

Use of mobile phone based hearing app Hear WHO for self detection of hearing loss

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Abstract

Introduction

Hearing loss has severe effects on the individual. Most hearing-impaired adults delay obtaining treatment. Diagnostic hearing testing at an appropriate facility is difficult and new methods for screening are needed to provide easy access for patients and optimum outcomes on rehabilitation.

Aim

The purpose of this study was to examine the effectiveness of android application-based hearing screening by Hear WHO app vis a vis pure tone audiometry.

Methodology

160 patients for hearing evaluation by pure tone audiometry where subjected to app-based hearing test Hear WHO. The test was evaluated in terms of sensitivity and specificity when compared against gold standard such as Pure Tone Audiometry (PTA).

Results

The sensitivity of WHO hearing app Hear WHO was 82% and 95% specific as compared to pure tone audiometry. WHO based hearing app was considered a feasible option for screening of hearing.

Conclusion

The application may be used as a screening tool for hearing loss

Keywords: hearing loss, screening, hearing testing

Introduction

Hearing loss affects close to 1.3 billion people and is a growing global health concern as the fourth leading contributor to years lived with disability, [1] The global economic cost associated with hearing loss is estimated at 750 billion United States dollars (US\$) annually [2].

There is a need to detect hearing loss early. The present methods of detecting hearing loss are free field hearing and puretone audiometry which require trained medical manpower. There is a need for an easily accessible self-test which can be done by the individual himself. Development of smartphone apps have harnessed technology to create self administered hearing tests. Speech based applications assess users ability to recognise speech in noise in different environments. WHO adopted this

approach and launched an app HEAR WHO in 2019 to assess hearing.

Objectives of this study

To find whether android app based hearWHO app can be used as a screening tool for early detection of hearing loss

Materials and methods

160 patients referred for hearing evaluation by Puretone audiometry were subjected to smart phone app based hearing test Hear WHO and the results were compared to pure tone audiometry. The app was downloaded from google play store and was free for use. The app Hear WHO is a self-explanatory diagnostic hearing test. A normal insert headphone/earphone was used for the test. The study was carried out after taking consent.

All patients belonged to the age group between 18 years to 65 years. The number of male patients was 106 and 54 were females. Sample size for comparing the sensitivity of a new test with a gold standard test with 5% level of significance and power of study being 99% the sample size was 133, here we took 160 as sample size.

These patients were subjected to hearing assessment using 1. Pure tone audiometry: A GSI 38 audiometer was used to conduct audiometry by a qualified audiologist. It was carried out in a standard audiometry room fulfilling BS EN ISO standards. 2. Hear WHO app test: It is a digit-in-noise test where recorded digit triplets (for example, 4-2-7) in background speech-shaped noise are present to determine the signal-to-noise ratio where a person can identify 50% of triplets correctly. 23 responses of the patient to varying sounds are taken. The equipment comprised of a smart phone used in the department for carrying out audiometry with standard insert earphones. The test was carried out by the patient himself in the outpatient department room and not in audiometry room so as to simulate environment where audiometry facility is not available. The criterion for abnormal hearing was predefined for the study as follows: 1. Pure tone audiometry: Average air conduction thresholds at 500Hz, 1000Hz, 2000Hz, 3000Hz, 4000 Hz more than 25 dB. 2. Android application Hear WHO: Score less than 50

- Score above 75- good hearing.
- Score between 50 to 75 - check hearing regularly
- Score below 50 shows- hearing loss lower the score more the loss

The observers were blinded to the results

The test environment (Audiology room) met all the specifications as per the guidelines laid by American National Standards Institute, 1999).

The ambient noise did not exceed 35 dB as recommended by BSA (2011).

Ambient noise level in OPD was 45dB

The data was analysed using MS Office (Excel) and IBM SPSS Statistics-version 20. A typical cross tabulation analysis utilizing the 2x2 contingent table was computed to determine the diagnostic accuracy indices like sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV). Institutional ethical committee clearance was taken for the study.

Results

On App - 118 had score above 50

42 had score below 50

On Audiometry:

45 patients had some degree of hearing loss (including 37 with app score below 50)

5 pts with app score below 50 had normal audiometry

Table 1: Hearing loss on audiometry

		Positive	Negative
Hearing loss on app	Positive	True positive 37	False positive 5
Hearing loss on app	Negative	False negative 8	True negative 110

Sensitivity $37/45 = 82\%$

Specificity $110/115 = 95\%$

PPV $37/42 = 88\%$

NPV $110/118 = 93\%$

Discussion

Hearing loss has a substantial impact on psychosocial wellbeing and economic independence [3]. If acquired in childhood, before speech has developed, hearing loss can impede language development and hence limit educational attainment [4]. Hearing loss also has high societal costs, mainly due to losses in productivity⁴. If hearing impairment is identified early and treatment is provided, many of these negative effects can be avoided [5, 6]. As hearing loss can be a gradual process, it is important to identify and provide options to enhance communication or identify if another issue is at hand, such as a pathology or neurological issue. People with hearing loss wait an average of seven years before seeking help. In case of sudden sensorineural hearing loss, the treatment needs to be instituted immediately to treat hearing loss lest may lead to permanent handicap.

To maintain health, regular hearing loss screening and treatment is necessary. If identified, hearing aids or cochlear implants can substantially help most people and early detection and treatment may facilitate rehabilitation.

Substantial challenges exist in screening for hearing impairment

due to severe shortage of hearing health care professionals (ie, audiologists, speech pathologists, and ear, nose, and ENT specialists). Due to these barriers, hearing impairment remains undetected and unmanaged for a substantial number of people in the periphery.

It is imperative to detect hearing loss at early stage to take immediate remedial measures. One of the current methods of screening of hearing is by Free Field Hearing which has numerous shortcomings. It is a subjective test with poor predictive value, lack of reproducibility, accuracy & standard technique. Moreover, it is known to have low sensitivity and specificity [7].

There is a huge demand for mobile devices that can assist people to conveniently have their hearing health checked. The advantages of the smartphone-based solution are portability, self-assistance, low cost, and it being less time consuming compared to the formal clinical facilities. Smartphone-based applications can have high reliability, sensitivity, and specificity towards identifying potential hearing loss [8].

Newly developed methods for screening such as telephone-based,

Internet based, and smartphone-based screening [9] aim to provide easy access for patients and reliable outcomes. For this reason, simple inexpensive testing is preferable to advanced testing, at least for initial screening. Smartphone-based screening is particularly attractive because of the widespread penetration of mobile phones and cellular network reception globally [9].

Speech-based apps typically assess ability to recognize speech in noise. Unlike pure tone audiometry, these tests do not require calibration, allowing use across various devices and headphones [10, 11]. Speech-in-noise tests directly evaluate what people with hearing loss find most challenging, understanding speech in acoustically challenging environments. These tests are thus considered more representative of impairment in functioning than pure tone audiometry. Digits-in-noise tests present recorded digit triplets in background speech-shaped noise to determine the signal-to-noise ratio where a person can identify 50% of triplets correctly. Highly correlated with Puretone audiometry, digits-in-noise tests' sensitivity and specificity are up to 90% and can be completed in three minutes [11]. 4–88% The World Health Organization recently adopted this approach for the hearWHO app (iOS and Android) released on World Hearing Day 2019. This app was created by hearX group which was founded at the University of Pretoria in 2015 by professor De Wet Swanepoel and Dr Herman Myburgh.

This app has a new version of the digits-in-noise test and uses antiphasic digit stimuli that make the app sensitive to a range of hearing losses including sensorineural, conductive and asymmetrical losses [12]. The new hear WHO app is designed to draw attention to the importance of early detection of hearing loss. According to the World Health Organization, the sponsor of the app, hear WHO is based on a validated digits-in-noise technology: users are asked to concentrate, listen, and enter into their mobile device a series of three numbers when prompted. These numbers have been recorded against varying levels of background sound, simulating listening conditions in everyday life. The app displays the user's score and its meaning and stores the outcome of the test so that the user can monitor hearing status over time. Reminders to take the test regularly can be set by users.

The increasing availability of apps provides an opportunity to integrate their use into screening for ear and hearing conditions in a cost effective and mobile way. These techniques would involve an offsite ENT, negating the need for such a specialist to be present with the patient, to help deal with the substantial human resource shortage. The portability, accessibility, self-administration, and low-cost nature of ear and hearing apps still offer an exciting opportunity to overcome the key barriers to screening for ear and hearing.

Advantages of mobile-based digital hearing test solutions include accessibility, affordability, advanced sensors and software-based quality control, alongside integrated cloud-based data management [13]. Some apps allow tracking hearing status over time and can also be linked to decision-support resources that encourage users to act on hearing loss. One of the chief

advantages of the test was that it was free to download, and no internet connection was required to carry out the test.

Limitations of app based hearing include need for a certain education level to use an app, access to smart phone/wifi and cannot be used in small children. App cannot quantify the hearing loss or differentiate between type of hearing loss. There can be responder bias in responding to stimulus and app is only available in english language.

Conclusion

App based hearing screening using WHO Hear app offer an a promising alternative to conventional screening methods.

Recommendations

It is recommended that the android based hearing screening app Hear WHO be incorporated to carry out hearing screening.

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