Inability to draw intersecting pentagons as a predictor of unsatisfactory spirometry technique in elderly hospital inpatients

SIR—The measurement of lung volumes by spirometry is one of the cornerstones of the diagnosis, assessment and management of asthma, chronic obstructive pulmonary disease (COPD) and certain other respiratory diseases. Indeed, recent guidance to medical practitioners in the United Kingdom has encouraged the greater use of spirometry to detect COPD in the middle-aged and elderly population [1]. However, accurate spirometry requires a sufficient level of co-operation and co-ordination on the part of the patient even when attended by a skilled technician. The criteria for a good technique were laid down by the American Thoracic Society in 1994 and are generally known as the ATS94 criteria [2]. These define minimum standards for the reliability, reproducibility and completeness of the volume–time and flow–volume curves generated during spirometry that can be assessed by visual analysis of the curves and/or by computer using dedicated algorithms. Although age is not an independent predictor of a satisfactory spirometric technique, studies have shown that older patients are often unable to meet the ATS94 standard, particularly when they have some degree of dyspraxia or cognitive impairment [3]. Of course, such impairments increase in prevalence with age in the elderly population. One study showed that very few patients were unable to perform spirometry [4], although that study did not include people above the age of 73, whereas the real problem tends to be seen in patients above the age of 80 [3, 5]. As a consequence of this, spirometric measurements on older people are often performed badly. Perhaps, more seriously, they are not attempted because the attending physicians expect the clinical information generated by the tests to be inaccurate. Both these positions oversimplify the issue and are not in the clinical best interests of this group of patients. Previous work has shown that spirometry technique and other techniques requiring co-ordination, such as the use of inhalers, can be predicted with a high degree of accuracy by performing tests of cognitive function, praxis and executive function [6, 7]. Some of those tests are time consuming and are consequently too inconvenient to be used in routine clinical practice. There is, therefore, a need to identify a quick screening test to distinguish the patients who are likely to be able to perform accurate spirometry from those in whom the testing would be misleading or futile. A potential candidate is the intersecting pentagon (IP) drawing component of the Mini-Mental State Examination (MMSE) [8]. This part of the MMSE is a test of understanding, execution and co-ordination that might therefore be able to discriminate between the two groups of patients. The main purpose of this study was to explore the predictive power of IP in this context and to compare IP with the entire MMSE.

Methods

We studied 80 patients (42 women) with a mean age of 84 years (range 75–98). All were current or recent inpatients in rehabilitation wards. For the purpose of this study, the patients have been referred to as frail; this reflects their recent acute illness, need for specialised geriatric rehabilitation and mean Barthel ADL index score of 8 at the time of admission to the ward. Inclusion criteria for the study were age 70 years or more, requiring spirometry, willing to perform spirometry, willing to perform the MMSE, willing to give written consent for the data to be used for this research project and lack of exclusion criteria. The exclusion criteria were advanced dementia (MMSE <11), terminally ill, relapse of asthma or COPD not yet stable, acute confusional state, dyspraxia demonstrated on neurological examination, severe communication difficulties, vision or hearing too poor to perform the tests, contra-indications to spirometry such as recent eye surgery and lack of inclusion criteria. Patients with severe dementia were excluded, on ethical committee advice, because it would have been too difficult to confidently take consent from them.

Spirometry was performed by one of the authors, after appropriate training, using a Microlabs 3000 portable spirometer. All patients made at least three attempts, and up to eight attempts were encouraged, if necessary. The spirometry data were stored electronically and as paper printouts for visual analysis. The ATS94 criteria were applied [2]. A separate observer performed the MMSE, and a photocopy of the IP was made for analysis. The IP was scored using the guideline for the MMSE, that is, it was considered adequate (IP+) if it consisted of two shapes overlapping. Those who did not meet that definition were scored IP−.

Statistical testing of categorical data was with Yates’ chi-squared test.

Results

We compared the patients’ ability to meet the ATS94 standards with their MMSE score at the 23/24 threshold (an MMSE of <24 is usually considered to be indicative of cognitive impairment and has been found to be a predictive threshold for the ability to learn to use inhaler devices [7, 9]) and with ability to adequately copy the IP (IP+) or not (IP−). The results are summarised in Table 1. We also calculated the sensitivity, specificity and predictive values of the MMSE and IP as a predictor of inability to meet the criteria (Table 2). Only 22% met the full ATS94 spirometry criteria, although 67% were able to perform a reliable FEV1.
In properly selected individuals, the test should be these frail and elderly patients can perform full spirometry, this study. First, we have shown that about one in five of portion (67%) can reliably perform the measurement of interestingly, we also demonstrated that a larger proportion (68%) were also unable to reach the stringent requirements of the strict ATS94 criteria. This effectively limits the usefulness of MMSE and IP to the prediction of inability to perform spirometry.

A large overall proportion (78%) of the group of patients studied could not do full spirometry. This contrasts with the finding of 6% of subjects unable to provide reliable spirometry data in a study of younger adults randomly selected from the community [4]. Our patients were much frailer physically and mentally, having been recruited from rehabilitation wards, and were more likely to have difficulties with executive function and subtle abnormalities of praxis. Although we did not specifically measure those functions for this study, we have found widespread abnormalities of that type in previous studies of patients recruited from the same environment [6, 7, 9].

There are clear clinical applications for the findings of this study. First, we have shown that about one in five of these frail and elderly patients can perform full spirometry, so in properly selected individuals, the test should be attempted to provide diagnostic and monitoring information. Interestingly, we also demonstrated that a larger proportion (67%) can reliably perform the measurement of FEV1. Although this is obviously of little value diagnostically, it might be of some use in tracking the response to treatment. Second, we have shown that the MMSE is useful for detecting patients who will probably not be able to perform full spirometry and that the IP drawing test has a specificity and positive predictive value which is at least as good as the whole MMSE in that regard and could therefore be used as a quick screening test for that purpose. The relatively low sensitivity of both tests would result in some patients being unable to perform spirometry despite passing the screen, although that would not be detrimental to an individual patient. In conclusion, cognitive screening with the MMSE and/or IP is a practical way to screen out frail elderly people who are unlikely to be able to provide reliable data from spirometric tests.

**Discussion**

We have shown that almost all patients with an MMSE <24/30 and all who were unable to copy the IP diagram were unable to perform spirometry to the standard required by the ATS94 criteria. This finding is consistent with the observations on similar patients attempting to learn to use inhaler devices [7, 9] and with the observation that cognitive impairment is an independent predictor of an inadequate spirometry technique [3]. However, a large proportion of patients with an MMSE >23/30 (67%) or who were able to copy the pentagons (68%) were also unable to reach the stringent requirements of the strict ATS94 criteria. This effectively limits the usefulness of MMSE and IP to the prediction of inability to perform spirometry.

**Table 1. Comparison of Mini-Mental State Examination (MMSE) and intersecting pentagons (IP) scores in patients able and not able to meet the ATS94 criteria for spirometry**

<table>
<thead>
<tr>
<th>MMSE &lt;24</th>
<th>P</th>
<th>Did not meet criteria</th>
<th>Met criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE &gt;23</td>
<td>16</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>IP−</td>
<td>0</td>
<td>23</td>
<td>18</td>
</tr>
<tr>
<td>IP+</td>
<td>0</td>
<td>39</td>
<td>0</td>
</tr>
</tbody>
</table>

IP+, able to copy intersecting pentagons; IP−, unable to copy intersecting pentagons.

**Table 2. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of a Mini-Mental State Examination (MMSE) <24 or inability to copy intersecting pentagons (IP−) in predicting the inability of a patient to meet the ATS94 criteria for adequate spirometry**

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE &lt;24</td>
<td>48</td>
<td>88</td>
<td>94</td>
</tr>
<tr>
<td>IP−</td>
<td>39</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**Funding**

None.

**Key points**

- Patients who are unable to copy IPs are unlikely to be able to perform full spirometry.
- Patients who are unable to copy IPs are unlikely to be able to perform full spirometry correctly.
- Most patients who are able to copy IPs can have their FEV1 measured reliably.

**Conflicts of interest**

None declared.

**Ethical approval**

Dorset Research Ethics Committee.

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One-stop clinics are more effective than neurology clinics for TIA

SIR—Approximately 15% of ischaemic strokes are preceded by a transient ischaemic attack (TIA) [1]. Whilst population-based studies initially underestimated stroke risk after TIA, recent studies have found stroke risk to be highest early (approximately 8% at 7 days, 12% at 1 month, and 17% at 3 months) with a rapid decline in risk over the first year [2, 3]. This “warning” event provides an opportunity to prevent stroke, and guidelines highlight the need for rapid access clinics [4–6].

The North American Symptomatic Carotid Endarterectomy Trial Collaborators and European Carotid Surgery Trial established that carotid endarterectomy (CEA) reduces the risk of recurrent stroke in patients with 70–99% stenosis of their symptomatic internal carotid artery [7, 8] and a recent analysis of these trials revealed benefit from surgery to be greatest in those who had CEA early after their event, with benefit falling with increasing delay [9]. Several approaches are currently being used to expedite assessment and treatment of symptomatic carotid artery stenosis. These include fast track carotid duplex services where referrals are made directly to the scanning service and patients with significant carotid artery stenosis are referred to a vascular clinic [10–11], single consultation cerebrovascular disease clinics with investigations performed before clinic attendance [12] and those in which patients are reviewed and investigated at the same clinic. The last option was adopted when we set up a ‘Rapid Access TIA clinic’ at Northwick Park Hospital with a stroke physician, vascular surgeon and carotid duplex service all present. The management of TIAs, particularly the assessment and treatment of symptomatic carotid artery stenosis, was compared between this TIA clinic and pre-existing neurology clinics in the same hospital.

Methods

In one calendar year, patients with a suspected diagnosis of TIA referred to the weekly TIA clinic were compared with patients referred to twice weekly conventional neurology outpatient clinics. Patients were referred to both clinics from both primary and secondary care. Data were collected retrospectively on patient demography and on the overall vascular risk profile including hypertension, diabetes mellitus, ischaemic heart disease, hypercholesterolaemia and cigarette smoking. Data on the time intervals between the following events were calculated: TIA; referral date; outpatient clinic appointment, carotid artery Duplex ultrasound scan, CEA. Using SPSS (version 12) categorical data were compared using Chi-squared tests, and continuous parametric and non-parametric data were compared using two sample t-tests and Mann–Whitney tests respectively. The study was approved by the local research ethics committee.

Results

Over a period of 12 months, 251 patients were referred to the TIA Clinic and 45 patients were referred to conventional neurology clinics. The characteristics of the patient populations are shown in Table 1.

Referrals to the TIA clinic were older than to neurology clinics and had a greater proportion of cigarette smokers but the two clinic populations had similar proportions of hypertension, diabetes and ischaemic heart disease. More patients in the TIA clinic had anterior circulation TIAs whilst more in neurology clinics had a completed stroke or posterior circulation TIA, although the latter was not significant. A large proportion of patients referred to both clinics had diagnoses other than stroke or TIA, including arrhythmias, vasovagal syncope and benign positional vertigo.

Compared with patients seen in neurology clinics, those in the TIA clinic were assessed more rapidly and had less time between TIA and subsequent investigation and treatment of carotid artery disease. The time intervals between patients’ TIA and its assessment, investigation and management are shown in Table 2.

Discussion

This study showed that the one-stop TIA clinic provided faster assessment, investigation and treatment compared with neurology clinics. This is important for secondary prevention to be started early. The combined presence of a stroke physician, vascular surgeon and carotid duplex service in the clinic enabled rapid assessment and treatment for patients with symptomatic carotid artery disease.

It is also important to identify correctly patients with a TIA and it is therefore interesting that about half of patients referred to either clinic had another diagnosis. By providing clinical assessment before starting investigations rather than the other way round, unnecessary requests and anxiety provoking investigations are prevented [13]. In order to improve further the efficiency of a specialist TIA service, screening of inappropriate referrals has been advocated [11].

The study was designed to compare the two clinic populations over 1 year in a single district general hospital. However, in so doing, there was a significant difference in the number of patients in each group and whilst the two groups were well matched for hypertension, diabetes and ischaemic heart disease, patients seen the TIA clinic were older and more likely to be smokers. Both clinic services were available to both primary and secondary care physicians but