Does spirometry training in general practice improve quality and outcomes of asthma care?

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Abstract

Objective. Clinical asthma guidelines recommend spirometry for asthma diagnosis, but there is inconsistent evidence about benefits to patients in using it for ongoing management. Our aim was to determine whether training in the use of spirometry for management of asthma provided better health outcomes and improved the quality of care in the primary care setting.

Design. Pragmatic, cluster randomized controlled trial.

Setting. General practices in two states of Australia.

Participants. Forty practices and 397 adults with asthma.

Intervention. The staff of 26 intervention practices received comprehensive spirometry training. Fourteen control practices provided usual care.

Main Outcome Measures. Primary outcome measures were quality of life, self-reported asthma symptoms and lung function. Secondary measures related to the process of care (e.g. performance of spirometry, preparation of a written asthma action plan) and patient and general practitioner rating of the acceptability and usefulness of spirometry.

Results. There were no statistically significant differences between the groups at 12 months for quality of life (mean difference = -0.23; 95% CI: -0.44, -0.01), days off work (rate ratio = 1.52; 95% CI: 0.91, 2.54), exacerbations (rate ratio = 1.09; 95% CI: 0.85, 1.41), asthma on waking (rate ratio = 1.21; 95% CI: 0.79, 1.85), nocturnal asthma (rate ratio = 0.98; 95% CI: 0.63, 1.51) and post-bronchodilator FEV1/FVC ratio (mean difference = -0.01, 95% CI: -0.03, 0.02). There was no improvement in the quality of care provided.

Conclusions. Training in spirometry did not result in any measurable improvement in the use of spirometry, quality of management of asthma or patient outcomes in primary care.

Keywords: asthma, spirometry, primary care, randomized controlled trial

Introduction

Internationally, clinical guidelines recommend the use of spirometry for both diagnosis and management of asthma [1–3]. In Australia, uptake of spirometry in general practice (GP) has been low; even though ownership of spirometers is high (estimated between 64 and 76% of practices) [4, 5]. Many barriers to performing spirometry in GP have been previously reported, including the cost of new equipment and the low level of reimbursement for tests, lack of time for adequate training and ongoing quality control, difficulty in fitting testing into the normal workflow of consultations and
GP practices performing spirometry have reported confusion and frustration by GPs and patients in the interpretation of results, leading to a lack of confidence in its use [6–9].

Studies in the primary care setting have shown that the quantity and quality of spirometry performance and the accuracy of interpretation are variable [10–21]. Spirometry testing requires maximal subject participation and an astute operator who can coach the patient to achieve the best result. If spirometry is not performed to a technically acceptable standard, then misinterpretation of the results will inevitably occur [4, 11, 21]. Conversely, if the test is correctly performed and properly interpreted, GPs should be in a position to use these objective data to make appropriate decisions about the diagnosis and treatment of asthma [14, 19, 22].

The importance of spirometry in providing an objective diagnosis of asthma, and as an aid to differentiation between asthma and chronic obstructive pulmonary disease (COPD), is not in question. However, there has been little consistent evidence about its ongoing use in management of asthma. The aim of our study was to examine the impact of training primary care health professionals in standardized spirometry measurement and interpretation, and encouraging its use in the management of asthma in adults.

Methods

Study design and practice recruitment

We conducted a pragmatic, cluster randomized controlled trial in two states of Australia [South Australia (SA) and Tasmania] during 2006–07. Incentives offered to participating practices were free training workshops about spirometry (with follow-up support available and credit for continuing medical education for GPs), compensation for administration time involved in identifying eligible patients and a nominal payment per patient recruited. If the practice did not have an appropriate spirometer, they were provided with an Easy One® instrument for the duration of the study.

Practices were randomized to one of three arms. The randomization, performed by an independent, blinded statistician, was stratified by state and urban/rural to provide a spread of intervention and control practices per strata.

Intervention

One intervention group received 6 h of spirometry training and the other 2 h, and the control group provided usual care without any training. Training was provided in small groups by either a respiratory scientist (A.C.) or a respiratory physician (R.X.B.). It incorporated the physiology of asthma, calibration of spirometers, correct procedures for coaching patients to provide optimal test results and interpretation of results. The training was a mix of theory and practice, with an emphasis on quality control including the American Thoracic Society and European Respiratory Society’s recommendations on the acceptability and repeatability of the test [23, 24]. Follow-up support was offered to participants through review of spirometry printouts and phone advice.

Patients

Practices searched their prescription databases for adult patients (aged 18 or over) currently prescribed asthma medications. GPs were asked to review the initial lists to ensure the patients did have asthma (as per the National Asthma Council guidelines) and not COPD. They were given the discretion to exclude anyone with life-threatening illnesses, pre-existing medical conditions for which spirometry was contra-indicated or the inability to read and understand the information sheet and consent form and complete the questionnaires without substantial assistance (either through lack of English or cognitive impairment).

Ethics approval for the study was gained from the Human Research Ethics Committee of The University of Adelaide (H-2005–131) and the Human Research Ethics Committee (Tasmanian) Network (H8708). Patients were invited to participate via a letter and information sheet sent by the practice. All participants gave written informed consent before taking part in the study.

Outcome measures and data collection

Primary hypothesis—health outcomes. The primary hypothesis was that asthma patients managed with spirometry would show better health outcomes compared with those managed with usual care in GP. All measurements were taken at baseline, 6 and 12 months.

- The primary measure was health-related quality of life as measured by Juniper’s Mini Asthma Quality of Life Questionnaire (MiniAQLQ) [25].
- Other primary endpoints, gathered by questionnaire, were number of days off work due to asthma and number of exacerbations in the previous 4 weeks. The numbers of emergency visits and hospital admissions in the previous 6 months were collected, but as their occurrence was rare, no analysis of these was performed.
- Secondary endpoints were self-reported patient symptoms such as asthma on waking (coughing or wheezing) and nocturnal asthma (night-time cough, shortness of breath or wheezing that woke them during the night) at least once in the previous 4 weeks.
- In addition, lung function measurements were taken on participants by research nurses who had been trained in the use of the EasyOne® spirometer. The key indicator was the post-bronchodilator ratio of Forced Expiratory Volume in 1 s (FEV1) to Forced Vital Capacity (FVC). Only valid, reproducible spirometry results were included in the analysis (i.e. those with a quality rating of A, B or C). It was stressed to GPs and patients that this spirometry was for data collection purposes only, that results would not be routinely made available to the GPs and that testing should still be undertaken by them as deemed clinically necessary.

Secondary hypotheses—process of care, and acceptability. A secondary hypothesis, that there would be an improvement in the process of asthma care provided to patients in the...
intervention groups, was assessed through a case note audit. The specific endpoints were the following:

- Performance of spirometry at least 6-monthly (either by the practice itself or by referring out);
- Number of planned and unplanned GP visits.
- Preparation or review of a written asthma action plan in the previous 6 months.

Another secondary hypothesis was that training in and use of spirometry would be acceptable to and valued by the patients, GPs and staff.

- Patients were asked to mark on a visual analogue scale how they felt about the acceptability of having spirometry done as part of their asthma care and how useful they thought it was to their management.
- GPs and practice nurses were surveyed at the end of the study about their opinions on the value of training and the use of spirometry in GP.

Sample size

A minimum sample size of 504 adult patients was the target for recruitment into the study. This sample size assumed a maximum intra-cluster correlation coefficient of 0.05, an average of 10 eligible adult patients per recruited practice and a maximum dropout rate of 10% over the course of the study. This minimum sample size would enable the study to detect:

- a 25% relative reduction (16% absolute) in the proportion of patients with some activity limitation from 0.67 in the control group to 0.508 in the intervention group, with 80% power at the 5% significance level and an increase of 0.5 in the quality of life score, with an average score of 5.07 in the control group and 5.57 in the intervention group, assuming a common standard deviation of 0.86, with at least 80% power at the 5% significance level.

Assuming an acceptance rate of 20% of patients, the target number of practices was 50, distributed as 20 urban and 10 rural practices in SA and 12 urban and 8 rural practices in Tasmania.

Statistical analyses

Prior to any analyses, differences between groups on potential confounders were examined and tested against mean quality of life scores. Means and proportions across groups were similar for all variables, except for the self-rated asthma severity which was included in subsequent analyses as a covariate.

Analysis was performed on an intention to treat basis. The results for patients in the intervention groups were combined for the primary analysis, with secondary analysis investigating any differences between the two intervention arms. Adjustments were made for multiple comparisons using Holm's method and statistical significance was set at the 5% level. Analysis was performed using SAS.

A linear mixed models approach was used to analyse change over time in continuous outcomes such as the quality of life and the FEV1/FVC ratio and also to account for the clustering of patients within practices. Change over the three study visits was modelled as a function of time, study arm and their interaction, and a compound symmetric covariance structure was assumed. A planned comparison of the estimated mean value for the intervention groups (together) against the mean value of the control group at 12 months was obtained.

For binary outcomes such as experiencing exacerbations and whether spirometry was performed, generalized estimating equations with log link and binomial distribution were used to account for clustering of patients within practices and to model the change over time in the outcomes. The relative risk of experiencing the outcome at 12 months for the intervention groups (together) versus the control group was obtained.

Results

The flow of participants through the study is reflected in Fig. 1.

Practice and GP recruitment

Forty practices were recruited from urban and rural areas of both states, with 13 practices allocated to the 6-h training intervention group, 13 to the 2-h training group and 14 to control. A summary of the characteristics of the practices and GPs is given in Table 1. The intervention group had a higher proportion of practices in the lower socio-economic areas. The intervention GPs tended to be younger (a higher proportion less than 40 years of age) and had worked in GP for less time than those in the control group practices.

Patient recruitment and baseline data

A total of 397 adult patients participated in the study—240 in the intervention practices and 157 in the control practices. Details of their baseline characteristics are shown in Table 2. The mean age was 56.7 years and the majority were born in Australia. The control patients were more likely to be in employment and to have a higher level of education. A lower proportion of intervention patients had never smoked, but they tended to rate their asthma control as worse than that of the control patients. The intervention patients had higher levels of co-morbidities.

We also gathered basic demographics for the pool of eligible patients ($n = 10 458$) who were either not selected to be invited to participate, or who declined to participate. The participant group was ~9 years older (mean age of non-participants 47.5 years) had a higher representation of females (67.5% compared with 62.7%), and were more likely to be from urban areas (56.4% compared with 53.0%) and from higher socio-economic areas (50.6% compared with 46.4%) compared with the non-participants.
The intervention

Only a few of the GPs (9%) and practice nurses (32%) in the trial reported having previously received spirometry training. Training for the purposes of this study was undertaken by 84 GPs and 33 practice nurses from 22 of the 26 intervention practices.

Feedback revealed that the majority found the training (whether 2 or 6 h) to be useful, comprehensive and long enough, with half of attendees feeling they had subsequently increased their use of spirometry. The quality of spirometry performed following training was assessed by grading a random sample of five printouts per practice. Nine of the 20 practices reviewed (printouts not available from six others) reached an acceptable grade of 12 or more out of 15. No evaluation of the accuracy of interpretation of the results by GPs was undertaken.

Outcome measures

Patient health outcomes. Tables 3 and 4 summarize the measures used to assess any change in patient outcomes.

- There was no statistically significant difference between the groups at 12 months in the total score achieved on the asthma-specific quality of life questionnaire, or the individual domains (see Table 3). In fact, control scores tended to be better than those for the intervention patients. The score for the domain of emotional functioning was statistically significant for the raw data, but not when adjusted for multiple comparisons. Both groups showed an improvement in total score between baseline and 6 months, but this trend was not sustained at 12 months.

- None of the indicators of asthma reported by patients revealed a statistically significant difference between groups at 12 months (see Table 4). The unadjusted data suggested that the control group had better asthma control in terms of days off work, asthma exacerbations and asthma symptoms on waking. There was little difference in the percentage of patients who had experienced nocturnal asthma.

- There was no statistically significant difference between the post-bronchodilator FEV1/FVC ratios for the intervention and control groups at any time point. Overall, the lung function results revealed considerable variation, and also raised questions about the accuracy of an asthma diagnosis in some participants. At baseline, 53% of the intervention patients and 51% of the controls had an FEV1/FVC <0.75, indicating a degree of obstruction (as defined by the National Asthma Council [3]). The prevalence of an abnormal ratio increased to 59 and 57%, respectively, at 12 months. The prevalence of reversibility ≥12%, which is a feature of asthma, was only 17% in the intervention group and 13% in the control group at baseline and 17 and 16%, respectively, at 12 months.

Process of care measures. Comparative results at 12 months for some key aspects of management of asthma are shown in Table 5.
Less than 10% of patients had received spirometry either in-house or by referral out to other services in the previous 6 months, with no significant differences between groups.

Of those GP visits deemed to be asthma related, only a very small percentage were planned reviews of the patient’s condition.

The numbers of patients who had written asthma action plans initiated or reviewed during the previous 6-month period were extremely small, and so no measure of statistical significance was able to be calculated.

Over 80% of patients felt it was acceptable and ∼75% felt it was useful to have spirometry performed, with no significant differences between intervention and control groups.

Table 1  Demographics of practices and GPs at baseline

<table>
<thead>
<tr>
<th>Practice characteristics</th>
<th>Intervention, n (%)</th>
<th>Control, n (%)</th>
<th>Total, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total, n = 26</td>
<td>Total, n = 14</td>
<td>Total, n = 40</td>
</tr>
<tr>
<td>Practice location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>15 (57.7)</td>
<td>8 (57.1)</td>
<td>23 (57.5)</td>
</tr>
<tr>
<td>Rural</td>
<td>11 (42.3)</td>
<td>6 (42.9)</td>
<td>17 (42.5)</td>
</tr>
<tr>
<td>Size of practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1–2 GPs</td>
<td>4 (15.4)</td>
<td>1 (7.1)</td>
<td>5 (12.5)</td>
</tr>
<tr>
<td>3–5 GPs</td>
<td>9 (34.6)</td>
<td>6 (42.9)</td>
<td>15 (37.5)</td>
</tr>
<tr>
<td>6+ GPs</td>
<td>13 (50.0)</td>
<td>7 (50.0)</td>
<td>20 (50.0)</td>
</tr>
<tr>
<td>Socio-economic index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low or low/medium</td>
<td>16 (61.5)</td>
<td>6 (42.9)</td>
<td>22 (55.0)</td>
</tr>
<tr>
<td>Medium/high or high</td>
<td>10 (38.5)</td>
<td>8 (57.1)</td>
<td>18 (45.0)</td>
</tr>
<tr>
<td>Number of nurses in practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1 (3.8)</td>
<td>0 (0.0)</td>
<td>1 (2.5)</td>
</tr>
<tr>
<td>1–2</td>
<td>12 (46.2)</td>
<td>9 (64.3)</td>
<td>21 (52.5)</td>
</tr>
<tr>
<td>3+</td>
<td>13 (50.0)</td>
<td>5 (35.7)</td>
<td>18 (45.0)</td>
</tr>
<tr>
<td>GP Characteristics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total, n = 127</td>
<td>Total, n = 45</td>
<td>Total, n = 172</td>
</tr>
<tr>
<td>Gender of GPs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>77 (60.6)</td>
<td>27 (60.0)</td>
<td>104 (60.5)</td>
</tr>
<tr>
<td>Female</td>
<td>48 (37.8)</td>
<td>16 (35.6)</td>
<td>64 (37.2)</td>
</tr>
<tr>
<td>Missing</td>
<td>2 (1.6)</td>
<td>2 (4.4)</td>
<td>4 (2.3)</td>
</tr>
<tr>
<td>Age of GPs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>45.2 years (9.0)</td>
<td>49.5 years (8.7)</td>
<td>46.3 years (9.1)</td>
</tr>
<tr>
<td>Years spent in general practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤10 years</td>
<td>50 (39.4)</td>
<td>10 (22.2)</td>
<td>60 (34.9)</td>
</tr>
<tr>
<td>11–20 years</td>
<td>47 (37.0)</td>
<td>16 (35.6)</td>
<td>63 (36.6)</td>
</tr>
<tr>
<td>≥21 years</td>
<td>30 (23.6)</td>
<td>19 (42.2)</td>
<td>49 (28.5)</td>
</tr>
<tr>
<td>Recent spirometry training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>13 (10.2)</td>
<td>3 (6.7)</td>
<td>16 (9.3)</td>
</tr>
<tr>
<td>No</td>
<td>112 (88.2)</td>
<td>40 (88.9)</td>
<td>152 (88.4)</td>
</tr>
<tr>
<td>Missing</td>
<td>2 (1.6)</td>
<td>2 (4.4)</td>
<td>4 (2.3)</td>
</tr>
</tbody>
</table>

- Less than 10% of patients had received spirometry either in-house or by referral out to other services in the previous 6 months, with no significant differences between groups.
- Of those GP visits deemed to be asthma related, only a very small percentage were planned reviews of the patient’s condition.
- The numbers of patients who had written asthma action plans initiated or reviewed during the previous 6-month period were extremely small, and so no measure of statistical significance was able to be calculated.
- Over 80% of patients felt it was acceptable and ∼75% felt it was useful to have spirometry performed, with no significant differences between intervention and control groups.

Discussion

Principal findings

This study was unable to provide evidence that training and support of GPs and practices nurses in the performance and interpretation of spirometry would lead to improvements in the management and health outcomes of adult patients with asthma. None of the primary outcome measures relating to quality of life, asthma symptoms, lung function and quality of care revealed any statistically significant differences between the intervention and control groups at 12 months. Overall, there was a very low level of performance of regular spirometry, and adherence to other management guidelines (e.g. written asthma action plans and proactive review) also was very poor.

Limitations of the study

As we did not achieve the desired sample size, our study was underpowered, which would have contributed to our inability to detect a result from the intervention. A second factor may have been that the majority of patients reported their asthma to be well controlled at baseline, thus leaving only small room for improvement. This is also supported by the baseline spirometry results with few patients demonstrating reversibility. Finally, although we explained that spirometry performed by
the research nurses was for research purposes only, this may have impacted on the GPs’ decisions to do their own spirometry. For ethical reasons, we felt obliged to notify GPs of any abnormal spirometry results obtained during our testing. This occurred for ≏13% of patients, being more common in the intervention groups (17%) than control (6%).

Comparison with other studies
The only other comparable published study which has assessed the impact of spirometry on ongoing management of asthma is another recent Australian study [26]. Although this incorporated a different model of providing and interpreting spirometry, the outcomes were very similar to ours,
with no improvement in the quality of life or other health outcomes. A study from the USA [14] reported an encouraging range of modifications in asthma care following spirometry, but this was only a small, quasi-experimental study. Most other papers relating to use of spirometry in primary care focus on the quality and accuracy of performance and interpretation, rather than on health outcomes.

Our study supports previous findings about the many barriers still remaining to successful implementation of the use of spirometry in GP. A recent Australian study found that lack of confidence by GPs in doing spirometry, in addition to time issues and patient compliance, was a major impediment [27]. Others have pointed out that GPs often do make the right decisions about spirometry and can interpret it

### Table 3: Patient asthma quality of life measures at 12 months

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Intervention</th>
<th>Control</th>
<th>Mean difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total, n</td>
<td>Mean score</td>
<td>Total, n</td>
</tr>
<tr>
<td>Symptoms</td>
<td>194</td>
<td>5.24</td>
<td>129</td>
</tr>
<tr>
<td>Activity limitation</td>
<td>194</td>
<td>5.77</td>
<td>129</td>
</tr>
<tr>
<td>Emotional functioning</td>
<td>194</td>
<td>5.62</td>
<td>129</td>
</tr>
<tr>
<td>Environmental stimuli</td>
<td>194</td>
<td>4.84</td>
<td>129</td>
</tr>
<tr>
<td>Asthma Quality of Life–TOTAL SCORE</td>
<td>194</td>
<td>5.38</td>
<td>129</td>
</tr>
</tbody>
</table>

*Mean scores on MiniAQLQ—max of 7 for each domain and for the total. All analyses for significance adjusted for clustering, covariates (asthma severity) and multiple comparisons.

### Table 4: Patient clinical health outcome measures at 12 months

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Intervention</th>
<th>Control</th>
<th>Rate ratios OR mean difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total, n</td>
<td>n (%)</td>
<td>Total, n</td>
</tr>
<tr>
<td>Days off work due to asthma (at least 1 day in the last 4 weeks)</td>
<td>194</td>
<td>38 (19.6)</td>
<td>129</td>
</tr>
<tr>
<td>Exacerbations (at least 1 in the last 4 weeks)</td>
<td>194</td>
<td>84 (43.3)</td>
<td>129</td>
</tr>
<tr>
<td>Asthma on waking (at least 1 night in the last 4 weeks)</td>
<td>194</td>
<td>49 (25.3)</td>
<td>129</td>
</tr>
<tr>
<td>Nocturnal asthma (at least 1 night in the last 4 weeks)</td>
<td>194</td>
<td>39 (20.1)</td>
<td>129</td>
</tr>
<tr>
<td>Post-bronchodilator FEV1/FVC ratio (mean)</td>
<td>171</td>
<td>0.71</td>
<td>119</td>
</tr>
</tbody>
</table>

*aForced expiratory volume in 1 s/forced vital capacity.*

All analyses for significance adjusted for clustering, covariates (asthma severity) and multiple comparisons

### Table 5: Process of care measures at 12 months

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Intervention</th>
<th>Control</th>
<th>Rate ratios OR mean difference (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total, n</td>
<td>n (%)</td>
<td>Total, n</td>
</tr>
<tr>
<td>Patients who had spirometry performed in the previous 6 months</td>
<td>225</td>
<td>15 (6.7)</td>
<td>153</td>
</tr>
<tr>
<td>Planned asthma GP visits as % of total asthma visits</td>
<td>225</td>
<td>9.3</td>
<td>153</td>
</tr>
<tr>
<td>Written asthma action plan prepared or revised in the previous 6 months</td>
<td>225</td>
<td>4 (1.8)</td>
<td>153</td>
</tr>
<tr>
<td>Patient rating of acceptability of spirometry (mean; max 10)</td>
<td>194</td>
<td>8.11</td>
<td>129</td>
</tr>
<tr>
<td>Patient rating of usefulness of spirometry (mean; max 10)</td>
<td>194</td>
<td>7.64</td>
<td>129</td>
</tr>
</tbody>
</table>

*aRR not able to be calculated due to small numbers.*

*bPatient rating on a visual analogue scale marked from 0 to 10.*

All analyses for significance adjusted for clustering, covariates (asthma severity) and multiple comparisons.
satisfactorily, and so it is unclear why there is such a lack of confidence [22]. It would seem from our study that provision of training aimed at improving confidence, is not sufficient to compensate for other barriers.

Conclusions and future research

Our findings do not refute the advice to use spirometry for accurate and objective diagnosis of asthma, and differentiation of it from COPD. However, given the common assumption that doing spirometry is important for management and monitoring of asthma treatment, it is important to reflect on the negative outcome from this study. It appears that training was valued, but made no difference to the rate of usage of spirometry, and hence was incapable of producing a favourable effect on the quality of care or health outcomes. Further analysis, not reported here, revealed that the GPs often made changes to their patient management after spirometry, but these actions were insufficient to improve health outcomes.

Recently, some discussion has focussed on ways of incorporating spirometry into a complete package of respiratory care, looking at either alternative methods of providing a spirometry service [17, 28, 29] or more viable systems (both practically and financially) for incorporating its use in the normal functioning of a busy GP [20, 29]. One area that may be critical is that of quality assurance and maintenance of competency in performing spirometry. In support of these moves, proposed standards for primary care have been promulgated [30], but it would seem that further research is required in all of these areas.

Should other barriers to performing quality spirometry be overcome, but it is still found that there is no evidence that doing spirometry is beneficial for the majority of patients, then further questions need to be asked about the usefulness of existing guidelines for management of asthma.

Trial registration

Australian Clinical Trials Registry No 1260600093583.

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References


