research network working for and with the GPIA membership. Formal research arrangements and co-tacts are emerging both within the UK and beyond.

Kevin Gruffydd-Jones, Hilary Pinnock and Vincen McGovern are assessing the needs of Primary Car clinicians who wish to develop their expertise in ma-aging respiratory illness. We then plan to addres these needs by supplying educational resources of th highest standard. The composition of this group i under development. We would like to invite any GP with an educational or academic interest who woul like to be involved, to please contact the GPIAG se-retariat.

We intend to join with the National Asthm Campaign, the British Thoracic Society and other t promote an effective, multi-agency external relation policy. The aim of this association is to lobby at go-ernment and senior NHS levels for adequate resource and a higher priority for strategies to deal with respir-tory diseases

At an international level, the inauguration of th International Primary Care Respiratory Group (*Prim Care Resp J 2000;9(2):*) has our full support, and i fact our Primary Care Respiratory Journal will be thei official journal. Increasingly, we can be involved i global activities paralleling our own in the UK

So what's not new at the GPIAG? Our core value remain "a commitment to improve patient care by pr-moting education, research and sharing of best pra-tice in UK primary care". And a restated desire t communicate better with members and to involv them actively in the Group's activities. More tha ever we need, and are grateful for, our members support. ■

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Feedback information from flow volume curves to the practic assistant improves spirometry test quality in general practic

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ABSTRAC
Objective To investigate whether the use of feedback information provided by viewing flo volume (F/V) curves during spirometry performe by practice assistants improves spirometry tes quality
Methods Randomised controlled single sessio crossover study. Eight practice assistants performe spirometry in healthy subjects (*n*=47). Two measurement conditions were applied, one allowin viewing of F/V curves during the tests ('unblinded') the other not ('blinded'). Outcome were differences in FE_1, VFVC, FE_1/FVC ratio PEF, FE_1 repeatability and number of manoeuvres per test. Two lung function technician indicated their preference for either the blinded o unblinded F/V curve
Results Higher PEF values were observed for th unblinded condition (0.43 L/s, 95% CI 0.08, 0.77) The other outcomes showed no differences. On lung function technician judged that in 62% (p=0.012) of the pairs the F/V curve from th unblinded condition was better, the other technicia judged so in 51% (p=0.349)
Conclusion: This study in healthy subjects showe that the use of information from F/V curves lead to a modest quality improvement of spirometri tests performed by practice assistants and can therefore be recommended for use in general practice

INTRODUCTIO

The use of spirometry is rapidly increasing within primary health care in many developed countries International practice guidelines on lung function measurement stress the importance of standardisatio of measurement conditions during spirometry [1,2] These guidelines underline the value flow volume (F/V curves may have in optimising spirometry test quality Most modern spirometers display real-time F/V or volume-time curves during forced breathing manoeuvres. However, apart from one single observational stud [3] we could find no evidence for th assumption that providing technicians with feedbac information from F/V curves contributes to the overal quality of forced breathing manoeuvres includin spirometry testing.

If information from the F/V curve does indeed optimise quality of spirometry, ample attention on ho to judge curves is appropriate for primary care professionals, since sufficient test quality is not alway guaranteed there [4]

The objective of the study reported in this paper wa to investigate the added value of information obtaine from viewing F/V curves on the quality of spirometri tests performed by sufficiently trained practice assistants. The study focused on the performance o the practice assistant. In Dutch general practice this i the paramedical discipline that has been trained fo administrative and patient care related activities

METHOD

Desig

The study was designed as a randomised controlle single session crossover study. In order to assess th feedback value of F/V curves during spirometry performance by practice assistants, two measuremen conditions were created, one with and one withou feedback information to the practice assistant. Of eac study subject a pair of F/V curves – consisting of th 'best' manoeuvre of both conditions - was judged b two experienced lung function technicians with specia

Table 1. Reminder for practice assistants on how to perform and judge single forced breathing manoeuvres and overall spirometry tes quality. (Items are derived from the recommendations of the European Respiratory Societ [1] and the American Thoracic Societ [2])

I **Initial Subject Instructio**
- 'Sit upright
- 'Breathe in as deep as you can
- 'Put your teeth on the mouthpiece and close your lips around it
- 'Breathe out forcefully
- 'Keep breathing out until you can not go on anymore
- 'Breathe in forcefully

II **General Points of Attentio**
- Observe the subject during the manoeuvre
- Encourage the subject during the manoeuvr
- Assess the flow volume curve after the whole manoeuvre has been complete #

III **Quality Criteria for Assessing Flow volume Curve** $
- Steep initial inclination of the expiratory curv #
- Sharp peak of the expiratory curve (PEF #
- Smooth continuation of the expiratory curve (e.g. no cough, abrupt termination #
- Total inhaled volume should equal the total exhaled volume (FVC #
- Three acceptable manoeuvres are necessary for a reproducible spirometry tes #

IV **FEV_1 repeatability between the two best manoeuvres ≤5% or ≤200 m**

$ since Spirar® does not display back extrapolated volume, FVC repeatability, time to PEF or rise time to PEF these indices could not be used by the practic assistants to eject manoeuvres, although international guideline [2] recommend their use

applicable for unblinded measurement condition onl

attention on quality criteria for F/V curves [1] The technicians indicated whether they preferred one curv over the other, or if both curves were of equal qualit being unaware of the condition in which each curv was obtained (blinded or unblinded)

Before they performed any spirometric tests in stud subjects, the practice assistants received a short, standardised oral reminder on how to perform spirometry and how to assess the 'quality' of force breathing manoeuvres by judging the F/V curv (table 1)

Measurement

All spirometric tests were performed using one singl turbine spirometer (Microloop I®, Micro Medical Ltd Rochester, UK) connected to a laptop computer o which Spirar® spirometry software (Version 2.11 Diagnostica, Oslo, Norway) was installed. readings of the spirometer were checked with a 3- calibration syringe after each subject had complete the measurements

A full spirometry test consisted of at least three force breathing manoeuvres. After completing a full test th practice assistant saved the F/V curve and matchin indices of the - in her opinion - 'best' manoeuvre Thus, a pair of single 'best' F/V curves was obtaine for each study subject, one from the blinded and on from the unblinded measurement condition.

The two measurement conditions were created as follows: *Blinded conditio*: The computer screen wa covered to hide the F/V curves. Only a table showin relevant spirometric indices (FEV_1, FVC, PEF) an the percentage FEV_1 repeatability between the variou performances in one full test was displayed on th screen. *Unblinded conditio*: spirometric indices a well as F/V curves were visible throughout measurements. The order in which blinded an unblinded measurement conditions were applied wa randomised for each subject. A time interval of at leas 5 minutes was kept between consecutive series o manoeuvres. In neither measurement condition the tes subjects could look on the computer screen

Prior to the measurements, the practice assistan instructed each test subject according to the standardised instructions (table 1). Each subject performed one single forced expiration and inspiratio to practice the manoeuvre

Practice assistants and test subject

Eight female practice assistants from 4 general pra - tices in the eastern part of The Netherlands participated. All assistants had attended a two-sessio spirometry training course 6 to 12 month earlier an all regularly performed spirometry within their practice setting

Test subjects were recruited from the general practitioners' waiting room. Eligible subjects had t meet the following criteria: age 25 – 80 years, n medical history of respiratory diseases, no use of airway medication and no previous spirometry tests

Outcome

Differences between blinded and unblinded condition in FEV_1 (Forced Expiratory Volume in One Second) FVC (Forced Vital Capacity), FEV_1/FVC ratio, PE (Peak Expiratory Flow), FEV_1 repeatability and th number of manoeuvres per full spirometry test serve

Table 2. Descriptive characteristics of the 47 test subjects. Figures are means (Sd) unless stated otherwise

Sex (M/F)	18/29
Smoking status (current/ex-/never smokers)	16/18/13
Age (years)	49 (13)
FEV$_1$ (L) #	3.14 (0.80)
as % predicted norma $	101.3 % (17.4%)
FVC (L) #	3.95 (0.90)
as % predicted norma $	107.0 % (15.4%)
FEV1/FVC (%) #	78.8 (7.3)

FEV$_1$ = forced expiratory volume in one second in litres; FVC = forced vital capacity in litres

Averaged value of blinded and unblinded measurement

$ Reference equations of the European Respiratory Society (ERS) were used [1]

Table 3. Comparison of outcomes (Mean (SD)) for unblinded (F/V curve visible) measurement condition *versus* blinded (F/V curve invisibled) measurement condition

	Unblinded condition	Blinded condition	Difference	95% CI*
PEF (L/s)	7.06 (2.17)	6.63 (2.12)	0.43 (1.18)	0.08, 0.7
FEV$_1$ (L)	3.15 (0.91)	3.12 (0.92)	0.03 (0.14)	-0.01, 0.0
FVC (L)	3.97 (1.08)	3.94 (1.07)	0.03 (0.18)	-0.03, 0.08
FEV$_1$/FVC%	78.90 (7.10)	78.70 (7.90)	0.29 (3.76)	-0.80, 1.4
Repeatability # (%)	1.76 (1.49) $	2.34 (3.05) &	-0.59 (2.87)	-1.43, 0.25

* 95% CI = 95% confidence interva

difference between the highest two FEV$_1$ values from three acceptable manoeuvre

$ including 1 measurement with FEV$_1$ repeatability >5% (5.2%)

& including 4 measurements with FEV$_1$ repeatability >5% (5.9, 6.1, 9.0 and 18.2%, respectively

as outcomes. FEV$_1$ repeatability is the relative difference between the two highest FEV$_1$ values from three manoeuvres [1]. A spirometry test was considered adequate when FEV$_1$ repeatability was less than 5% or 200 ml. The rating of the two lung function technicians regarding the quality of blinded and the unblinded measurements was also considered as an outcome

Statistics

A power calculation showed that 46 subjects were needed to detect a difference of 3% in FEV$_1$ repeatability. The intra-cluster correlation introduced by the fact that each practice assistant contributed measurements from several (5 to 7) subjects was accounted for in this calculation. Predicted FEV$_1$ and FVC values were calculated using ERS reference equation [1]. Student *t* and Wilcoxon tests for matched pairs were used to analyse differences between unblinded and blinded conditions, Student *t* test for independent samples to analyse carry-over and order-effects between consecutive test series. Bland-Altman plots [5] were generated to graphically express relative differences in outcomes between conditions

Distribution of the lung function technicians' judgements of the pairs of F/V curves was analysed for technician A and B separately by sign-test. Cohen's kappa was calculated to determine the degree of mutual agreement between the technicians. This statistic takes the difference between the proportion of cases agreed between two observers and the proportion expected by chance and standardises this by 1 minus the proportion expected by chance. In biological systems a value of 0.40 to 0.60 is generally considered as moderate agreement. Alpha was set on 0.05 and 95% Confidence Intervals (95% CI) were calculated if applicable. SPSS for Windows (Release 9.0.1, 24 February 1999) was used for data analysis

RESULTS

Test subjects and practice assistants:

Descriptive characteristics of the test subjects – all Caucasian - are shown in Table 2. Although we aimed to include equal numbers of males and females, this turned out to be difficult because more females than males visited their GP on the chosen study days. Mean age of the practice assistants was 34.7 (SD 8.0) years, mean experience with spirometry 4 years (range 0.5-8)

Differences between measurement conditions

Mean PEF was 0.43 L/s or 6.1% higher (95% CI 0.08, 0.77) when practice assistants used the F/V curves as visual feedback. No statistical significant differences were observed for the FVC, FEV$_1$, FEV$_1$/FVC or FEV$_1$ repeatability (Table 3). While blinded for the F/V curve, practice assistants used an average of 3.8 manoeuvres, 4.0 manoeuvres when unblinded (*p*=0.375)

The relationship between the average value of each subject and the difference between blinded and unblinded measurements is shown in Bland-Altman plots for the FVC and PEF (Figure 1a and 1b). Both plots show two outliers but no clear systematic deviations. Excluding the two outliers (*n*=45) resulted in a reduction of the mean PEF difference to 0.22 L/s (95% CI 0.02, 0.43). No carry-over effects in favour of the second measurement condition were observed

Judgement of lung function technicians

Lung function technician A judged F/V curves from unblinded conditions superior to blinded curves in 24 (51%) pairs and inferior in 17 (36%) pairs. Technician B judged 29 (62%) of the unblinded curves as superior, 12 (26%) as inferior compared to the blinded curves. For the remaining 6 pairs, the technician could not decide in favour of either curve. The distribution of the judgements ("unblinded measurement preferred above blinded" versus "blinded measurement preferred above unblinded") was statistically significant (p=0.013) for technician B, not for technician A. Agreement between lung function technicians was acceptable (Kappa=0.44)

Figure 1a. Bland-Altman[5] plot of differences in PEFR of 47 paired observations (unblinded minus blinded values)

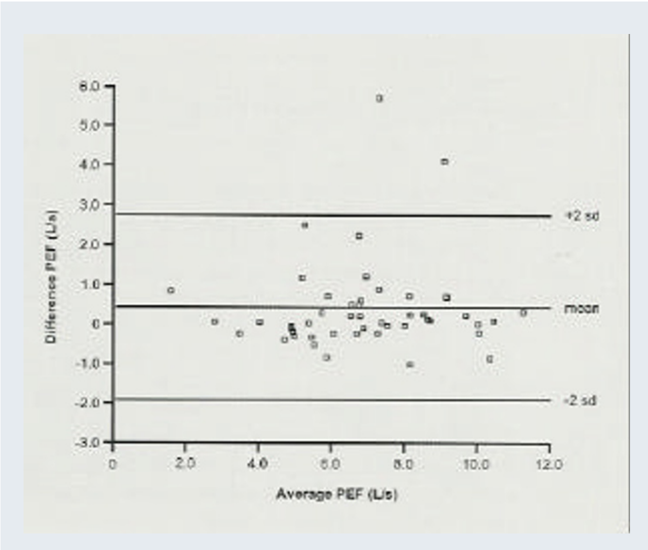
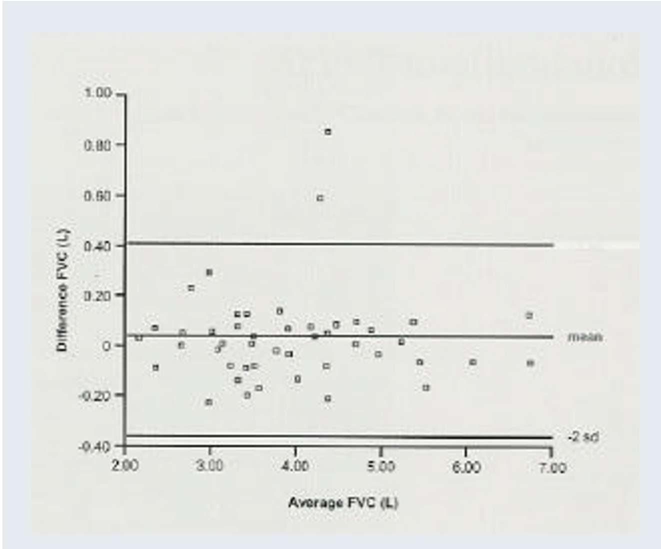


Figure 1b. Bland-Altman[5] plot of differences in FVC of 47 paired observations (unblinded minus blinded values)



DISCUSSION

The objective of this study was to investigate the value of feedback information obtained from F/V curves on the quality of spirometry performed by trained practice assistants. International guidelines recommend the use of F/V curves to improve test quality, but this is not firmly supported by empirical data. We only found one study addressing this issue: Banks *et al*[3] investigated changes in lung function indices after the spirometer of an occupational health service had been replaced by equipment that automatically gave feedback on test quality by assessing the F/V curve. The authors observed an increased number of tests fulfilling acceptability criteria as well as increased FVC and PEF values. FEV_1 values did not change after implementation of the advanced spirometry system. Our finding that PEF values increased and FEV_1 values remained unaltered when trained practice assistants used F/V curves is in line with these findings. Because we did not observe increased FVC values, the two studies are contradictory with regard to the effect of feedback on this outcome. One explanation for this inconsistency may be the fact that in Banks' study nurses with ample experience performed the spirometry tests, whereas in our study less seasoned practice assistants were engaged. Indeed, previous work from our department showed that practice assistants are particularly uncritical in stimulating subjects to exhale maximally,[6] which will inevitably result in lower FVCs. A recent study by Eaton *et al*.[4] confirms that most spirometry failures seen in general practice are end-of-test related. Although F/V curves typically provide information to critically assess FVC adequacy, our data suggest that practice assistants do not utilise this information optimally.

However, it is important to realise that we used healthy individuals (test subjects) as study subjects. Patients suffering from chronic airway disease (especially COPD) may need more time to reach their FVC plateau, enabling practice assistants to profit more from the information the F/V curve provides.

In conclusion, in this study among healthy subjects feedback information to the practice assistants from F/V curves led to a modest quality improvement of spirometric tests and can therefore be recommended for use in general practice. In spirometry training programs, special attention should be given on how to critically assess F/V curves. Finally, if a GP considers purchasing a spirometer, the device chosen should preferably display a real-time F/V curve. ■

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