Online screener accuracy and follow through for in clinic testing and treatment.

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Objectives

This study aims to determine the efficacy of using online hearing screeners to assess hearing sensitivity by comparing screener results with traditional test booth audiometry to ultimately inform clinicians on how results might be used. Secondary aims are to estimate follow through for treatment and evaluate using screeners for other purposes.

Background

There are a wide variety of reasons for delays in hearing assessment and hearing aid uptake including access, denial and cost.[1,2] In recent years, various internet-based screeners have emerged allowing prospective patients to screen their hearing from virtually anywhere with an internet connection, significantly eliminating or reducing barriers. However, clinicians have little guidance on how to use these results, as tools vary wildly, with many having undergone little or no validation. In some cases, developers provide whitepapers giving added confidence in the screener itself, yet how these results translate to a clinical setting is unknown.[3] Web-based screeners are marketed with additional benefits such as lead generation, patient engagement and even sales, and yet, little is known about the effectiveness in achieving these aims.[4] A better understanding of how screening results compare with conventional audiometry will inform clinicians on how results can be used to achieve these aims. Whitepapers and current literature currently offer little insight into what becomes of prospective patients who undergo screening. Data on follow through for in-clinic service might support an understanding of how effective screening of this type is for the purposes of engagement, marketing and resource management. A better understanding of how effectively such a tool might filter out individuals who do not require in-clinic services could also be of special interest in managing clinic capacity.

Figure 1. Shoebox Online is an example of a self-administered internet-based hearing screener. It is one of two screeners that Hearing Solutions has used, and is the tool being examined in this study as it provides frequency specific data for 1, 2, 4 and 6kHz.

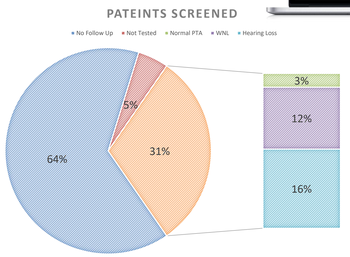

Figure 2. Represents the total proportion of subjects screened online and their follow through testing status. Tested patients included those within normal limits, those with some hearing loss and a normal pure tone average and those with greater degrees of hearing loss.

Methods

Demographic information was collected for 146 samples in which the shoebox online self-administered hearing screening was completed on the Hearing Solutions website by prospective and existing patients. Attempts were made to link demographic details such as name, phone number, or email contact information provided at screening to patients in the Hearing Solutions database to determine follow through for assessment and treatment. Once linked, hearing status was obtained along with frequency specific screening results at 1, 2, 4 and 6 kHz for both ears and were then compared with pure tone test results obtained in clinic at the same frequencies. Screening accuracy was determined based on this comparison along with sensitivity and specificity which were compared with the values obtained in the validation whitepaper.[3] The screening threshold was subtracted from conventional threshold to determine individual discrepancies and obtain an absolute average. Among the subset of subjects who followed through for assessment, hearing aid uptake was calculated as well as hearing aid return rate. Finally, the demographic information from all samples (including those that were unable to be linked to database patients) were analyzed, coded and counted to begin identifying trends based on demographic details such as location or valid contact information.

Results

The screener yielded an accuracy of 76%, specificity of 70% and sensitivity of 80%. While reasonably favorable, these values were reduced by 15-21% compared to those reported in the validation whitepaper suggesting limited transferability of those outcomes to a clinic setting.[3]

Results demonstrate that the majority (64%) of samples who completed screening could not be linked to a confirmed patient and likely did not pursue any further assessment or treatment. This indicates many screenings are required to support goals around marketing. A small portion (5%) did contact the clinic for other services or to book an appointment that was never completed. Normal, as defined by having thresholds of 25dB HL or better at all tested frequencies, accounting for 12% of samples (a normal rate of 40% of those tested in clinic.) Of the remaining 16% with some degree of hearing loss, 14 samples were hearing aid users. It was identified that one such user was already a patient prior to screening (suggesting some level of passive patient engagement) and another individual repeated the screening 3 times thus accounting for 3 samples. After controlling for these factors, it was determined that hearing aid uptake after screening was 57% (based on those with a PTA greater than 25dB), 48% (based on those with any thresholds above 25dB), or 28% (based on all patients tested including those within normal limits.) The return rate was 8%.

The 45 samples matched to a corresponding conventional audiogram allowed for the comparison of 89 ears to screening thresholds. The results from this comparison demonstrate greater variability than the generally accepted standard of 5dB.[5] The absolute averages were 11.1dB for 1kHz, 9.4dB for 2kHz, 10.7dB for 4kHz and 10.6dB for 6kHz. While clustered heavily around the average, some outliers varied by as much as 40-50dB. These findings will likely limit the utility of using thresholds for the purpose of sales unless confirmed by conventional testing. There may, however, be an opportunity to improve the fit of over-the-counter devices.

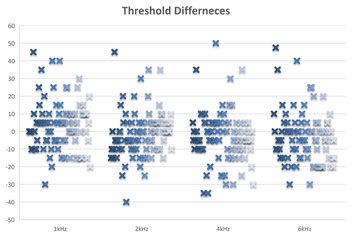

Figure 5. Screening threshold minus conventional threshold in dB HL for 89 ears. Significant clusters observed around the absolute average of approximately 10dB per frequency.

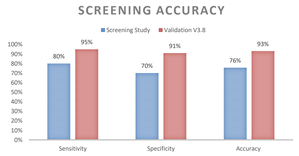

Figure 3. Compares the Sensitivity, Specificity and Accuracy results obtained in this study (blue) with those reported in the validation whitepaper (red).

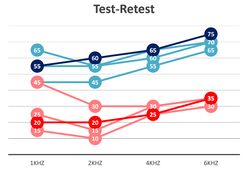

Figure 6. Test-retest reliability for a single subject who repeated screening 3 times. Variance within a single subject appears consistent with the between subject variance seen among the larger group.

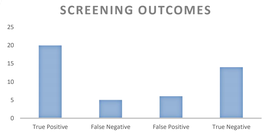

Figure 4. Displays grouped outcomes when conventional audiometry is compared against screening results. True positives were correctly identified as having hearing loss while false negatives were missed. True negatives were correctly identified as having normal hearing while false positives were incorrectly flagged for possible hearing loss.

Discussion

One perceived benefit of an online screener would be to qualify leads by filtering out individuals who do not need clinic services, particularly those with low motivation or who have little to no hearing loss. Further investigation, however, is warranted as the follow-through data obtained in this study does not fully support this hypothesis. The hearing aid uptake and return rates among the population tested in the clinic conform to industry norms, especially for those with some degree of hearing impairment. However, the 40% normal rate appears higher than baseline, and several subjects correctly identified during screening as having good hearing reported to the clinic despite these findings. These findings suggest that individuals' faith in an online tool versus an in-person assessment could be a factor.

Comparing the perceived impact on the quality of life from intake questionnaires would be incredibly informative. Increasing screening of the general population is only desirable if it is selective to those with suspected hearing loss, as it risks incidental identification of unperceived hearing loss. [7,8]

Most individuals who screened their hearing did not report to the clinic for assessment, which may result in a sampling difference, a possible explanation for the discrepancy in accuracy, sensitivity, and specificity observed between this study and the validation whitepaper, which had a larger proportion of normal results. This could be a desirable outcome for triage if screening gives those with normal results faith to forgo in-clinic assessment. However, because this was not reflected in the normal rate of those tested in the clinic, it also suggests that online screening may attract a higher proportion of patients with normal hearing.

The subject who repeated screening multiple times offered an interesting case study for test-retest reliability (figure 6), as the results from this single case are consistent with the between-subject data observed in the larger study. The results reinforce the overall findings that repeated thresholds were generally within 5-10dB of the test booth results. However, the two outliers of 15 and 25dB observed among the 24 thresholds also suggest caution is warranted when using threshold-specific data.

These preliminary findings set the stage for a significant amount of continued research. Numerous topics, such as patient engagement, mentioned only briefly in this study warrant investigation, and large topic areas have yet to be addressed. For instance, we can learn much from the demographic data extracted from 94 unlinked samples. A transtheoretical model would suggest they are at an earlier stage of change, and online screening may have had value in moving them along in that cycle.[6]

Looking for trends among this subset will likely yield other exciting pieces of information, such as the marketing insight that became evident surrounding many samples originating far from Hearing Solutions clinics. Many individuals also included false identifying information in the screener. This confounded attempts to link subjects and may have impacted this study in several ways, including multiple samples for a single subject or subjects pursuing treatment in a clinic without our knowledge. Interestingly, it also hints at underlying skepticism, denial or their stage of readiness. This is also worth further exploration as we observed that several subjects repeated the screening more than once in a short time, and many appear to encourage their family to complete the assessment as well.

Conclusions

Self-administered internet-based hearing screeners represent a valuable tool in approximating hearing sensitivity in general. However, threshold-specific data may not be applicable without clinical assessment to confirm findings beyond conservative use cases, like over-the-counter devices. Such tools could be invaluable in allocating clinic time, marketing, and moving patients along their hearing healthcare journey.

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