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BRIEF COMMUNICATION OPEN

Clinical assessment of speech correlates well with lung function during induced bronchoconstriction

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Clinical assessment of asthma often includes a crude assessment of speech, for example whether the patient can speak in full sentences. To date, this statement, despite appearing in national asthma guidelines, has not been related to lung function testing in asthma exacerbation. Seven asthmatics underwent a bronchial challenge and were then recorded reading a standardised text for 1 min. The recordings were played to 88 healthcare professionals who were asked to estimate FEV_1% predicted. Health care professionals' estimations showed moderate correlation to FEV_1% predicted (rho = 0.61 $P < 0.01$). There were no significant differences between professionals grouped by seniority or speciality. Speech can intuitively be estimated by health care professionals with moderate accuracy. This gives an evidence basis for the assessment in speech in acute asthma and may provide a new avenue for monitoring.

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INTRODUCTION

Asthma is a chronic inflammatory respiratory condition that is characterised by bronchoconstriction leading to a multitude of symptoms, including wheeze, cough and dyspnoea.[1]

Assessment and monitoring of asthma is multifaceted, including symptom-based diaries,[2] as well as objective measurements of lung function and airway inflammation. Clinicians may also evaluate the way the patient is speaking, either consciously or subconsciously, as part of an assessment of asthma severity.[3]

Speech assessment is not a formal technique; however, statements recorded in patient's notes such as 'inability to complete sentences in one breath' are used with other measures to triage patients into severity categories during acute asthma in adults and children in current published guidelines.[4,5] In addition, asthma limiting speech has been used as an indicator of severity in longitudinal questionnaire-based studies of asthma.[6] To our knowledge, it has not been determined whether subjective assessment of changes in the quality of speech in patients with asthma can be related to alterations in pulmonary function.

Hypothesis

Health care professionals are able to accurately estimate forced expiratory volume in 1 s (FEV_1) during experimentally induced bronchoconstriction from speech samples recorded at the time of bronchial challenge.

MATERIALS AND METHODS

Adult mild asthmatics atopic to house dust mite (*Dermatophagoides pteronyssinus*) taking short-acting β_2-agonists as required as their only asthma therapy (Global Initiative for Asthma step 1) were recruited. All the participants gave written informed consent, and the study was approved by the local research ethics committee. The participants were excluded if they had any past medical history of psychiatric issues such as anxiety or haematological anomalies such as anaemia, as these factors may have influenced baseline speech quality.

Seven volunteers were recruited and underwent either a methacholine or allergen (*D. pternyssinus*) challenge to a targeted fall in FEV_1 of 20% from baseline according to published protocols.[7,8] After each challenge dose, the participant read a standardised text for 30 s into a digital recorder fitted with an external microphone set at 10 cm from the mouth (Olympus DM450 Speech Recorder with Olympus ME34 Microphone, Tokyo, Japan).

The patients also evaluated their symptoms on a 200-mm horizontal visual analogue scale (VAS) from 'no asthma symptoms' to 'worst possible asthma symptoms' immediately after each episode of speech had been recorded. One speech track from each participant was then selected to display a range of lung functions from 100% FEV_1 predicted to 53% FEV_1 predicted; the quality of speech was not known before selection of the data files. Predicted lung function was calculated using the European Respiratory Society data.[9]

Recorded speech was played on standardised equipment to 88 individuals including laboratory scientists, clerical support staff, nurses and physicians from a range of specialities including respiratory medicine, family practice, allergy medicine and paediatrics.

Before hearing the speech recordings, assessors were read a standard introduction (see Supplementary Information S1) briefly explaining what FEV_1 means and how speech samples were collected. They then listened to the speech recordings and estimated FEV_1 on a 150-mm horizontal VAS-labelled 'FEV_1 100% predicted' to 'FEV_1 0% predicted'. The VAS used was a continuous line with no incremental markings.

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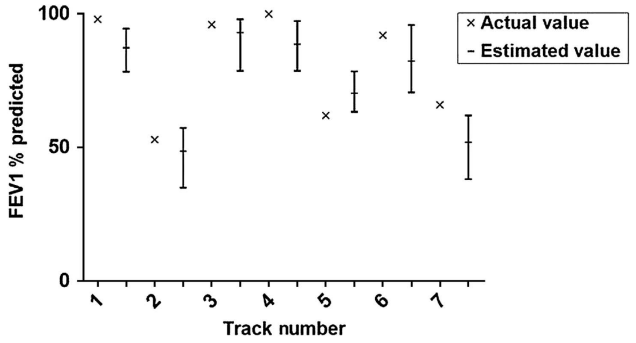

Figure 1. Actual and median estimated values of FEV_1% predicted. Figure shows the FEV_1% predicted of each recording, accompanied by the median estimated value and interquartile range for each track. FEV_1, forced expiratory volume in 1 s.

Table 1. Correlation of FEV_1 estimated from speech compared with actual FEV_1 by speciality or clinical experience of assessor

Speciality or experience	N	*Correlation (rho)*	P *value*	*Number of tracks*
Allergy and dermatology	6	0.58	< 0.01	42
General practice	15	0.62	< 0.01	105
Medical	5	0.64	< 0.01	35
Paediatrics	15	0.68	< 0.01	105
Respiratory	35	0.57	< 0.01	245
Surgical	7	0.64	< 0.01	49
Scientist	5	0.74	< 0.01	35
1 = Consultant, matron	27	0.61	< 0.01	189
2 = Registrar, advanced nurse	9	0.64	< 0.01	63
3 = SHO, CNS	16	0.55	< 0.01	112
4 = FY1, staff nurse	28	0.62	< 0.01	196
5 = Non-clinical	6	0.67	< 0.01	42

The correlation coefficients for each group of health care professionals in the top section, and for the same professionals grouped by experience category in the bottom section.
Abbreviations: CNS, clinical nurse specialist; FY1-, foundation year 1 doctor; SHO, senior house officer.
No significant difference in correlation was found between specialities ($P = 0.29$) or clinical experience groups ($P = 0.39$) when analysed with one-way analysis of variance.

RESULTS

Participants' symptoms measured by VAS strongly correlated with lung function (rho = 0.86 $P = 0.014$).

Estimated FEV_1 from listening to speech showed a moderate correlation with measured FEV_1 values (rho = 0.61, $P < 0.01$). The median absolute difference of assessor's estimation compared with measured FEV_1 was 10.6% (interquartile range 4–21.3%). This is shown in Figure 1.

There was no significant correlation between the patient's FEV_1% predicted and the median difference of FEV_1 estimation ($P = 0.43$).

No significant difference was found in the ability to estimate FEV_1 from speech between assessors when grouped either by clinical experience or specialisation ($P = 0.39$ and $P = 0.29$). This is summarised in Table 1.

DISCUSSION

Health care professionals, regardless of clinical experience or speciality, can estimate lung function with moderate accuracy on the basis of recorded speech alone with a median error of 10.6%. In addition, asking our volunteers to evaluate their symptoms using a VAS also provided a reasonably accurate assessment of FEV_1. Assessment of speech is a reasonable part of a comprehensive asthma evaluation, and it may be especially useful when lung function testing is not possible or available, although caution should be taken not to overestimate asthma severity, as seen in the majority of our results. This may be due to a confounding factor, as health care professionals were aware that the patients were asthmatic, and thus may have subconsciously adjusted their estimations towards worsening lung function.

There was no significant correlation between FEV_1 values and absolute difference of estimation, indicating that the accuracy of prediction is not affected by pulmonary function.

Although assessment of speech has been advocated in internationally approved asthma guidelines for many years[4,5] and has been used in long-term follow-up of asthma,[10] the ability of health care professionals to estimate lung function from quality of speech has not previously been assessed. We demonstrate that alterations in speech that occur with worsening asthma can be detected and apparently intuitively quantified, as type and length of training do not affect accuracy.

More precise determination of the changes being detected, for example, wheeze and duration or frequency of breath sounds, could open new avenues for non-invasive monitoring of asthma. In addition, further work could include determining whether categorised exacerbations of asthma (mild, moderate, severe, life threatening) can be detected with suitable accuracy by speech analysis. Repeating this study with a larger sample size of speech tracks from asthmatics could improve results.

In the meantime, traditional assessment of asthma severity by evaluation of speech has value and should continue to be recorded.

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CONTRIBUTIONS

All authors designed the study, collected and analysed the data and wrote the manuscript.

COMPETING INTERESTS

The authors declare no conflict of interest.

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Supplementary Information accompanies the paper on the *npj Primary Care Respiratory Medicine* website (http://www.nature.com/npjpcrm)