

Using A Machine Learning Prediction Model And Structured Light Plethysmography To Predict Physician Diagnosed Lung Disease From Tidal Breathing.

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Abstract Body

Introduction:

Structured Light Plethysmography (SLP) is a non-invasive, non-contact method of assessing the movement of the rib cage and abdominal wall. SLP projects a grid of light onto the subject's chest and abdomen, the movement of the grid allows both the analysis of compartment volume change and assessment of the surface motion. We present a novel method of breaking down the surface motion of tidal breathing that we believe to be able to characterise a subject's healthy or diseased state.

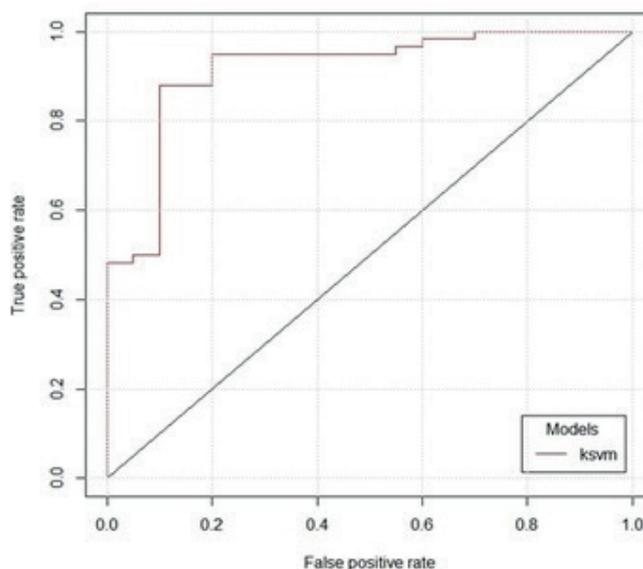
Methodology:

The study was conducted in the respiratory outpatients of a large teaching hospital. Tidal Breathing data was collected from 101 subjects (56 female, 45 male,) age range 16 – 80 years (mean age 55). Subjects were a mix of healthy (Normal) n=44, and patients with lung disease n= 57, (Asthma n= 28, COPD, n=14, Emphysema n= 4, Other n=11. Each was studied using Structured Light Plethysmography (SLP) (Thora3Di™ PneumaCare Ltd, UK). Each subject was asked to change into a close fitting white stretchy top and was asked to sit down on a chair with their neck in a neutral position and their back as straight as possible. The participant was asked to breathe “normally” for 5 minutes of tidal breathing. The movement of the projected grid of light is analysed to derive a Konno-Mead loop (KM) from which 20 novel outputs can be calculated including KM Principal Angle (Phi), KM Spread, Overall phase (OPhi), and the entropy (B phase Ent).

A 3 phase process was undertaken to correlate subject's breathing pattern to physician diagnosis: 1- Correlation Pattern from the Extracted Features including traditional PFT, 2 - Kruskal-Wallis (KW) Analysis against physician diagnosis, 3- Kernel-based support vector machine classification (KSVM)”.

Results:

The KW showed that Mean Phase, Entropy of Phase, Median Inspiratory time, Median Angle Change, and RCe, were significant when compared to physician diagnosis. The KSVM predicted Asthma in 22 of 36, COPD in 16 of 20, Emphysema in 3 of 4, “Other” in 10 of 14, and normal in 54 of 58 subjects.



Conclusion:

Non-invasive, non-contact interpretation of breathing pattern, in conjunction with a machine learning prediction model is able predict Physician diagnosis with a high degree of certainty for COPD, Emphysema and “Normal / Healthy” subjects. As many of the subjects with asthma had good disease control when they attended clinic and were indistinguishable from normal, they were less easy to classify using the model.