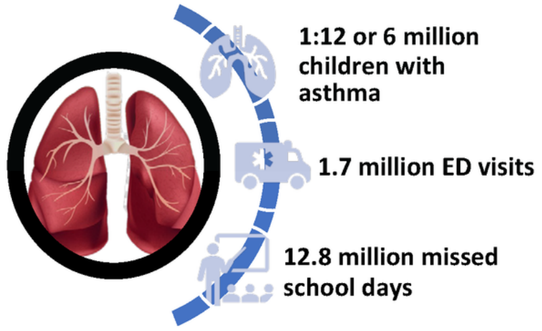
Automated Wheeze Detection in Children Using Data-Efficient Deep Learning Models

[1]Shilpa J. Patel, [2]Youness Arjoune, Trong N. Nguyen, [3]Anha Telluri, [4]Jonathan J. Schroder, [4]Dinesh K. Pillai, [1,5]Stephen J. Teach, [2]Raj Shekhar
[1]Division of Emergency Medicine, [2]Sheikh Zayed Institute for Pediatric Surgical Innovation, [3]George Washington University School of Medicine and Health Sciences, [4]Division of Pulmonary and Sleep Medicine, [5]Center for Translational Research, Children's National Hospital, Washington, D.C.

BACKGROUND



- Initiation of "yellow zone" management on the asthma action plan (AAP) currently relies on subjective measures of acute asthma severity, often delaying initiation of rescue therapy
- Combining the current AAP with an objective mobile app that scores acute asthma severity (automated detection and assessment of wheeze severity + respiratory rate + pulse oximetry + measure of dyspnea) could provide parents with decision support and allow for more timely initiation of rescue therapy, ultimately decreasing ED utilization
- A key requirement for developing an objective mobile application for home management of acute asthma is automated wheeze detection

OBJECTIVE

To develop an automatic deep learning-based wheeze detection algorithm to assist parents/clinicians in assessing the severity of asthma in children

GREEN means Go Zone!
Use preventive medicine.

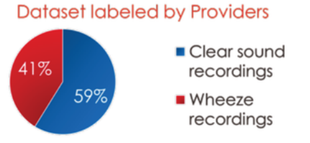
YELLOW means Caution Zone!
Add quick-relief medicine.

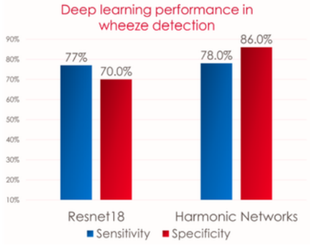
RED means Danger Zone!
Get help from a doctor.

RESULTS

Automatic wheeze detection with an accuracy of 84%

StethAid Lungs consists of a digital stethoscope, mobile app, website portals, and cloud storage. StethAid Lungs combined with oximeter was used to build asthma lung sound database.





Harmonic Networks data efficient models outperforms ReseNet18 model by about 10%

METHODS

Data Collection

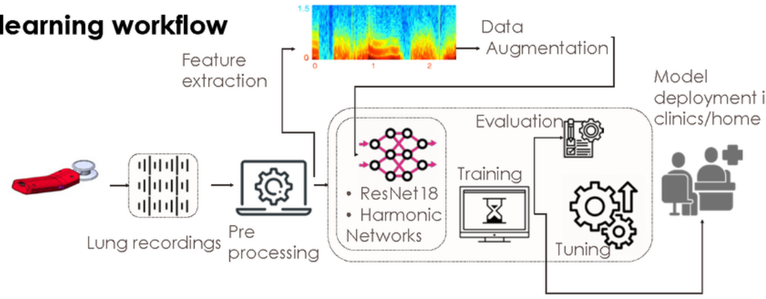
Enrolled children with asthma (2 -18yo), between 7/22-4/23, from the Emergency Department

Trained research assistants to collect lungs sound and voice recordings using the *StethAid Lungs* platform

- Each lung sound recording was 15 seconds in duration
- Recordings originated from 11 separate locations

Lung sound labels (ground truth) were provided by physicians at the bedside using their acoustic stethoscope and asynchronously by study physicians SP, DP and JS

Deep learning workflow



DISCUSSION

Potential applications of *StethAid for Lungs*:

❖ In Hospitals/Clinics

Minimizing ED visits for asthma
Tracking the efficacy of treatments
Extend care access to communities in underserved areas
Improving confidence in diagnoses

❖ At Home

Identifying symptoms early reducing severity of exacerbations
Lowering costs and improving medical outcomes

Ongoing Work:

1) Deep learning for dyspnea detection
2) Respiratory rate calculation
3) Asthma score calculation

CONCLUSIONS

- *StethAid Lungs* could assist parents in managing their child's asthma at home
- *StethAid Lungs* could be used in quickly identifying high risk patients and prevent asthma attacks
- *StethAid Lungs* could aid in reducing ED visits and school absenteeism

ACKNOWLEDGEMENTS

Current study: NIH grant R41NR019735; *StethAid Lungs* platform: CTSI, Board of Visitors

AusculTech Dx

Co-Host

Sponsors

Children's National

NIH National Institute of Allergy and Infectious Diseases