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Using otoacoustic emissions to screen for hearing loss in early childhood care settings☆

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Summary

Objective: Until recently, no objective tool has been available to help health and early childhood education providers screen young children for hearing loss. The aim of this study was to screen underserved children ≤3 years of age for hearing loss using otoacoustic emissions (OAE) technology and to systematically document multi-step screening and diagnostic outcomes.
Methods: A total of 4519 children, ≤3 years of age in four states were screened by trained lay screeners using portable OAE equipment set to deliver stimuli and measurement levels sensitive to mild hearing loss as low as 25 decibels (dB) hearing level. The screening and follow-up protocol specified that children not passing the multi-step OAE screening be evaluated by local physicians and hearing specialists.
Results: Of the 4519 children screened as a part of the study, 257 (6%) ultimately required medical or audiological follow-up. One hundred and seven children were identified as having a hearing loss or disorder of the outer, middle or inner ear requiring treatment or monitoring. Of these 107 children, 5 had permanent bilateral and 2 had permanent unilateral hearing loss. The seven children with permanent hearing loss included four who had passed newborn screening, two who were not screened at birth and one who did not receive follow-up services after referring from newborn screening.
Conclusions: OAE screening, using a multi-step protocol, was found to be a feasible and accurate practice for identifying a wide range of hearing-health conditions

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warranting monitoring and treatment among children ≤3 years of age in early childhood care programs. Future studies are needed to: (1) further examine barriers to effective OAE screening in early childhood care settings and (2) explore the value of extending early childhood OAE hearing screening into health care clinics and settings where young children receive routine care.

1. Background

Language deficits from undetected and untreated hearing loss can result in low level literacy, educational under-achievement, and poor socialization [1,2]. By the time children are in school, the cumulative incidence of severe permanent hearing loss has been estimated at 6 per 1000 including the 1—3 per 1000 likely to be detected and confirmed at birth [3,4]. Although newborn screening has done much to improve detection of permanent congenital hearing loss [5—7], problems remain. Data from the Centers for Disease Control and Prevention show that among the 2% of infants referred for follow-up after newborn screening, only 40% were documented as having received a diagnostic evaluation [3]. For newborns with confirmed diagnoses, there is a median time lag of 18 months between screening and intervention [1]. In addition to these newborn-screening issues, no comprehensive programs exist to detect cases of permanent hearing loss in early childhood. Public health strategies for detection, referral, and treatment of children not screened at birth, lost to follow-up from newborn screening, or presenting with post-neonatal hearing loss are still needed to prevent serious developmental problems associated with untreated hearing loss [1,8]. Further, an estimated 35% of pre-school children experience repeated episodes of ear infections and intermittent hearing loss, some untreated for extended periods, that may also interfere with language and social development [5].

Health and early education providers and professional organizations serving young children are increasingly aware of the importance of hearing screening during a child's language learning years. Concurring with recommendations by the American Academy of Pediatrics promoting periodic screening in early and middle childhood [9], authors of one multi-center study that followed screened infants to 9 months of age noted the need for subsequent screening in early childhood [10]. In that study, some programs found that up to 22% of infants passing the newborn screen were later shown to have permanent hearing loss. However, consensus on specific tests, equipment, protocols and populations (e.g., pre-school, well-baby, and high-risk infants) has yet to be reached.

At present, the use of otoacoustic emissions (OAE) technology has been increasing in early childhood education and clinical settings, but remains limited as the preponderance of attention has focused on newborn screening [11]. Pediatricians and other primary care providers have routinely utilized otoscopy, pneumatic otoscopy or tympanometry to diagnose common middle-ear disorders, but have had to rely on subjective methods such as observations of the child's behavioral response to sound (i.e., hand clapping or bell ringing) or parent perceptions of the child's behavior, to screen inner ear functioning of children ≤3 years of age. OAE screening, used widely in newborn hearing screening programs, holds great promise for health and early childhood care providers in screening infants and toddlers for permanent hearing loss because it is: (a) objective and independent of child's behavior; (b) painless; (c) portable, reliable and efficient; (d) simple to administer with an appropriate protocol [12].

The objective of this study was to screen underserved children ≤3 years of age for hearing loss using OAE technology and to systematically document multi-step screening and diagnostic outcomes.

2. Methods

2.1. Subjects

A total of 4519 children, ≤3 years of age enrolled in Early, Migrant and American Indian Head Start programs in Kansas, Oregon, Utah and Washington participated in the study. As part of Head Start requirements, all enrolled children must receive some type of hearing screening annually in conjunction with other health screenings. This allowed researchers to implement a standardized screening and follow-up protocol across 65 sites. Table 1 summarizes the demographic backgrounds of the children. Hearing screenings were conducted by lay screeners who attended a 6-h training session and had subsequent access to audiological technical support. Subjects were screened in a range of natural environments including classroom play settings and homes. Screening and follow-up outcome data were collected on each subject. Approval for human