684: delayed umbilical cord clamping after birth. *Obstet Gynecol*. 2017;129(1):e5–e10
25. American College of Nurse-Midwives. *Position Statement: Delayed Umbilical Cord Clamping*. Silver Spring, MD: American College of Nurse-Midwives; 2014
26. World Health Organization. *Guideline: Delayed Umbilical Cord Clamping for Improved Maternal and Infant Health and Nutrition Outcomes*. Geneva, Switzerland: World Health Organization; 2014
27. Ministerul Sănătății, Comisia de Obstetrică. Na terea înainte de termen. 2019. Available at: <https://soqr.ro/wp-content/uploads/2019/02/Na-terea-%C3%83%C2%AEnainte-de-termen.pdf>. Accessed August 23, 2019
28. Di Renzo GC, Cabero Roura L, Facchinetti F, et al. Preterm labor and birth management: recommendations from the European Association of Perinatal Medicine. *J Matern Fetal Neonatal Med*. 2017;30(17):2011–2030
29. Ladhani NNN, Chari RS, Dunn MS, Jones G, Shah P, Barrett JFR. No. 347-obstetric management at borderline viability. *J Obstet Gynaecol Can*. 2017;39(9):781–791
30. Al-Salam Z, Al-Alaiyan S, Alallah J, et al. The golden hour approach: practical guidelines of the Saudi Neonatology Society on managing very low birth weight infants in the first hour of life. *J Clin Neonatol*. 2016;5(4):222–229
31. La Fondazione Confalonieri Ragonese. *Gestione Del Parto Pretermine*. 2016. Available at: <https://www.sigo.it/wp-content/uploads/2016/03/Gestione-del-Parto-Pretermine.pdf>. Accessed August 23, 2019
32. National Institute for Health and Care Excellence. *Preterm Labour and Birth: NICE Guideline*. London, United Kingdom: National Institute for Health and Care Excellence; 2015
33. Sindelar R. *Vård av extremt för tidigt födda barn: En vägledning för vården av barn födda före 28 fullbordade graviditetsveckor*. Stockholm, Sweden: Socialstyrelsen; 2014
34. Yeo CL, Biswas A, Ee TTK, et al. Singapore neonatal resuscitation guidelines 2016. *Singapore Med J*. 2017; 58(7):391–403
35. Australian and New Zealand Resuscitation Committee on Resuscitation; New Zealand Resuscitation Council; Australian Resuscitation Council. ANZCOR Guideline 13.1 – Introduction to Resuscitation of the Newborn Infant. 2017. Available at: <https://www.nzrc.org.nz/guidelines/>. Accessed August 23, 2019
36. Berger TM, Bernet V, Schulzke SM, et al. *Support of Adaptation and Resuscitation of the Newborn Infant*. Swiss Society of Neonatology; 2018
37. Queensland Clinical Guidelines. *Neonatal Resuscitation*. Brisbane, Australia: Queensland Health; 2016
38. Nederlandse Reanimatie Raad. *Richtlijnen Reanimatie in Nederland 2015*. The Hague, Netherlands: Nederlandse Reanimatie Raad; 2015
39. Wyllie J, Ainsworth S, Tinnion R. *Guidelines: Resuscitation and Support*

- of *Transition of Babies at Birth*. London, United Kingdom: Resuscitation Council UK; 2015
40. Japan Resuscitation Council. *Japan Resuscitation Council Resuscitation Guidelines 2015*. Japan Resuscitation Council; 2016
 41. World Health Organization. *Guidelines on Basic Newborn Resuscitation*. Geneva, Switzerland: World Health Organization; 2012
 42. Queensland Clinical Guidelines. *Primary Postpartum Haemorrhage*. Brisbane, Australia: Queensland Health; 2018
 43. Leduc D, Senikas V, Lalonde AB. No. 235-active management of the third stage of labour: prevention and treatment of postpartum hemorrhage. *J Obstet Gynaecol Can*. 2018;40(12):e841–e855
 44. Association of Ontario Midwives. *Clinical Practice Guideline 17: Postpartum Hemorrhage*. Toronto, Canada: Association of Ontario Midwives; 2016
 45. Obstetrics Subgroup, Chinese Society of Obstetrics and Gynecology, Chinese Medical Association. Guideline of prevention and treatment about postpartum hemorrhage (2014) [in Chinese]. *Zhonghua Fu Chan Ke Za Zhi*. 2014;49(9):641–646
 46. World Health Organization. *WHO Recommendations for the Prevention and Treatment of Postpartum Haemorrhage*. Geneva, Switzerland; World Health Organization; 2012
 47. Federation of Obstetric and Gynaecological Societies of India. *Consensus Statement for Prevention of Post Partum Hemorrhage (PPH)*. Mumbai, India: Federation of Obstetric and Gynaecological Societies of India; 2014
 48. Simma B, Kiechl-Kohlendorfer U, Wald M, Weissensteiner M, Urles Berger A, et al; Arbeitsgruppe Neonatologie und Pädiatrische Intensivmedizin der Österreichischen Gesellschaft für Kinder- u. Jugendheilkunde (ÖGKJ). Betreuung des gesunden neugeborenen in kreißsaal und kinderzimmer. *Monatsschr Kinderheilkd*. 2018;166(9): 808–813
 49. Queensland Clinical Guidelines. *Normal Birth*. Brisbane, Australia: Queensland Health; 2017
 50. Society of Estonian Gynaecologists. *Juhend Normaalse Sünnituse Käsitlemiseks*. Tartu, Estonia: Society of Estonian Gynaecologists; 2014
 51. Delgado Nunes V, Gholitabar M, Sims JM, Bewley S; Guideline Development Group. Intrapartum care of healthy women and their babies: summary of updated NICE guidance. *BMJ*. 2014;349: g6886
 52. Uranga A, Urman J, Lomuto C, et al. *Guía para la Atención del Parto Normal en Maternidades Centradas en la Familia*. Buenos Aires, Argentina: Ministerio de Salud; 2004
 53. New HV, Berryman J, Bolton-Maggs PH, et al; British Committee for Standards in Haematology. Guidelines on transfusion for fetuses, neonates and older children. *Br J Haematol*. 2016; 175(5):784–828
 54. Haute Autorité de Santé. *Transfusion de Globules Rouges Homologues: Produits, Indications Alternatives*. Paris, France: Haute Autorité de Santé; 2014
 55. Ryan M, Lacaze-Masmonteil T, Mohammad K. Neuroprotection from acute brain injury in preterm infants. *Paediatr Child Health*. 2019;24(4): 276–290
 56. Sweet DG, Carnielli V, Greisen G, et al. European consensus guidelines on the management of respiratory distress syndrome - 2019 update. *Neonatology*. 2019;115(4):432–450
 57. Caughey AB, Wood SL, Macones GA, et al. Guidelines for intraoperative care in cesarean delivery: Enhanced Recovery After Surgery Society recommendations (part 2). *Am J Obstet Gynecol*. 2018;219(6):533–544
 58. The Royal College of Midwives. *Midwifery Care in Labour Guidance for All Women in all Settings: RCM Midwifery Blue Top Guidance*. London, United Kingdom: The Royal College of Midwives; 2018
 59. Özkan H, Erdeve Ö, Kutman HGK. Türk Neonatoloji Derneği respiratuvar distres sendromu ve surfaktan tedavisi rehberi. *Türk Pediatri Ars*. 2018;53(suppl 1):S45–S54
 60. Armson BA, Allan DS, Casper RF. Umbilical cord blood: counselling, collection, and banking. *J Obstet Gynaecol Can*. 2015;37(9):832–844
 61. Royal College of Obstetricians and Gynaecologists. *Umbilical Cord Prolapse (Green-Top Guideline No. 50)*. London, United Kingdom: Royal College of Obstetricians and Gynaecologists; 2014
 62. Lemyre B, Sample M, Lacaze-Masmonteil T; Canadian Paediatric Society, Fetus and Newborn Committee. Minimizing blood loss and the need for transfusions in very premature infants. *Paediatr Child Health*. 2015;20(8): 451–462
 63. Lee L, Dy J, Azzam H. Management of spontaneous labour at term in healthy women. *J Obstet Gynaecol Can*. 2016; 38(9):843–865
 64. Wyllie J, Perlman JM, Kattwinkel J, et al; Neonatal Resuscitation Chapter Collaborators. Part 7: neonatal resuscitation: 2015 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Resuscitation*. 2015;95:e169–e201
 65. Wyllie J, Bruinenberg J, Roehr CC, Rüdiger M, Trevisanuto D, Urlesberger B. European Resuscitation Council guidelines for resuscitation 2015: section 7. Resuscitation and support of transition of babies at birth. *Resuscitation*. 2015;95:249–263
 66. Wyckoff MH, Aziz K, Escobedo MB, et al. Part 13: neonatal resuscitation: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation*. 2015; 132(18, suppl 2):S543–S560.
 67. Backes CH, Rivera BK, Haque U, Bridge JA, Smith CV, Hutchon DJ, Mercer JS. Placental transfusion strategies in very preterm neonates: a systematic review and meta-analysis. *Obstet Gynecol*. 2014;124(1):47–56
 68. Nagano N, Saito M, Sugiura T, Miyahara F, Namba F, Ota E. Benefits of umbilical cord milking versus delayed cord clamping on neonatal outcomes in preterm infants: a systematic review and meta-analysis. *PLoS One*. 2018; 13(8):e0201528
 69. Balasubramanian H, Ananthan A, Jain V, Rao SC, Kabra N. Umbilical cord milking in preterm infants: a systematic review and meta-analysis [published online

- ahead of print March 9, 2020]. *Arch Dis Child Fetal Neonatal Ed*. doi:10.1136/archdischild-2019-318627
70. Gillon TE, Pels A, von Dadelszen P, MacDonell K, Magee LA. Hypertensive disorders of pregnancy: a systematic review of international clinical practice guidelines. *PLoS One*. 2014;9(12):e113715
 71. McDonald SJ, Middleton P, Dowswell T, Morris PS. Effect of timing of umbilical cord clamping of term infants on maternal and neonatal outcomes. *Evid Based Child Health*. 2014;9(2):303–397
 72. Ghavam S, Batra D, Mercer J, et al. Effects of placental transfusion in extremely low birthweight infants: meta-analysis of long- and short-term outcomes. *Transfusion*. 2014;54(4):1192–1198
 73. Weeks AD, Watt P, Yoxall CW, et al. Innovation in immediate neonatal care: development of the Bedside Assessment, Stabilisation and Initial Cardiorespiratory Support (BASICS) trolley. *BMJ Innov*. 2015;1(2):53–58
 74. Katheria AC, Brown MK, Faksh A, et al. Delayed cord clamping in newborns born at term at risk for resuscitation: a feasibility randomized clinical trial. *J Pediatr*. 2017;187:313–317.e1
 75. Mercer JS, Erickson-Owens DA. Is it time to rethink cord management when resuscitation is needed? *J Midwifery Womens Health*. 2014;59(6):635–644
 76. Tarnow-Mordi WO, Duley L, Field D, et al. Timing of cord clamping in very preterm infants: more evidence is needed. *Am J Obstet Gynecol*. 2014;211(2):118–123
 77. Katheria A, Steen J. Two year developmental follow-up for PREMOD2 trial (Premature Infants Receiving Milking or Delayed Cord Clamping) (PREMOD2FU). 2019. Available at: <https://clinicaltrials.gov/ct2/show/NCT03476980>. Accessed June 2, 2020
 78. Katheria AC, Arnell KM. Premature infants receiving milking or delayed cord clamping: PREMOD2 (PREMOD2). 2020. Available at: <https://clinicaltrials.gov/ct2/show/NCT03019367>. Accessed March 10, 2020
 79. Anton O, Jordan H, Rabe H. Strategies for implementing placental transfusion at birth: a systematic review. *Birth*. 2019;46(3):411–427

Guidelines on Deferred Cord Clamping and Cord Milking: A Systematic Review

Sugee Korale Liyanage, Kiran Ninan and Sarah D. McDonald

Pediatrics 2020;146;

DOI: 10.1542/peds.2020-1429 originally published online October 21, 2020;

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/146/5/e20201429
References	This article cites 47 articles, 5 of which you can access for free at: http://pediatrics.aappublications.org/content/146/5/e20201429#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): Fetus/Newborn Infant http://www.aappublications.org/cgi/collection/fetus:newborn_infant_sub Neonatology http://www.aappublications.org/cgi/collection/neonatology_sub Gynecology http://www.aappublications.org/cgi/collection/gynecology_sub Obstetrics http://www.aappublications.org/cgi/collection/obstetrics_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.aappublications.org/site/misc/reprints.xhtml

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®



PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Guidelines on Deferred Cord Clamping and Cord Milking: A Systematic Review

Sugee Korale Liyanage, Kiran Ninan and Sarah D. McDonald

Pediatrics 2020;146;

DOI: 10.1542/peds.2020-1429 originally published online October 21, 2020;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://pediatrics.aappublications.org/content/146/5/e20201429>

Data Supplement at:

<http://pediatrics.aappublications.org/content/suppl/2020/10/20/peds.2020-1429.DCSupplemental>

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2020 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

