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Quality of spirometric performance in older people†

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Abstract

Objectives: chronic obstructive pulmonary disease and asthma are major causes of hospitalisation and mortality among older patients but respiratory diseases are often under- or misdiagnosed because spirometry is not extensively used at this age.
Design: we examined 715 elderly subjects with respiratory symptoms; all underwent a spirometric test and were administered the Mini Mental State Examination, Activities of Daily Living, Instrumental Activities of Daily Living and Geriatric Depression Scale questionnaires for cognitive, functional and effective evaluation. Their educational level and Body Mass Index were also taken into consideration.
Results: a total of 585 patients (81.8%) were able to perform spirometry according to ATS'94 criteria while 130 (18.2%) were unable to do it. As regards educational level, Mini Mental State Examination, Activities of Daily Living and Instrumental Activities of Daily Living scores showed a significant difference ($P < 0.001$) between the groups of patients with high-quality spirometries and those with inadequate ones. There was no difference between the two groups in terms of age, Body Mass Index or Geriatric Depression Scale score.
Conclusions: the majority of elderly subjects can perform spirometry according to international guidelines; age itself cannot be considered a risk factor for a bad spirometric performance, but it becomes influential if it is associated with cognitive and functional impairment.

Keywords: *spirometry, ageing, cognitive and functional impairment*

Introduction

A natural consequence of the progressive ageing of the population is that more attention is being given to the geriatric aspects of common health problems, especially chronic disorders.

Chronic obstructive pulmonary disease (COPD) and asthma are particularly important as they are major causes of hospitalisation and mortality among the elderly and have a high cost for society [1].

The prevalence of COPD in subjects aged over 65 years is 6–15% in women and 7–34% in men, and the prevalence of asthma is respectively 7% and 3% [2]. The variability in these figures, especially in relation to COPD, is probably due to the under- or misdiagnosis of respiratory diseases and one of the main causes is probably the limited use of spirometry in this category of patients. It is commonly believed, even amongst geriatricians, that elderly patients cannot perform spirometry properly. In addition, elderly patients often have concomitant diseases with similar clinical symptoms that may confuse the diagnosis [2, 3].

As a consequence the majority of studies with spirometry in the adult population have involved only a small number of elderly subjects [4], and the specific characteristics of the elderly that may influence functional measurements and their interpretation have not been established.

The aim of this study is to evaluate spirometric performances in a large sample of elderly outpatients and correlate the results with some social, clinical and functional variables.

Methods

Between February 1996 and May 1999, 715 elderly patients (427 females and 288 males) with a mean age of 75 years (range 65–94) were examined in the Geriatric

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Department of the Ospedale Maggiore IRCCS, Milan, complaining of respiratory symptoms. The most frequently reported symptoms were breathlessness, wheezing and cough with mucus hypersecretion; 66% of these patients had a previous diagnosis of respiratory disease.

All of the patients were clinically evaluated and underwent a spirometric test using a fully computerised water-sealed Stead-Wells spirometer (Baires System, Biomedin, Padova, Italy). Their spirometric performances were assessed by means of a Biomedin computerised quality control program according to ATS'94 criteria [5], which are international guidelines based on specific standards of accuracy and precision established by the leading scientific societies.

The approval for analysis was determined using the ATS'94 criteria; accuracy was achieved if, within the same evaluation, three curves are acceptable and the best two are reproducible, which means a difference $\leqslant 200$ ml for Forced Vital Capacity (FVC) and Forced Expiratory Volume at 1 second (FEV1). When a subject performs a spirometric curve in a reliable way we are quite sure that it is the expression of his/her real respiratory function. A curve is judged as acceptable if there are any artefacts, the start of the test is satisfactory (back-extrapolated volume $<5\%$), the minimum FVC exhalation time is 6 s [Forced Expiratory Time (FET^3 6 s)] and the end-of-test criteria are satisfactory (final $plateau^3$ 1 s). The acceptability criteria must be reached before the reproducibility criteria can be considered. All spirograms, supplied by Biomedin, were blindly evaluated by computer based on ATS'94 criteria.

Mini Mental State Examination (MMSE), Activities of Daily Living (ADL), Instrumental Activities of Daily Living (IADL) and Geriatric Depression Scale (GDS) questionnaires were administered by a separate team who were not aware of the spirometry results to obtain the cognitive, functional and effective evaluations.

The educational level and Body Mass Index (BMI) of the patients were also recorded. Approval for the study was given by the University of Milan research ethics committee.

Statistical analysis

Student's *t*-test was used to compare the means of variables for patients who could and could not perform the spirometric test correctly.

Results

A computerised quality control program was used to divide patients into two groups on the basis of whether they could (Group A) or could not (Group B) perform spirometry according to international guidelines.

Group A consisted of 585 patients (81.8%, 351 female, 234 male). There was a mean of 3.6 curves per subject with a mean reproducibility of 40 ml for FEV_1 and 57 ml for FVC. Only 118 subjects (16.5%) satisfied the end of test criteria (final $plateau^3$ 1 sec). Examples of acceptable and reproducible spirograms are shown in Figures 1 and 2.

Group B consisted of 130 patients (18.1%, 76 female, 54 male). Eleven failed to produce any acceptable curve. An example of an unacceptable, non-reproducible spirogram is given in Figure 3.

The most common causes of the inability to perform spirometry were early interruption of expiration (6%), physical impairment (2.8%) and misunderstanding of the instructions (5.6%).

The mean values of the variables in the two groups and the results of statistical analysis are shown in

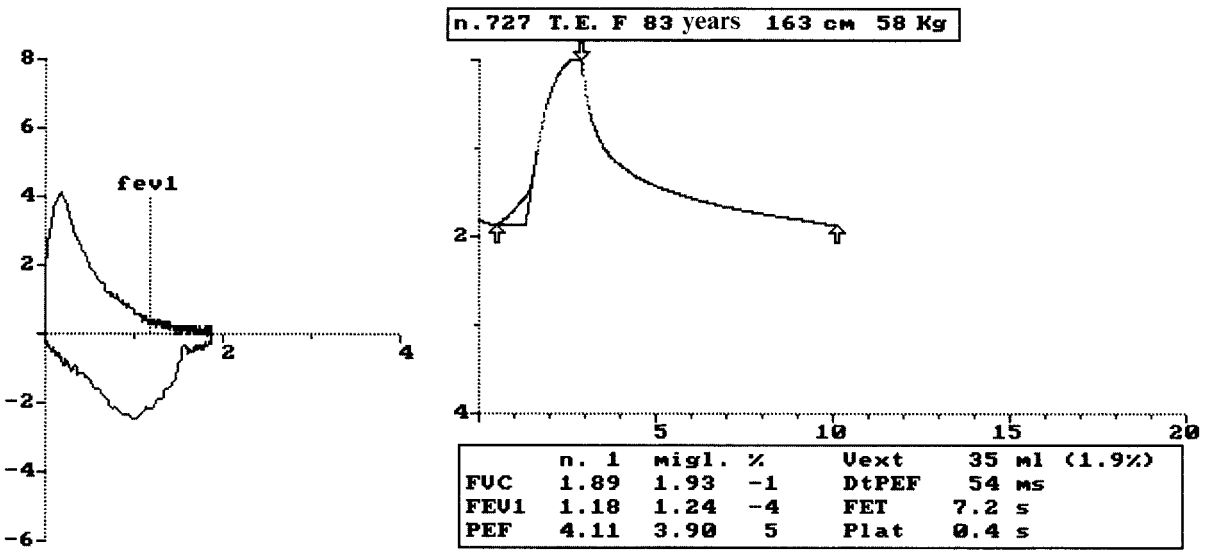
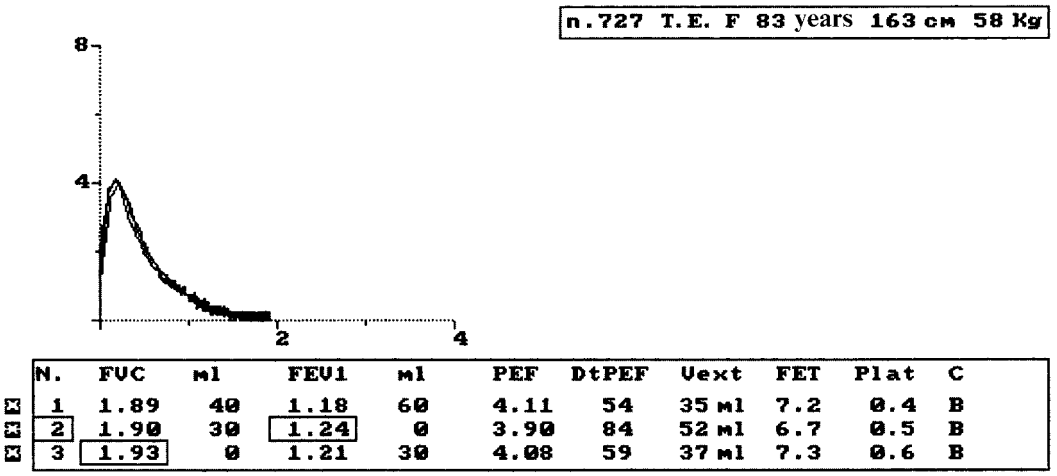
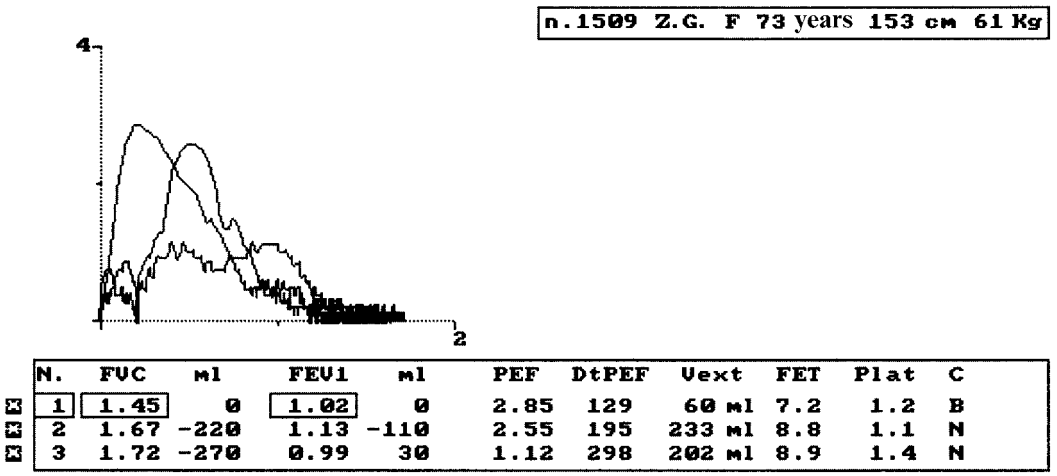


Figure 1. Example of an acceptable spirogram.



N.	FVC	ml	FEV1	ml	PEF	DtPEF	Vext	FET	Plat	C
1	1.89	40	1.18	60	4.11	54	35 ml	7.2	0.4	B
2	1.90	30	1.24	0	3.90	84	52 ml	6.7	0.5	B
3	1.93	0	1.21	30	4.08	59	37 ml	7.3	0.6	B

Figure 2. Example of a reproducible spirogram.



N.	FVC	ml	FEV1	ml	PEF	DtPEF	Vext	FET	Plat	C
1	1.45	0	1.02	0	2.85	129	60 ml	7.2	1.2	B
2	1.67	-220	1.13	-110	2.55	195	233 ml	8.8	1.1	N
3	1.72	-270	0.99	30	1.12	298	202 ml	8.9	1.4	N

Figure 3. Paradigmatic example of an unacceptable, not reproducible spirogram.

Table 1. Educational level and the MMSE, ADL and IADL scores were significantly different in the two groups. There were no differences in terms of age, BMI or GDS score.

Discussion

Spirometry is the most important test for respiratory function in chronic obstructive airway diseases [6], but it is not widely used in geriatric practice and experience in these subjects is limited [4, 7, 8]. In patients with and without airflow obstruction we found that spirometric performance was not affected by age because there was no age difference between the patients who could and could not perform spirometry according to the ATS'94 guidelines. The same was true with regards to BMI and GDS score. However, there were significant differences in relation to the functional and cognitive tests, and the educational level.

Sixty-six percent of our sample had respiratory disease (COPD or asthma) and only 9 suffered from cognitive decline (MMSE <21). None had real depression (GDS >20), and nor did any of them suffer from serious malnutrition (BMI <19).

The skill of the operator plays an important role in obtaining an acceptable spirometry, but this can be limited by applying international criteria such as ATS'94, by providing instructions that can be readily understood by patients with sensory and cognitive limitations, and by allowing the manoeuvres to be repeated after a suitable rest interval.

The time needed for complete spirometry in our population was about 20–30 min – at least double that of a younger population – in our experience.

Results can be compared with a limited number of other studies of spirometry in geriatric patients. Milne and Williamson observed that the percentage of elderly women who were unable to perform spirometry increased with age and correlated with a diagnosis of

Table 1. Results about variables considered

		Spirometry (ATS criteria)	Spirometry (not ATS criteria)	*P*
No. of patients		585	130	
Sex	Male	234	54	
	Female	351	76	
Age	Mean	72.46	78.31	NS
	2SD	26.13	6.58	
	Range	65–92	65–94	
BMI (kg/m^2)	Mean	25.50	25.46	NS
	2SD	4.82	4.96	
Education (years)	Mean	9.46	6.77	<0.001
	2SD	4.57	4.12	
ADL	Mean	5.79	5.52	<0.001
	2SD	0.42	0.72	
IADL	Mean	6.80	5.91	<0.001
	2SD	1.65	2.15	
MMSE	Mean	28.18	25.43	<0.001
	2SD	2.34	4.76	
GDS	Mean	10.67	12.71	NS
	2SD	6.44	6.00	

NS = not significant.

dementia [4]. This was later confirmed by Sherman *et al.* [7] who reported that the subjects unable to perform spirometry had the lowest psycho-motor test scores. The S.A.R.A. (Respiratory Health in the Elderly) study found that cognitive impairment, a shorter 6-min walking distance (used to assess functional status) and a lower educational level were independent risk factors for a poorer acceptability rate. The S.A.R.A. study also found that age and male gender were risk factors for a less reproducible FEV1 [6].

In conclusion, we found that the majority of elderly patients are able to perform spirometry according to ATS'94 guidelines; age *per se* did not influence spirometric performance but it had an effect if it was accompanied by cognitive and functional impairment. On the other hand, low educational level and cognitive and functional impairment seem to detract from the quality of spirometry.

Therefore spirometry can be used as a diagnostic test for respiratory disease in the elderly and should be encouraged in geriatric practice. Wider application among older people would probably contribute toward reducing the number of undiagnosed cases of COPD and asthma and allow appropriate therapy in order to improve the quality of life and reduce mortality.

Key points

- We recruited 715 consecutive elderly out-patients to perform spirometry according to the ATS'94 guidelines.
- The majority (81.8%) achieved a good performance.
- Age itself does not influence spirometric performance but it has an effect if it is accompanied by cognitive and functional impairment.
- The skill of the operator plays an important role and the ATS'94 criteria provide useful support.
- Spirometry should be used more widely in the elderly as a diagnostic test for respiratory disease.

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