Media Intervention with NICU Staff to Support the Development of Preterm Newborns

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Abstract

Objectives. Evaluate a media intervention *Focus on the Brain: The Science of Preterm Infant Development*.

Design. Controlled clinical trial, randomized by site.

Setting. Four hospital-based Level III Neonatal Intensive Care Units (NICUs)

Participants. 265 professional nursing staff

Methods. Survey measured staff knowledge of preterm infant development, and favorable attitudes toward Developmentally Supportive Care (DSC), at baseline (enrollment). After the intervention at two sites, follow-up surveys at 1 and 4 months later.

Results. Nurses at intervention sites exhibited greater knowledge of DSC and its importance, suggesting that this intervention promises to be a standardized training tool for clinical NICU staff.

BACKGROUND

In 2004 there were 508,356 infants born preterm, or 12.5% of all births. (Martin et al. 2006) Between the time newborn intensive care began in the 1970s and 2000, the mortality rate of VLBW babies decreased from 50% to less than 20% (Westrup et al. 2000). However, between 2000 and 2005, the mortality rate rose again from 34.6 % in 2000 to 36.5% in 2005 (Mathews & MacDorman 2008). Advances in medicine have yet to reduce morbidity for premature infants in similarly striking ways, especially in terms of neurofunctional outcomes including behavior and learning problems. Existing scientific and clinical insight into the neurobehavioral development of premature newborns needs to be communicated to clinicians and parents who provide direct care to preterm newborns in the early days and weeks of life. The application of current neurobehavioral science to the care of premature newborns requires changes in the practices of clinicians and parents.

Scientific and clinical attention to the neurobehavioral development of premature newborns is the new, relatively uncharted frontier of NICU care. The urgency of exploring that frontier is becoming more evident as the population of very early-born preterm children reaching school age is on the rise. A 2002 meta-analysis concluded that gestational age at birth is proportional to their average cognitive test scores at school age, thus children born preterm are at risk for reduced cognitive test scores. Furthermore preterm and low birth weight children are 50% more likely to be enrolled in special education services (Bhutta et al. 2002). Even in cases where preterm children have a generally normal IQ, they are at risk of exhibiting submnormal levels of executive functioning (Bohm, Smedler, & Forssberg 2004). Additionally, prematurity and low birth weight double the risk of behavior problems; these problems show stability over time, measured by a study examining children at 3, 5, and 8 years of age (Gray, Indurkhya, & McCormick 2004). The neurological and educational sequelae to preterm birth are dramatic evidence that more must be done to support the developing brains of infants during the time spent in the NICU. Also, concern is growing about increasing costs of: ongoing physical, occupational and speech therapy; early intervention (EI) caseloads; grade repetition; and special education directly proportionate to the rise in the population of NICU graduates. Costs incurred by parents in their child's ongoing rehabilitation and education have not been fully explored. (Zupanic et al. 2000)

The research of Heidelise Als, Ph.D., and her colleagues at Harvard Medical School, shows that the unexpected experiences of life in the NICU may inhibit developing neuronal pathways and interfere with full differentiation (Duffy, Als, & McAnulty 1990). In addition, their work shows that the sounds, lights and constant activities in a typical NICU influence infants' arterial oxygen saturation directly (Als et al. 1994). Als' seminal 1994 RCT study of the Newborn Individualized Developmental Care and Assessment Program (NIDCAP) in the *Journal of the American Medical Association* demonstrated improved medical and neurodevelopmental outcomes for preterm infants receiving individualized developmental care. NIDCAP presents an approach to intensive care that is geared to support each individual infant's strengths and efforts toward self-regulation and competent functioning. The model was shown to result in medical, neurodevelopmental and cost-saving benefits.

After surfactant replacement therapy became available in NICUs to treat respiratory distress syndrome (RDS) in the mid 1990s, two studies confirmed Als' initial findings and suggest that IDC contributes to significant reduction in major morbidities including intraventricular hemorrhage (bleeding into the brain), chronic lung disease, need for respirator assistance and tube feedings. (Fleisher, VanderBerg, & Constantinou 1995) and 2000 (Westrup). Additionally, individualized, developmentally supportive care was also shown to be connected to improvements in self-regulatory abilities, weight gain, and mental and psychomotor development at nine months of age, corrected for prematurity (Als et al. 1994). Infants who received IDC also had shorter hospital stays (between 64 and 91 fewer days) and savings in hospitalization charges of over $91,000 per infant.

Als has contributed longer-term outcome data to the discussion around individualized developmental care with results from cognitive, motor and neuro-organizational assessments (at ages 3 and 7) of children who had participated in Als' initial1986 study (Als in Guralnick 1996). Infants who had received IDC in the

NICU demonstrated advantages in verbal, motor, memory and general cognitive indices of the McCarthy Scales. They also showed better expressive language abilities, less perseveration, better sentence complexity, enhanced behavioral organization, and improvement in visual and spatial measures suggestive of better frontal lobe functioning. Developmental care in a NICU, could be associated with improved cortical and frontal lobe development lasting into school age.

In addition to Als' research supporting the benefits of developmental care, a systematic review was conducted of 31 eligible RCTs involving developmental care interventions clinical outcomes (Symington & Pinelli 2000). While the review called for more evidence demonstrating short and long-term effects, it also pointed to proven benefits of developmental care including: improved short-term growth outcomes, decreased respiratory support, decreased length and cost of stay, improved neurobehavioral outcomes to 24 months of corrected age. Another systematic review also itemizes long-lasting advantages to developmental care (Bowden et al. 2000).

In the practice of developmentally supportive care, a central premise is that careful, trained observation, documentation and interpretation of infant behavior by caregivers constitute the best basis for developing clinical care plans and the amelioration of stress behaviors. The focus is always on enhancement of each infant's unique repertoire of self-regulation strategies and emerging competencies.

Developmental care in nurseries calls for a paradigm shift in the way NICU practitioners approach their work and define their roles and professional identities. Instead of thinking in terms of tasks, clinicians in a developmental care model are supported to reframe their work as engagement in relationships.

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Developmentally supportive, family-centered care givers are encouraged to make use of their specialized knowledge and expert intensivist skills based on observation of infant behavior and in continuous reflection on themselves and those with whom they engage – patients and their families.. When given the appropriate supports for implementation, staff practicing individualized, developmentally supportive care frequently experience greater job satisfaction. . In one hospital in central Florida nursing turnover dropped from 12% to 4% with the introduction of individualized developmental care (J. Byers, personal communication, November 16, 2003).

In 2004, National Institute on Child Health and Human Development (NICHD) funded Vida Health Communications, Inc. of Cambridge, Massachusetts to produce, evaluate and distribute two DVDs for the distinct audiences of parents and clinicians. The resulting integrated set of multimedia programs consists of "No Matter How Small" – for parents and "Focus on the Brain" for clinicians. In ways that are appropriate for their different audiences and by using visual media's potential to magnify, slow-down, freeze and repeat hard-to-identify behaviors, the programs teach about fetal and preterm infant brain development, the neurobehavioral competencies of newborns, and specific care strategies now known to support the growth and development of premature infants in NICUs.

This article reports on findings from the evaluation of the program *Focus on the Brain: The Science of Preterm Infant Development,* which targets clinical staff working in NICUs. The media sought to increase the knowledge and understanding of staff, and to affect staff attitudes concerning Developmentally Supportive Care (DSC). The researchers hypothesized that:

1. Nurses in the NICU who received the DVD program would exhibit significantly greater increase in knowledge of and positive attitudes about preterm brain development from enrollment to one month later, than nurses who received the usual education and training.

2. These changes would persist three months following the intervention.

METHOD

Overview

This research design combined randomization of study sites with a quasi-experimental pre/post study design (Campbell and Stanley 1963), using survey instruments designed specifically for these purposes. Additional analysis explored the potential compounding interaction of the use of both DVD programs with their intended populations in the same NICU.

To evaluate the media program, this study compared knowledge and attitudes about care of preterm newborns among clinical staff who were given the DVD program to staff who did not have access to it. Baseline and short-term follow-up surveys were administered to all staff approximately one month apart, with staff at intervention sites viewing the program during the interim. Staff were asked to complete a final survey approximately three months after the second administration.

Participants

Four NICU sites agreed to take part in the study:

Site 1: a Level III NICU, had 46 bassinettes, 180 NICU staff, 8,000 live births/year, and 800 births before 37 weeks.

Site 2: a Level III NICU, had 55 bassinettes, 100 NICU staff, 4,200 live births/year, and 370 births before 37 weeks.

Site 3: a Level III NICU, had 43 bassinettes, 110 NICU staff, and 4,300 live births/year.

Site 4: a Level III NICU, had 30 bassinettes, 30 NICU staff, 1,300 live births/year, and 250 births before 37 weeks.

The sites were randomly assigned to either the intervention or control condition. The same research team at each of the four sites coordinated both the parent and the staff aspects of the study. At each site, trained study staff approached potential participants individually or, in the case of staff, at a staff meeting or in-service training, explained the study, answered questions and screened for eligibility.

The study attempted to recruit all professional nursing staff at each of the four NICUs – a total pool of just under 400 staff nurses, clinical nurse specialists, neonatal nurse practitioners, and neonatal nurse educators. There was wide variability in staff size by NICU.

Individuals who were eligible and wished to enroll completed written informed consents (all appropriate human subject protections were implemented under supervision by each institution's Institutional Review Board).

Procedures

Baseline. Staff participants were asked to complete the baseline survey immediately upon enrollment. As an incentive for participation and persistence, all participants who completed the study were qualified for a raffle for small gift certificates (customized by site and not to exceed $100 for any individual staff member).

Intervention. Participants at the intervention sites viewed the DVD program, either privately in a quiet location in or by the NICU, or as part of an in-service training program.

Follow-up. Staff completed a second survey approximately one month after the first. It was generally completed independently, on-site or at home, and then returned to study staff. Approximately three months following completion of the second survey, the third and final survey was administered to each staff participant. It was generally completed independently, on-site or at home, and then returned to study staff.

Measures

Instrument Development. The survey instrument was developed specifically for use in this study. Researchers articulated six domains of outcomes, generated measurement items for each. Eight experts rated the suitability of each item ("Poor," "Fair," "Good," or "Excellent"), suggested wording changes to improved clarity and consistency without raising the reading level, additional questions, and reversing valence of some true/false items to improve the distribution.

Thirty-six clinical staff at a NICU not in the study anonymously tested the survey. The level of item non-response was low and acceptable. Three true-false questions had even distributions of responses, so the language was clarified to avoid possible confusion or misinterpretation. With a mean of 2.5 incorrect true/false responses per individual and median and mode of 2 incorrect, these questions appeared to be at the correct level of difficulty. The valences of two of the eight Likert-type attitude questions were reversed in the hope of prompting future respondents to think about and answer these questions individually.

Table 1. Outcome Domains, Scales, Sample Items, and Number of Items

Outcome Domain	Scale	Sample Item	Number of Items
1. Knowledge of fetal and neonatal brain development.	T/F	Neural development does not begin until well into the second trimester of pregnancy.	12
2. The importance of developmentally supportive routine care and medical procedures.	T/F	For very low birth weight babies who are on respirators, developmentally supportive care has been shown shorten their time on a respirator	8
3. Partnering with parents and families.	T/F	Developmental care involves individualized infant care delivered collaboratively by family and healthcare providers	5
4. Creating a calm environment in the NICU.	T/F	By helping create a calm and soothing atmosphere in the nursery, caregivers can help infants to stabilize more easily following emergencies and to remain calmer for longer periods of time	8
5. DSC strategies and techniques	T/F	Because a preterm infant's sense of smell is well developed, strong odors such as perfume, hair spray, alcohol or nicotine should be kept away from the NICU	9
6. Attitude toward DSC practices (extent of agreement)*	5-point Likert-type scale	Proponents of developmental care are realistic about what we can do on the NICU.	8

* Cronbach's alpha = .95

Demographic characteristics and contact information were collected as part of the baseline survey only.

Knowledge was assessed in total and across five specific domains. Answers on the True/False tests were scored using a sum of points, with one point awarded for each correct answer, zero points for blanks, and minus one point for each incorrect answer. Each staff member's change in knowledge score from baseline to follow-up was calculated.

Staff attitude toward DSC was assessed in a single domain using a four-point Likert scale (1=strongly disagree to 4=strongly agree). Valences were reversed for the two questions with opposite valences from the others, so that on all items a higher score on any item represented a more positive attitude toward DSC. Individuals' responses were then averaged at baseline and at follow-up, and the change calculated.

Optional user feedback. The short-term follow-up survey included a 1-page "Optional Viewer Evaluation" to elicit users' reactions to the DVD. Seven questions inquired about the usefulness of the information, its relevance, level of organization, level of complexity, overall quality, length, and whether the user would recommend it to others.

Analyses

Except as specified, analyses focused on the 265 staff who took both the baseline and the short-term follow-up survey. Responses to the optional user feedback questions were compiled for review but not used in the quantitative analyses.

Preliminary analyses. As a check on randomization, bivariate analyses (chi-square and t-tests) were used to check for significant differences in demographic characteristics between the control and intervention groups, and for differences in baseline outcomes**,** both overall and by domain (knowledge or attitude).

Data were analyzed for potential time bias, i.e., differences in baseline outcomes attributable to the date each survey was completed. Correlations between date and outcomes were examined first overall and then separately by group (control and intervention).

Next, to check for potential consequences of attrition, and for bias of model estimates, participant characteristics and baseline outcomes were compared between dropouts and completing participants. .

Bivariate analyses. T-Tests were performed to determine the apparent effect of the intervention without accounting for other factors. These t-tests used either a pooled standard error or the Satterthwaite method, depending on results of a Folded F test of equivalence of variance. In each t-test, the null was tested against a one-sided alternative of greater improvement in the treatment group, using alpha=.05 to assess the level of significance.

Multivariate analyses. Multivariate analyses, which adjust for other possible explanatory variables, provide fairer estimates of the effects of intervention and represent the principal results of the study. Multivariate analyses consisted of modeling outcomes in two domains, knowledge and attitude, under two specifications: using *main effects* only, and including selected demographic characteristics and their *interactions with* the experimental variable. The interaction models, which used close to the recommended maximum number of independent variables, are best construed as sensitivity tests of the main effects model to indicate how much the estimate of treatment is influenced by model specification. Selection of characteristics to interact with the treatment variable was based on demonstrated significance in main effect models.

Longitudinal repeated measure models were also constructed to examine the effects of the treatment over time, from baseline to short-term follow-up, and from baseline to longer-term (3-month) follow-up. The specification of the model included a treatment indicator, two time indicators (for follow-ups), and two "treatment by time" interactions. The treatment indicator adjusts for baseline differences between the treatment and comparison groups, the two time indicators adjust for temporal differences occurring simultaneously to both groups, and the coefficients of the two interactions represent the effects of treatment at the two respective times.

RESULTS

Participants

Overall, 80% of the clinical staff approached agreed to participate in the study. While more response is always preferable, this is a common and acceptable response rate for such a population. Table 2 provides demographic characteristics of the study participants. Despite wide variation in numbers of NICU staff at the four study sites, the study design of randomizing at the level of the site resulted in two study groups, treatment and control, that were well balanced on measured demographic characteristics .

Table 2. Participant Characteristics (n=265)

Characteristic	n	Percent
Condition		
Control	126	47.5
Intervention	139	52.5
Sex		
Male	5	99.3
Female	258	0.7
Race/Ethnicity		
Hispanic / Latino	4	1.5
Black / African American	1	0.8
Asian	2	0.8
White	255	96.2
Age		
15-19	0	0
20-24	0	0
25-29	22	8.3
30-39	46	17.4
40-49	103	38.9
50-59	84	31.7
60-69	8	3.0
Type of Degree		
Diploma	50	19.0
Associates Degree	59	22.4
Bachelors Degree (BS/BSN)	136	51.7
Masters Degree (MS/MSN)	13	4.9
Neonatal Nurse Practitioner	3	1.1
Doctorate (PHD/DSN)	2	0.8
Previous Training in Developmentally Supportive Care		
None	9	3.0
Hospital In-Service	206	69.4
Other (Wee Care, NIDCAP)	82	27.6

Note: Percentiles may not total to 100% due to rounding errors.

Preliminary Analyses

No significant differences in demographic characteristics were found between the control and intervention groups. There was 10.6% attrition as of the short-term follow-up survey, which may limit the generalizability of the findings. Compared with participants who completed the short-term follow-up, those who did not had significantly higher number of errors on knowledge of fetal and neonatal development ($t=3.42$ $p<.01$), and knowledge overall ($t=2.52$ $p=.01$). These findings suggest that the

intervention may not be as effective in a general population of staff members, as it was in our completing sample. However, given the small attrition rate, the difference might well be minor. In addition, attrition differed between treatment (14.4%) and control (6.4%) groups which could have implications for our estimates of treatment impact. An auxiliary regression modeling baseline scores against treatment/control status, dropout status, and their interaction indicate that for knowledge of partnering with parents and families the treatment/attrition interaction was significant. This could bias the estimate of treatment impact, if, as is often the case, there is correlation between initial baseline score and score change. However, differences in attrition rates between the treatment and control groups remain very small and thus the problem is likely a minor one. With respect to baseline scores in the other domains and overall scores, the treatment/attrition interactions were not significant.

Effects of Program

Bivariate Comparisons of Intervention and Control Groups

Preliminary bivariate analyses indicated significant group differences in the hypothesized direction in several of the domains (Table 3): staff in the intervention group exhibited greater improvement than those in the control group in overall knowledge ($p<.05$), including the specific domains of the importance of developmentally supportive routine care and medical procedures ($p<.01$), and of DSC strategies and techniques ($p<.01$); treatment effect on other knowledge domains was not significant. They also exhibited greater improvement in attitude towards DSC ($p<.001$).

Table 3. Group Differences in Change Scores

Outcome	Mean Change[1]		t	P (<t)
	Intervention Site	Control Site		
Knowledge (five domains combined)	**2.04**	**.96**	**2.05**	**0.0205**
1. Knowledge of fetal & neonatal brain development	-.08	.18	-.99	0.3255
2. Knowledge of the importance of developmentally supportive routine care and medical procedures	**.99**	**.32**	**2.83**	**0.003**
3. Knowledge of partnering with parents and families	.02	.03	-.30	0.7614
4. Knowledge of creating a calm environment in the NICU	.10	.16	-.35	0.7234
5. Knowledge of DSC strategies and techniques	**1.00**	**.26**	**2.95**	**0.0018**
Attitude toward DSC	**.16**	**.02**	**3.71**	**0.0002**

[1] positive indicates improvement

Multivariate Analyses

Main Effects Models. The main effects models, with demographic characteristics included as covariates (Table 4) affirm all apparent findings of the bivariate analyses. Treatment showed a statistically significant effect on staff knowledge of DSC across all domains ($p<.05$) increasing treatment respondents' knowledge by 1.04 (.52 questions) more than controls.

Table 4. Effect of Program, Controlling for Covariates

Outcome	Effect	t	P (>|t|)
Knowledge (five domains combined)	**1.04**	**1.96**	**0.03**
1. Knowledge of Fetal & Neonatal brain development	-0.30	-1.10	0.86
2. Knowledge of the importance of developmentally supportive routine care and medical procedures	**0.66**	**2.76**	**0.003**
3. Knowledge of partnering with parents and families	-0.02	-0.31	0.62
4. Knowledge of creating a calm environment in the NICU	-0.05	-0.31	0.62
5. Knowledge of DSC strategies and techniques	**0.75**	**2.95**	**0.002**
Attitude toward DSC	**0.15**	**3.57**	**0.0002**

The models also confirm a statistically significant effect on two specific knowledge domains. For staff knowledge of the importance of developmentally supportive routine care and medical procedures (p=.006), treatment respondents' knowledge increased by .66 (.33 questions) more than controls, and for staff knowledge of DSC strategies and techniques (p=.002) treatment respondents' knowledge increasing by .75 (.375 questions) more than controls.

Finally, the main effects models confirm the highly significant improvement in staff attitude towards DSC for the intervention staff in comparison to the control group (p<.001), improving the average responses by 0.15.

Interaction Models. Estimates of treatment impact in these models (not displayed) – which include interaction terms for race/ethnicity, age, degree type and training – were similar to estimates of treatment in the main effect models. This provided evidence that the significance we found was not solely the product of fortuitous model specification.

Longitudinal Models Examining Persistence

By the time of the 3-month follow-up (Table 5), the treatment group's differential improvement in attitude persisted, remaining at a significantly high level (short term value of -.14 at p<.01 and longer term value -.08 at p=.015). Differential improvement in staff's knowledge persisted, or grew at longer term follow-up. Due to strong, highly significant differences in domain 2 (mean=.84 with p<.01) and domain 5 (mean = .81 with p<.01), the overall difference in knowledge grew to 1.7 by longer term follow-up (p<.01). There was no knowledge difference in longer term follow-up for the other three domains.

Table 5. Effect of Program in Longitudinal Models (Interaction of Time x Treatment)

	Immediate (1 month) Follow-Up			Long-Term (3-month) Follow-Up		
Outcome	**Effect**	**t**	**P (>|t|)**	**Effect**	**t**	**P (>|t|)**
Knowledge (five domains combined)	**-1.12**	**-1.78**	**0.04**	**-1.76**	**-2.70**	**0.004**
1. Knowledge of Fetal & Neonatal brain development	0.28	0.99	0.84	0.05	0.17	0.57
2. Knowledge of the importance of developmentally supportive routine care and medical procedures	**-0.67**	**-2.70**	**0.004**	**-0.84**	**-3.28**	**0.001**
3. Knowledge of partnering with parents and families	-0.02	-0.23	0.41	-0.02	-0.25	0.40
4. Knowledge of creating a calm environment in the NICU	0.03	0.15	0.56	-0.14	-0.75	0.28
5. Knowledge of DSC strategies and techniques	**-0.76**	**-2.95**	**0.002**	**-0.81**	**-3.08**	**0.001**
Attitude toward DSC	**-0.14**	**-3.28**	**0.001**	**-0.08**	**-1.88**	**0.03**

Optional User Feedback

The program was assessed favorably by the 44 staff who rated it (Table 6). All would recommend it for use in their hospital. The percent who rated the usefulness, relevance, organization, clarity and quality as "good" or "excellent" ranged from 93% to 96%.

Table 6. Responses to Optional User Evaluation Questions (n=44)

Item	Percent giving Rating				
Please rate the program on the following traits:	**Poor**	**Fair**	**Average**	**Good**	**Excellent**
Usefulness of information	5	0	0	25	70
Relevance to what I'm going through	0	0	3	41	56
Organization of information	0	0	3	37	60
Level of understanding / complexity	0	0	7	36	57
Overall quality of the program	0	0	2	35	63
	Too long	**Too short**	**The right length**		
The program was…	8	0	92		
	Yes	**No**			
Would you recommend this program for use for use in your hospital?	100	0			

DISCUSSION

Clearly significant effects were found on staff knowledge as a whole (across the five combined domains) and in the specific domains of knowledge about developmentally supportive care (DSC) strategies and techniques, and of the importance of routine DSC care for medical procedures. Moreover, all significant findings persisted at follow-up. These findings clearly indicate the DVD program's potential to educate NICU staff about DSC and to promote its importance. The clear effect the DVD program had on staff attitudes may be even more important in moving the field's substantive knowledge about the power of DSC from the "bench" to the bedside. Further research is needed to explore the factors that control nurses' attitudes toward DSC, and ways in which the media program, independently or in concert with other interventions, can affect the NICU culture generally and attitudes about DSC specifically.

The program's ability to educate NICU staff about DSC and its importance can help move knowledge of DSC from the "bench" to the bedside.

NICUs are very specialized environments rife with life-and-death pressures and a host of social, medical, financial, and organizational factors at play. The study sites varied greatly in physical design and in their culture, leadership and institutional context. For example, throughout the study, one site was led by a dynamic young Director whose influence in the hospital was on the ascendancy, and who advocated, funded and pursued a developmentally supportive approach as a lynch-pin of the unit's own development. Another boasted one of the world's leading researchers in DSC who happened to be offering a DSC in-service program for staff during the extended course of the study.

NICUs are very specialized environments rife with life-and-death pressures. Still, the environment of care can be influenced for the better.

Moreover, nurses face pressures endemic to caring for three NICU infants over long shifts. They are likely to be influenced by their colleague's attitudes and by their NICU's work culture. Any intervention that reflects, and affects, the level of support for, attention to and education about DSC in a NICU

environment is thus bound to have a clear effect on individual nurse care practices. This web of factors weighs on and constrains NICU nurses' care practices daily. While NICUs cannot easily change their architectural design and physical layout, and financial pressures on nursing care show no signs of abating, these findings offer good reason to believe that the environment of care can be influenced for the better. By utilizing modern media formats and technologies, the DVD program clearly provides a cost-effective and reusable tool to support NICU nursing training and continuing education. The potential for self-administration, repetition and non-sequential review make this tool all the more valuable.

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