



## Research article

# Developmental care education in Australian surgical neonatal intensive care units: A cross-sectional study of nurses' perceptions

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## ABSTRACT

**Background:** Nurse perceptions of developmental care practices have been researched globally for almost 30 years. Yet, there is a lack of research exploring this subject in the specialised setting of the surgical neonatal intensive care unit (sNICU). This research explores the effect of developmental care education programs on sNICU nurses' perceptions of developmental care.

**Objective:** To determine perceptions and attitudes towards developmental care in a specialty neonatal setting.

**Design:** Cross-sectional study.

**Settings:** Two surgical neonatal intensive care units in Australia.

**Participants:** Registered nurses permanently employed at the study sites between May 2021 to April 2022.

**Methods:** A modified electronic survey explored sNICU nurse perceptions of developmental care organised around three themes: effects of developmental care on parents and infants, application of developmental care, and unit practices. Associations between site, nurse characteristics, developmental care education and nurses' perceptions were explored using logistic regression [odds ratios (OR) and 95 % confidence intervals (CI)].

**Results:** Of 295 sNICU nurses, 117 (40 %) participated in the survey. Seventy-five percent of respondents had attended a formal developmental care education program. High levels of agreement (>90 %) were reported regarding the benefits of developmental care for parents and infants. Exposure to developmental care education influenced perceptions of its application. Nurses without formal developmental care education were more likely to agree that it was consistently applied [OR:3.3, 95%CI:1.3–8.6], developmental care skills are valued [OR:2.7, 95%CI:1.1–6.8], and that their nursing peers offered support in its application ([OR:2.5, 95%CI:1.1–6.2].

**Conclusions:** The results from our research suggest sNICU nurses have a high level of awareness of developmental care and its positive impacts. Despite differences between the surveyed units' developmental care education programs, the value of developmental care in reducing stress for

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infants and supporting families was collectively recognised. Future research in this setting should focus on evaluating the application of developmental care in this setting.

## 1. Introduction

In Australia, one in five (17 %) newborns require neonatal care due to premature birth, post-resuscitation care, or treatment of congenital anomalies [1]. The surgical neonatal intensive care unit (sNICU) provides specialised care for infants requiring surgery in the first months following birth. Care is often provided by numerous specialist teams in a hospital where the infant was not born, requiring families to travel [2]. Infants requiring surgery share similar neurodevelopmental outcome risks as those born preterm, including a higher risk of behavioural problems, motor and sensory abnormalities, developmental delay, and poor academic performance [3,4]. This is likely due to a combination of early hospitalisation, illness and exposure to life-saving and caregiving interventions including anaesthesia [5].

During hospitalisation infants are exposed to stress, maternal separation, and clinical interventions at a time of rapid brain development [6], which potentially affects long-term health and their development trajectory [7,8]. Individualised developmental care (DC) is a model of care implemented since the 1980's to buffer the effects of neonatal unit admission [9]. Developmental care is a framework of infant and family-centred care that requires specialised education to enable staff to observe and interpret infant behaviour, encourage, and support parents in their primary caregiver role and develop strategies to modify the sensory and clinical environment [10,11]. It is recommended as a core component of care for hospitalised infants by the European Foundation for the Care of Newborn Infants [12] and the American Heart Association [13], with extensive evidence describing its efficacy in preterm infants including improving parental wellbeing and caregiving, and the infant's cognitive, motor and socio-emotional development [11,14,15].

Education is central to DC provision [16–18]. While several education programs and models exist, the Newborn Individualised Developmental Care Education Program (NIDCAP) is considered the gold standard [19]. NIDCAP is recognised as a structured education program that has been widely and successfully tested, and is based on sound theoretical frameworks [12]. NIDCAP implementation is reliant on access to in-depth training which has been described as time and labor-intensive as well as expensive [20,21]. The costs of training, however, are considered offset by the benefits and subsequent savings to the infant, hospital, and society [22].

Challenges in accessing DC education programs such as NIDCAP have led to the development of alternate education models to meet clinician educational needs. One such alternative is the Family and Infant Neurodevelopmental Education Program (FINE). The FINE program is a tiered-education pathway developed to apply the theoretical and evidence-based components of developmental care into practice [18]. This program is viewed as accessible and cost-effective.

The implementation of education programs can influence clinician perceptions of DC [23–25]. When NIDCAP was introduced in Spain, nurses viewed it as time-consuming and reported it created less optimal working conditions [26]. Conversely, nurses in the United Kingdom viewed the FINE program positively and reported increased confidence and job satisfaction [25]. Clinician perceptions of the benefits of education programs and their correlation to behavioural practice change, however, is often not linear [27]. Evaluation of education program effectiveness requires an understanding of the context for learning application and the potential barriers that may exist.

The implementation of DC involves all members of the multidisciplinary team, however, the responsibility for its application lies primarily with nurses. Research by Hendricks-Muñoz [28] explored nurse perceptions towards factors that influence developmental care across different NICU sites. To our knowledge there has not been a similar comparison undertaken within the sNICU. This represents a gap in our understanding of the potential effects of DC education programs and their influence on both nurse perceptions and practice within this setting. Developmental care education programs focus on raising awareness of the caregiving environment, effects of caregiving interactions and the developmental needs of vulnerable infants.

Many experiences in the sNICU are like those experienced in the premature intensive care setting, however, sNICU infants, parents and nurses face unique stressors. sNICU Infants experience frequent pain and stress from surgical procedures, monitoring lines, drains, and post-surgical interventions, disrupted enteral nutrition due to periods of nil by mouth, pharmacotherapy including sedation, separation from their families and disrupted periods of physical contact. sNICU parents experience stress due to a diagnosis requiring surgery, uncertainty about their infants survival and longer-term outcomes, can be overwhelmed by the appearance of congenital anomalies, altered parenting role, stress and depression lasting long after discharge from hospital [29–31]. sNICU nurses work in a high acuity, fast paced environment with shorter admission durations, and frequent patient turnover. Given the high risk setting of the sNICU it is imperative that DC knowledge translates into nurse caregiving practices in this context.

Comparison of the effects of DC education programs helps to establish the quality of the program and its effectiveness in meeting local needs, it also provides an insight into how differing factors may influence their application and transferability. This may allow us to address some of the challenges and inequalities identified in access to DC education [32] and inform the development of effective and inclusive educational policies and practices in the sNICU.

This study is part of a larger, longitudinal project evaluating the effect of nurse-delivered caregiving for infants, parents, and nurses in the sNICU within the context of DC education. The current study aimed to investigate Nurses' attitudes towards DC in the sNICU. Our research sought to explore associations between DC education and sNICU nurses' attitudes and perceptions about DC and DC practices. In addressing these aims and answering the research question, the study findings contribute to the DC education literature and, specifically to the limited evidence regarding DC education and practice in the highly-specialised critical care setting of the

surgical NICU.

## 2. Methods

### 2.1. Design

This descriptive, exploratory study utilised a cross-sectional anonymous electronic survey. This method was chosen as it would provide a snap-shot in time of nurses' perceptions that would address the study aims. It was also cost-effective, could be administered across two geographically-distanced sites, and offered the convenience (and anonymity) for participants that can promote participation. The was considered an important factor for nurses in busy critical care settings and when questions ask for personal perceptions regarding care-practices and the clinical environment. In addition to increasing the number of nurses that could be invited to participate, collecting data from two sNICUs that offered differing DC education programs enhanced exploration of effects that would address the study aims. Ethics approval was granted by Sydney Children's Hospital Network (2021/ETH00265) and The Royal Children's Hospital (HREC:81,995). To ensure standardized reporting according to the Enhancing the Quality and Transparency of Health research (EQUATOR) guidelines, this paper complies with the Improving the Quality of Web Surveys: Checklist for Reporting Results of Internet E-Surveys (CHERRIES) checklist [33].

### 2.2. Instrument

The electronic survey was developed with permission from a site-assessment document used internationally in the licensed FINE program [18]. The FINE program has been implemented in over 20 countries, with the site-assessment tool used across a range of neonatal clinical settings. The original site-assessment tool comprised 26 items exploring domains of practice specific to the implementation of DC, including access to education, unit resources, integration of concepts in everyday care, staff interpersonal relationships, and collaboration with families.

Four experienced NIDCAP Certified Australian neonatal nurses (1 x academic, 3 x hospital-based senior neonatal nursing clinicians), and a statistician (psychometrician) assessed the survey for contextual relevance, technical functionality, and usability. An iterative process was used for tool development. The review team independently evaluated the survey, before submitting recommendations to the principal investigator via email. Amendments were incorporated in the document and forwarded to the review team for endorsement. Consensus agreement from the review team on the survey content was finalised during a face-to-face meeting. Following review, five questions focusing on access to resources were revised for contextual relevance. Two questions were divided into four questions to differentiate between multidisciplinary groups. Three questions were added to the survey to explore participant perceptions of the application of developmental care. The final survey comprised 30 Likert-scale questions exploring respondent perceptions and experiences of developmental care in the sNICU, organised around three themes: effects of developmental care on parents and infants, application of developmental care, and unit practices. Respondents rated their agreement with statements using a nominal scale of 'yes', 'partially', or 'no'. Nurse characteristics were collected (viz., experience, nursing education level, developmental care education completed).

The first section of the survey comprised four questions regarding nurse demographics: number of years worked in a neonatal setting; highest level of nursing education completed; developmental programs completed; and years worked in the study site. The first three were considered as potential confounders, based on previous research reporting their influence on nurse perceptions and attitudes (Griffiths et al., 2021). Study-site specific experience was also explored as a potential influence on sNICU nurses' perceptions of DC.

### 2.3. Participants and setting

Our study was conducted with registered nurses employed at two sNICUs in Australia. Given that the Australian neonatal nursing workforce consists predominately of registered nurses [34], this was considered an appropriate selection criterion for obtaining a representative sample of sNICU nurses. Participants were required to be permanently employed at the respective study site as it was thought that, compared to other nurses, these nurses' perceptions were more likely to be based on regular exposure to experiences in the study site. A convenience-based sampling technique was used and participants self-selected into the study. This fitted with the nature and purpose of the study.

**Table 1**  
Site-specific information.

Site	Number of beds	Number of nursing staff	Annual admission numbers	Surgery offered at site	Developmental care components
A	23	110	600	All surgery including cardiac (Level 6 NICU)*	Developmental round, DC committee, DC policy, digital resources for staff & families
B	35	185	851	All surgery excluding cardiac (Level 6 NICU)	Developmental rounds & digital resources for staff & families

DC, developmental care, \* [35].

The sites were chosen as they represent comparative units in a country with limited sNICU sites and represent a convenience sample. Both sites in Australia are classified as Level 6 NICU's providing life-support and multidisciplinary care for high-risk newborns with complex and critical conditions requiring surgery [35] (Table 1). The units are comparative to a Level IV unit in the United States of America; specifically in that they meet the following criteria described for a Level IV NICU in the American Academy of Pediatrics 'Standards for levels of Neonatal Care: I, III and IV' [36]. They are located in Children's hospitals, have medical directors, neonatologists, with onsite surgeons and anaesthetists, established nursing leadership teams including advanced practice nurses, clinical nurse specialists, nursing education teams, specialist medical and nursing orientation programs, allied health teams, social workers, developmental follow-up clinics and other related service components.

Different developmental care education models were utilised at each site (Table 2). Site A utilised the FINE program [18,25] and Site B used a unit-specific model titled Circle of Care Optimising Outcomes for Newborns (COCOON). COCOON is a locally-developed model of family-centred care that utilises education and resources for staff and families which aims to support inpatient experiences and improve longer-term developmental outcomes [37]. It is delivered on an electronic platform (HERO) and in-person.

#### 2.4. Data collection

Recruitment occurred over two separate three-month periods: Site A, May to July 2021; Site B, February to April 2022. Permanent nursing staff were invited by email to participate in the survey. The recruitment process was managed at Site A by the principal investigator (PI) and Site B by the local research team. To enhance access and promote participation the survey was distributed to each site four times; at the commencement of the data collection period, after two weeks with a reminder of the survey closing date, at four weeks with a reminder the survey was closing in two weeks, and 48 h prior to the survey closing. The closed survey was hosted through the QUALTRICS © platform. Participants accessed the survey via an electronic link. Participants who clicked the link were directed to a page that explained the purpose of the study and contained the contact information for the PI, ethics committee and free support services in the event they experienced distress during survey completion. Participants self-selected to take part in the research by clicking a button indicating 'start survey', thus utilizing implied consent. At the completion of the survey, they were directed to a thank you page prior to exiting the online platform. Participants could opt out of completion at any stage by closing the survey page. No incentives were provided for participation. Data responses were anonymous and only accessible by the PI. Ethics permission was not granted to share the raw data.

#### 2.5. Statistical analysis

All variables in the dataset were categorical. To assess the relationship between nurses' perceptions and DC education, nurses' item responses were treated as outcome/dependent variables (DVs) and DC education was treated as the predictor/independent variable (IV) of interest. Other independent variables of interest as potential confounders were the Study Site and nurse characteristics: Nurse Education; Years of Neonatal Experience; and Years in Surgical NICU.

Data were summarized using frequencies (count) and percentages. Associations between variables were calculated using the Chi-square test/Fisher's exact test. These revealed issues of concern regarding assumptions related to further analysis. Firstly, concerns about case-to-variable ratios arose when several cells with small numbers and empty cells were identified. Multiway frequency crosstabulations confirmed concerns about adequate expected cell frequencies between pairs of discrete predictors. To address these concerns, categories for variables with more than two levels were collapsed. Item response variables were dichotomised as 'yes'

**Table 2**  
Site-specific developmental care education program description.

Site	Program	Duration	Content
A	FINE Level 1	1.5-day workshop	Foundational program introduction to evidence and practical application. Delivered by NIDCAP Certified Professionals. <b>Program content:</b> Neurodevelopment, observing babies states, FCC, stress, pain and comfort, sleep, motor development & positioning, kangaroo care, sensory development, support in the development of feeding skills
	FINE Level 2	6 months	Builds upon the skills acquired in FINE 1. Self-directed development of practical skills to improve practice and confidence in partnering with professionals and families. Delivered by NIDCAP Certified Professionals. <b>Program content:</b> Observing (autonomic, state, motor), infant behavioural regulation, Stress, pain & comfort, Kangaroo Care, feeding, support during caregiving, assessing unit practice and managing change.
B	Neurodevelopmental Learning Package (COCOON)	2.5 h	In-depth eLearning modules. <b>Program content:</b> COCOON program aims and team member roles, the effects of hospitalisation, FCC, practical tips including how to provide clinical education to families.
	COCOON eLearning program or workshop	45 min–7 h	10 Fundamental concepts of neurodevelopmental care. Delivered via interactive eLearning program or in-person by unit team. <b>Program content:</b> FCC, Infant state recognition and response, Stress, pain & comfort, positioning, skin care, nutrition, supporting development and evaluating developmental delay

FINE, Family and Infant Neurodevelopmental Education Program [18,25]; NIDCAP, Newborn Individualised Developmental Care Education Program [60]; COCOON, Circle of Care Optimising Outcomes for Newborns; FCC, Family-centred care.

(indicating agreement) and by combining 'no' and 'partially' as 'no' (i.e. no agreement). For Nursing Education: hospital certificate and bachelor's degree were combined as 'bachelor degree or less'; all post-graduate qualifications were combined as 'post-graduate qualifications'. For Years of Neonatal Experience and Years in Surgical NICU: 0–1 year and 2–4 years were combined as '4 or less years' ( $\leq 4$  years); 5–10, 11–15, and  $>5$  years were combined as '5 or more years' ( $\geq 5$  years). DC education was dichotomised: 'inservice/study day' as 'without formal DC education' and combining FINE categories and COCOON categories as 'with formal DC education'. Secondly, these preliminary analyses identified several significant notable associations among predictor variables, raising concerns about multicollinearity. Except for Years in Surgical NICU (which was removed), results for collinearity diagnostics were within acceptable limits, and all predictors were retained for further analysis. Inspection of residuals revealed no outliers.

As the outcome variable had been dichotomised, binary logistic regression was chosen to determine the influence of site, nurse characteristics and DC education on nurses' perceptions. Analysis proceeded along several steps and involved testing models for each of the outcome variables (that is, each item was analysed as a separate DV). We chose the most straightforward test of relationship using direct logistic regression with forced entry method; comparing the model that had only the constant and a model with the constant plus predictors [38]. This approach allowed DC education, study site, years of neonatal experience, and nursing education to be tested in one block to assess their predictive ability, while controlling for the effects of the other predictors. Because a predictor by itself may be highly correlated to outcome but show little predictive capacity in the presence of other IV's, we also explored the effects of sequentially adding predictors. To do this, we performed multiple runs entering predictors in a sequence based on associations with outcome that were found in preliminary analyses [39]. No significant changes in predictive power of the models were found, however, some predictors showed changes. Given concerns about potential confounders, we chose to investigate interaction effects. To avoid complicating the models, and concerns about case-to-variable ratios, we decided to include only two-way interaction terms based on variables that were significantly associated with outcome and with each other. The tested interaction terms were found to be non-significant.

The results of the logistic regression analyses are reported as odds ratios (unadjusted and adjusted OR's) and 95 % confidence intervals. For simplicity, results are presented only for outcomes (DV's) where models were statistically significant and only for statistically significant predictors. Odds ratios have been presented in tabular form for results of comparisons between groups based on predictors (IVs), examining associations to outcome. For ease of interpretation, odds ratios have been expressed such that the odds of a respondent agreeing with the item statement increased by the value of the OR, when the respondent was a member of the first group shown for that comparison. Statistical significance was set at  $p < 0.05$ . All analyses were conducted using SPSS v.25 [40].

### 3. Results

#### 3.1. Sample characteristics

Two hundred and ninety-five surgical neonatal nurses were invited to participate in the survey. One-hundred and seventeen (117) participated (40 % participation rate), and 112 completed the survey (96 % completion rate). Participation rates differed between the sites; Site A  $n = 57$  (55 %) and Site B  $n = 55$  (30 %). Participant characteristics are reported in Table 3. Compared to previously reported data of the Australian neonatal nursing workforce by Griffiths et al. in 2021b, participants in this study sample were less experienced (67.8 % versus 32 % with less than 10 years' experience in the neonatal setting) and had lower levels of post-graduate qualifications (54 % versus 75 %). Differences were also seen between the two sites; Site A having less experienced staff (45 % with up to 4 years experience versus 24 %,  $p = 0.018$ ), and lower levels of post-graduate qualifications (45 % versus 65 %,  $p = 0.037$ ) than Site B. For nurses with four or less years employment in sNICU, 25 % had five or more years of neonatal experience ( $p < 0.001$ ), suggesting they had worked in a perinatal NICU prior to employment in the sNICU. Post-graduate qualifications were more likely to be

**Table 3**  
Participant nurse characteristics.

Variable	Category	Site A (n = 60)		Site B (n = 52)	
		Number	%	Number	%
Years employed in NICU	0–1 year	15	25	2	3.8
	2–4 years	12	20	10	19.2
	5–10 years	16	26.7	21	40.4
	11–15 years	8	13.3	10	19.2
	$>15$ years	9	15	9	17.3
Years employed in surgical NICU	0–1 year	19	31.7	9	17.3
	2–4 years	11	18.3	13	25
	5–10 years	15	25	19	36.5
	11–15 years	7	11.7	4	7.7
	$>15$ years	8	13.3	7	13.4
Education	Hospital Certificate	3	5	1	1.9
	Bachelor's degree	30	50	17	32.7
	Graduate Certificate	13	21.7	19	36.5
	Graduate diploma	4	6.7	8	15.4
	Master's Degree	9	15	7	13.4
	Doctoral Degree	1	1.7	0	0

held by nurses employed for five or more years in sNICU (64 %) than other nurses (36 %,  $p = 0.022$ ). The lowest level of DC education was found among nurses with four or less years neonatal experience (65 %,  $p = 0.001$ ) and those employed for four or less years in sNICU (69 %,  $p = 0.029$ ). Differences in attending developmental care education were seen across the sites (Table 4), ranging from attending in-service or study day education through to 6-month comprehensive program completion. Seventy-six percent of respondents had attended a formal DC education program. A higher proportion of Site A (31 %) than Site B nurses (13.5 %,  $p = 0.014$ ) had attended only in-service/study day DC education.

### 3.2. Nurses' perceptions and experiences of developmental care

The results examining the influence of site, nurse characteristics, and DC education are presented under the three themes addressed in the study regarding nurses' perceptions of: effects of developmental care on parents and infants, application of developmental care, and unit practices. Results for group comparisons are reported in Table 5.

## 4. The benefits of developmental care for parents and infants

Fig. 1 presents the high levels of agreement (>90 %) among nurses regarding the benefits of DC for parents and infants. A question exploring nurse perceptions of communication with parents whose coping strategies are challenging had lower levels of agreement, Site B nurses were twice as likely than site A nurses to agree that parents' communication style influenced nurse-parent interactions [95 % CI:1.2–6.4]. (Table 5).

### 4.1. Practical application of developmental care

Low levels of agreement (<50 %) were found for five of the eight questions exploring the practical application of DC (Fig. 2). Nurses without formal DC education and those with 4 years or less of neonatal experience were more likely to agree that their nursing peers offered support in the application of DC ([OR:2.5, 95%CI:1.1–6.2] and [OR:3.8, 95 % CI:1.6–8.6], respectively). Nurses without formal DC education were more likely to agree that developmental care is consistently applied in their unit [OR:3.3, 95%CI:1.3–8.6] and that DC skills are valued [OR:2.7, 95%CI:1.1–6.8]. (Table 5).

### 4.2. Unit developmental care practices

Low levels of agreement were seen on three of seven items regarding DC training opportunities, medical staff collaboration, and DC as a source of disagreement between colleagues (Fig. 3). Three in four nurses agreed that they referred to clinical practice guidelines, with 57 % of respondents indicating they seek information from their peers as the next most reliable source of information. Site A nurses were three times more likely to agree that DC education is part of nursing orientation [95%CI:1.3–7.4]. Site B nurses were nearly four times more likely to agree that medical staff collaborate in DC practices [95%CI:1.6–8.9]. Nurses with five years or more experience were twice as likely to agree that nurses are offered unit-based DC education [OR 2.8, 95%CI:1.03–7.4] and external training opportunities [OR:2.4, 95%CI:1.1–5.3]. (Table 5).

## 5. Discussion

The motivation for this research was to establish sNICU nurses' perceptions of DC and its application in this setting. We found sNICU nurses reported high levels of support for the concept of DC and recognise the importance of its application to support infants and families in the sNICU. The relationship between infants and parents, a core principle of DC, was viewed as a high priority by respondents, suggesting this relationship was valued at the study sites. These results differ from a multi-centre cardiac intensive care unit study which found that parents were not consistently included in DC practices [41], however this may have been due to DC not being widely-practiced in that setting at the time.

The importance of specialist knowledge, skills, and standardised education in the provision of DC is well-established [17,42]. The completion of DC education programs in several studies positively correlated to nurse perceptions of DC practices [43,44]. This

**Table 4**  
Developmental care education level of nurses at the two study sites.

Developmental care education completion	Site A (n = 60)		Site B (n = 52)*	
	Number	%	Number	%
Inservice education or study day	19	31.7	7	13.5
FINE Level 1	29	48.3	4	7.7
FINE Level 2	12	20	0	0
COCOON learning module	0	0	18	38.5
COCOON One day workshop	0	0	21	40.4

FINE, Family and Infant Neurodevelopmental Education Program; COCOON, Circle of Care Optimising Outcomes for Newborns. \* Missing data for two nurses.

**Table 5**

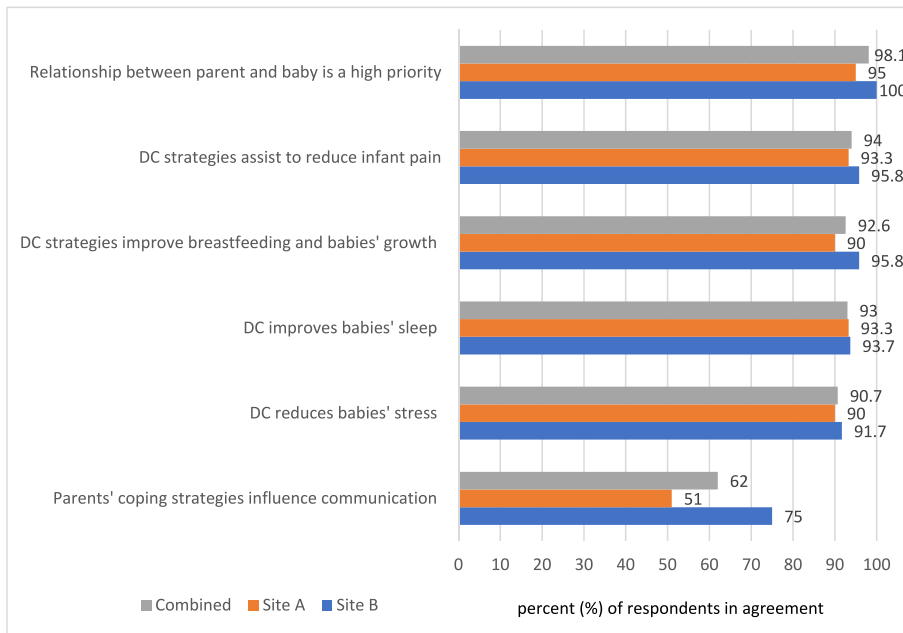
Dichotomised group comparisons for effects of site, years of neonatal experience and developmental care education on nurses' perceptions of developmental care (n = 108).

Group comparisons	Theme: Benefits of DC for parents and babies	
	Q. Parents' coping strategies influence communication	
Site B nurses compared with Site A nurses	unadjusted OR (95 % CI)	p-value
	2.8 (1.2–6.4)	0.014*
	adjusted OR (95 % CI)	p-value
	3.4 (1.4–8.3)	0.007*
<b>Theme: Practical application of DC</b>		
Nurses without formal DC education compared with nurses with formal DC education	Q. <i>Nursing peers offer support in the application of DC</i>	
	unadjusted OR (95 % CI)	p-value
	2.5 (1.1–6.2)	0.045*
	adjusted OR (95 % CI)	p-value
	1.55 (0.6–4.29)	0.395
	unadjusted OR (95 % CI)	p-value
Four years or less neonatal experience compared with 5 years or more	3.8 (1.6–8.6)	0.002**
	adjusted OR (95 % CI)	p-value
	3.3 (1.3–8.1)	0.012*
	Q. <i>Developmental care is consistently applied in the unit</i>	
Nurses without formal DC education compared with nurses with formal DC education	unadjusted OR (95 % CI)	p-value
	3.3 (1.3–8.6)	0.012*
	adjusted OR (95 % CI)	p-value
	3.9 (1.3–11.2)	0.013*
Nurses without formal DC education compared with nurses with formal DC education	Q. <i>DC skills are valued in the unit</i>	
	unadjusted OR (95 % CI)	p-value
	2.7 (1.1–6.8)	0.036*
	adjusted OR (95 % CI)	p-value
	2.60 (0.9–6.9)	0.051
	<b>Theme: Unit DC practices</b>	
Site A nurses compared with Site B nurses	Q. <i>DC education is part of nursing orientation</i>	
	unadjusted OR (95 % CI)	p-value
	3.1 (1.3–7.5)	0.009**
	adjusted OR (95 % CI)	p-value
	2.5 (1.0–6.3)	0.045*
	Q. <i>Medical staff collaborate with DC</i>	
Site B nurses compared with Site A nurses	unadjusted OR (95 % CI)	p-value
	3.8 (1.6–8.9)	0.003**
	adjusted OR (95 % CI)	p-value
	4.0 (1.6–10.0)	0.004**
Five years or more neonatal experience with four years or less experience	Q. <i>DC education updates are offered (unit-based)</i>	
	unadjusted OR (95 % CI)	p-value
	2.4 (1.1–5.3)	0.038**
	adjusted OR (95 % CI)	p-value
	4.6 (1.5–14.3)	0.008**
	Nurses are offered DC education	
Five years or more neonatal experience with four years or less experience	unadjusted OR (95 % CI)	p-value
	2.8 (1.03–7.4)	0.040*
	4.9 (1.5 – 13.8)	0.009**

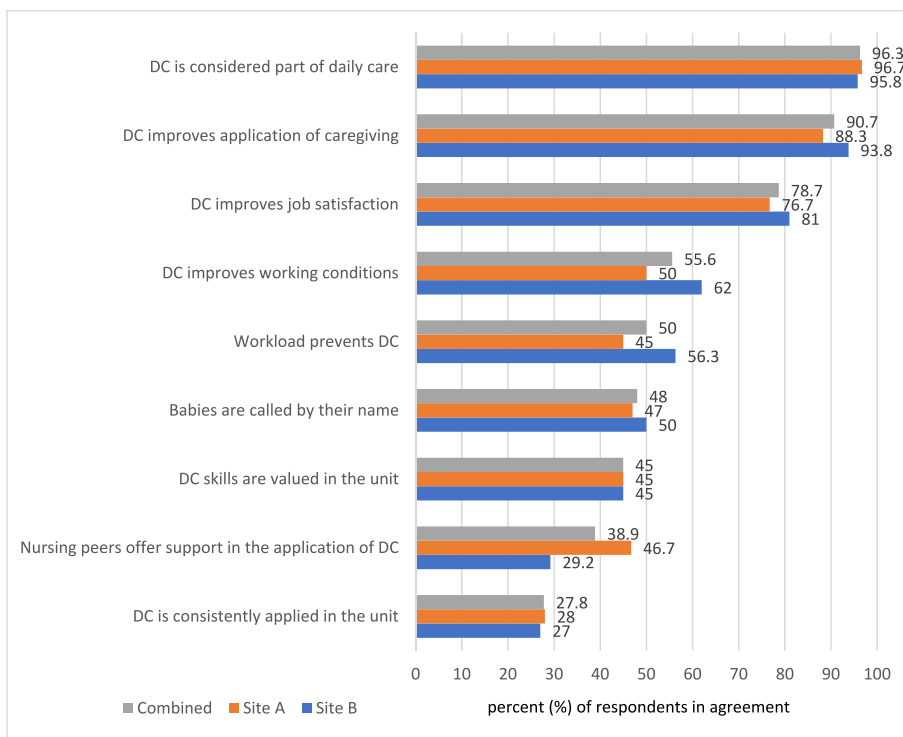
Adjusted OR's are based on multivariable binary logistic regression of full models with all four predictors: DC education; study site; years of neonatal experience; nursing qualifications. CI, confidence interval; DC, developmental care; OR, odds ratio. \* statistically significant at  $p < .05$ ; \*\*statistically significant at  $p < 0.01$ .

concur with our finding that sNICU nurses' support the constructs and benefits of DC in this specialist setting. Both sites in this study had embedded DC education programs. Evaluation of the FINE program in the United Kingdom [25], showed nurse perceptions improved towards DC and their personal DC practices. An evaluation of the COCOON program is in progress and has not yet been published. We found minimal differences in nurse perceptions of DC education that could be attributed to the type of DC education program the nurses completed. This finding suggests that in the sNICU, as with other researched settings, exposure to a high-quality evidence-based DC education program likely has a positive effect [28].

Research on NICU nurse stressors highlights the importance of potential mediating factors including adequate induction/orientation and ongoing education [45], to the translation of evidence to clinical practice. Participants in this study perceived a positive impact of DC education from initial unit induction. This approach ensures nurses are immediately exposed to the DC model and philosophy of care. The established DC education frameworks at both study sites likely positively contributed to a unit culture of learning and may account in part for the nurses' positive perceptions of DC. While unpacking in depth the influence of unit culture on nursing practice was beyond the scope of this research, it is an important consideration when evaluating the impact of education programs. Identifying barriers and enablers that support the implementation of education initiatives in a highly technical, busy, and time-sensitive environment is necessary to ensure success [46].



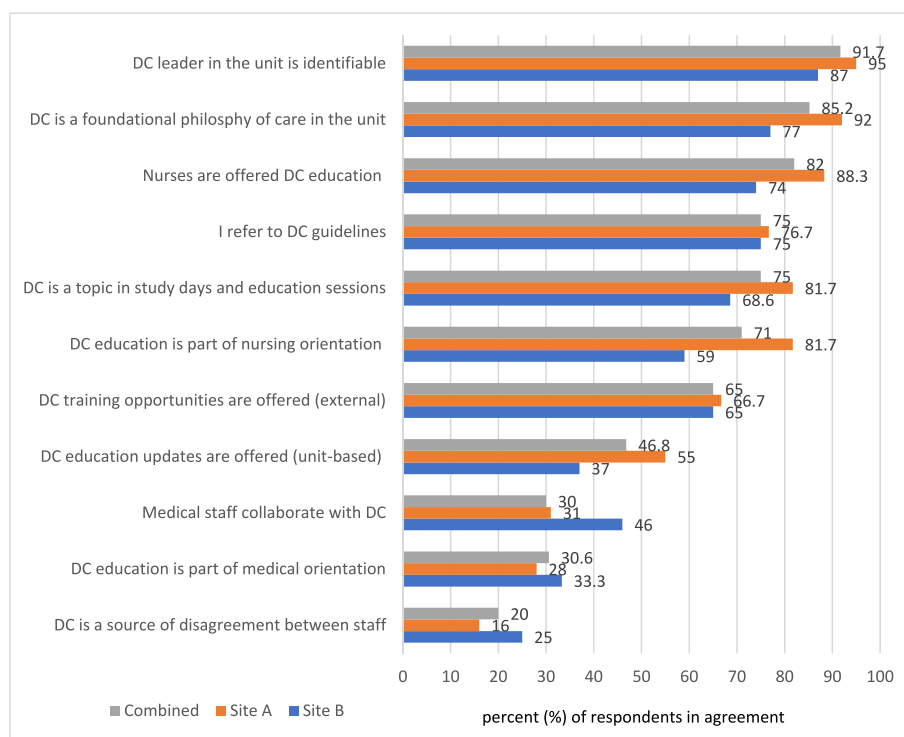
**Fig. 1.** Site-specific and combined sites surgical NICU nurses' perceptions of the benefits of developmental care for parents and babies, showing percentage of respondents in agreement.



**Fig. 2.** Site-specific and combined sites surgical NICU nurses' perceptions of the practical application of developmental care, showing percentage of respondents in agreement.

Nurses in this study were critical of the application of DC in the sNICU, reporting differing levels of peer and multidisciplinary support for its implementation. Reports of DC barriers being attributed to nursing and medical colleagues have been identified in the literature [47]. Our research found increasing years of experience and completion of formal DC education programs were inversely





**Fig. 3.** Site-specific and combined sites surgical NICU nurses' perceptions of unit developmental care practices, showing percentage of respondents in agreement.

correlated to perceptions of peer support and the consistent application of DC. It is possible that, as with other areas of clinical practice, as knowledge increases so too does the capacity for greater scrutiny and critical appraisal of DC practices. Inconsistent DC practices have been reported beyond Australia [32], and highlighted in China [48], Denmark [49], Korea [42], Spain [24] and the USA [41]. Contributing factors to the inconsistent application of DC include high workload, patient acuity, DC education level, lack of DC awareness, and years of experience [48,50]. The sNICU is an environment where there are consistently high levels of patient acuity, shorter admission durations, and frequent patient turnover. Acknowledging that these factors have likely influenced our findings supports the need to recognise the sNICU as a unique research setting.

sNICU nurses' perceptions of peer support for DC application in our study were likely influenced by a professional practice environment that can either facilitate or constrain nursing practice [51]. Further evaluation of the nursing team structure, function, and process at each site may have elicited an understanding of teamwork components that influence the clinical application of DC. The paradox between nurses supporting the concept of DC whilst criticizing its application by peers and across the clinical setting, as found in our study, has also been reported elsewhere [47]. A commonality observed between previous research and this study is the differing levels of DC training in participant respondents. It is possible that as DC training levels increase and DC practice is embedded within unit cultures, the paradox between supporting the concept of DC and criticism of peer and unit practice become less apparent [52].

Surgical NICU nurses in this study represent a workforce that differs from previously reported regional (Australian) NICU nurse characteristics [32,53]. In our study sNICU nurses compared to the general Australian NICU nurse population were less experienced and with fewer post-graduate qualifications. This finding may be due to a lack of specific sNICU post-graduate education programs nurses, with subsequently prioritising workplace learning over formal attainment of post-graduate education qualifications. These unique workforce characteristics warrant further investigation to ensure the highly specialised to ensure sNICU education needs are being met.

We found sNICU nurses with four years or less experience were more likely to view DC constructs positively including peer support and access to DC education, both elements contributing to the application of DC. These findings are reflected in research evaluating predictors of quality of care in the NICU, where fewer years of NICU experience correlated to positive perceptions of caregiving [54]. The authors concluded that experienced nurses were more critical of care provision due to a combination of heavier workloads and higher stress, suggesting the work setting and circumstances may influence perceptions of care quality [54]. Articulating the effect of years of experience on clinical care was beyond the scope of this research, however, it is an important consideration when implementing DC. In addition to experience, nurse qualifications may also contribute to nurse perceptions. In our sample, the significant association between years of experience and nurse qualification made it difficult to discriminate between their effects. Research by Spence [53] showed that in Australia neonatal qualifications were predictive of clinical knowledge but not nursing expertise. According to Benner [55], nursing expertise incorporates a level of intuitive knowledge that develops with experience. Ongoing

structured education could act as a potential mediator in the development of this knowledge [53]. Providing evidence-based education in specialised settings that can overcome the gap between best practice and actual clinical care faces many challenges [52]. Less than half of our sample agreed that DC skills were valued, consistently applied, and supported. This indicates the importance of DC education programs to facilitate valuing of DC skills and their consistent application in caregiving practices.

Our findings support the notion that how nurses learn can influence their uptake of DC. Researchers evaluating critical care nurses preferred ways of learning identified that in a complex, time-pressured environment, obtaining information from colleagues allowed quick access and application of knowledge [56]. Similar findings have been reported in the NICU, with nurses frequently seeking information from their peers rather than resources that include formal education and clinical practice guidelines [53,57]. These findings were reflected in our study with over half of respondents seeking information about DC from their peers. The established information-seeking behaviours of sNICU nurses highlights the importance of having an accessible and sound DC education program available to support knowledge across the workforce. Overall 73 % of participants had attended formal DC education. Maintaining high levels DC education completion rates is suggested as a baseline to sustain high levels of baseline education in the sNICU may avoid some of the pitfalls observed in peer-to-peer information sharing including incorrect information and subsequent clinical uncertainty [56].

Differences in DC education completion were observed between the two sites. The timing of nurse attendance at formal DC education likely influenced some of our findings. The workforce at Site A consisted of a higher number of new NICU clinicians, with formal DC education at this site offered only after 12 months employment. Several other contextual differences between the units may have influenced our results. Site A is an internationally endorsed DC training centre, delivering licensed evidence-based education programs. Site B during the research period did not have a DC clinical practice guideline available for clinicians.

It is not clear from this research to what extent sNICU nurses' perceptions of DC translates to its application in clinical practice. When questioned, nurses are often critical of their peers' performance [46], yet the reality of evaluating respondents' own practices is more complex and warrants a different research methodology. Additional research exploring the real-time application of developmental care in the NICU and sNICU is necessary to evaluate the transfer of knowledge and evidence to practice. The use of longitudinal research methodologies may help to further explain how changes in education and policy affect DC practices.

In general, sNICU's have adapted DC education programs designed for use in preterm infants and developed unit specific programs. However, to our knowledge this is the first paper that has evaluated multiple educations in the sNICU setting. Our findings help to establish an understanding of the effectiveness of two DC programs and describe nurses learning preferences in the sNICU setting. sNICU providers face an opportunity to support and improve outcomes within and beyond the clinical setting. This can be achieved by ensuring that adequate resources are available to provide high-quality DC education and the implementation of evidence-based DC clinical guidelines to support the consistent application of care. Engagement and prioritization of these components in the sNICU by nursing leaders, managers, and members of the multidisciplinary team is essential to ensure success.

Based upon our findings in conjunction with evidence from other DC program evaluations [16,25,47,58] and applying the foundational elements of health care professional education [52] we are proposing 10 key recommendations when implementing DC education programs in the sNICU (Table .6).

## 6. Strengths and limitations

The study methods utilised likely limit the generalizability of our findings. Non-probability sampling, as used in our study, generally results in samples that are less representative of the target population. We found sNICU nurses in our sample were less experienced and with fewer post-graduate qualifications than previously reported Australian NICU populations [32,53]. However, that data related to NICU nurses in general and we are not aware of more recent data that could provide a comparison specific to the sNICU setting. It may be that while not representative of the target population, the sample is representative of a subset of the target population. With the associations valid, however, applicable to a restricted population. In this way, the study has internal but not external validity [59]. It is likely our results represent the evolving characteristics of the NICU workforce in the post-COVID pandemic era. Our results contribute to the limited evidence-base regarding these issues.

Our participation rate of 40 % and self-selection bias may lead to non-representativeness of the sample. Despite offering convenience and ease of access to the survey, as well as issuing reminders, the participation rate was low, with differences observed at each site (site A 55 % and site B 30 %). Nurses who participated may not be representative of the sNICU nurse population at the sites. However, we could not investigate for systematic bias as we had no information about non-responders. While the findings of the research are not generalizable, they may be transferable to other NICU's where neonates who have surgery are cared for when implementing DC education programs. Additional research is needed to ascertain the degree to which this applies.

There was a risk of measurement bias associated with using a modified tool. While the reported psychometric properties of the original tool are acceptable, we did not evaluate these for the modified version. Another limitation of the study was that the DC programs at the two sites are not comparable in terms of duration and content. Although exploring the effects of different programs was of interest, it was not possible due to statistical concerns related to small subgroup numbers. It was possible, however, to answer the research question and address the aims with two groups: without formal DC education and with formal DC education. The information lost in collapsing the categories to create a dichotomous variable may have influenced our findings and provided further insight. It may be that a study utilizing more than two study sites would be required to obtain an adequate sample size for that level of analysis.

The choice of logistic regression presents some limitations to reproducibility and replicability. Logistic regression was chosen to assess associations between nurses' perceptions, DC education and other potential confounders as this technique is widely recognised

**Table 6**  
10 key recommendations when implementing DC education programs in the sNICU.

1	Individuals delivering DC education have completed an accredited DC education program
2	DC Program content includes the identified foundational components of evidence-based DC education (interpreting/observing baby behaviour, Neurodevelopment, FCC, stress, pain and comfort, sleep, motor development & positioning, kangaroo care, sensory development, support in the development of feeding skills)
3	DC education programs consist of current and evolving evidence, utilize patient examples and clinical scenarios, are delivered via flexible and learner centred modalities
4	Information from DC programs for premature infants are adapted by sNICU content experts to meet the needs of the sNICU population
5	Members of the sNICU community contribute evidence to understanding the application of DC within this population
6	Resources are available and developed with former sNICU families to support the application of DC within family units
7	Ongoing training and training updates are available for staff
8	sNICU's aim for >80 % of clinical staff to have received formal DC education to support sustained change
9	sNICU units have DC committees and clinical practice guidelines to support the clinical application of DC
10	A process is implemented to notify the broader sNICU of evolving DC practices and evidence

as the most appropriate for this type of study. Selecting predictors based on well-justified theoretical models or empirical evidence is an important factor to drawing sound conclusions when using this technique. One strength of our study is that we chose our predictors based on previous literature.

Notwithstanding the limitations, the study also had several strengths, and the findings contribute to the DC education literature and specifically to the limited evidence regarding DC education and practice in the highly-specialised critical care setting of the surgical NICU.

## 7. Conclusion

Our research has identified that nurses in the sNICU recognise the importance and benefits of DC, generally apply the principles in this complex clinical setting, and have specific learning preferences. We found years of experience in neonatal nursing and exposure to DC education programs influenced nurses' perceptions of DC. Embedding a contextually relevant DC education framework is essential to translate the concept of DC to the clinical setting. Based on our findings and to ensure DC positively impacts longer-term outcomes, sNICUs should focus on providing access to education, peer-to-peer support, collaboration within the multidisciplinary team including medical staff, and family-centred communication. Future research in this setting should move beyond individual perceptions and evaluate the effect of education on nurse-delivered developmental care in the sNICU.

## Data availability statement

The authors did not receive ethical approval to have data associated with the study deposited into a publicly available repository.

## CRediT authorship contribution statement

**Nadine Griffiths:** Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Sharon Laing:** Writing – review & editing, Writing – original draft, Visualization, Validation, Formal analysis, Data curation. **Kaye Spence:** Writing – review & editing, Supervision, Methodology. **Maralyn Foureur:** Writing – review & editing, Supervision, Methodology. **Himanshu Popat:** Writing – review & editing, Supervision. **Leah Hickey:** Writing – review & editing, Project administration. **Lynn Sinclair:** Writing – review & editing, Supervision.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e30572>.

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