# Encouraging Parental Reading for High-Risk Neonatal Intensive Care Unit Infants

Viral G. Jain, MD[1,2], Christy Kessler, RN[1], Linda Lacina, RN[1], Greg A. Szumlas, MD[3,6], Clare Crosh, MD[3,6], John S. Hutton, MD[3,4,6], Robert Needlman, MD[5], and Thomas G. Dewitt, MD[3,4,6]

**Objective** To assess whether a citywide structured book-sharing program (NICU Bookworms) designed to promote reading to infants while admitted in the neonatal intensive care unit (NICU) would increase parental reading behaviors (≥3-4 days/week) in the NICU and after discharge home, including high-risk parents who do not themselves enjoy reading.

**Study design** The NICU Bookworms program comprised staff training, parent education, and building a literacy-rich environment. In this quasi-experimental intervention study, parents of medically high-risk NICU graduates <6 months of age were administered a questionnaire at their first NICU follow-up clinic visit. The survey incorporated questions from the StimQ-I READ subscale to assess home reading environment and shared reading practices.

**Results** A total of 317 infants were enrolled, 187 in an unexposed comparison group and 130 in the intervention group. Parents exposed to Bookworms were significantly more likely to read ≥3-4 days per week while in the NICU (34.5% vs 51.5%; $P = .002$; aOR, 2.2; 95% CI, 1.2-4.0), but reading at home did not differ (67.9% vs 73.1%; $P = .28$; aOR, 0.99; 95% CI, 0.5-1.8). However, among parents who did not themselves enjoy reading, frequency was significantly higher both in the NICU (18.4% vs 46.1%; $P = .009$; aOR, 5.0; 95% CI, 1.2-21.5) and at home (36.9% vs 70%; $P = .003$; aOR, 3.7; 95% CI, 1.1–12.9). A qualitative thematic analysis found that Bookworms decreased parental stress, enhanced bonding, and supported positive parent-infant interactions.

**Conclusions** A book-sharing intervention in the NICU increased parent-reported reading aloud during hospitalization and among parents disinclined to read for pleasure, both in the NICU and following discharge. This change may have been mediated by enhancement of parent-infant interactions. *(J Pediatr 2021;232:95-102)*.

Infants admitted to the neonatal intensive care unit (NICU) are at increased risk for neurodevelopmental deficits due to prematurity or illness, which may adversely affect school performance and later employment. Delays in language and reading skills are among the most common neurodevelopmental deficits seen in preterm infants.[1-3] In utero language exposure is linked to normal development of auditory processing, speech, and reading.[4-6] Infants born preterm are often deprived of this normative auditory input.[7] The language and speech areas of the brain grow exponentially in the first few months of life.[8] For many NICU infants, these formative months are spent in an environment that is often high stress, exposed to nonconstructive, nonspeech noises. By contrast, increased exposure to language and parental voice in the NICU enhances brain plasticity, and has been associated with higher language and cognitive scores at 2 years of age.[9,10]

Admission to a NICU environment can also convey risks of impaired parent-infant interaction.[11] Parents of premature infants are often stressed and/or depressed, and may have difficulty engaging spontaneously in parenting behaviors.[12] It is also possible that, if parents are not given appropriate feedback and guidance on reading to their sick infant in a stressful NICU environment, they may become discouraged if they are not able to understand the infant's behavioral cues.

The American Academy of Pediatrics recommends that parents read to their children as soon as possible after birth, to stimulate optimal patterns of brain development and strengthen parent-child relationships.[13] To reinforce this guidance, the American Academy of Pediatrics and clinic-based programs such as Reach Out and Read encourage pediatric providers to promote shared reading during well-child visits beginning in early infancy.[13,14] However, many parents are not aware of the benefits of reading to very young infants, let alone those cared for in the NICU.[12] This finding is particularly of concern for parents who do not enjoy reading; these parents were 3 times less likely to read to their newborns.[15]

The NICU Bookworms program was inspired by evidence of developmental risks associated with prematurity, and the cognitive, relational, and neurodevelopmental benefits of parental voice in the NICU and reading aloud. This

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| CCHMC | Cincinnati Children's Medical Center |
| NICU | Neonatal intensive care unit |

From the [1]Perinatal Institute, Division of Neonatology, Cincinnati Children's Hospital Medical Center, Cincinnati, OH; [2]Division of Neonatology, University of Alabama at Birmingham, Birmingham, AL; [3]Department of Pediatrics, University of Cincinnati College of Medicine; [4]Reading & Literacy Discovery Center, Cincinnati Children's Hospital Medical Center, Cincinnati; [5]Department of Pediatrics, Case Western Reserve University, MetroHealth Medical Center, Cleveland; and the [6]Division of General Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, OH

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study involved the citywide application of this program in our NICUs to encourage shared reading behaviors in the NICU and at home after discharge. The goals were to describe parental attitudes and reading aloud behaviors in the NICU, and how these changed following the institution of the NICU Bookworms program. The hypothesis was that exposure to the program would increase "regular" reading frequency (≥3-4 times/week) in the NICU and also at home after discharge from the baseline. We further hypothesized that the association between exposure to Bookworms and "regular" reading frequency (≥3-4 times/week) would be higher in the subgroup of parents reporting that they do not themselves read for pleasure.

## Methods

In this quasi-experimental intervention study, infants discharged from the NICUs in the Greater Cincinnati region from May 2018 to May 2019 and attending the Cincinnati Children's Medical Center (CCHMC) NICU High-risk Clinic were consecutively enrolled. The clinic follows graduates from all the NICUs in the greater Cincinnati region, all staffed by CCHMC faculty and trainees. Historically, the clinic's follow up rate has been 80%-90% among infants fitting the high-risk clinic criteria, which include gestation of <32 weeks or birth weight of <1250 g, grade 3 or 4 intraventricular hemorrhage, hypoxic-ischemic encephalopathy, chronic lung disease with oxygen requirement, extracorporeal membrane oxygenation, medical or surgical necrotizing enterocolitis, genetic syndromes with feeding or surgical problems, and any congenital anomaly requiring surgical intervention. For this study, infants with NICU stays of <7 days were excluded.

All infants <6 months of age attending the high-risk clinic during the study period were approached for enrollment. The NICU Bookworms program was launched on December 17, 2018. Unexposed NICU graduates discharged between May 2018 and December 2018 (before program launch) comprised the comparison group, and infants discharged between January 2019 and May 2019 comprised the intervention group. The study was approved by the CCHMC Institutional Review Board.

### Intervention

The intervention included staff training, parent education, and the creation of a literacy-rich environment.

### Training

All personnel involved in the care of infants in the NICUs were trained in developmentally appropriate reading aloud. Topics included parent-infant bonding in the NICU and benefits for brain development; the benefits of reading aloud, singing, and talking; goals for shared reading; and techniques for counseling parents to individualize each shared reading experience. Novel guidelines were developed for developmentally appropriate practices at different gestational ages (23 weeks to 6 months) based on the synactive theory of infant development.[16] The basic concept underlying this approach is that the infant will defend himself or herself against stimulation if it is inappropriately timed or is inappropriate in complexity or intensity (the full training curriculum is available on request). The training also accounted for infants or parents with vision or hearing impairment or both, those parents who cannot read, or those who spoke a different language, and so on.

In addition to the training as described, at the 2 main NICUs (a level IV and a level III NICU) a core Bookworms team of nurses, child life specialists, and other therapists, called Bookworms Champions, underwent in-person training regarding the Reach Out and Read program and advanced training on the synactive theory of infant development. Their role was to supervise the day-to-day activities of Bookworms implementation and help the bedside staff and parents when questions arose. They also reported directly to the study team with any concerns. The core Bookworms Champions and the study team met monthly to assess reading practices in the NICU based on nursing staff feedback and book stocks. At the other NICUs, grand rounds for the neonatologist group and regular training sessions for the nursing educators were conducted. Training materials were shared with all the NICUs.

Parent education was carried out by trained nursing and other ancillary staff. Within the first 7 days of admission, a trained provider introduced the program and educated the parents on reading to their infant. Parents were encouraged to read, talk, and sing to their infants. Parents were provided with a Bookworms bag, which contained a children's storybook and information sheets with evidence about the benefits of reading aloud and tips on developmentally appropriate reading practices based on infant cues. Parents were encouraged to customize this book with their child's footprint. Staff members were frequently encouraged to promote reading and educate parents by sending Bookworms reminders and updates in the weekly newsletter. Book carts were pushed out across the unit every week to distribute free books in the main NICUs. Parents were encouraged to read any book of their liking, which they can bring from home or from the NICU library to which they had free access. Several local and social media campaigns were conducted to educate about the benefits of reading aloud starting in the NICU, including a parent information video and a professionally produced song about the benefits of reading aloud in the NICU.

The literacy-rich environment included a NICU library providing easy access to story books in multiple languages and prominently displayed posters and pamphlets about the NICU Bookworms program and the benefits of reading aloud. Merchandise (eg, t-shirts) on NICU Bookworms were regularly distributed to keep the staff engaged throughout the campaign. Prominent leaders from CCHMC, Cincinnati City Council, various outside organizations, and

celebrities were enlisted to promote the program and to keep parents and staff engaged.

### Data Collection

In both the intervention and comparison groups, parents were administered a written questionnaire at their first high-risk clinic visit. Parents could opt to have the questionnaire read to them, and language interpretation was offered when required. As measures of the home reading environment, the questionnaire included core items adapted from a validated measure (the Reading subscale of the StimQ-I), as well as questions on access to books, reading frequency, reading routines, reading aloud advised by a healthcare worker, parents' educational level, and infant's ethnicity per parent report. Where possible, these questions were derived from the published literature.[12,17] An open-ended question was included for thematic analysis asking parents' thoughts and feelings on reading to their infants. Additional demographic data were abstracted from medical records.

The enrollment goal for this study at the follow-up clinic visit was 256 infants (128 in each group) to detect an increase in regular NICU (≥3-4 days/week) reading from 33% to 50% ($\alpha = 0.05$) with 80% power.

### Qualitative Analysis

A thematic analysis was performed on the qualitative caregiver comments on shared book reading.[18] Three independent reviewers read each response and assigned codes to describe the meaning behind each. The codes and coded data extracts were then consolidated and grouped within broader themes to create a thematic map. The 3 reviewers compared their predominant themes and used collaborative discussion to decide on the final themes and specifics of each (eg, name, definition, characteristics). Exemplary quotes are provided to illustrate the meaning behind each theme.

### Statistical Analyses

We used the SPSS 22.0 (SPSS Inc), with the significance value set at a $P$ value of $< .05$, with $\chi^2$ tests for categorical data, Student $t$ tests for normally distributed data, and the Mann-Whitney $U$ tests for nonparametric analyses. To account for multiple outcomes testing, the Holm-Bonferroni method was used to correct $P$ values. For post hoc regression analyses, we dichotomized reading frequency as ≤1-2 days per week (not regular) or ≥3-4 days per week (regular), because the original distributions were highly skewed. We selected potential confounders based on their importance in the literature, including chronological age, gestational age, length of stay, mother's education, and insurance status (as a proxy for income).[19] We also controlled for which of the NICUs was mainly involved with the child.

## Results

### Demographics

An estimated 381 infants were eligible during the study period. Seventeen infants who received care in NICUs outside greater Cincinnati and 2 for blank questionnaires (nonresponders) were excluded. During the study period, we enrolled 317 subjects out of an estimated 381 eligible; thus, the enrollment rate was 87.6%. We enrolled 187 in the comparison group and 130 in the intervention group. The level IV NICU accounted for 135 infants (43%), the level III NICUs for 165 (52%), and the level II NICUs for 17 (5%). The majority of the beds in these NICUs were open pods with a few single occupancy rooms, generally reserved for isolation cases.

The mean gestational age was 34.4 ± 4.4 weeks (range, 23.0-42.2 weeks), the mean birthweight was 2.34 ± 1.0 kg, and the mean length of stay in the NICU was 38 ± 30 days. Questionnaires were completed at a mean of 45.0 ± 29.4 days after discharge from the NICU and the mean age at the time of questionnaire completion was 89.5 ± 39.5 days with the comparison group being on average 2 weeks older than the intervention group. There were no other group demographic differences and the comparison and intervention groups were balanced (Table I).

### Healthcare Professional Role

Before and after implementation, there was no difference in the rate at which primary care physicians seeing NICU infants after discharge advised reading aloud (43% vs 40%; $P = .53$). Before the implementation of NICU Bookworms (ie, in the comparison group), 36.9% of parents reported having been advised to read aloud to their infants and 10.7% reported that NICU staff had actually shown them how to do it. After Bookworms implementation (ie, the intervention group) significantly more parents reported having been advised to read aloud (53.8%) or shown how (22.3%) ($P < .01$ for both comparisons).

### Reading Aloud in the NICU and at Home

NICU Bookworms was universally acceptable to parents. More parents in the intervention group (51.5%) reported having read aloud to their babies in the NICU ≥3-4 days per week, compared with 34.5% in the comparison group ($P = .002$). There was no difference in regular (≥3-4 days per week) reading aloud at home (73.1% intervention vs 67.9% comparison; $P = .3$) (Table I). After adjusting for potential confounders, parents in the intervention group were more likely to read aloud in the NICU (aOR, 2.2; 95% CI, 1.2-4.0), but there was no difference in reported reading at home (aOR, 0.99; 95% CI, 0.5-1.8) (Table II).

### Reading by Parents Who Do Not Enjoy Reading

Compared with parents who reported enjoying reading, mothers who stated that they did not enjoy reading were less likely to have college degrees (49.3% vs 62.8%;

**Table I. Demographics of the study population**

| Variables | Entire population | | | Parents who do not themselves enjoy reading | | |
|---|---|---|---|---|---|---|
| | Comparison (n = 187) | Intervention (n = 130) | *P* value | Comparison (n = 38) | Intervention (n = 40) | *P* value |
| Infant demographics | | | | | | |
| Infant sex (males) | 105 (56.1) | 70 (53.8) | .68 | 25 (65.8) | 19 (47.5) | .10 |
| Gestational age (weeks) | 34.4 ± 4.3 | 34.7 ± 4.5 | .52 | 34.3 ± 4.0 | 35.3 ± 4.1 | .29 |
| Birth weight (kg) | 2.31 ± 1.0 | 2.38 ± 1.0 | .52 | 2.41 ± 1.0 | 2.63 ± 1.2 | .39 |
| Age at questionnaire (days) | 95.4 ± 39 | 80.7 ± 37 | .001* | 96.1 ± 40.9 | 79.4 ± 33.0 | .06 |
| Length of stay (days) | 34.9 ± 27 | 41.6 ± 33 | .46 | 36.1 ± 25 | 40.6 ± 28 | .46 |
| Parent demographics | | | | | | |
| Insurance status (Medicaid or uninsured) | 136/187 (72.7) | 101/130 (77.6) | .31 | 29/38 (76.3) | 31/40 (77.5) | .90 |
| Mother's education (>college or General Educational Development) | 94/165 (56.9) | 65/108 (60.1) | .52 | 15/36 (41.6) | 21/40 (52.5) | .35 |
| Father's education (>college or General Educational Development) | 46/96 (48) | 37/82 (45) | .72 | 6/19 (31.5) | 12/27 (44.4) | .38 |
| Race | | | | | | |
| White | 130/172 (75.5) | 86/114 (75.4) | .89 | 31/37 (83.5) | 31/40 (77.5) | .77 |
| African American | 22 | 12 | | 3 | 4 | |
| Multiracial | 18 | 13 | | 3 | 5 | |
| Other | 2 | 1 | | - | - | |
| Primary language: English | 170/174 (97) | 112/114 (98.2) | .51 | 38/38 (100) | 40/40 (100) | - |
| No of books at home (≥5 books) | 146/184 (79.3) | 104/130 (80.0) | .88 | 29/38 (76.3) | 32/40 (80) | .69 |
| Family member reading (yes) | 106/176 (60.2) | 79/118 (66.9) | .24 | 13/38 (34.2) | 21/40 (52.5) | .10 |
| Read to as a child (yes) | 113/182 (62.1) | 80/124 (64.5) | .41 | 21/38 (55.2) | 23/40 (57.5) | .84 |

*$P < .05$.
Values are number (%), mean ± SD, or number/total population (%).

$P = .046$). Within the subset of parents who did not enjoy reading, the intervention and comparison groups did not differ in the infant or parent demographics (Table I). In this subgroup, the frequency of regularly reading aloud (≥3-4 days per week) in the NICU rose from 18.4% in the comparison group to 46.1% in the intervention group ($P = .009$). Similarly, regular reading aloud at home increased from 36.9% to 70.0% ($P = .003$) (Table II); these differences persisted after adjusting for potential confounders (aOR, 5.0; 95% CI, 1.2-21.5 for reading in the NICU and aOR, 3.7; 95% CI, 1.1–12.9 for reading at home).

### Parental Beliefs and Current Behaviors

Overall, parents generally agreed or strongly agreed with the statements that they enjoyed reading books with their babies (78% in the comparison group vs 79% in the intervention group); that reading helped them feel closer to their babies (78% vs 79%), and that reading aloud was very important to their child's development (94% vs 91%). They generally disagreed or disagreed strongly that reading aloud takes too much time (83% vs 89%). None of these differences were statistically significant.

A minority (9% in both groups) stated that they did not have enough books at home to read to their child, 6% of those in the comparison group stated that they thought that babies do not understand enough yet to start reading to them, vs 9% in the intervention group ($P = .8$), and only 1 parent in each group stated that they were not comfortable reading out loud to their NICU babies.

### Thematic Analysis

The following themes arose in the analysis of parents' beliefs about the value of the Bookworms intervention: strengthening infant-parent bonding, facilitating positive infant-parent interactions, reducing parental stress levels, and helping parents to establish a reading aloud routine (Table III). Many parents expressed a lack of knowledge of when (<6 months) they should start reading aloud and the cues that would signal developmental readiness to be read to.

## Discussion

Advances in care for premature infants over the past several decades have improved survival, although accompanied by risks

**Table II. Outcomes of the study population after Bookworms intervention**

| Populations | Comparison group | Intervention group | *P* value | aOR (95% CI) |
|---|---|---|---|---|
| Entire population | | | | |
| Regularly (≥3-4 days/week) read in the NICU | 64/185 (34.5) | 66/128 (51.5) | .002* | 2.2 [1.2-4.0] |
| Regularly (≥3-4 days/week) read at home | 127/187 (67.9) | 95/130 (73.1) | .28 | 0.99 [0.5-1.8] |
| Parents who do not themselves enjoy reading | | | | |
| Regularly (≥3-4 days/week) read in the NICU | 7/38 (18.4) | 18/39 (46.1) | .009* | 5.0 [1.2-21.5] |
| Regularly (≥3-4 days/week) read at home | 14/38 (36.9) | 28/40 (70.0) | .003* | 3.7 [1.1–12.9] |

Adjusted for gestational age, age at the time of questionnaire, length of stay, mother's education, insurance status, and center. Values are number/total population (%) unless otherwise indicated.
*Significant *P* values after correction with Holm-Bonferroni procedure.

**Table III. Thematic analysis of shared reading**

| Themes | Representative quotes |
|---|---|
| Comparison population | |
| Lack of knowledge/misconception | "Don't feel like he's old enough." |
| | "We have not started reading yet as I did not know you were supposed to start at 1 month." |
| | "We haven't started reading to him yet. We are going to start once he is able to interact with us better" |
| | "We thought James was too young to be read to. We're open to reading to him when he is ready" |
| Importance of understanding behavior cues | "Somedays she's not interested and gets cranky, so I stop." |
| Intervention population | |
| Positive interaction with infant through books | "She loves to read and look at the pictures. She likes the shapes and colors but like people pictures the best." |
| | "I love to read to my baby. I think he likes it a lot." |
| | "He may not understand what is being said, but he loves looking at the colorful pictures in the books and listening to us talk. It's a good way to keep him preoccupied when he is awake and alert." |
| | "He loves it, I have been reading to him since he was a week old and he loves it." |
| Reduces parental stress | "Reading is a special time for sharing 'downtime' or time for calm with baby." |
| Importance of the program | "I loved the bookworm program. Wish there would have been a certificate on completion though." |
| Enhances bonding | "I feel it is also a great bonding tool between me and baby, besides furthering his development!" |
| | "We enjoy bedtime stories very much, helps us get more bonding time in and has become a bedtime routine." |
| Established a routine | "Reading to my kids is a great thing to do while they are still really little because they can start learning new things, then when they get a little bit older they will already know it, and they will love to read books." |

of language and other delays, including subsequent reading abilities.[20,21] Prolonged NICU stays can be highly stressful for parents, who are often anxious about how they can help their child. The third trimester is a dynamic span of brain development, highly sensitive to nurturing stimulation such as touch and parental speech. Shared book reading is a major source of language exposure across childhood, including calming cadence, soothing tone, and a range of word sounds.[22] The purpose of this citywide study was to explore parental attitudes and behaviors related to reading aloud and changes inspired by the NICU Bookworms program, both during the NICU stay and after discharge at home.

The institution of the Bookworms program to encourage reading aloud led to a doubling in the number of parents who reported reading aloud to their babies regularly (≥3-4 days/week) while in the NICU. This difference was no longer significant several weeks after discharge. However, among a subset of high-risk parents with less maternal college education who reported not enjoying reading, those in the intervention group were 5.0 times more likely to report having read to their infant in the NICU, and 3.7 times more likely to report regularly reading aloud at home. This finding is particularly noteworthy, because parental enjoyment of reading is positively associated with reading aloud both in the neonatal period and across childhood, with nonenjoyment considered a risk factor for lower shared reading frequency and quality, in turn fueling lower exposure to language at home.[15,23]

The NICU experience can be highly stressful for parents and can impair parent-infant bonding. Parents who feel overwhelmed with their sick newborn may be less likely to hold, feed, talk with, and read to their babies, and more likely to experience impaired parent-infant interactions.[11] The loud background noise in the NICU may affect cardiac and respiratory functioning and also lead to developmental problems.[24] By contrast, maternal voice and reading have been associated with fewer cardiorespiratory events in preterm infants.[24,25] Themes related to parental impression of the Bookworms program in the qualitative aspect of this study suggest a sense of hope and empowerment, including less stress, enhanced bonding, and more positive interactions with the infant. This finding aligns with changes in shared reading frequency in the NICU reported before and after the implementation of the Bookworms program. Before the implementation of Bookworms, even though 78% of the parents stated that reading helped them feel closer to their baby and 94% agreed that reading was important for their infants' development, the rate of regular reading aloud in the NICU was still low (34%). It seems likely that the guidance in the Bookworms program reassured parents that reading can begin in the NICU even if their child seems small or frail. Bookworms' guidance may also help parents to understand and respond to their infant's cues to make reading a more rewarding experience, fueling greater frequency. Previous studies during prenatal care have found that parents are very open to discussing shared reading as early as the perinatal and even prenatal period.[26] This aligns with parental responsiveness to Bookworms' guidance found in the current study.

Infants admitted to the NICU are at risk of poor neurodevelopment, including deficits in language and literacy abilities. Fewer opportunities to perceive meaningful speech sounds during NICU hospitalization can alter brain structure and may account for some of these deficits,[4] which may persist for years.[2] For example, infants in single-occupant rooms in the NICU with poor language exposure have been found to have poor cerebral maturity and neurodevelopmental outcomes at 2 years of age.[27,28] In turn, these factors confer risks of reading and other academic difficulties. It has been suggested that emergent literacy be considered a distinct domain of child development, given its importance to long-term health outcomes, myriad risk factors identifiable by pediatric providers, and requisite integration of functionally distinct brain networks.[29] Thus, early intervention strategies that provide

enriched exposure to oral language such as reading aloud have the potential to mitigate deficits and improve outcomes. This finding is true for infants and young toddlers, where reading aloud has been associated with enhanced language and literacy outcomes, with greater effects for earlier age of onset and higher reading frequency.[30] Further, reading aloud to preterm infants in the NICU ≥2 times per week in retrospective studies has been associated with improved neurodevelopmental outcomes at 2 years of age.[31]

Fetal auditory brain networks begin to emerge as early as 16 weeks of gestation and infants born as early as 23 weeks of gestation can hear and were thus included for reading intervention. By 25-26 weeks of gestation, loud noises can trigger changes in autonomic function. Around 28 to 30 weeks, neural connections needed to recognize and react to language, music, and meaningful environmental sounds are functional.[32] By contrast, auditory feedback mechanisms do not come on-line until near term gestation, rendering preterm infants vulnerable to loud, nonhuman noises with a limited ability to modulate such stimuli. This point reflects another opportunity of the Bookworms intervention, namely, focusing staff and caregiver attention on infant cues to decrease overstimulation and stress, while presenting shared reading as an exemplar of nurturing exposure to human speech. This was guided via principles of the synactive theory,[16] which were incorporated into Bookworm's education and guidelines for both parents and NICU staff to understand and respond appropriately to the infant's behavioral cues based on gestational age, medical acuity, and family dynamics. The goal was to help parents to better respond to their child's cues, bond with them using books as a medium, take an active role in their care, and establish healthy routines to continue at home.

The findings from this study underscore the opportunity for healthcare providers to improve parent-child relationships and child health outcomes by conveying consistent, empowering reading guidance in clinical settings. In a previous study, 93% of parents reported that they would have read to their sick infants in the NICU if they had been encouraged by a healthcare professional.[12] Our study suggests that NICU professionals are poised to play a significant role in increasing reading aloud by parents. There have been few studies on reading programs based in NICUs, and only one of these has examined reading aloud behaviors after discharge.[12,25,33] The preintervention NICU reading rate in our study was high (34%) compared with rates as low as 0% cited in a study based in Boston NICUs.[33] Similarly, the home reading rate in our preintervention group was also very high (67%) compared with a rate of 17% cited in a Canadian study involving NICU infants.[12] This high baseline rate was a likely contributor to the nonsignificant increase at home after the Bookworms intervention (to 73%). These high baseline rates of home reading were not surprising given our institute's and the City of Cincinnati's aggressive efforts over the past decade to promote early literacy. Nonetheless, we observed a significant increase in home reading among parents who did not themselves enjoy reading, who were reading aloud at a much lower rate at baseline (36% to 76%), which has not been reported previously. Finally, Bookworms provided a unique opportunity for parents to bond with their sick infant, a nurturing benefit of reading together increasingly emphasized in Reach Out and Read and other programs.[13]

This study has limitations. Only families attending the high-risk clinic after discharge were included, possibly fueling participation bias. Even though we aimed for consecutive recruitment, some patients were missed owing to staff unavailability. There was also variability in the administration of the program at various participating NICUs, which could have diluted the results relative to administration with maximum fidelity. In a sense, however, this factor is a strength, because our citywide study may more closely represent the outcomes in actual practice (ie, effectiveness) rather than in a tightly controlled experiment (ie, efficacy) and makes this study generalizable to other NICU settings. Follow-up and evaluation of home reading practices were only done at the first clinic visit (mean 45 days) and the long-term effects of the Bookworms intervention are unclear, warranting future study. Outcomes were assessed via parental self-report with no direct observations, diaries, vocabulary scores, or neurodevelopmental assessments, rendering findings susceptible to social desirability and/or recall bias. Baseline levels of parental anxiety or depression were not measured, which can impact shared reading behaviors. We also did not measure how frequently parents were advised by neonatal staff to read to their infant or the quality of such advice, making dose-response estimates uncertain. However, by design, the study used a pragmatic approach for a citywide implementation focused on building a literacy-rich environment and training healthcare professionals on a practical, ecological level. Thus, it is likely that families experienced continuous encouragement on reading aloud during their NICU stay. The pragmatic approach of this study provides evidence for the benefits of a NICU reading program that can be easily adopted and generalized to other NICUs. Now, future studies should use a quality improvement approach to optimize the magnitude of the impact of NICU reading programs and the fidelity of administration. To avoid contamination of the comparison group, we chose to use a preintervention group as the comparison group. We are unaware of other programs locally or nationally that might have differentially influenced outcomes between our preintervention and postintervention population. This finding is also supported by the fact that there was no difference in the rate at which primary care physicians seeing NICU infants after discharge advised reading aloud (43% vs 40%), suggesting no change in healthcare professional behavior outside the NICU occurred during the study period.

In conclusion, this citywide test of the NICU Bookworms program promoting reading aloud to medically high-risk infants in the NICU suggests that it is acceptable to parents and staff, and more than doubled reported rates of reading aloud

during the NICU stay. The benefits were especially strong for parents who did not themselves enjoy reading aloud. Given the value of home reading routines to promote skills, attitudes, and healthy brain development, the low reading group is of particular importance for further studies. Qualitative analysis suggests that improvements in reading behaviors may be mediated by enhancement of parent-infant interaction and bonding, although confirmatory studies are needed. Altogether, by encouraging parents to read aloud and attend to their infants' cues, NICU Bookworms may be an efficient and accessible means for doctors, nurses, and other NICU professionals to create an environment that fosters language and underlying brain growth and parent-infant bonding. This, in turn, has the potential to help mitigate the neurodevelopmental risks associated with NICU admission. Future studies are needed to refine the Bookworms intervention and better understand the mechanisms of effect and longer term impacts. ■

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Reprint requests: Viral G. Jain, MD, Perinatal Institute, Division of Neonatology, Cincinnati Children's Hospital Medical Center, 3333 Burnet Ave, Cincinnati, OH 45229. E-mail: viral_jain@live.com

## Data Statement

Data sharing statement available at www.jpeds.com.

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## 50 Years Ago in *THE JOURNAL OF PEDIATRICS*

### Is Gowning Necessary in the Nursery?

Evans HE, Akpata S, Baki A. Bacteriologic and clinical evaluation of gowning in a premature nursery. J Pediatr 1971; 78:883-6.

The report by Evans et al described a single-center study testing whether routine caregiver gowning in a premature nursery influenced the developing bacterial flora and the acquisition of hospital-acquired infections (HAIs) in babies housed in enclosed incubators. Alternating 3-month periods were compared, one in which gowning was uniform and the other in which the caregiver only hand-washed when entering the incubator. No effect on either the flora or HAI rates was demonstrated.

HAIs, including those in newborn intensive care units, are a significant source of morbidity, mortality, and costs in the acute care environment. Since the publication of the article by Evans et al, the field of hospital quality improvement has blossomed in an attempt to better healthcare outcomes, including HAI rates. It is now clear that the success of interventions such as those described in Evans et al depends on the recognition that they are applied in multimodal, complex systems. Perhaps the most frequently used framework to develop and study healthcare quality initiatives is the Model for Improvement. This model, driven by successive heuristic plan-do-study-act cycles, was developed through the 1990s and has been used by many quality and safety departments now routine in American hospitals. Individual center efforts have been further enhanced by incorporating them into multicenter quality networks. These networks are built on infrastructures at both the local and national levels. National collaboration organizations such as The Children's Hospitals Solutions for Patient Safety leverage the leadership and data from local quality activities to set national standards and benchmarks aimed at achieving measurably improved outcomes for the entire population. The adoption of quality frameworks such as the Model for Improvement by individual centers, and the participation by hospitals in quality collaboratives, have identified additional factors, such as frequent communication and feedback regarding outcomes to healthcare workers and other hospital stakeholders, the development of a safety culture, and transparent and nonpunitive disclosure of medical errors, as dynamics that promote improved outcomes and explain performance variation from center to center. Since the time of Evans et al, we have learned much about the importance of the environmental influences surrounding quality interventions, and one wonders what their efforts would have yielded had they been applied today.

**Joan Zoltanski, MD**
**Philip Toltzis, MD**
Department of Pediatric
Rainbow Babies and Children's Hospital
Cleveland, Ohio