Respiratory Screening
শ্বাসযন্ত্র স্ক্রিনিং

INSTRUCTIONS FOR USE – for Healthcare Providers
(AudibleHealth AI)

Please read all instructions carefully before using this device.

These instructions for use are for healthcare providers who intend to prescribe an AudibleHealth AI screening test.

DESCRIPTION
The AudibleHealth AI is a Clinical Decision Support Software (CDSS) comprising of an ensemble of software subroutines that utilize Artificial Intelligence/Machine Learning (AI/ML) to analyze forced cough vocalizations (FCV) for screening purposes.

Components of the AudibleHealth AI are as follows:
- One-Time Test Web App Module
- Sound Processing Module
- Predictive Engine
- Laboratory Information Management System (LIMS) interface

The One Time Test Web App Module, the user interface seen by the end user, allows the end user to submit the audio file using a smartphone.

The Sound Processing module has several components that ensure each FCV is of adequate sound quality and prepares the FCV to be evaluated by the AI/ML models. The first 50ms are trimmed from the beginning of the audio file as they do not provide data that assists in screening. A normalization step is used to scale the value of the signal to a uniform range (-14dBFS) to help with the de-clipping of the samples. If the audio file is in stereo sound (presented through two channels), it is converted to mono (one channel). The high-pass filter removes frequencies below a specific threshold from the file. A second normalization step is then performed to further scale the file to a better range (-6dBFS). Then the FCV passes through the wav2vec splitter, which turns the files into individual segments containing only one cough each. The duration filter ensures the quality of the splits by removing multi-cough segments and segments that are too short to be properly analyzed. If at least ten segmented coughs are usable after the completion of sound processing, the samples will be resampled to the sampling rates needed by the algorithm and sent to the AI/ML models. If there are not ten usable coughs, the user is prompted to submit a new FCV sample as described in section 6. When a new cough sample is submitted, the usable coughs from both samples are accumulated to reach a minimum of 10.

The predictive engine consists of an ensemble of AI classifiers and a deterministic oracle. The classifiers are a group of deep convolutional neural networks (CNNs) trained to detect specific disease signatures in the cough sample, which gets converted from an audio file to an

extremely data-rich spectrogram image. Another custom piece of software, known as a deterministic oracle, is connected to the ensemble to take in predictions from each CNN and deliver a final predictive score based on the data provided by the CNNs. Respiratory-related illnesses create specific disease signatures or patterns in the thousands of data points collected in each cough sample. This is due to the unique ways in which each disease affects the human respiratory system. Some diseases create additional mucus, cause changes in mucus viscosity, cause varying inflammation and cough harmonics, or produce conditions like airway constriction. By collecting many coughs from subjects who are confirmed positive for a specific disease and many coughs from people who are confirmed negative, AudibleHealth AI data scientists train AI/ML models that detect the specific patterns correlated to the target disease positives or negatives. After the CNN classifiers and the accompanying oracle have been trained and tested on a sufficient number of positive and negative samples, the predictive engine is capable of analyzing a new cough to determine whether the cough pattern matches the known signature for the target illness. For each illness, a separate ensemble of AI/ML models with their own accompanying oracle is trained, tested, and deployed. Each time the solution is used, the provider receives a numeric probability score between 0 and 100, indicating the likelihood that the sample does or does not correlate to the known disease being screened, with scores over 50 being considered positive and scores below 50 being negative. Each predictive engine algorithm used for screening is a locked ML solution that is not continuously learning while in live production.

The LIMS interface is a laboratory industry-standard data transfer protocol for reporting and recording test results.

DEVICE PACKAGING or PRESENTATION

The user interface for this device is offered as a web application (app) for Android version 12 through current version and iOS version 17.7 through the current version. The app is the only packaging for this device. To use the app, a healthcare provider must prescribe a test. After a test is prescribed (via online qualification or manual entry), the web app will be accessed directly from the URL or via a link. This web app is only available as a point-of-care-use product. Only healthcare providers and organizations with appropriate credentials may prescribe this app for screening.

INTENDED USE/CLINICAL APPLICATIONS

AudibleHealth AI is a Clinical Decision Support Software (CDSS) intended for screening for tuberculosis through the utilization and classification of a forced cough vocalization. The test is intended for point-of-care use by a healthcare provider to screen adults 18 years of age or older. AudibleHealth AI is not intended to be a standalone diagnostic tool. As a CDSS, it is intended for use in conjunction with risk assessment, radiography, and other medical diagnostic evaluations to assist the clinician in making individual patient management decisions.

CONTRAINDICATIONS

Use of the AudibleHealth AI device for screening is contraindicated for the following persons:

- Recent acute traumatic injury to the head, neck, throat, chest, abdomen, or trunk
- Patent tracheostomy stoma
- Recent chest/abdomen/trunk trauma or surgery, recent/persistent neurovascular injury, or recent intracranial surgery
- Persons unable to cough voluntarily
- Medical history of cribriform plate injury or cribriform plate surgery, diaphragmatic hernia, external beam neck / throat / maxillofacial radiation, phrenic nerve injury/palsy, radical neck / throat / maxillofacial surgery, vocal cord trauma or nodules
- Persons with aphasia may have difficulty in producing an FCV in the time allotted by the app and have not been evaluated as a population.

COMPATIBILITY

The AudibleHealth AI web app is compatible with the following web browsers: Google Chrome, Safari, Samsung Internet, and Android Chrome when used on smartphones running iOS (version 17.7 or newer) and Android (version 12 or newer) operating systems.

WARNINGS

The AudibleHealth AI only provides screening information, not diagnostic, treatment, or management information. Results should be clinically correlated.

PRECAUTIONS

Patients experiencing breathing difficulties or shortness of breath may require more than one attempt to achieve a successful FCV submission for analysis. If breathing difficulties persist or worsen, the patient should stop coughing and seek other means of testing.

POTENTIAL COMPLICATIONS/ADVERSE EVENTS

Submission of cough samples for analysis by an AI/ML clinical decision support software is a low-risk procedure. Potential complications may occur during or following FCV collection, including but not limited to light-headedness or shortness of breath.

Although the device has been tested and performed adequately in clinical studies, it is possible that the device could provide an incorrect screening result.

INSTRUCTIONS / DIRECTIONS

Prescribing a Test

- Tests are prescribed in two ways.
- Manual prescription requires manual entry of patient information and sending a link via SMS or WhatsApp message. In order to send a test to a smartphone, you must have an account with a distributor or have the ability to send tests integrated with your electronic health record. Separate instructions are available for sending a test based on which option your administrator has chosen. Please refer to these instructions to send a test to a patient.
- Some organizations choose to set up protocols and procedures that allow a patient meeting certain criteria to receive a prescription after entering their own information.

Installation

1. If possible, ensure the smartphone receiving the test is compatible with the one-time test web app (see **COMPATIBILITY** above). If completing a manual prescription, you will send a link as per the instructions referenced above.
2. When the patient selects the link within the text message, the smartphone will automatically be taken to the web browser with the web app open.
3. If a qualifying patient is receiving an automatic prescription, the web app will be accessed directly from the URL where the qualifying information was entered.

Login

1. When the web app opens, the patient will be informed that the test is a respiratory screening and should select “Proceed” to continue.
2. Patients receiving a manual prescription will log in using date of birth (two digits for the month, two digits for the day, and 4 digits for the year) and accept the Terms of Use. *Note: The Terms of Use is a link, which the patient can select and review if they choose.
3. After “Login”, the patient will receive instructions for cough submission.
4. A patient who entered the web app from another URL will have already entered demographic data and will be logged in automatically.

FCV Collection and Testing Instructions

1. The first two screens provide a brief tutorial, reviewing the test process and helpful tips for a successful FCV collection. Once the patient has finished reading these (or you have explained them to the patient), the “Next” button will continue the process. **Note: Patients can also listen to an example of a good-quality cough by selecting the “play” triangle at the bottom of the second instruction screen.
2. Note: In addition to the sound considerations below, please consider the environment from an infection control perspective prior to preparing the patient to cough. The facility protocol should be followed based on the patient’s symptoms and clinical suspicion.
3. To submit an FCV for analysis, you or the patient should tap the microphone button, and the patient should cough for at least 15 seconds. To optimize FCV quality:

a. You (or the patient) will need to reduce any background noise in your space, such as turning off the television or radio and turning off or moving away from loud appliances or air conditioning units.
b. Silence the phone before submission.
c. Find the microphone on the smartphone. The phone should be held along the sides so that no fingers are over the microphone while the patient is coughing.
d. Whoever is holding the phone should not move it or their fingers. This may add extra noise and interfere with a successful submission.
e. Do not allow the patient to talk, eat, chew gum, or make noises other than the cough during the submission.
f. Hold the phone at least 12 inches from your mouth.
g. Ensure you start coughing as soon as you click Start.
h. Encourage the patient to provide a strong cough from deep in their chest.
i. The patient should cough for at least for 15 seconds, and briefly pause between coughs. (The patient can listen to the example cough to understand this pause.)
j. The volume of the cough should be at about the level someone would normally talk on a smartphone.
k. Make sure the only sound you submit is the cough.

4. If an unexpected noise occurs or there is a problem with the submission, you may select “Stop & Retry” to retry the FCV collection. If there are no concerns about the cough submission, select “Stop & Submit.”
5. While the FCV is being processed, the screen will show “Analyzing”.
6. If a submission contains zero coughs that could be used for screening, the patient will see the “Oops.” screen and be prompted to try again. This is not related to the screening result. The audio processing system is designed to reject coughs that do not have the appropriate sound quality to ensure that you receive the most accurate screening result possible for your patient.
7. If a submission contains some coughs that were usable for screening, but not the full 10 that are required, the “Getting There” screen will appear, asking for another cough submission. Again, this is not related to the screening result.
8. If the patient receives the “Oops.” or “Getting There” screen, try to follow the specific instructions given on the screen. These screens are tailored to the audio issues detected by the audio processing system. Then select “Try Again,” and the patient will be prompted to submit another cough sample.
7. If the device is not able to evaluate the patient’s cough sample after 3 attempts, the 30-minute countdown screen will appear. Waiting 30 minutes before another attempt helps to prevent voice strain from coughing many times. If you choose to have the patient wait 30 minutes, the patient will be able to use the same link in the text of the WhatsApp message.
8. If the device is able to analyze the patient’s cough and provide a diagnosis, a “Success!” message is displayed.

9. At that time, the patient can select “Done” and close the web browser. The smartphone should be sanitized at that time according to the facility's policy to prevent the spread of infection.
10. The screening results will be transmitted to the system where the test was ordered.

Troubleshooting the One-Time Link (for Manual Prescriptions)

- The link you send to your patient expires after 14 days (or a shorter timeframe if requested by your administrator). If the patient attempts to access an expired link, a screen will appear in the web browser noting the expiration. The patient will have an option to request a new link. You will be able to view the request in the system you use to send tests (as noted in **Sending a Test).**
- The link will also expire as soon as it has been used. If the patient attempts to access a link that has already been used, a screen will appear in the web browser noting that the link has been used. The patient will NOT have an option to send a further request through the system if this occurs.

Results

Results are for screening for pulmonary tuberculosis, COVID-19, or pneumonia in individuals aged 18 years or older. Positive results are indicative of forced cough vocalization associated with the presence of the infection indicated. Clinical correlation with patient history and other diagnostic information is necessary to determine the patient's infection status. Positive screening results do not rule out co-infection with other bacteria or viruses.

Negative results are indicative of a forced cough vocalization that appears as someone who is confirmed negative for tuberculosis, pneumonia, and/or COVID-19. Negative results do not rule out infection with a different virus or bacteria and should not be used as the sole basis for treatment or patient management decisions, including infection control decisions. Negative results should be considered in the context of a patient’s recent exposures, history, and the presence of clinical signs and symptoms consistent with the illness, and should undergo follow-up testing if necessary for patient management.

Test results for reportable diseases will be reported to the appropriate public health authorities by AudibleHealth AI, Inc., following local, state, and federal requirements.

EXPLANATION OF SYMBOLS USED IN PRODUCT LABELLING

This is governed by the law of the nation where marketed (requirements and symbols may vary across countries and jurisdictions). Below are provided the picture and the definition of that picture, as the image appears on the device label and packaging.

i.e., **REF** = Catalogue number

WARRANTY
No warranty, actual or implied, is offered for the AudibleHealth AI.

MANUFACTURER
This product is manufactured by:
AudibleHealth AI, Inc.
6400 S. Fiddlers Green Circle, Suite 250
Greenwood Village, Colorado 80111 USA