

Critical Review:

What effect does being in a neonatal intensive care unit (NICU) have on a child's speech and language development?

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This critical review appraises literature examining the effects of a neonatal intensive care unit (NICU) environment on the speech and language development of children. The three articles reviewed in this paper include one cohort study, one cross-sectional cohort study and one survey research study. Results of this critical review revealed useful findings regarding the impact of the NICU environment on speech and language outcomes. However, no absolute conclusions can be made due to the challenges and limitations of research.

Introduction

In the past, many studies investigated factors associated with deficits in the speech and language skills of children who once required neonatal intensive care (NIC). Variables include gestational age, birth weight, comorbidities, and the postnatal environment (Vohr, 2013). The primary focus of the current paper is on the effects of the neonatal intensive care unit (NICU) environment on the speech and language development of children.

In the NICU, infants are bombarded with unfamiliar noises and sights, such as the sounds of telephones, alarm lights, ventilators, and other related machinery (Wachman & Lahav, 2010). Infants in the NICU are also exposed to minimal adult language, leading to concerns regarding the amount of language stimulation infants receive (Caskey, Stephens, Tucker & Vohr, 2011). All these factors may affect an infant's access and exposure to language.

According to Mathisen, Carey and O'Brien (2012), the number of NICU graduates requiring speech and language therapy has increased greatly in recent years. Common deficits observed in these children include difficulties in acquiring expressive language skills, receptive language skills, articulation issues, and difficulties with phonological memory (Vohr, 2013). Wachman and Lahav (2010) also found that although survival rates of low birth weight infants increased significantly in recent decades, several of these infants are also experiencing neurodevelopmental problems, including speech and language deficits, when approaching school age.

Such trends motivated researchers to investigate what sounds are present in the NICU, the amount of noise exposure infants receive in the NICU, the nature of the care these infants receive, and the effects of these variables on the speech and language development of children. Thus far, research on the NICU environment and speech and language development has been minimal and varied. Some studies suggest that the NICU environment has a positive effect on speech and language, while other studies disagree. The current review will investigate both these perspectives.

Objectives

The purpose of this review is to evaluate current research describing noises and sights in the NICU environment and the effects of this setting on the speech and language development of children who have once stayed in the NICU.

Methods

Search Strategy

The sources for this paper were collected using the computerized databases PubMed, PsycINFO and Proquest. One of the papers was found through Google Scholar and retrieved from the Rutgers School of Arts and Sciences website. The following keywords were used:

[NICU] OR [NICU effects] OR [neonatal intensive care unit] OR [neonatal intensive care] OR [NICU environment] OR [NICU noise] AND [speech language] OR [speech language development] OR [communication development] AND [infants] OR [children] OR [preterm infant]

Selection Criteria

The articles selected for this paper were not restricted in terms of the year of publication or location of the study. The papers included in this review investigated the effects of the NICU environment on the speech and language development of infants.

Data Collection

The literature search resulted in three articles: one cohort study (Level 2b), one cross-sectional cohort study (Level 2b) and one survey research study (Level 4). The level of evidence of these studies was determined by analysis of the study designs according to Archibald (2014) as adapted from: Oxford Center for Evidence-based Medicine Levels of Evidence (2009) and NHMRC additional levels of evidence and grades for recommendations for developers of guidelines (2009).

Results

Caskey, Stephens, Tucker, and Vohr (2011) studied the effect of exposure to adult language on infant vocalizations using a cohort study design with 36 infants in the NICU. Sixteen hour recordings of NICU environmental sounds were analyzed for background noise, adult language, and child vocalizations at 32 and 36 weeks gestation using the Language Environment Analysis (LENA) digital language processor. Regressions were performed to analyze the prevalence of adult to infant conversational turns, gestational age, chronological age, and age of the mother.

Recordings revealed that the NICU setting contained mostly background noises, while adult and infant language was infrequent. Appropriate regressions revealed a positive correlation between adult language and infant vocalizations, where vocalizations and adult to infant conversational turns increased immensely during parent visits and feeding times.

A limitation of this study is that differences between background noise levels and adult and infant language levels may have been caused by changes in the type of cribs infants were in at certain ages (i.e., infants were in isolettes at 32 weeks and in open cribs at 26 weeks). Therefore, increases in infant language and conversational turns may be an effect of other variables, rather than an increase in adult interactions. The generalizability of results were also limited by the fact that recordings were gathered from a single hospital, where other NICUs may consist of different sounds and noises, as well

as varying opportunities for adult-infant interactions. Lastly, the LENA recording device had not been previously used to record infant language; therefore normative data for the infant population was not available and the reliability of this method of recording was also unknown.

This study offers suggestive information regarding sounds in NICU environments and how changes in the NICU influence speech and language behaviours of infants, ultimately affecting speech and language development later on in life.

Jennische and Sedin (1999) explored the effects of the NICU environment on speech and language skills in a cross-sectional cohort study with 310 NICU graduates (6.5 years of age) who were extremely preterm, very preterm, moderately preterm or full term. Although data was collected on each participant's speech and language skills, the only data analyzed were results from parental interviews of either NICU graduates or healthy children.

Appropriate ANOVAs were performed on the data collected, although not all the results were extensively reported in the paper. Results of the study revealed that children who once required NIC began using short sentences later than children in the control group. Furthermore, the absence of babbling was more apparent in NICU groups compared to controls of the same gender.

Results of this study were based on a substantial sample size which allowed researchers to group participants depending on degrees of prematurity and further analyze differences in that regard. However, subjects of the study were selected from a single hospital, limiting the generalizability of these results to other NICU environments.

The study was also dependent on parent responses to the questionnaires distributed. The study also failed to ask parents for background information that may contribute to biases in responses; therefore these differences were not incorporated into the analyses.

Overall, findings from this study are suggestive as it offers evidence regarding the speech and language performances of children requiring NIC compared to controls.

Stromswold and Sheffield (2004) examined how exposure to developmentally inappropriate sensory stimuli can affect a preterm infant's linguistic and

nonlinguistic development using a survey research study design with parents of 382 preterm children who stayed in the NICU for more than a day. The subjects included 55% males and 76% twins with a mean age of 29 months. Questionnaires that were sent to parents addressed demographic information, case history details, and questions regarding the NICU environment to which the infants were exposed (e.g., light levels of the NICU, noise levels, and frequency of ringing alarms).

Outcome measures of the study included 10 linguistic outcome measures (e.g., the onset of babbling and first words), standardized assessments (e.g., Ages and Stages Questionnaires (ASQ)), and the amount of speech therapy required. Outcome measures also included 8 neonatal outcome measures (e.g., APGAR scores and neurological outcomes) and 21 non-linguistic development measures.

Numerous analyses were conducted with variables believed to negatively impact speech and language development. However, only results relevant to this review are reported. Regression analyses revealed that NICU noise levels, as rated by the parents of the subjects, were associated with 6 out of 10 linguistic measures, where preterm infants from louder NICUs exhibited better linguistic outcomes than those from quieter NICUs. Lastly, it was found that higher NICU light levels were associated with higher ASQ communication scores.

When analyzing the outcomes for twins included in the study, NICU noise levels were associated with better outcomes for 7 out of 10 language outcome measures, even though twins were often enduring serious neonatal complications. Stromswold and Sheffield (2004) concluded that the language outcomes of these subjects were selectively influenced by NICU sound and light levels.

An ample sample size was incorporated in this study with genders equally represented. However, no detailed information regarding the distribution of age groups was reported. The representativeness of the subjects in this study was also reliant on the responses received from the number of questionnaires distributed.

Analyses of numerous variables were performed to address why language outcomes were unexpectedly better for children in noisier NICU environments. The paper also addressed different aspects of the NICU environment, leading to a comprehensive analysis of the NICU setting. However, ratings of

the NICU noise, light levels, and alarm frequencies were based on questionnaires where parents were asked 'How noisy was your child's NICU?' and guided by descriptions such as 'Quiet enough to carry on a normal conversation, as if you were at home with your spouse or significant other'. The ambiguity of the questions and descriptions may lead to different interpretations. Parents also had difficulty remembering when various milestones were achieved. Therefore, validity of the results was limited by how ratings were derived, parental biases, and the parents' memory.

Overall, the study offered equivocal findings regarding the effects of the NICU environment on speech and language skills of children as the reliability of results from parental reports is questionable.

Discussion

Based on the results of this critical review, minimal to moderate evidence on the impact of the NICU environment on speech and language development was found. However, the literature has provided preliminary evidence describing the speech and language behaviours of infants in the NICU as well as the speech and language skills of children who once required NIC.

Results of two studies in this review support the argument that the NICU environment has a negative impact on speech and language development. Findings from the cross-sectional cohort study presented suggestive evidence that NICU graduates displayed reductions in babbling and delays in the use of short sentences when compared to healthy controls (Jennische & Sedin, 1999). Recordings from the cohort study by Caskey et al. (2011) revealed that the NICU environment was deprived of adult language when compared to the incidence of background noise. Past research has suggested that adult and child conversations are associated with better language outcomes in children (Caskey, et al., 2011) as a higher incidence of adult language would allow for more exposure to linguistic structures and experimentation with language. Therefore, findings from the study suggest that the NICU may cause speech and language deficits due to reduced exposure to adult language.

On the contrary, findings from Stromswold and Sheffield (2004) suggest that the NICU setting has a positive effect on speech and language as higher noise levels resulted in better linguistic outcome measure scores. However, NICU ratings were

reliant on parent reports. Hence, the reliability of these results is uncertain. Contradictory findings in the studies reviewed may be explained by the different factors the studies analyzed. Caskey et al. (2011) studied both speech and non-speech occurrences in the NICU. However, Stromswold and Sheffield's study (2004) was directed to NICU environmental noises, alarms, and light levels, and did not account for the prevalence of adult language. Therefore, it is unknown as to whether improved language outcomes found by Stromswold and Sheffield (2004) were due to incidences of unrecorded adult language or the NICU environment.

In this area of research, variability in the case history of participants poses a great challenge to the gathering of a representative and homogeneous population. For example, many infants differ in levels of prematurity, comorbidities, birth complications, birth weight, and family background, all of which can influence speech and language outcomes. Hence, it is difficult to decipher whether language outcomes are due to the NICU environment infants are experiencing or individual characteristics.

Many studies in this area are also limited by the methods available for collecting and analyzing data on the NICU environment. One study obtained findings from a single hospital. However, it is difficult to generalize results from one hospital as infants in varying NICU settings are exposed to different background noises and perhaps differing methods of care. Therefore, further research should incorporate various hospitals and examine the effects of different NICU environments to help identify which factors contribute particularly to development.

Two of the reviewed studies also relied on parent reports, one of which based analyses of NICU conditions on parent interpretations of NICU noise levels, lighting, and alarm frequencies. The studies also relied on parent reports of the child's speech and language skills. Many existing child language measures use only parent report, and maintain a high level of validity. However, according to Jenniche and Sedin (1999), factors such as the education level of the parent or their attentiveness to their child's development influence parental observations of speech and language skills. Therefore, more reliable methods of data collection are also required when seeking to describe variables in the NICU environment to maintain the validity and reliability of future research findings.

Furthermore, Caskey et al. (2011) relied on recordings of NICU sounds and noises to determine the amount of noise, adult language, and infant language existent in NICUs. However, other variables of the NICU that influence language levels (e.g., the types of cribs infants were in) were not taken into account. In addition, the LENA device used by Caskey et al. (2011) had not been previously used for data collection with the infant population. Caskey et al. also mentioned that the LENA device did not have normative data associated with infants, limiting the analyses of the data collected. Therefore, additional research into methods and devices for data collection is also required to support future research in this area.

Conclusion and Clinical Implications

The results of this paper indicate that further research is required to formulate conclusive remarks on the effects of the NICU environment on speech and language development.

The present literature has increased our understanding of the relationship between speech and language and the NICU; however, reasons for these occurrences are not yet determined. Recordings revealed that the NICU consists of mostly background noises and minimal adult language, resulting in a non-optimal language environment. The findings also revealed that infant vocalizations increased when in the presence of adult interactions. At this point in time, it can only be speculated that the speech and language development of these infants benefit from more parent to infant interactions since incidences of adult language increased conversational turns and the infants' experimentation with language. Therefore, future research directions should focus on how aspects of the NICU environment influence speech and language development.

Future investigations should also be directed at providing evidence for potential adjustments to the NICU environments which may serve to enhance speech and language development of infants. With more substantial research, speech-language pathologists can also advocate for the significant role they can play in the care of infants in the NICU and seek to provide them with a more favorable speech and language environment.

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