A Comparison of the Human Voice ("Baah") Test and the Automated Auditory Brainstem Response in Detecting Neonates with Hearing Loss in a Community Setting

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ABSTRACT

Objective. To assess the usage of the "Baah" Test compared to the AABR (Automated Auditory Brainstem Response) in detecting hearing loss of neonates in the community setting.

Methods. This is a retrospective cross-sectional study. The targeted sample population are infants less than a month old who underwent screening at a testing facility in Malolos, Bulacan spanning the years 2011 and 2012.

Results. A total of 201 infants were included in the study, with a mean age of 10.77 days with a standard deviation of 7.79. The ratio of males to females was almost equal at 1:1.01. For infants who passed hearing screening on at least one ear, 96% (193 infants) correlated with the results of "Baah" testing. For those with bilateral refer results on AABR, 4 out of the 6 correlated with the "Baah" Test.

Conclusion. There is potential in using the "Baah" Test as a tool for hearing loss assessment of infants in situations wherein the usual hearing screening tests are inaccessible. It makes use of little resources, and though it does have its limitations in assessing for unilateral hearing loss (as the test cannot test ears in isolation), it would be able to identify infants likely to have bilateral hearing loss.

Keywords: newborn hearing screening, community hearing screening, "Baah" test, automated auditory brainstem response test, voice test

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INTRODUCTION

Early detection followed by timely intervention for congenital hearing loss prevents hearing and speech disability. The Universal Newborn Hearing Screening and Intervention Act of 2009 was signed into law in the Philippines with the aim to establish a national program for the prevention, early detection, and diagnosis of congenital hearing loss among newborns and infants. The Newborn Hearing Screening Reference Center (NHSRC)[1] adopts the practice of performing hearing screening before one month, confirmatory testing by three months, and early intervention by six months similar to the 2007 Joint Committee on Infant Hearing[2] and World Health Organization recommendations[3]. However, there is difficulty in achieving full coverage which is multifactorial in nature.

Though this incapability to provide absolute coverage is related to the cost of the devices used for hearing

screening, namely for Otoacoustic Emissions (OAE) testing and Automated Auditory Brainstem Response (AABR) testing, other factors play a part as well. The Philippines is an archipelago and far-flung areas are not capable of providing hearing screening testing. Such communities with a population affected by factors such as inaccessibility, isolation due to distance or transportation difficulties, high poverty incidence, or in a state of crisis among others, are identified as Geographically Isolated and Disadvantaged Areas (GIDA).[4] Given these, GIDAs face many obstacles in the implementation of public health programs on account of their less than ideal environments. An island municipality for example, is faced with a difficult or non-existent transportation system, poor network signal, costly travel to the nearest health facility, as described in a study by Collado regarding public health challenges in an identified GIDA in the Quezon Province of the Philippines.[5]

There is also the issue of out-of-hospital births. Data provided by the Philippine Statistics Authority showed that 1 out of 10 registered births are not attended by a health professional (a doctor, a nurse, or a midwife). The percentage varies by region, with the Ilocos Region having the lowest at 2%, followed closely by the National Capital Region at 3%, and the ARMM having the highest at 52%. The other regions had percentages ranging from 4 to 16.[6] Despite this, the current screening program is hospital-based. This may contribute to the difficulty in achieving high coverage, as facilities and personnel for screening are not readily accessible to the significant proportion of newborns born outside their own homes.

A study by Rivera et al. in 2017 determined a community-based universal hearing screening program in the Philippines as cost-effective, as well as cost-saving from a societal perspective (though no comparison was made with a hospital-based program). Being cost-effective indicates that screening would involve increased costs compared to not doing screening but prevents disability-adjusted life years (DALYs), a time-based measure of years lost due to a time in which an individual lived in a state of less than full health used to assess the burden of disease. The cost required to invest in screening would be counter-acted by the decrease in costs of potential treatments and rehabilitation. Being cost-saving indicates that screening would put into effect health benefits in addition to decreasing costs compared to the status quo (which in this case is when screening would not be done). This may be seen from a societal point of view in which an untreated child grows up to have a disability that affects his/her potential to contribute to society, while one who was identified early on and treated promptly would have better chances to develop normally. There is a need to point out however, that for the program to be successful, there should be adequate follow-up for confirmatory testing, and those identified to have hearing loss should be able to receive and complete necessary treatment.[7]

A community approach to screening could then be a good fit in screening newborns considering the current state of births in the country, but the Philippines is not yet capable of implementing this in its many regions. There is a need to identify other methods that will allow healthcare personnel to assess hearing loss in some way while still not having access to conventional testing methods.

A voice test is one possible tool of assessment. A systematic review of studies was done investigating the use of a voice test in testing the hearing of both adults and children. Here, the whispered voice test was identified as a simple but accurate test for hearing impairment. Sensitivity for the reviewed adult studies was 90-100% and specificity was 70-87%. Childhood studies showed 80-96% sensitivity and 90-98% specificity.[8]

There have also been local studies supporting the use of a voice test in detecting hearing loss in infants. The value in this method lies in their ease of use and low cost. It involves using the tester's voice to produce a loud sound stimulus to elicit reflexive reactions from the infants. The voice test was coined the "Baah" Test in the local setting given that the "baah" syllable was found to have more favorable characteristics over "psst" for the purpose of screening.[9] The tester is to take two deep breaths before relaying the syllable 1 foot away from the newborn's head. It is then noted if there is a present or absent behavioral response from the newborn.

Testing of infants aged less than 6 months old at a tertiary hospital with the standard screening test (OAE), and then with the "Baah" test was done to assess the latter's accuracy. The "Baah" Test was determined to have a sensitivity of 71.4%, a specificity of 95.7%, accuracy of 94%, positive predictive value of 55.6%, and a negative predictive value of 97.8%. The results show its potential as a cost-effective screening tool in identifying infants with high risk for hearing loss.[10]

Significance of the Study

The "Baah" Test has already been compared with one standard screening test, the OAE. This was done in the hospital setting.

Newborn hearing screening program methods vary among countries, and in the Philippines, the OAE test is mainly used at this time. The other alternative, the AABR has been shown to be another viable option as it can also be done by non-professionals, though the machine itself is one that could be more costly to procure. A study has assessed the congruence between these two tests, and the AABR has been shown to have detected more infants with hearing loss. In addition, cost analysis favored use of the AABR over the two-step OAE.[11] The AABR has also been shown to have lower refer rates from 14.98 to 0.84%, compared to the OAE with rates of 17.97 to 8.9%.[12]

This study aimed to investigate the viability of using the "Baah" Test in the community setting. The refer rates of the voice test and a different screening test, the AABR, was

compared. Determining the congruence between the two could help assess whether the "Baah" test could be used as a tool by healthcare providers. This will be useful when there is a need to assess a newborn's hearing in locations without access to facilities with screening equipment.

Limitations of the Study

This study obtained data by going through the records of a hearing screening facility where testing of infants with OAE, AABR, and the "Baah" Test was done several years prior. Only infants who underwent both AABR and the "Baah" Test will be included in the study.

METHODS

The study design is a retrospective cross-sectional design, with the target population being previously screened newborns less than one month old done in a testing facility in Malolos, Bulacan from 2011 to 2012. All newborns underwent testing by nurses manning the facility. One nurse performed all OAE and AABR tests, while a second nurse performed the "Baah" Test on all infants while the other observed for the response. Records from this facility were reviewed, and the tabulated data were obtained, as well as the actual case report forms. Only those who completed both the "Baah" Test and the AABR were included in the study.

RESULTS AND DISCUSSION

A total of 201 infants tested by the nurses at the screening facility were included in the study. The demographics of the subjects are shown in Table 1. The mean age of infants screened was 10.77 days with a standard deviation of 7.79. Sex distribution was almost equal with a 1:1.01 ratio (100 males, 101 females). The patient records only took into account maternal risk factors and it was found that 34.33% (69 subjects) of infants were born with them. Some of the most common factors were noted to be urinary tract infections, acute upper respiratory infections, and bleeding episodes during pregnancy.

Test results of the infants are shown in Table 2. AABR results are recorded as either bilateral pass, unilateral refer, or bilateral refer, and it was compared with the "Baah" Test results of either having "no response" or "with response". It is noted that one of the primary limitations of the "Baah" Test is that it is a test of bilateral hearing function. This means that it cannot test the ears in isolation, and so it is expected that an infant with a single hearing ear and with both ears functioning would both have a "with response" result under the "Baah" Test. For patients who passed hearing screening on at least one ear, 96% (193 infants) correlated with the results of "Baah" test, meaning there was a noted response to a loud stimulus. Only 1% (two infants) had no observable response. For bilateral refer results on the AABR, it was found that four out of six correlated with the "Baah" Test, which means that no response was elicited when the infant was exposed to a loud sound stimulus. It was however noted that two out of the six exhibited a response despite bilateral refer results.

Those infants with at least one failed ear were subsequently scheduled for confirmatory testing. Unfortunately, even with maximum efforts to contact patients, there was only a follow-up rate of 30%. In Table 3, results of confirmatory ABR among infants with a refer result upon hearing screening are shown. As the exact hearing thresholds can be determined with this test, infants having a reaction despite being "refer" bilaterally can be explained. These infants, though having hearing loss, would still be stimulated by the loud "Baah" which reaches up to 85-95 decibels when given. Inconsistency of results were still noted however such as in Patient 2. This could have been due to factors involved in the presentation of the stimulus, such as how the confirmatory ABR uses additional equipment like an earphone or a headset which allows better transmission and quality of sound compared to simply giving it by voice.

Table 1. Demographics of Infants Screened by Community-based Hearing Screening Program (N=201)

Variable	Value
Age at time of screening in days (Mean ± SD)	10.77 ± 7.79
Male to Female Ratio	1:1.01
With maternal risk factors	34.33% (69)

Table 2. Percentage and Frequencies of Results of Behavioral "Baah" Test versus Automated Auditory Brainstem Response (AABR) Test Among Screened Neonates at a Community-based Hearing Screening Program (N=201)

		"Baah" Test at 2 feet Percentage (N)	
		No Response	With Response
AABR	Bilateral Pass	0.50% (1)	93.53% (188)
	Unilateral Refer	0.50% (1)	2.49% (5)
	Bilateral Refer	1.99% (4)	1.00% (2)

Table 3. Results of Confirmatory Auditory Brainstem Response Test among Infants with "Refer" Result at a Community-based Newborn Hearing Screening Program (N=4; Lost-to-Follow up Rate of 66.67%)

Patient	Results of AABR		Results of "Baah" Testing at 2 feet	Hearing Thresholds of Confirmatory ABR	
	Right	Left		Right	Left
1	Refer	Pass	No Response	60 dB	30 dB
2	Refer	Refer	No Response	45 dB	50 dB
3	Pass	Refer	With Response	Pass	Pass
4	Refer	Refer	With Response	40 dB	45 dB

Further studies could be done to compare the "Baah" test against the current standardized protocol for screening. It should not replace the OAE or AABR as a screening modality without further investigation, but it has the potential to be an alternative. As it stands, however, it shows promise especially considering its ease of use and applicability in communities challenged by less than ideal situations.

With time, technological advances could be made that will help develop more refined tests for a fraction of the cost, making universal hearing screening coverage a more easily attainable goal. In the meantime, alternative testing options should be explored.

CONCLUSION

There is potential in using the "Baah" Test as a tool for hearing loss assessment of infants in situations wherein the usual hearing screening tests are inaccessible. It makes use of little resources, and though it does have its limitations in assessing for unilateral hearing loss (as the test cannot test ears in isolation), it would be able to identify infants likely to have bilateral hearing loss.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

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