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The value of spirometry for primary care: Asthma and COPD

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ABSTRACT

In this paper, the need for widespread use of spirometry in primary healthcare is appraised through a literature review. The added value of spirometry for and the quality of measurement made by general practitioners (GPs), and the economic consequences of greater use of spirometry in primary care are discussed

Appropriate application of spirometry in general practice may lead to improved health status of patients with chronic obstructive pulmonary disease (COPD) or asthma, but consistent attention to quality assurance measures is vital. If good quality cannot be guaranteed in the general practice setting the reliability and validity of the tests is uncertain. Pulmonary function laboratories, nurse-run asthma clinics, primary care group (PCG)-commissioned and mobile community-based spirometry service may be other choices, but it depends on local availability as to which choice is most suitable for organising primary care spirometry. It is concluded that spirometry is a potentially useful and feasible tool for GPs, provided that test results are easily integrated into the GP's usual management of patients with obstructive lung disease. At this time the health costs of widespread application of spirometry in primary care are unknown

INTRODUCTION

The use of spirometry is a topic of discussion among general practitioners (GPs). At least one third of general practices in the UK either own a spirometer or have easy access to external spirometry services [1] and in recent contributions to this journal have debated its value in primary care [2,3].

In the 1997 COPD guidelines of the British Thoracic Society (BTS), spirometry was assigned a central role in diagnosing and monitoring COPD [4]. Since management of patients with mild to moderate COPD usually takes place in primary care, these guidelines certainly apply to general practice

The aim of this paper is to review the added value of spirometry for GPs, the quality of spirometric tests performed in general practice, and the economic consequences of large-scale application of spirometry in primary care. The evidence from the literature (collected by Medline search), recent dissertations and the three latest annual conference proceedings of the European Respiratory Society (ERS) and American Thoracic Society (ATS) annual conferences is summarised

THE VALUE OF SPIROMETRY FOR GP

Spirometry can benefit primary care in several ways (Table 1). Recent studies indicate that the number of undetected cases with asthma or COPD may be reduced significantly by spirometry screening in general practice [5,6]. Based on FEV_1, FVC, FEV_1/FVC ratio and reversibility after bronchodilatation, asthma can be differentiated from COPD and severity of airway obstruction assessed. Choice of reference equations appropriate for the local population is important, since different reference values may lead to dissimilar conclusions in terms of normal and abnormal values and therefore diagnosis [9]

When spirometry was introduced in one general practice, Spann demonstrated a significant reduction of the underdiagnosis of COPD in high-risk populations, as well as improved differentiation between reversible and irreversible airway obstruction [10]. After bronchodilator treatment had been adjusted on the basis of spirometry results, 25% of patients reported a significant improvement in respiratory symptoms. More recently, Pinnock et al found 56% of the cases referred to a primary care asthma clinic had the diagnosis modified after spirometry [2]. However, GPs can be inconsistent in choosing to perform spirometry when chronic airway disease is suspected. Kesten *et al.* found that only 5% (4/75) of Canadian GPs requested a pulmonary function test when consulted by an individual with clear signs of COPD [11]. Access to spirometry facilities was not a limiting factor, since the majority (2/3) of the GPs involved had access to such services. Although he did not consider COPD, Jones demonstrated that availability of spirometry facilities in itself does not guarantee integration of spirometry in the GPs' management of asthma [12]. Moreover, the author concluded that further consideration and clarification on a wider scale is required before limited resources, whether in terms of time or money, are committed to spirometry testing in asthma in primary care

INTERPRETATION

Although the practice of expressing FEV_1 values as a percentage of the predicted value is widely used, there is evidence that using 80% of the predicted FEV_1 value as a consistent lower limit of normal is not the best method of assessment. This method could lead to more elderly and shorter individuals being classed as abnormal than the original regression equations would support. Although the use of standardised residual scores (SRS) would obviate this problem [13], this method is far more complicated and therefore impractical for use in general practice

Assessment of exacerbation severity and recovery is another useful application of spirometry, especially in patients with COPD [14]. Monitoring of annual FEV_1 decline – a typical feature of COPD – may be a less

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Table 1. Relevant indications for spirometry in general practice

Detectio
- Screening of subjects 'at risk' for developing chronic airway disease
  - *Smoker*
  - *Occupational exposition to dust and/or irritant*
  - *Subjects with recurring respiratory infectio*
  - *In routine physical examination*

Diagnosi
- Evaluation o
  - *Respiratory symptoms (cough, dyspnoea, dyspnoea during exercise, wheezing or non-specific chest pain*
  - *Physical signs (hyperinflation, cyanosis, chest deformation, crepitations during auscultation*
  - *Abnormal laboratory findings (e.g. chest X-ray*
- Nature and underlying mechanism of airway obstruction by reversibility testin
- Determination of the influence of (worsening of) diseases on the lung function
- Assessment of prognosi

Monitorin
- Determining the effect of therapeutic intervention
  - *Bronchodilatator*
  - *Inhaled and oral corticosteroid*
- Providing information on the course of lung function declin

*Adopted and modified from reference 8

useful indication for primary care spirometry. Although serial measurement of FEV_1 provide valuable information on disease progression, change over periods of less than a few years are difficult t detect because the annual rate of FEV_1 decline is smal relative to measurement variability. This problem cannot be overcome by increasing measurement frequency [5]. Moreover, recent work by den Otter *et a* suggests that annual FEV_1 decline rates measured i general practice are not interchangeable with rate based on pulmonary function laboratory measurements, the latter tending to be higher [6].

ACCURACY, LINEARITY AND REPRODUCIBILITY OF ELECTRONI SPIROMETER

In recent years, spirometers have become more an more manageable and affordable, and therefore attractive, for use in primary care. The first questio that emerges, however, is how these modern electroni spirometers perform compared to a 'gold standard' – a conventional spirometer or computer-driven calibration equipment. Linearity and reproducibilit are also essential characteristics [7]. Since the performance of different types of spirometers varie considerably, no general statements on these characteristics can be made [8], but they have have bee evaluated for several spirometers [19-21]. Correlation between parameters as measured by electronic spirometer and a gold-standard are generally high [19,20,2]. Nonetheless, it has been shown that FEV_1 and FV values measured with rotary vane spirometers or pneumotachographs may be systematically lower tha gold-standard values [19,20,22,2]. This deviation seems t increase with higher values of the respective parameters ('non-linearity') [19,20,2]. Short-term reproducibility of electronic spirometers appears t be quite acceptable for both FEV_1 and FVC [19,22,2] and there is some evidence that electronic spirometer keep producing valid measurements in the lon term [22,2].

Quality control of spirometry needs to be checked regularly. Although manufacturers test each new typ of spirometer to ATS-standards [7], individual spirometers of a particular brand may deviate substantially. As flow calibration or control require sophisticated test equipment, this is not feasible in primary care. Calibration with a syringe provide information on volume accuracy, and does not guarantee accurate volume or flow readings durin forced breathing manoeuvres [3]. Frequent 'biological calibration' by a healthy test subject may be a vali alternative for primary care [8], but more studies on thi matter are needed.

TRAINING AND QUALITY ASSURANC

A prerequisite for sufficient test quality in primar care is training of the professionals responsible for th execution of spirometry [7]. The consequences of inadequate expertise have recently been revealed in New Zealand study by Eaton *et a* [2]. In this study experienced lung function technicians scored severa quality aspects of spirometric tests performed b trained GPs. Sixty-seven percent (16/24) of the GP scored above standard, compared to 16% (4/25) in non-trained reference group. However, measuremen quality dropped considerably after a few months which stresses the importance of consistent attentio to test procedures. In the same study, the practice nurses of the same general practices were als trained [2]. Although the nurses' performance score were initially lower compared to the GPs, test performance became equal several months later. Wor by our own research group showed that instruction and coaching of patients before and during forced expiratory manoeuvres were generally insufficient i general practice [8].

VALIDITY AND

For valid spirometric test results, the measurement must be reliably performed. When measurement quality is insufficient, the error term and the 'true

lung function of the patient will each contribute to the test result, thus hindering good interpretation [29]. Criteria are available for judging the reliability of spirometric tests in two aspects:

- assessment of single breathing manoeuvre (judged by full inspiration, rapid onset of forced expiration, smooth course of the forced expiration and duration of expiration ≥6 s or to an adequate completion)
- reproducibility after repetition of the manoeuvre (i.e. FEV_1 of the two highest acceptable manoeuvres differing by <5% or 100 ml [BTS] or 200 ml [ATS])

In ideal circumstances, reliability of spirometry can be very high. Two large clinical trials performed in the USA showed that a high proportion of spirometry tests complying with ATS criteria can be achieved by pulmonary function laboratories (approximately 95%) [30,31], but it is unclear whether this can be achieved in day-to-day situations. Eaton *et al.* investigated the reliability of spirometric tests in 15 New Zealand general practices [32]. Four months after completion of a two-session training programme for GPs and practice nurses, one-third of the spirometric tests conducted were found to meet the ATS criteria. In the reference group of non-trained GPs and nurses, only 13% of all tests were reliable. So it may be difficult to guarantee sufficient reliability of spirometric tests when they are performed in general practices.

It is also important to know how spirometric tests in general practice compare to tests performed in pulmonary function laboratories. A group of 52 people with asthma, selected by 20 GPs who had previously attended a spirometry training session, were studied by van der Molen *et al.* [33]. FEV_1, as well as FVC, values measured by the GPs were on average 280 ml lower than laboratory values. In a similar study, den Otter *et al.* evaluated spirometric tests of 68 subjects with respiratory symptoms [34]. On average, FEV_1 was 110 ml lower, to the disadvantage of the measurements obtained in general practice. In both studies, however, GPs and lung function technicians used different types of spirometers, which may explain an unknown part of the observed differences.

Recently, Woolhouse *et al.* reported results of a study in which two patients with severe, but stable, COPD visited 14 general practices for spirometry [35]. Compared with measurements by a lung function technician, 86% of the GP-based FEV_1 values measured were judged acceptable (i.e. <160 ml difference from the technician's value). Of the FVC values, 54% were acceptable (FVC difference <330 ml). However, interpretation of these results is complicated by the fact that only two patients were involved, both with ample experience in undergoing spirometry.

INTERPRETATION OF SPIROMETRY TEST RESULT

Interpretation of spirometry requires specific expertise which can be expected from chest physicians, but not necessarily from GPs. Eaton *et al.* took a random sample from the spirometry records of the 15 trained New Zealand GPs to address this issue [32]. The GPs had to label spirometric tests of some of their own patients out of seven pre-defined diagnoses (such as 'normal', 'obstructive disorder', 'inadequate test performance'). Two chest physicians judged the interpretation of the GP as correct in 53% of the cases, an almost similar percentage to that in a reference group of non-trained GPs.

These results need to be put in perspective. For instance, Hnatiuk *et al.* showed that internists in the US interpreted one out of every four screening spirometric tests incorrectly as normal, and one out of every three cases incorrectly as abnormal [3]. Quadrelli *et al.* showed significant variation within a group of 15 Italian chest physicians in interpretation of spirometric tests [36]. There was a substantial inter observer variability between chest physicians (40% disagreement), particularly in the assessment of presence and severity of airway obstruction. However, it should be noted that Eaton's GPs were provided with clinical data and indications for spirometry of their own patients, while Quadrelli's chest physicians did not have such data, and were further required to agree on severity classifications as well as diagnosis.

HEALTH ECONOMIC CONSEQUENCES

Currently, little is known about the impact on healthcare cost of widespread application of spirometry in primary care. The only information available comes from Canada, where Chan *et al.* analysed trends in declared expenses for lung function testing by GPs [37]. (In the Ontario area from which the data were derived, GPs could declare C$31.90 for a flow–volume curve examination and C$16.20 for a spirogram.) In this cost evaluation study, the possible health benefits were not included. When the total cost for spirometry by GPs for the periods 1989–90 and 1994–95 were compared, costs had increased by 37% (from C$10.3 to 14.1 million). A quarter of this increase could be explained by a rise in the total number of tests, attributable to the fact that in the 1994–95 period, 47% more GPs declared spirometric tests than in the earlier period, while the average number of declared tests per GP remained unchanged. Undoubtedly, the concurrent introduction of affordable electronic spirometers will have contributed to the increased costs.

DISCUSSION

From the evidence discussed above it is concluded that spirometry can be a valuable additional instrument in care for patients with obstructive airway disease in general practice. However, although the use of spirometry is disseminating fast among GPs, several aspects of primary care spirometry (especially GP surgery-based spirometry) deserve critical consideration. An important finding is that the reliability of modern electronic spirometers does not limit their use in general practice. Although these spirometers may produce systematically lower values than the conventional equipment used in pulmonary function laboratories, this is only a problem in the higher range of FEV_1 and FVC values.

Table 2. Advantages and disadvantages of four different alternatives for organising spirometry in primary car

Spirometry performed at	Advantage	Disadvantage
General practice surger	• Little access limitation • No extra healthcare cost • Small travelling distance for patient • Enable GPs to acquire expertis	• Reliability of measurements not always guarantee • Extra workload for general practice • General practice has to build up expertis • (Often) changes in practice organisation necessar
Nurse-run asthma clini	• Good reliability of measurement • Little access limitation • No extra workload for general practic • No high demands on spirometry expertis in general practice	• Extra healthcare cost • (Considerable) travelling distance for patient
PCG-commissioned spirometr service	• Good reliability of measurement • Little access limitation • No extra workload for general practice • No high demands on spirometry expertis in general practic • Centralisation of judgement and interpretation of spirometric test	• Extra healthcare cost • (Considerable) travelling distance for patient • Clear communication lines are indispensabl
Hospital-based pulmonar function laborator	• Optimum reliability of measurement • No extra workload for general practice • No high demands on expertise in genera practic • Easy consultation of chest physician	• Possible access limitations • Limited capacity next to regular task • Extra healthcare cost • (Considerable) travelling distance for patient

* n Depending on local cooperation with secondary care chest physicia

As spirometry is only one of the many task demanding attention in the general practice setting, i is to be expected that practices will find it hard t fulfil the strict quality criteria that apply t laboratories. As a consequence, results of surgery based spirometry should be handled differently t values obtained in pulmonary function laboratories Spirometric indices obtained in a general practic generally turn out to be lower, but rarely higher The problem of false positive diagnoses that migh result from this is particularly relevant for genera screening of subjects, much less so in selectiv screening of high-risk populations (i.e. smokers) o subjects with airway symptoms. In the case of lo values or doubt about the reliability of a surgery-base spirometric test, GPs should seek confirmation b referring the patient to an experienced spirometr service

In the light of the available evidence one could argu whether surgery-based spirometry is the best solution There are several other good choices:
Pulmonary function laboratories may provide ope access spirometry service directly to GPs or loca nurse-run asthma clinics. Mobile community-base spirometry services or primary care group (PCG) commissioned spirometry services could be initiated [2] Possible advantages and disadvantages of these alternatives are listed in Table 2

It is obvious that GPs who consider implementin spirometry in their practice will have to invest sufficient time to develop expertise. A short trainin programme alone is not sufficient to acquire the specific knowledge, skills and insight necessary t judge quality and interpret results of spirometry adequately. This may result in false negative and positive diagnoses as well as misclassification of th severity of lung function impairment

The health-economic implications of widespread spirometry in primary care are not clear from the literature. The results of the Canadian study reviewed are difficult to extrapolate to other countries, since declaration of spirometric tests by GPs is not possibl in other countries

As a result of intensified use of spirometry as screening tool in primary care, more patients will b treated for respiratory diseases, which will generat additional expenses. An increase in the number o X-rays requested and referrals to secondary care i also conceivable [8] On the other hand, better focused care can save the costs of inappropriate treatment an is likely to improve health-status of patients wit obstructive lung disease. Studies evaluating both cost and benefits are needed to establish the effectivenes of widespread use of spirometry in primary care ■

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