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Scheduling Hearing Appointments Prior to Hospital Discharge Improves Follow-up After Failed Newborn Hearing Screening

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Abstract: The study aimed to identify if there was a relationship between a follow-up hearing appointment scheduled prior to hospital discharge (hospital scheduled appointment) and follow-up status, including loss to follow-up or loss to documentation (LTF/LTD); early follow-up initiation; and early completion of audiological diagnosis. The study included 4,597 children who were born between January 2015 and June 2016 in Louisiana birthing hospitals and failed newborn hearing screening (NHS) prior to hospital discharge. Of the study population, 56.1% of children were scheduled for a follow-up hearing appointment prior to hospital discharge. The LTF/LTD among children without a hospital scheduled appointment was 52% higher than children with a hospital scheduled appointment. The rate of early follow-up initiation with a hospital scheduled appointment was 25% higher than if an appointment was not scheduled while in the hospital. There was no statistical association of early completion of audiological diagnosis with a hospital scheduled appointment. Thus, a hospital scheduled appointment improved LTF/LTD and early follow-up initiation among newborns who failed NHS.

Key Words: Newborn hearing screening, loss to follow-up, hearing appointment, hospital discharge, hospital scheduled appointment

Acronyms: CDC = Centers for Disease Control and Prevention; IS = Information System; LA EHDI = Louisiana Early Hearing Detection and Intervention program; LTD = lost to documentation; LTF = lost to follow-up; LTS = lost to system; NHS = newborn hearing screening; NICHQ = National Initiative for Children's Healthcare Quality; PCP = primary care physician; UNHS = Universal Newborn Hearing Screening

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Introduction

Universal newborn hearing screening (UNHS) has been implemented in all states and some U.S. territories. All newborns with positive screening are advised to get further testing to confirm hearing status, preferably by three months of age (Joint Committee on Infant Hearing, 2007). In fact, follow-up status of many newborns who failed hearing screening is still unknown. According to a 2016 Centers for Disease Control and Prevention (CDC) report using 2014 U.S. data, 42.4% of infants who did not pass the newborn hearing screening (NHS) had no documented diagnosis and 34.4% were lost to follow-up (LTF) or lost to documentation (LTD) for diagnosis. Previous studies have indicated risk factors of LTF/LTD such as government funded health insurance (Liu, Farrell, MacNeil, Stone, & Barfield, 2008); inadequate service-system capacity; lack of provider's knowledge (Moeller, Eiten, White, & Shisler, 2006; Shulman et al., 2010); lack of medical home-state NHS program communication (Kim, Lloyd-Puryear, &

[1]Per CDC data (CDC, 2016); parents of LFU patients are either unresponsive or cannot be contacted.

Tonniges, 2003); late NHS; late follow-up; and multiple follow-ups (Tran, Ng, et al., 2016); long commuter distance (Ravi et al., 2016); mother's lack of knowledge about retesting (Alvarenga, Gadret, Araujo, & Bevilacqua, 2012; Luz, Ribas, Kozlowski, Willig, & Berberian, 2016); rural physicians' limited training in hearing detection; and lack of confidence to direct further care (Bush, Alexander, Noblitt, Lester, & Shinn, 2015). Studies have also shown improvement in follow-up with education of parents before discharge (Spivak & Sokol, 2005; Cockfield, Garner, & Borders, 2012); use of multidisciplinary teams focusing on public awareness (Ravi et al., 2016); collaboration with the Woman, Infants, and Children (WIC) Program (Hunter et al., 2016); partnerships with pediatric otolaryngologists and audiologists (Danhauer et al., 2006); scripting messages given to remind families of follow-up appointments (Russ, Hanna, DesGeorges, & Forsman, 2010); and use of repeated hearing screens to reduce false-positive rates (Shoup, Owens, Jackson, & Laptook, 2005).

Louisiana Early Hearing Detection and Intervention program (LA EHDI) implemented UNHS in 2002. Newborns who fail initial hearing screening prior to hospital discharge are advised to have a follow-up hearing appointment for further testing within one month of discharge. A follow-up hearing appointment can be scheduled either by hospital staff prior to hospital discharge, which is recommended by LA EHDI, or by hospital staff, primary care physician (PCP), or parents after discharge. In Louisiana, scheduling an appointment prior to hospital discharge varies among birthing hospitals and its effect on follow-up status is still unknown. To our knowledge very limited studies evaluating the effect have been published. The objective of this study was to identify if there was any relationship between a follow-up hearing appointment scheduled prior to hospital discharge and follow-up status including (a) loss to follow-up or loss to documentation (LTF/LTD), (b) early follow-up initiation, and (c) early completion of audiological diagnosis. The study findings may help EHDI programs enhance follow-up compliance of newborns who fail newborn hearing screening by developing strategies to improve the rate of scheduling follow-up hearing appointments prior to hospital discharge.

Methods

Data Source and Study Population

The data from LA EHDI-Information System (IS) were used for analysis. The LA EHDI-IS is a web-based database that collects and manages LA EHDI surveillance data including NHS, hearing follow-up/diagnosis, and early intervention. The database system is integrated with birth and death certificates provided by Louisiana Center for Health Statistics and Vital Records. The study included 4,597 children who were born between January 2015 and June 2016 in Louisiana birthing hospitals and had hearing screening prior to hospital discharge but did not pass. Babies born to non-Louisiana residents at birth or those who died at any time after birth were excluded from the study.

Analysis Variables

Study outcomes. Three study outcomes of follow-up status were analyzed: LTF/LTD, early follow-up initiation, and early completion of audiological diagnosis.

LTF/LTD. LTF was defined if a child was reported as LTF to LA EHDI by the follow-up provider. LTD was defined if a child did not have any follow-up reported to LA EHDI by a follow-up provider. LTD newborns had no follow-up indicated in the database, while LTF newborns either had no follow-up indicated or had at least one documented follow-up and still needed additional follow-up to determine audiological diagnosis.

Early follow-up initiation. Early follow-up initiation was defined if follow-up was started within 30 days after NHS, that is, the length of time between NHS and first follow-up was < 30 days. If a child had more than one NHS, time of the last screening was used to calculate the length of time between NHS and first follow-up. Late follow-up initiation was determined if follow-up was started more than 30 days after NHS.

Early completion of audiological diagnosis. Early completion of audiological diagnosis was defined if a child had at least one follow-up and audiological diagnosis was completed by three months of age, that is, age at last follow-up was less than or equal to 90 days. Late completion of audiological diagnosis was determined if the last follow-up for audiological diagnosis was completed after three months of age.

Predictor. The predictor was follow-up hearing appointment scheduled prior to hospital discharge, categorized as yes or no. The predictor was yes if both date and audiologist/facility for follow-up hearing appointment were indicated in the NHS Report Form; otherwise, the predictor was categorized as no.

Covariates. Eight covariates derived from birth certificates included race/ethnicity, child sex, geography of residence at birth, maternal age and education, Medicaid paid delivery, birth weight, and number of previous live births. Five covariates derived from NHS and follow-up/diagnosis reports included number of failed screening ears, age at NHS, screening place, length of time between NHS and first follow-up, and total number of follow-ups. All covariates were defined as categorical variables. Table 1 shows distributions of all covariates in detail.

Data analysis

Three analyses were conducted for the three study outcomes separately. All children who failed NHS prior to hospital discharge (4,597) were included in the LTF/LTD analysis; only children who failed NHS and had follow-up (3,480) were included in the early follow-up initiation analysis; and only children who failed NHS and

completed follow-up (3,404) were included in analysis of early completion of audiological diagnosis. Generalized linear models using PROC GENMOD in SAS were used to determine associations between study outcomes and the predictor. In adjusted models, covariates were included to control for confounding effects. Specifically, for models of LTF/LTD and early follow-up initiation, the following covariates were adjusted in multiple regression models: race/ethnicity, sex, geography of residence at birth, maternal age and education, Medicaid paid for delivery, birth weight, number of previous live births, number of failed screening ears, age at NHS, and screening place. Two additional variables (total number of follow-ups and length of time between NHS and first follow-up) were included in adjusted models of early completion of audiological diagnosis. A backward elimination procedure was used in multiple regression models. All final adjusted models included only variables with p value < 0.05 for statistical significance. The project was deemed exempt by the Louisiana State University Institutional Review Board because it did not meet the federal definition of human subjects research.

Table 1. **Hearing Appointment Scheduled Prior to Hospital Discharge (%) among Newborns Who Failed Newborn Hearing Screening (N = 4,597)**

Demographic, hearing screening, and follow-up characteristics		Number	Percent (CI 95%)
	Total	**2,579**	**56.1 (54.7-57.5)**
Race/Ethnicity	Non-Hispanic White (42%)	1,087	56.8 (54.5-59.0)
	Non-Hispanic Black (45%)	1,187	57.1 (55.0-59.3)
	Non-Hispanic Other (4%)	95	50.8 (43.6-58.0)
	Hispanic (9%)	210	50.4 (45.6-55.2)
Child sex	Female (43%)	1,114	56.3 (54.2-58.5)
	Male (57%)	1,465	55.9 (54.0-57.8)
Medicaid-paid delivery	No (29%)	637	47.7 (45.0-50.4)
	Yes (71%)	1,942	59.5 (57.8-61.2)
Residence at birth	Rural (38%)	1,124	64.6 (62.4-66.9)
	Urban (62%)	1,455	50.9 (49.1-52.7)
Maternal age	< 20 (9%)	243	58.3 (53.5-63.0)
	20-34 (81%)	2,093	56.1 (54.5-57.7)
	35+ (10%)	243	54.2 (49.6-58.9)
Maternal Education	< High school (22%)	554	56.4 (53.3-59.5)
	High school (33%)	885	57.9 (55.4-60.4)
	> High school (45%)	1,140	54.7 (52.5-56.8)
Previous live births	None (39%)	922	52.0 (49.7-54.4)
	One (29%)	779	58.0 (55.3-60.6)
	Two+ (32%)	878	59.3 (56.8-61.8)
Birth weight (grams)	< 1,500 (4%)	62	34.8 (27.8-41.8)
	1,500 - 2,499 (10%)	216	48.3 (43.7-53.0)
	2,500+ (86%)	2,301	57.9 (56.4-59.5)
Age at newborn hearing screening (NHS)	< 30 days old (96%)	2,504	56.9 (55.5-58.4)
	30+ days old (4%)	75	37.7 (31.0-44.4)
Number of failed screening ears	One (64%)	1,633	55.9 (54.1-57.7)
	Two (36%)	946	56.4 (54.0-58.8)
Screening Place	Well-baby nursey (88%)	2,383	59.2 (57.7-60.7)
	NICU (12%)	196	34.2 (30.3-38.1)
Time between NHS and first follow-up	No follow-up (24%)	506	45.3 (42.4-48.2)
	< 30 days (44%)	1,322	66.0 (64.0-68.1)
	30+days (32%)	751	50.8 (48.3-53.4)
Total number of follow-ups	No follow-up (24%)	506	45.3 (42.4-48.2)
	One (67%)	1,860	60.6 (58.9-62.4)
	Two (7%)	166	52.0 (46.6-57.5)
	Three (2%)	47	50.5 (40.4-60.7)

Results

Characteristics of Follow-Up Hearing Appointment Scheduled Before Discharge

Of 93,996 children born to Louisiana residents between January 2015 and June 2016, 98.8% had NHS at birthing hospitals before discharge. Among newborns with NHS, 4,597 (5.0%) did not pass screening and needed further testing. Of those, 56.1% (2,579) were scheduled for follow-up hearing appointments prior to hospital discharge. The percentage was higher among newborns whose screening was conducted in the well-baby nursery (59.2% vs. 34.2% in NICU), those with screening before 30 days of age (57.0% vs. 37.7% for NHS after 30 days of age), normal weight babies (58.0% vs. 34.8% for very low birth weight and 48.3% for low birth weight), children living in rural areas (64.6% vs. 50.9% in urban areas), and those whose delivery was paid for by Medicaid (59.5% vs. 47.8% non-Medicaid). Table 1 indicates distributions of mother and child demographic characteristics and rate of follow-up hearing appointment scheduled prior to hospital discharge, henceforth referred to as hospital scheduled appointment. LTF/LTD, early follow-up initiation, and early completion of audiological diagnosis will be referred to as lost to system (LTS; Beauchaine & Hoffman, 2008), early follow-up, and early diagnosis, respectively.

Associations between Hospital Scheduled Appointment with Study Outcomes

Among newborns who failed NHS, rate of LTS (1,193 including 554 LTD and 639 LTF) after screening was 26.0% (95% confidence interval [CI]: 24.7–27.2). This rate was 20.9% (CI: 19.4–22.5) and 32.4% (CI: 30.3–34.4) among newborns with and without a hospital scheduled appointment, respectively. The adjusted regression model showed that the rate of LTS was 52% higher in children without a hospital scheduled appointment than in counterparts with a hospital scheduled appointment (adjusted prevalence ratio [PR] = 1.52, CI: 1.38–1.68; Table 2). Reasons for LTF were different between those with and without a hospital scheduled appointment. For the 312 LTF children with a hospital scheduled appointment, the most common LTF reason was missed appointment (85.6%), while no appointment made (59.0%) and missed appointment (32.7%) were the most common reasons for LTF among the 327 LTF children without a hospital scheduled appointment (Table 3).

In children who failed NHS and had follow-up, rate of early follow-up after screening was 57.5% (CI: 55.9–59.2). The rate was 63.8% (CI: 61.7–65.8) and 48.3% (CI: 45.7–50.9) among children with and without a hospital scheduled appointment, respectively. The rate of early follow-up was 25% higher among newborns with a hospital scheduled appointment than those without one (PR = 1.25, CI: 1.17–1.33; Table 2).

For children who failed NHS and completed hearing follow-up after screening, the rate of early diagnosis was 87.9% (CI: 86.9–89.0). The rate was 90.8% (CI: 89.5–92.0) and

83.6% (CI: 81.6–85.6) among newborns with and without a hospital scheduled appointment, respectively. There was no statistical association of early diagnosis with hospital scheduled appointment (PR = 1.02, CI: 0.98–1.05, p = 0.3620; Table 2).

Table 2. **Percent and Prevalence Ratio (PR) to Follow-Up Status after Newborn Hearing Screening**

	Percent (CI 95%)	Unadjusted PR (CI 95%)	*P* value	Adjusted PR (CI 95%)	*P* value
Loss to follow-up or loss to documentation, *N* = 4,597					
Follow-up not scheduled before discharge	32.4 (30.3-34.4)	1.55 (1.40-1.70)	< .0001	1.52 (1.38-1.68)	< .0001
Follow-up scheduled before discharge	20.9 (19.4-22.5)	1.0		1.0	
Total	26.0 (24.7-27.2)				
Early follow-up initiation, *N* = 3,480					
Follow-up not scheduled before discharge	48.3 (45.7-50.9)	1.0		1.0	
Follow-up scheduled before discharge	63.8 (61.7-65.8)	1.32 (1.24-1.41)	< .0001	1.25 (1.17-1.33)	< .0001
Total	57.5 (55.9-59.2)				
Early completion of audiological diagnosis, *N* = 3,404					
Follow-up not scheduled before discharge	83.6 (81.6-85.6)	1.0		1.0	
Follow-up scheduled before discharge	90.8 (89.5-92.0)	1.09 (1.06-1.12)	< .0001	1.02 (0.98-1.05)	0.36250
Total	87.9 (86.8-89.0)				

*Models of loss to follow-up/loss to documentation and early follow-up initiation were adjusted for race/ethnicity, sex, geography of residence at birth, maternal age and education, Medicaid-paid delivery, birth weight, number of previous live births, number of failed screening ears, age at newborn hearing screening and screening place. Two additional variables including total number of follow-ups and length of time between newborn hearing screening and first follow-up were adjusted for the model fo early completion of audiological diagnosis.

Table 3. **Reasons for Loss to Follow-Up among Children Who Failed Newborn Hearing Screening and Were Reported as Loss to Follow-Up after Screen (*N* = 639)**

	Follow-up not scheduled before discharge	Follow-up scheduled before discharge	Total
Reasons for loss to follow-up	Percent (number)	Percent (number)	Percent (number)
Missed/canceled appointment	32.7 (107)	85.6 (267)	58.5 (374)
Unable to contact parents	2.4 (8)	5.1 (16)	3.8 (24)
Rescreened by other provider	3.1 (10)	5.1 (16)	41.(26)
Moved out of state	0.6 (2)	2.2 (7)	1.4 (9)
No appointment made	59.0 (193)	0.0 (0)	30.2 (193)
Other	2.1 (7)	1.9 (6)	2.0 (13)
Total	100.0 (327)	100 (312)	100.0 (639)

Discussion

This study indicated that only 56% of newborns who did not pass NHS were scheduled for a follow-up hearing appointment prior to hospital discharge. The hospital scheduled appointment improved both LTF/LTD and early follow-up, but not early diagnosis. Newborns with a hospital scheduled appointment were less likely to be lost to the system and more likely to start follow-up early. No appointment made and missed appointment were the most common reasons for LTF among children without a hospital scheduled appointment, while missed appointment was the most common reason for LTF among children with a hospital scheduled appointment.

In Louisiana, hospital staff schedule a follow-up hearing appointment before discharge by contacting audiologists to schedule the appointment, and then notifying the parent of the appointment time and audiology facility. However, in some instances, the appointment cannot be scheduled due to discharge on a weekend when the audiology office is not open or due to a hospital policy that all follow-up appointments are scheduled after discharge. In these instances, post-discharge follow-up appointments are scheduled in different ways, and reasons for not making an appointment can be potentially explained by the following:

1. Hospital staff contact an audiologist to make the appointment, and then contact the parent to notify them of the appointment made. In this scenario, hospital staff may be unable to contact parents to inform them of the time and location of the follow-up.

2. Upon discharge, parents are provided with a list of select audiologists or even just a specific audiologist and instructed to make the appointment themselves. In many cases, the list provided by the hospital may not provide a viable choice for the parent because of location, hours, or other barriers. Furthermore, an appointment may not occur when the parent ignores the importance of re-screening, forgets to schedule an appointment, or could not make an appointment due to a language barrier (Holte et al., 2012).

3. Some physicians adopt a wait-and-see attitude and may not refer babies who failed NHS to audiology facilities for further testing because they may not realize the urgency of early intervention (Luz et al., 2016; Ravi et al., 2016; Shulman et al., 2010; Tran, Wang, et al., 2016).

Missed appointment was identified as the second most common reason for LTF among children without a

hospital scheduled appointment and the most common among children with a hospital scheduled appointment. The barriers leading to missed appointments have been reported in previous studies such as inaccessibility of follow-up facilities (Park, Warner, Sturgill, & Alder, 2006); lack of transportation (particularly in rural areas), lack of health insurance, lack of parents' knowledge and awareness of the importance of early diagnosis of hearing loss (which may be because screening results were not explained well or the importance of follow-up evaluation was not stressed), and overwhelming parent responsibilities (Shulman et al., 2010; Russ et al., 2010; Ravi et al., 2016; Liu et al., 2008).

Regarding loss to follow-up, results of our study were similar to previous studies. A study by Borders, Vess, Dumas, and Edlund (2016) indicated improvement of follow-up visit with a hospital scheduled appointment among Emirati infants who failed newborn hearing screening. Borders et al.'s study focused on nurse-led interventions, which included delivery of culturally specific educational counseling, prearranged follow-up appointments, and automated message reminders to parents whose newborns failed hearing screening at a hospital. Prearranged appointments were scheduled by nurses prior to discharge, and parents were registered for a follow-up phone message reminder 24 hours before the scheduled appointment. The rate of follow-up compliance within three months from birth improved from 25% to 75%. Aprahamian, Coats, Paysse, and Brady-McCreery (2000) also found that newborns with appointments scheduled by hospital personnel before discharge were more likely to be brought to a follow-up examination. Aprahamian et al.'s study included newborns who were at risk of retinopathy of prematurity and needed follow-up after discharge. Results of the analysis showed that 73% of patients with appointments scheduled by hospital personnel before discharge were brought to their follow-up appointment, compared with 37% of patients with appointment scheduled by parents after discharge.

Through this study and previous ones it is evident that follow-up improves when strategies implement a hospital scheduled appointment prior to discharge that includes a clear and universal protocol for appointment scheduling during discharge planning. A multidisciplinary team of nurses, physicians, audiologists, technicians, and administrative staff should be used to ensure that parents whose infants fail NHS receive proper counseling about the test results, clear communication with PCPs and follow-up audiologist, and a follow-up appointment for rescreening and/or diagnosis scheduled prior to hospital discharge (Ravi et al., 2016; Russ et al., 2010). The use of automated reminders is an effective strategy to ensure parents remember appointments once they are scheduled. Telephone calls or text messages 24 hours before an appointment will help to increase compliance for follow-up (Borders et al., 2016). The National Initiative for Children's Healthcare Quality (NICHQ), a nonprofit organization dedicated to bettering children's health and healthcare (NICHQ, 2013), has identified several strategies to decrease LTF for infants who do not pass screening. These include the following: (a) scripting the communication with parents after a failed NHS; (b) standardizing procedures for collecting contact information including alternate phone numbers or contacts and verifying the PCP prior to discharge; (c) scheduling the follow-up appointment before the family leaves the hospital and stressing the importance to the family; (d) calling the family to verify the follow-up appointment and provide assistance with transportation if needed; and (e) using fax-back forms between all parts of the care team, including at the time of the diagnostic evaluation to alert the PCP of the results and need for follow-up. (Russ et al., 2010; Spivak & Sokol, 2005).

Strengths and Limitations

This study had three major strengths: First, mother and child demographics and important characteristics of NHS and follow-up were controlled for in adjusted regression models to evaluate the independent effect of the study predictor—hospital scheduled appointments. Second, the study indicated most common reasons of LTF/LTD so that interventions to improve LTF/LTD were clearly delineated. Last, to date few peer-reviewed published papers have addressed the important effect of a hospital scheduled appointment on follow-up status among newborns who failed NHS.

The study included one major limitation—true follow-up status of children reported as LTD and verification of LTF. Verification of LTF/LTD can be done through contacting parents or follow-up facilities. This may help identify over-reporting problems and avoid misclassification of follow-up status (Tran, Wang, et al., 2016).

Conclusion

Scheduling follow-up hearing appointments prior to hospital discharge is strongly recommended. The study showed that hospital scheduled appointments improved not only LTF/LTD but also early follow-up initiation among newborns who failed NHS. The most common reason for LTF/LTD in children whose appointment was not scheduled before hospital discharge was no appointment made after discharge. Missed appointment was a main reason for LTF for children whose appointments were scheduled before or after discharge. Follow-up providers' lack of reporting of follow-up status among children whose appointments were scheduled after discharge made LTS worse for these children. Effective strategies focusing on improvement of hospital scheduled follow up appointments, missed appointments, and follow-up providers' reporting of results will help reduce both LTF/LTD and late follow-up.

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