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Research Article

Close Collaboration with Parents Affects the Length of Stay and Growth in Preterm Infants: A Register-based Study in Finland

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Short Title: Effects of Close Collaboration with Parents

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Abstract

Introduction: This study aimed to evaluate how Close Collaboration with Parents (CC), a NICU-wide educational model for healthcare staff to improve their family-centred care practices, affects the length of stay (LOS), growth, and later hospital visits and rehospitalizations of preterm infants.

Methods: This register-based study included all preterm infants born below 35 weeks of gestation in Finland from 2006 through 2020. Eligible infants were classified into the Full-CC group (n=2,104) if the neonatal intensive care units (NICU) of both the delivery and discharge hospitals had implemented the intervention; into the Partial-CC group (n=515) if only one of the NICUs had implemented the intervention; and into the Control group (n=11,621) if neither had implemented the intervention.

Results: The adjusted LOS, the primary outcome, was 1.8 days or 6% shorter in the Full-CC group than in the Control group (geometric mean ratio 0.94, 95% confidence interval 0.89 to 1.00). Growth was better in the Full-CC group compared to the Control group (adjusted group difference 11.7 g/week [95% CI 1.4 to 22.0] for weight, 1.3 mm/week [95% CI 0.6 to 2.0] for length). The Full-CC group infants had lower odds of having any unscheduled outpatient visits compared to the Control group (adjusted odds ratio 0.81; 95% CI 0.67 to 0.98). No significant differences were found in any other comparisons.

Discussion/Conclusion: The unit-wide intervention improving family-centred care practices in NICUs may lead to more efficient use of hospital resources by shortening the length of stay, improving growth, and decreasing hospital visits of preterm infants.

Introduction

During neonatal care, preterm infants often spend a long time in hospital. The care in a neonatal intensive care unit (NICU) can lead to parent-infant separation. One study showed that very preterm infants spent 80% of their time alone in a NICU [1]. Family-centred care interventions, which aim to increase parent-infant closeness and interaction, have improved both parent and infant outcomes [2–4]. Therefore, a new recommendation has been published by WHO about support for parents and their involvement in the care of preterm or low-birth-weight infants [5]. Family-centred care interventions may also optimise the use of healthcare resources by reducing the length of stay (LOS), later hospital visits, and rehospitalisations. Reducing the LOS will decrease parent-infant separation and reduce other risks from the hospital environment such as nosocomial infections and adverse stimuli such as excess light and noises [6].

Four studies about family-centred care interventions showed a reduction in LOS [7–10] but the other three did not [11–13]. Many of these studies were conducted in two or three NICUs with less than 300 participants. A meta-analysis, including 3,070 infants from seven studies, could not demonstrate a beneficial effect of family-centred care on LOS [2]. In addition, most studies targeted a selected group of preterm infants according to gestational age or birth weight. Furthermore, only two previous studies evaluated the effect of family-centred care interventions on later emergency department visits; neither indicated a significant effect [8,14]. The studies showed an inconsistency in the effect obtained on the risk of rehospitalisation [8,9,14].

Some studies and a meta-analysis showed that family-centred care intervention increased weight gain [2,9,12,13,15]. However, each study included less than 1,000 infants. In addition, to our knowledge, no study has evaluated its effect on the increase in length or head circumference.

Thus, the effects of family-centred care interventions are still unclear because of the small number of studies and participants, the selected groups of preterm infants, and the inconsistent and missing outcomes. We used nationwide register data collected over a period of 15 years to evaluate whether the Close Collaboration with Parents, a family-centred care intervention, affected the LOS and other outcomes of preterm infants.

Materials and Methods

Study design and population

This retrospective nationwide register-based study in Finland used the Medical Birth Register, Care Register for Health Care, and Very Preterm Infant Register maintained by the Finnish Institute for Health and Welfare under the Ministry of Social Affairs and Health [16]. These registers cover all infants born in Finland.

The study population consisted of preterm infants born in Finland before 35 weeks of gestation from January 1, 2006 to December 31, 2020, who required care in a NICU immediately after birth. The following infants were excluded: those who died during the NICU stay, those whose discharge information was missing or likely to be incorrect (LOS of 0 day or discharged below 32 weeks of postmenstrual age [PMA]). Those who were still hospitalised at 50 weeks PMA were also excluded as outliers.

Eligible infants were classified into three groups depending on the NICU of the delivery and discharge hospital (Fig. 1 and Fig. 2): into a Full Close Collaboration (Full-CC) group if both NICUs had completed the intervention, into a Partial-CC group if only one of the NICUs had implemented it, and into a Control group if neither had implemented it. The infants were excluded if they were taken into care in a NICU during the intervention.

No ethical approval or informed consent was required based on national research legislation regarding register studies, and data were handled and analysed pseudonymously via a secure remote access platform (Findata Kapseli). This trial has been registered at ClinicalTrials.gov (identifier, NCT05765136).

Data collection and outcome measures

Eligible infants were identified from the Medical Birth Register. The LOS was available from all three registers. If the data were missing or inconsistent, the LOS data were derived following this order of priority: 1. the Care Register for Health Care, 2. Very Preterm Infant Register, and 3. Medical Birth Register.

The primary outcome was the LOS (days) in any NICUs before the first discharge home. The secondary outcomes were the change in growth parameters from birth to discharge (weight z-score; weight, g/week; length, mm/week; head circumference, mm/week); unscheduled outpatient visits (yes/no) and rehospitalisations (yes/no) during the first year of life. The growth data at 42 weeks PMA were used if the infant was still in NICUs at that point because of the legislative permission to

collect data only up until then. The weight z-scores were calculated using Fenton's growth chart and the LMS parameters [17–19].

Intervention

The Close Collaboration with Parents intervention is an educational model for healthcare staff in NICUs [20–22]. It aims to improve the ability of the NICU healthcare staff to I) observe the infants' behaviours and needs, II) support parents to take the initiative and share their observations and understanding of their infant's behaviours and to collaboratively plan the infant's care with the healthcare staff, III) understand the individual story of the family regarding parenthood through a dialogue with parents, and IV) involve parents in the decision-making about the care of their baby from an early stage of care through to the preparation for discharge. The final goal is to improve the care culture in the NICUs by changing the attitudes of the healthcare staff and the care practices of the unit to be more in line with family-centred care principles.

This intervention was implemented in 11 out of 23 NICUs in Finland between 2009 and 2020. In most NICUs, it took about 1.5 years to complete the intervention (white square in Fig. 2). The "train the trainer" model was used in the implementation. The training team mentored the local mentors in each NICU, who then mentored the other healthcare staff. Each healthcare staff received approximately 36 hours of mentoring integrated into their daily work including theory, bedside practices and their reflections with a mentor.

Statistics

Continuous demographic variables were compared with a 1-way analysis of variance and further pairwise comparisons between the Full-CC and Partial-CC groups and Control group using Dunnett's method. The χ^2 test was used to test the differences in the categorical demographic variables. The linear mixed model and mixed effects logistic regression model were used to estimate the group differences in outcomes. The LOS values were natural logarithm transformed for statistical analyses due to positively skewed distributions. The results were expressed as adjusted geometric mean ratios for the LOS, as mean differences for normally distributed outcomes, and as odds ratios for binary outcomes with 95% confidence intervals (95% CI). Models were adjusted for exposure to at least one dose of antenatal corticosteroid, mode of delivery, year of birth, gestational age at birth, birth weight

z-score, sex, multiple birth, and a NICU single-family room (yes/no) [23,24]. The random intercepts for the NICU of the delivery and discharge hospital were included in the models taking into account the clustering effects of the NICUs. All statistical analyses were conducted using SPSS version 27 for Windows (SPSS Inc, Chicago, IL, USA). Two-tailed tests were used, and P <0.05 was considered statistically significant.

Results

A total of 18,107 preterm infants were born in Finland before 35 weeks of gestation in 2006-2020 (Fig. 1). Of those, 2,645 infants were excluded due to death during the NICU stay (n=729), missing discharge data (n=1,489), the LOS data possibly being incorrect (LOS of 0 days [n=171] or discharge before 32 weeks PMA [n=126]), or discharged after 50 weeks PMA (n=130). The infants staying in the NICU during the intervention (n=1,222) were also excluded. The infants were classified according to their exposure to the intervention into a Full-CC group (n=2,104), a Partial-CC group (n=515), and a Control group (n=11,621). The final study groups including 14,240 infants were comparable in their demographic variables, except for an earlier gestational age, a smaller birth weight, and a higher rate of cesarean delivery in the Partial-CC group compared to the Control group (Table 1).

Table 2 summarises the primary and secondary outcomes. The geometric mean LOS was 22.9 days (95% CI, 22.1 to 23.8) in the Full-CC group, 35.6 days (33.4 to 37.9) in the Partial-CC group, and 22.3 days (21.9 to 22.6) in the Control group. The adjusted geometric mean LOS was shorter in the Full-CC group than in the Control group by 1.8 days or 6% (geometric mean ratio [95% CI], 0.94 [0.89 to 1.00]; P=0.041). There was no significance between the Partial-CC and Control group.

The Full-CC group (n=684) had a smaller decrease in the weight z-score than the Control group (n=3747) in the unadjusted analyses, but the difference did not remain significant in the adjusted model. The increase in weight and length was more rapid in the Full-CC group (n=685 in weight and n=670 in length) than in the Control group (n=3768 and 3644) from birth to discharge: the adjusted mean difference of the Full-CC compared to the Control group was 11.7 g/week (95% CI, 1.4 to 22.0; P=0.020) in weight and 1.3 mm/week (95% CI, 0.6 to 2.0; P<0.001) in length. No significant difference was found in head circumference. No growth parameters differed between the Partial-CC and Control group.

The proportion of infants having at least one unscheduled outpatient visit by one year of age was 41.6% in the Full-CC, 36.5% in the Partial-CC, and 41.9% in the Control group. In the adjusted model,

the infants in the Full-CC group had lower odds of having at least one unscheduled outpatient visit compared to the Control group (adjusted odds ratio, 0.81; 95% CI, 0.67 to 0.98; *P*=0.031), whereas the difference between the Partial-CC and Control group was not significant. The proportion of infants having at least one rehospitalisation by one year of age was 16.8% in the Full-CC, 15.3% in the Partial-CC, and 23.5% in the Control group. In the unadjusted model, the odds of having at least one rehospitalisation in the Full-CC and Partial-CC groups compared to the Control group were significantly lower, but the difference disappeared in the adjusted model.

Discussion/Conclusion

We studied a NICU-level intervention to improve family-centred care and found that the intervention shortened the LOS, improved the growth, and reduced the unscheduled outpatient visits of preterm infants. The effects were shown by using nationwide register data including more than 14,000 preterm infants to compare NICUs before or without the intervention to NICUs after the intervention.

Our finding that the Close Collaboration with Parents intervention shortened the LOS is in line with some previous studies on family-centred care interventions [7–10]. However, the decrease in the LOS in this study (1.8 days or 6%) was more modest than in the previous studies. The Creating Opportunities for Parent Empowerment (COPE) intervention shortened the LOS by 3.8 days or 11% in infants born at 28 to 34 weeks of gestation in two NICUs in the USA [7]. The Family Integrated Care (FICare) intervention shortened the adjusted LOS by 6.8 days or 19% in infants born at 29 to 34 weeks of gestation in 11 level III NICUs in China [9]. The Alberta FICare intervention shortened an adjusted LOS by 2.6 days or 13% in infants born at 32 to 34 weeks of gestation in 10 level II NICUs in Canada [8]. The Stockholm neonatal family centered care study showed that a new model of family care with single-family rooms shortened the LOS by 5.3 days or 16% in infants born less than 37 weeks of gestation in two NICUs [10]. The modest effect in our study may be attributed to short baseline LOS in Finland, demonstrated in an international comparison in which Finland had the shortest LOS for extremely preterm infants among 11 high-resource countries [25].

The Close Collaboration with Parents intervention has several components which could explain the shorter LOS [20]. One of them is the impact through improved staff skills: the intervention was shown to be associated with improved skills of the staff in active listening, gaining parents' trust,

shared decision-making, and providing parenting support [26]. Another mechanism might be an impact through increased parents' presence. It has already been shown that the Close Collaboration with Parents intervention increased parents' presence in NICUs [22]. The longer time they spend in the NICU gives them more opportunities to participate in caretaking and decision-making. The positive effects on family-centred care can promote parents' confidence and caretaking skills, through which parents may become ready for discharge sooner. However, more research is needed about the mechanisms of how the intervention shortens the LOS in different phases of hospital care. We do not yet have research on sustainability of the effects of the intervention either. The effects might increase over time when family-centred care culture has become established in a unit.

The promotion of growth in both weight (11.7 g/week) and length (1.3 mm/week) in our study was consistent with previous studies. FICare interventions in Canada, Australia and New Zealand [15] demonstrated an increasing weight gain of 2.03 g/day and in China [9] 5.43 g/kg/day. Two studies in Taiwan showed an increasing weight gain of 2.0 and 3.3 g/day [12,13]. A meta-analysis showed a significant improvement in weight gain of 4.57 g/day [2]. The Close Collaboration with Parents intervention was associated with both longer duration of parents' presence at the bedside and skin-to-skin contact [22]. Skin-to-skin contact has been shown to promote the growth of weight, length and head circumference [27–32]. The mechanisms are not known but it can be speculated that skin-to-skin contact promotes breastmilk production, which promotes infant growth.

Our finding about reduced unscheduled outpatient visits was different from the previous studies which failed to reduce emergency department visits up to two months of corrected age in infants born at 29 to 34 weeks of gestation [8,14]. Our study population had a lower average gestational age and received longer follow-up which possibly explained a higher need for unscheduled/emergency outpatient visits: the proportion of infants with unscheduled/emergency visits was 41.9% in the control group of our study compared to 25.5% in the Alberta FICare study and 23.1% in the H-HOPE study. The Close Collaboration with Parents intervention, which facilitates parents' stay in NICUs, possibly provided them with more time to acquire knowledge, skills, and confidence in childcare [22], and may have attributed to fewer unscheduled outpatient visits.

In contrast, and similar to the Alberta FICare or H-HOPE interventions, the risk of rehospitalisation was not changed by our intervention [8,14]. However, the FICare intervention in China reduced the rehospitalisation rate from 7.48% to 3.65% within 30 days post-discharge in infants born at 29 to 34 weeks of gestation [9]. These participants with the FICare intervention possibly had a low risk of physical illness which required later hospital admission because the intervention improved weight

gain and breastfeeding rate, shortened duration of the need for supplemental oxygen, and reduced nosocomial infections [9].

One strength of our study was that we used national databases with very high coverage regarding the main outcomes. As a result, this study was able to select patients in an unbiased manner, making it a real-world descriptive study. In addition, more infants were included in this study than in the previous studies. Furthermore, as the Close Collaboration with Parents intervention was carried out in 11 NICUs, this study demonstrated its effects in different hospital contexts. Lastly, adjusting for year of birth enabled us to partially account for advances in neonatology during the study period.

This study has some limitations. First, neonatal morbidities were not included in the adjusted models. Therefore, we cannot conclude whether morbidities were mediating factors for shorter LOS [25] and better growth [33]. In addition, the causal inference could not be drawn due to the observational study design. The small number of infants in the Partial-CC group limited the significance and overall reliability of the comparisons made between the Partial-CC and Control groups. In addition, the infants in the Partial-CC group were born at smaller gestational ages and birth weights. This is logical because all the infants in the Partial-CC group needed neonatal transfer. According to the national guidelines, very preterm deliveries (below 32 weeks of gestation) are centralized in the level 3 NICUs in Finland. When the infant is stable, (s)he is transferred to the closest hospital to home.

To conclude, we found that the implementation of the Close Collaboration with Parents intervention was associated with a shortened hospital stay, improved growth, and a reduction in unscheduled outpatient visits for preterm infants. A unit-wide intervention improving family-centred care practices may lead to more effective use of hospital resources and better growth in preterm infants.

Statements

Acknowledgement

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Statement of Ethics

No ethical approval or individual informed consent from each participant was required based on national research legislation regarding register studies, and data were handled and analysed pseudonymously via a secure remote access platform (Findata Kapseli). The study approval was granted by Finnish Social and Health Data Permit Authority Findata, approval number THL/6323/14.02.00/2020. This trial has been registered at ClinicalTrials.gov (identifier, NCT05765136).

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All authors contributed to the study concept and design, the acquisition, analysis, and interpretation of data. RI carried out the initial analyses and the draughting of the initial manuscript. TV helped RI conduct analysis from statistician's perspective. LL obtained the funding and KH and RI also contributed to the process. RI, KH, and LL had full access to all the data in the study. KH accessed and verified the data. All authors critically revised the manuscript for important intellectual content, approved the final version, and had final responsibility for the decision to submit for publication.

Data Availability Statement

The data that supports the findings of this study can be accessed via the Finnish Social and Health Data Permit Authority Findata which has integrated patient information from three national, governmental databases. The pseudonymised data can be analysed only via a secure remote access

platform (Findata Kapseli) which has also archived the data. Further enquiries can be directed to the Finnish Social and Health Data Permit Authority Findata.

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Figure Legends

Fig. 1 Patient flow diagram and patient grouping. NICU, neonatal intensive care unit; CC, Close Collaboration with Parents intervention; PMA, postmenstrual age.

Fig. 2 Timing and duration of implementation of the CC in 11 NICUs in Finland (white square). In addition, there were 12 NICUs without the intervention. Eligible infants were classified into three groups according to the CC implementation status of the NICUs (No/before CC or CC completed). Infants cared for during the implementation period was excluded. CC, Close Collaboration with Parents intervention; NICU, neonatal intensive care unit.

Table 1. Demographics of the study patients in the study groups

	Full-CC (n=2,104)	Partial-CC (n=515)	Control (n=11,621)
Gestational age, wk, mean (SD)	32.4 (2.5)	31.1 (2.8) [a]	32.4 (2.5)
Birth weight, g, mean (SD)	1914 (631.3) [a]	1631 (598.9) [a]	1874 (587.5)
Birth weight z-score, mean (SD)	0.09 (1.00) [a]	−0.00 (0.99)	−0.00 (0.96)
Male sex, n (%)	1173 (55.8)	277 (53.8)	6329 (54.5)
Singleton, n (%)	1583 (75.2) [a]	361 (70.1)	8200 (70.6)
Antenatal corticosteroid, n (%)	1601 (98.1)	459 (99.6)	7785 (98.1)
Cesarean delivery, n (%)	1178 (56.0)	344 (66.8) [a]	6299 (54.2)

SD, standard deviation.

[a] P-value of comparison with the Control group was <.05 after Bonferroni correction

Table 2. Length of stay, growth, and later hospital visits/rehospitalisations in preterm infants compared between the Full-CC, Partial-CC, and Control groups

	Full-CC (*n*=2,104) Mean (95%CI) or *n* (%)	Partial-CC (*n*=515) Mean (95%CI) or *n* (%)	Control (*n*=11,621) Mean (95%CI) or *n* (%)	Full-CC vs. Control	*P*	Partial-CC vs. Control	*P*
Primary Outcome							
Length of stay, days							
Unadjusted	22.9 (22.1, 23.8)	35.6 (33.4, 37.9)	22.3 (21.9, 22.6)	1.03 (0.98, 1.08) [a]	.54	**1.60 (1.45, 1.76)** [a]	**<.001**
Adjusted	30.1 (27.5, 32.9)	30.9 (28.1, 34.1)	31.9 (29.4, 34.6)	**0.94 (0.89, 1.00)** [a]	**.041**	0.97 (0.89, 1.05) [a]	1.00
Secondary Outcomes							
Δ Weight z-score [b]							
Unadjusted	−0.71 (−0.78, −0.65)	−0.89 (−1.00, −0.77)	−0.83 (−0.86, −0.81)	**0.12 (0.04, 0.20)** [c]	**.001**	−0.06 (−0.18, 0.07) [c]	.86
Adjusted	−0.85 (−0.99, −0.71)	−0.91 (−1.06, −0.76)	−0.89 (−1.00, −0.78)	0.04 (−0.09, 0.17) [c]	1.00	−0.02 (−0.17, 0.13) [c]	1.00
Δ Weight, g/week [b]							
Unadjusted	172.7 (168.1, 177.4)	158.9 (151.5, 166.3)	160.6 (158.7, 162.6)	**12.1 (5.9, 18.3)** [c]	**<.001**	−1.8 (−11.1, 7.6) [c]	1.00
Adjusted	169.2 (157.0, 181.4)	154.9 (141.8, 168.0)	157.5 (147.3, 167.7)	**11.7 (1.4, 22.0)** [c]	**.020**	−2.6 (−14.8, 9.5) [c]	1.00
Δ Length, mm/week [b]							
Unadjusted	9.7 (9.4, 10.0)	9.5 (9.0, 10.0)	9.1 (9.0, 9.2)	**0.6 (0.2, 1.1)** [c]	**.001**	0.5 (−0.1, 1.1) [c]	.21
Adjusted	10.1 (9.3, 10.8)	9.2 (8.4, 10.0)	8.8 (8.2, 9.4)	**1.3 (0.6, 2.0)** [c]	**<.001**	0.4 (−0.4, 1.3) [c]	.57
Δ Head circumference, mm/week [b]							
Unadjusted	8.3 (8.1, 8.6)	8.1 (7.8, 8.5)	8.4 (8.3, 8.5)	−0.1 (−0.4, 0.3) [c]	1.00	−0.2 (−0.7, 0.3) [c]	.83
Adjusted	8.1 (7.5, 8.8)	7.6 (6.9, 8.3)	7.7 (7.1, 8.3)	0.4 (−0.1, 1.0) [c]	.15	−0.1 (−0.8, 0.5) [c]	1.00
Unscheduled outpatient visit to 1 year of age							
Unadjusted	875 (41.6)	188 (36.5)	4868 (41.9)	0.98 (0.89, 1.07) [d]	.59	**0.78 (0.65, 0.94)** [d]	**.009**
Adjusted	–	–	–	**0.81 (0.67, 0.98)** [d]	**.031**	1.20 (0.93, 1.56) [d]	.16
Rehospitalization to 1 year of age							
Unadjusted	353 (16.8)	79 (15.3)	2733 (23.5)	**0.65 (0.57, 0.73)** [d]	**<.001**	**0.57 (0.45, 0.73)** [d]	**<.001**
Adjusted	–	–	–	0.97 (0.78, 1.21) [d]	.77	1.35 (1.00, 1.84) [d]	.052

Eligible preterm infants were classified into three groups according to the NICU of the delivery and discharge hospital: Full Close Collaboration group (Full-CC group) if the infant had been cared for in a NICU(s) which had completed the Close Collaboration with Parents intervention, the Partial-CC group if the infants had been cared for one NICUs which had completed the intervention and the other which had not started the intervention yet, and the Control group if the infants had been cared for in a NICU(s) without the intervention. Adjusted for the exposure to one or more doses of antenatal corticosteroid, mode of delivery, year of birth, gestational age at birth, birth weight z-score, sex, multiple births, and single-family room NICU (yes/no).

95% CI, 95% confidence interval.

[a] Geometric mean ratio (95% CI), the dependant variable was analyzed after natural logarithm transformation. Means are estimated marginal means from the models and are presented as geometric means. A linear mixed model with the random intercepts for the NICU of the delivery hospital and the NICU at discharge. Bonferroni correction was

used in pairwise comparisons.

[b] Change in each parameter from birth to discharge or 42 weeks of postmenstrual age. A linear mixed model with the random intercepts for the NICU of the delivery hospital and the NICU at discharge. Means are estimated marginal means from the models.

[c] Mean difference (95% CI). Bonferroni correction was used in pairwise comparisons.

[d] Odds ratio (95% CI). Mixed effects logistic regression model with the random intercepts for the NICU of the delivery and discharge hospital.

Preterm infants (*n*=18,107)
Born at < 35 weeks of gestation between 2006 and 2020

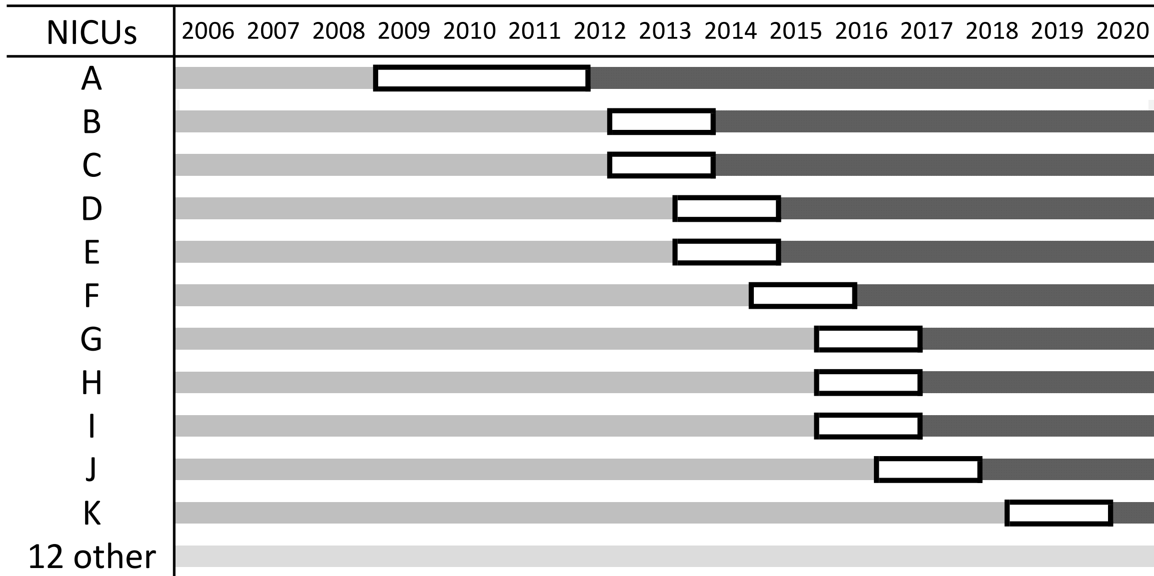
Excluded for exclusion criteria (*n*=2,645)

- Death in NICUs (*n*=729)
- No discharge data (*n*=1,489)
- Length of stay was 0 day (*n*=171)
- Discharge < 32 weeks of PMA (*n*=126)
- Discharge > 50 weeks of PMA (*n*=130)

		NICU at discharge		
		No/before CC	During intervention	CC completed
NICU of the delivery hospital	No/before CC	–/–		–/+
	During intervention		Excluded (*n*=1,222)	
	CC completed	+/–		+/+

Analyzed (*n*=14,240)

+/+ : **Full-CC group** (*n*=2,104)
+/– or –/+ : **Partial-CC group** (*n*=515)
–/– : **Control group** (*n*=11,621)


NICUs
2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
A
B
C
D
E
F
G
H
I
J
K
12 other
: Before CC
: No CC
: CC implementation
: CC completed