Artificial Intelligence versus conventional spirometry, to detect early asthma attacks in children.

An observational prospective study

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Background

14%
Of children affected by Asthma Worldwide.

Home care managment of asthma is **Difficult.**

Families commonly **underestimate** the severity of the disease.

Mismanagment leads to **Increased hospital admissions, School absenteeism, Life-threatening exacerbations.**

Deep learning has the potential to **automate the evaluation** of RESPIRATORY SOUNDS

EARLY detection & prompt assessment reduces morbi-mortality rate

Aim

- To gather a standardised dataset of digitally aquired lung auscultations, in children with suspected acute exacerbations of asthma
- Produce a DEEP LEARNING model for early diagnostis of asthma exacerbations, from lung sounds.

Method

Study design & Population
- Observational prospective study.
- Paediatrics University Hospital of Geneva.
- During asthma follow-up consultation with spirometry testing.
- Children aged 5-18 y/o.

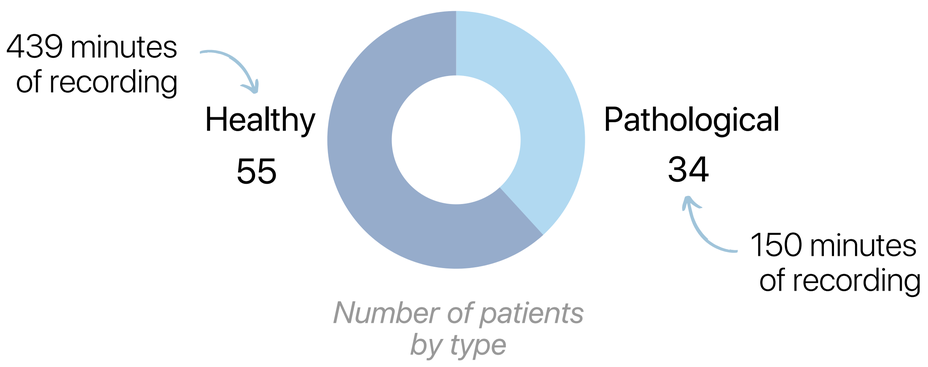
Data collection
- Demographic & clinical data collecting.
- Retroactive Spirometry test results compiling.
- Registration of lungs sounds with 2 digital stethoscopes (Littmann® 3200 & EKO® CORE) b/a bronchodilatator (B2) inhale, in 8 positions, during 30sec each.

Artificial Intelligence
- Deep learning algorithm trained on audio recordings (training set), to obtain an automated prediction of asthma exacerbation (healthy vs pathological).

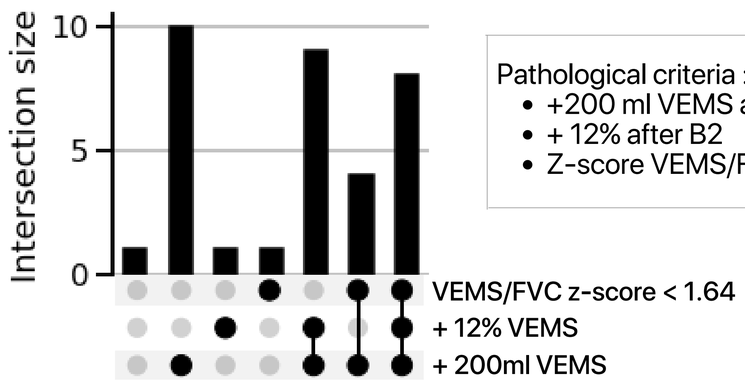
Performance evaluation
- AI model performance evaluated on an held-out validation set.
- Comparison between performance of recordings from each stethoscope.

Results

Dataset analysis



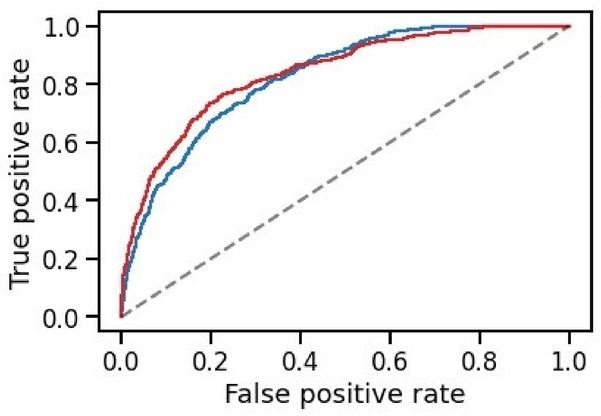
Number of patients by type



Pathological criteria :
- +200 ml VEMS after B2
- + 12% after B2
- Z-score VEMS/FVC < -1.64

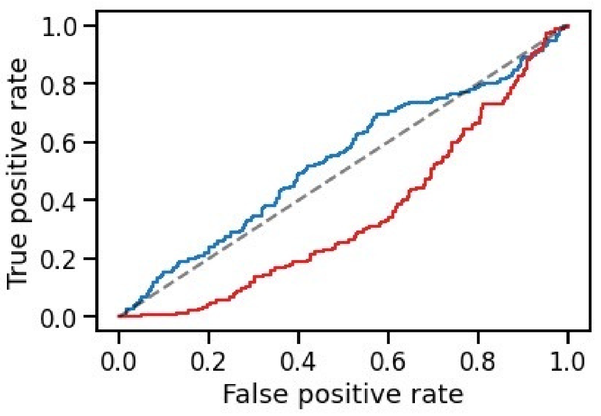
Upset plot showing the distribution of the criterias for pathological patients

Algorithm performance analysis



- Area under the ROC curve (AUC) significantly larger than 0.5 for both stethoscopes, in the training set.
- The model is able to distinguish an asthmatic record from a normal one, for both stethoscopes, when confronted with data it has been trained on.

ROC curve for each stethoscope, training set



- AUC close to 0.5 for both stethoscopes in the validation set.
- No discrimination capacity to distinguish an asthmatic record from a normal one, when confronted to new data it hasn't been trained on.

ROC curve for each stethoscope, validation set

Discussion

Strengths
-First study to compare AI to spirometry in lung souds analysis.
-Standardised lung sound dataset.
-Automatic interpretation of lungs sounds.
-Interpretation of large amounts of data.

Weaknesses
-Small dataset size.
-Model yet ineffective on validation set.
-Large volume of data needed to train the model.

S W O T

Opportunities
-Fill the lack of ressources for asthma diagnosis, in low and middle income countries.
-Home care and telemedecine possibilities.
-Empower caregivers.

Threats
-Data collection conditions difficult to repeat elswere (e.g. in homecare).
-May not perform well on populations not seen during training.
-Unequal access to AI.

SWOT analysis for our study (blue) and for AI (red)

Conclusion

01 Necessity of new asthma managment strategies/tools, including for diagnosis, in home care and where medical expertise is scarce.

02 The algorithm is performant on the training set, not yet on the validation set. It can recognise asthma on data it has been trained on.

03 A Larger sample size is needed.

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