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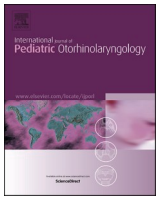

Impact of COVID-19 on diagnosis and management of newborn hearing loss

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ABSTRACT

Introduction: The COVID-19 pandemic has caused unexpected disruptions in patient care, including adherence to the Early Hearing Detection and Intervention (EHDI) 1-3-6 guidelines. These guidelines mandate newborn hearing screening (NHS) by 1 month of age, diagnosis of hearing loss (HL) by 3 months, and referral to Early Intervention by 6 months. The objective of this study was to investigate the impact of COVID-19 on EHDI benchmarks in a major US city to help clinicians address current needs and prepare for future disruptive events.
Methods: Retrospective review was performed for all patients who did not pass NHS at two tertiary care centers between March 2018 and March 2022. Patients were divided into three cohorts based on the periods of time before, during, and after the COVID-19 Massachusetts State of Emergency (SOE). Demographics, medical history, NHS results, Auditory Brainstem Response results, and hearing aid (HA) intervention data were collected. Two-sampled independent t-tests and analysis of variance were used to compute rate and time outcomes.
Results: 30,773 newborns underwent NHS and 678 failed NHS. There was no difference in 1-month benchmark NHS rates, increased 3-month benchmark HL diagnosis rate post-SOE COVID (91.7%; $p = 0.002$), and increased 6-month benchmark HA intervention rate post-SOE COVID compared to pre-COVID (88.9% vs. 44.4%; $p = 0.027$). Mean time to NHS was lower during SOE COVID compared to pre-COVID (1.9 days vs. 2.0 days; $p = 0.038$) and mean time to HL diagnosis was higher during SOE COVID (47.5 days; $p < 0.001$). Lost to follow-up (LTF) rate at HL diagnosis decreased post-SOE (4.8%; $p = 0.008$).
Conclusion: No differences in EHDI 1-3-6 benchmark rates between pre-COVID and SOE COVID patients were observed. However, increased 3-month benchmark HL diagnosis and 6-month benchmark HA intervention rates and a decreased LTF rate at 3-month benchmark HL diagnosis were observed post-SOE COVID.

1. Introduction

The coronavirus disease (COVID-19) pandemic has created profound global impacts on the practice of medicine and delivery of healthcare. SARS-CoV-2, the causal pathogen of COVID-19, was first reported in Wuhan, China in December 2019 and rapidly spread around the world, reaching the United States (US) in January 2020 [1]. Prior to the declaration of the COVID-19 pandemic on March 11, 2020 by the World Health Organization (WHO), large outbreaks in specific regions of the US resulted in the establishment of state-specific states of emergency. These states of emergency imposed restrictions on gatherings and nonessential services. The Northeast region specifically was an early epicenter. The abrupt lockdown and high volume of emergent COVID-19 cases created the need to triage patients and shut down certain aspects of patient care.

In pediatric otolaryngology, these disruptions posed a challenge for clinicians, audiologists, and patients to adhere to the American Academy of Pediatrics' Early Hearing Detection and Intervention (EHDI) 1-3-6 guidelines. These guidelines mandate newborn hearing screening by 1 month of age, diagnosis of hearing loss (HL) by 3 months, and referral to early intervention services by 6 months [2]. Currently, all 50 states and the Joint Committee on Infant Hearings (JCIH) endorse these guidelines. It has been well-established that delayed detection and intervention of hearing loss in infants result in adverse language, speech, and social and emotional developmental outcomes [2,3]. Several studies have shown that these permanent detrimental effects can be mitigated by achieving EHDI 1-3-6 benchmarks [4–6]. Therefore, it is essential that all medical practitioners provide timely audiologic care for children. However, there is evidence that the COVID-19 pandemic has delayed achievement of each of the 1-3-6 benchmarks. A study examining the impact of the

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pandemic in six rural US Western states showed significantly decreased rates of screening by 1 month of age, screening overall, and referral to early intervention services. Decreased rates of diagnosis by 3 months were also reported, although trends varied between states [7]. Nevertheless, the effect of the COVID-19 pandemic on EHDI 1-3-6 guideline adherence in large urban areas remains unknown. There are unique challenges associated with major cities, especially during the pandemic, as high population densities facilitated rapid spreading of COVID-19 and high patient volumes created ethical dilemmas of triaging patients. Furthermore, it has been two years since the start of the pandemic at the time of this writing. No studies have evaluated EHDI guideline adherence post-peak pandemic. Our study seeks to provide novel insight into the impact of the COVID-19 pandemic on newborn hearing screening and management in a major US city to help clinicians address current needs and prepare for future disruptive events.

2. Materials and methods

2.1. Hearing evaluation and structure

EHDI 1-3-6 benchmarks were evaluated by a multidisciplinary team, including otolaryngologists, audiologists, speech-language pathologists, and pediatricians, among others. Initial newborn hearing screening was performed at the birth hospital with Auditory Brainstem Response (ABR) 20–24 h after delivery or 36–48 h after cesarean section. There were no outpatient screens. Infants who did not pass this initial screen were either rescreened 24 h later with ABR or directly scheduled a confirmatory diagnostic ABR test. Each stage of the screening process was performed at the birth hospital prior to discharge, so there was no lost to follow up between screens. Whether there is immediate rescreen for a failed ABR is dependent on the hospital. One hospital in our study performed routine rescreens and one did not. These protocols remained constant throughout the study period. A confirmatory diagnostic ABR test, which includes determination of hearing thresholds, was performed for all patients who did not pass the initial screen or rescreen if applicable. Intervention was initiated if an infant was determined to have hearing loss. This includes referral to Early Intervention (EI) programs for developmental support and potential amplification depending on the etiology and severity of hearing loss. Hearing aid (HA) intervention specifically was evaluated in this study due to inconsistencies in documentation of Early Intervention referrals.

2.2. Study population

This study used data from two tertiary care medical centers in the greater Boston area. All individuals born between March 1, 2018 and March 27, 2022 were included (Fig. 1). Data on demographics, medical history, newborn hearing screen (NHS) timing, confirmatory ABR hearing diagnosis timing, and HA intervention timing were collected. Data were divided into 3 time periods by following the dates during which the Massachusetts (MA) governor declared a COVID-19 Pandemic State of Emergency (SOE) in MA (March 10, 2020 to June 14, 2021). As such, our pre-COVID cohort included patients born between March 1, 2018 and March 9, 2020; SOE COVID cohort included patients born between March 10, 2020 to June 14, 2021; Post-SOE COVID cohort included patients born between June 15, 2021 and March 27, 2022. This study was approved by the Massachusetts Eye and Ear Institutional Review Board (protocol 2022P000797).

2.3. Outcome variables

Outcome variables included rate of NHS completed by 1 month of age for all patients (proportion of patients with NHS by 1 month of age out of all patients with NHS), rate of diagnostic ABR completed by 3 months of age (proportion of patients with diagnostic ABR by 3 months of age out of all patients who failed NHS), rate of hearing aid intervention by 6 months of age (proportion of patients with hearing aid fitting by 6 months of age out of all patients who were recommended a hearing aid), and mean number of days (from date of birth) until NHS, diagnostic ABR, and hearing aid intervention. We additionally computed patients lost to follow up at hearing loss diagnosis (proportion of patients not completing diagnostic ABR out of patients who failed NHS) and patients lost to follow up at intervention (proportion of patients not completing hearing aid fitting out of patients who were recommended for a hearing aid).

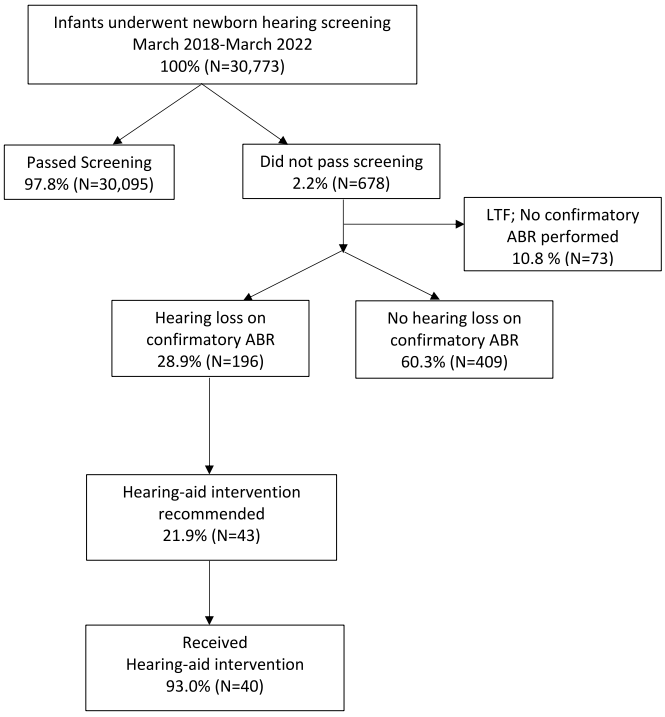

Fig. 1. Study population.

2.4. Statistical analysis

Rate and time outcomes were computed between the 3 time periods using two-sampled independent t-tests and analysis of variance (ANOVA) for normally distributed data. 95% confidence intervals were also calculated. Data were analyzed with SPSS 28.0 (IBM Corporation, Armonk, New York), and significance was defined at the $P < 0.05$ level.

3. Results

A total of 30,773 newborns underwent NHS and 678 failed NHS between March 1, 2018 and March 27, 2022. Of those who failed, 299 were pre-COVID (1.9% of 15,504), 211 were SOE COVID (2.3% of 9183), and 168 were post-SOE COVID (2.8% of 6085).

3.1. Newborn hearing screening by one-month benchmark

There was no difference in 1-month benchmark NHS rates across pre-COVID, SOE COVID, and post-SOE COVID groups ($p = 0.796$; Fig. 2). However, mean number of days to NHS decreased during SOE COVID (1.9 days; SD, 5; 95% CI, 1.8–2.0) compared to pre-COVID (2.0 days; SD, 4.9; 95% CI, 1.9–2.1; $p = 0.038$; Fig. 3A). There was no significant difference in mean number of days to NHS post-SOE COVID (2.1 days; SD, 5.5; 95% CI, 1.9–2.1) compared to pre-COVID ($p = 0.712$) and SOE COVID ($p = 0.059$).

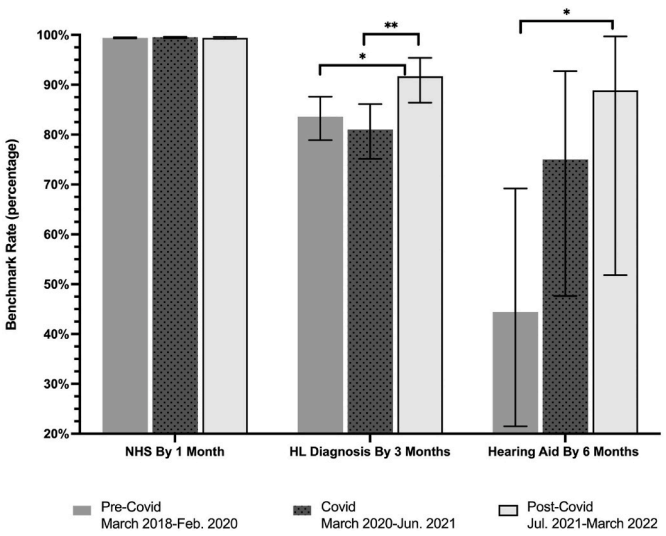

Fig. 2. Benchmark rates (percentage) with 95% confidence intervals of newborn hearing screen (NHS) by 1 month of age, hearing loss (HL) diagnosis by 3 months of age, and hearing aid intervention by 6 months of age pre- during- and post- COVID state of emergency. Error bars indicate 95% confidence interval. *P < 0.05, **P < 0.01.

3.2. Diagnosis of hearing loss by three-month benchmark

No difference in 3-month benchmark HL diagnosis rates was observed during SOE COVID compared to pre-COVID (p = 0.451). Interestingly, the 3-month benchmark HL diagnosis rate was significantly higher post-SOE COVID at 91.7% (154/168; 95% CI, 86.4–95.4) compared to both pre-COVID at 83.6% (250/299; 95% CI, 78.9–87.6) and SOE COVID at 81.0% (171/211, 95% CI, 75.1–86.1; p = 0.002; Fig. 2). Mean number of days to diagnostic ABR was significantly higher during SOE COVID (47.5 days; SD, 30.8; 95% CI, 43.1–51.9) compared to pre-COVID (32.6 days; SD, 18.4; 95% CI, 30.4–34.9) and post-SOE COVID (36.3 days; SD, 19.0; 95% CI, 33.4–39.3; p<.001; Fig. 3B). Lost to follow up rate decreased post-SOE COVID at 4.8% (8/168; 95% CI, 2.1–9.2) versus pre-COVID at 14% (42/299; 95% CI, 10.3–18.5) and SOE COVID at 10.9% (23/211; 95% CI, 7.0–15.9; p = 0.008; Fig. 4).

3.3. Hearing aid intervention by six-month benchmark

There was no difference in the 6-month benchmark HA intervention rate during SOE COVID compared to pre-COVID (p = 0.074). However, compared to the pre-COVID 6-month benchmark HA intervention rate of 44.4% (8/18; 95% CI, 21.5–69.2), the post-SOE COVID 6-month benchmark HA intervention rate was significantly higher at 88.9% (8/9; 95% CI, 51.8–99.7; p = 0.027; Fig. 2). No difference in mean number of days to HA intervention was observed across the three time periods (p = 0.217; Fig. 3C).

4. Discussion

This study demonstrates that the acute, early COVID-19 pandemic did not significantly affect rates of achieving EHDI 1-3-6 benchmarks compared to pre-pandemic rates in a major US city. It has been speculated that in some areas, EHDI benchmarks were compromised due COVID changes in hospital-specific policies [7,8]. Therefore, the consistent 1-3-6 benchmark rates during the height of the pandemic in this study may reflect the efficacy of the pandemic policies at our institution. Our policies rendered hearing screening for all newborns essential care. This may explain why the 1-month benchmark NHS rate remained unchanged, as it was part of standard protocol. Additionally, like many hospitals [9,10], our labor and delivery unit policies shortened post-partum hospital stays for mothers and newborns. This is reflected in the decrease in mean number of days to NHS from 2.0 days

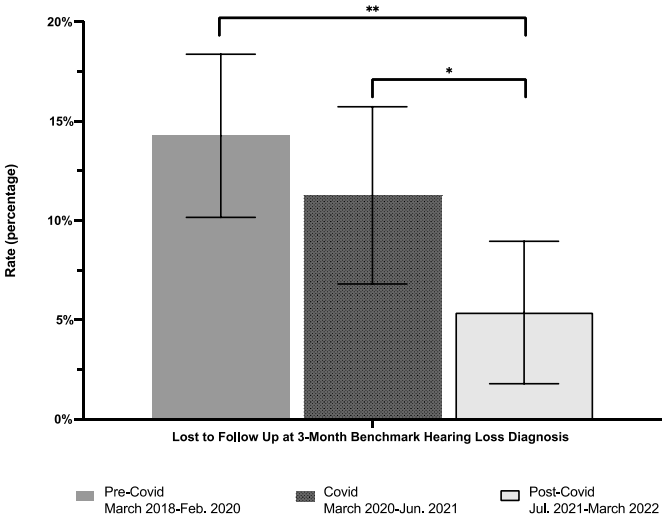

Fig. 4. Rates (percentage) of patients lost to follow up at 3-month benchmark hearing loss diagnosis pre- during- and post- COVID pandemic state of emergency. Error bars indicate 95% confidence interval. *P < 0.05, **P < 0.01.

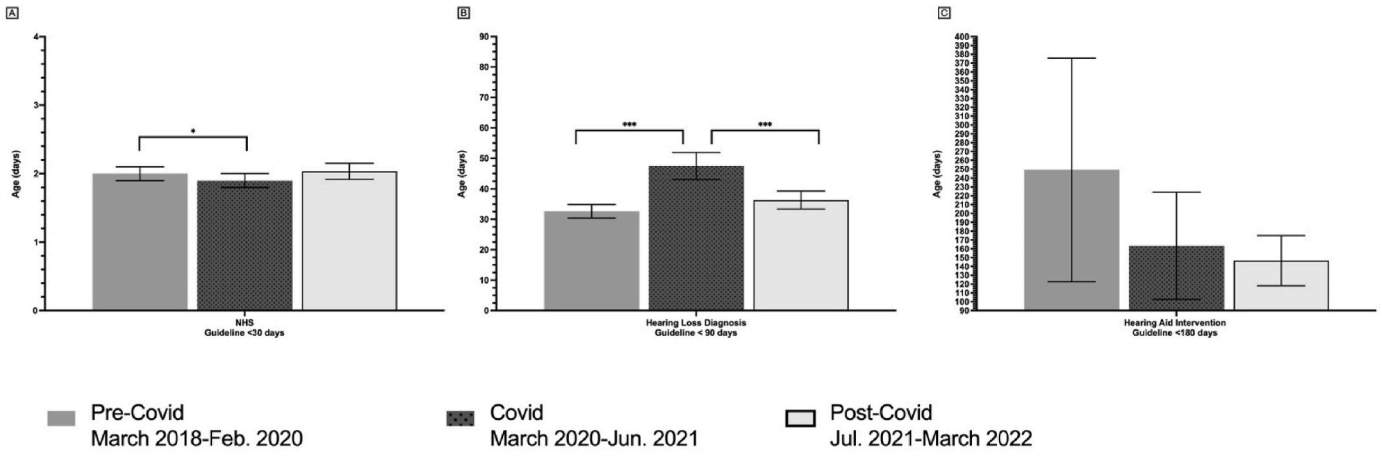

Fig. 3. Mean age (days) at (A) newborn hearing screen (NHS), (B) hearing loss diagnosis, and (C) hearing loss intervention pre- during- and post- COVID pandemic state of emergency. Error bars indicate 95% confidence interval. *P < 0.05, **P < 0.01, ***P < 0.001.

pre-COVID to 1.9 days during SOE COVID. However, the 1-month benchmark NHS rate remained >99% during both periods, indicating that shortened post-partum stays are not likely to reduce the opportunity for NHS. It is noted that the percentage of newborns who did not pass NHS was greater after the onset of the pandemic. This could be due to chance, as protocol steps and screening methods did not change due to COVID-19. All eligible infants who were given parental consent, including COVID-19 positive infants, underwent NHS. Newborns who failed NHS were referred to a pediatric audiologist for a confirmatory ABR test at a follow-up visit. Reduced services, fewer healthcare providers, and limited facility capacity necessitated triage protocols for these patients. Priority was given to infants who had bilateral HL and certain congenital etiologies of HL, followed by those with unilateral HL. It is important to note that while the mean number of days to HL diagnosis did increase from 32.6 days to 47.5 days during the SOE, infants still met the 3-month benchmark for HL diagnosis. HA intervention was considered essential care, and this may explain why these rates also remained constant.

Interestingly, this study also shows that the 3-month benchmark HL diagnosis and 6-month benchmark HA intervention rates increased post-SOE COVID. Additionally, lost to follow up rate at 3-month benchmark HL diagnosis decreased post-SOE COVID. These results suggest that COVID-19 may have increased patient perceptions of the importance of health maintenance, resulting in greater health compliance. This may be especially true for new parents. This is consistent with previous literature showing that risk perception motivates health behaviors, especially during pandemics [11,12].

Limitations to this study should be considered. Available data were limited to the information documented in clinical records due to the retrospective nature of this study. For children who are diagnosed with hearing loss, the audiologist usually refers the patient to EI. While all EI referrals are documented and reported to the state Department of Public Health (DPH), they are not consistently documented in a patient's medical chart. Instead, these data are maintained by the state. In addition, children with hearing loss who also have independent developmental needs are often referred to EI from their pediatricians, which can make it difficult to distinguish whether EI was initiated for hearing loss. Both factors precluded the evaluation of EI adherence at the 6-month benchmark. Therefore, only HA intervention by 6 months could be evaluated. HA are recommended to patients based on HL severity, etiology, and physician clinical judgement. While the proportion of subjects receiving HA in this study are representative of that of the general pediatric population, the small sample sizes limit robust conclusions of the data, as indicated by large 95% CIs.

Despite the limitations, this study provides valuable insight into the impact of COVID-19 on EHDI 1-3-6 benchmarks throughout the course of the pandemic in a large metropolitan area. The results of this study differ from previous studies, and they demonstrate that it is possible to meet EHDI 1-3-6 benchmarks in the event of unpredictable widescale disruptions. Consequently, we provide the following suggestions below for optimizing reaching EHDI 1-3-6 benchmarks during future unexpected events.

4.1. Newborn hearing screening

During resource-limited times that require hospitals to determine which services to provide to patients, all steps of NHS should be established as essential care. Designating screeners as "essential workers" and refraining from redeployments to other services can ensure timely continuation of NHS.

4.2. Hearing loss diagnosis

Limited staffing and space may require triaging of patients who do not pass their NHS for follow-up testing. Infants who are referred for bilateral HL and known congenital etiologies of HL should be prioritized first for confirmatory ABR.

Close monitoring of benchmark success should also be performed. We believe that part of our success can be attributable to this. If an infant was scheduled for a confirmatory ABR after a failed NHS and did not show up or canceled the appointment, we attempted to contact patients to reschedule it and reported this to the MA DPH. Subsequently, DPH team members also reached out to families to ensure infants received needed support.

4.3. Hearing aid intervention

Hearing aid fittings should also be considered urgent and therefore all infants who are diagnosed with HL should be prioritized. There is typically a relatively smaller proportion of infants requiring HA intervention. As such, triaging is not likely to be necessary at this stage.

4.4. Patient communication and safety

Rapidly evolving landscapes necessitate timely communication with patients. Telehealth appointments can be efficient and safe. We used telehealth for counseling, review of test results and recommendations, and speech therapy.

5. Conclusions

The COVID-19 pandemic may not have had adverse effects on achieving EHDI 1-3-6 benchmarks in large metropolitan areas. Certain protocol adaptations intended to increase efficiency in patient care when resources are limited can be effective and may serve as a model for future unexpected events. Additionally, COVID-19 may have increased patient awareness and compliance to health maintenance, leading to improved rates post-peak pandemic. Further studies should investigate parent perceptions and attitudes regarding their child's hearing loss care during the pandemic to elucidate these findings.

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Declaration of competing interest

This work was selected for presentation at the American Society of Pediatric Otolaryngology Annual Meeting at Combined Otolaryngology Spring Meetings; May 3–7, 2023; Boston MA. The authors declare no other funding, financial relationships, or conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijporl.2023.111598.

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