SHORT REPORT

Impact of an educational intervention on the quality of spirometry performance in a general practice: an audit

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Abstract

Aims: To assess the technical performance of spirometry in one general practice, and then to deliver in-house education to effect change.

Methods: Retrospective audit of 45 spirometry reports assessed against possible alternative quality criteria. Three subsequent educational interventions for those clinicians performing and interpreting spirometry. Re-audit of 45 spirometry report sheets four months later against the same criteria.

Results: 38% of the initial post-bronchodilator spirometries were technically flawed. Post-education, 2% of spirometries were technically flawed and respiratory referrals fell by 50%.

Conclusion: The technical quality of practice spirometry can be audited. In-house education significantly reduced spirometry errors and was associated with a 50% reduction in respiratory referrals.

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Introduction

Spirometry is an established primary care investigation for patients with respiratory illness which can influence significantly GPs' diagnostic and referral patterns.[1] Its role in the diagnostic process has been established for many years, but in UK primary care this role has been highlighted recently by the introduction of the Quality and Outcomes Framework (QOF) which made spirometry an outcome target. The publication of chronic obstructive pulmonary disease (COPD) guidelines by the UK National Institute for Health and Clinical Excellence (NICE) confirmed that spirometry was mandatory in order to confirm the diagnosis of COPD.[2]

However, poor quality primary care spirometry, leading to increased numbers of secondary care referrals, is a concern both nationally[3] and internationally.[4] Part of the reason for poor quality primary care spirometry is that it is seen as a simple test which can be delegated to less qualified staff – yet spirometry performance is prone to possible errors on a

number of levels, particularly when repeated measurements are made over long periods of time.[5]

Standards for performing spirometry in primary care were published in this journal in 2009 in order to improve the quality and reproducibility of primary care-based spirometry.[6] The Standards document clearly states that referral for further investigation, principally Total Lung Capacity, should be made if a restrictive spirometry pattern is identified.[6]

Following a series of spirometry reports identified as being restrictive by the spirometry evaluative software in our practice – which had led the clinicians to refer patients because of presumed restrictive lung disease – we carried out an audit of recent spirometries to see if spirometry performance and technique was the source of the problem. In assessing the quality of spirometry performance, the aim was to minimise the risk of spirometries being influenced by poor technique (particularly a poor inspiratory or expiratory effort) which might then lead to unnecessary secondary care referrals.

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Methods

Practice

The practice is based in a UK rural market town and has 12,000 registered patients. There are seven general practitioner (GP) principals, one salaried GP, and three practice nurses involved with respiratory chronic disease management. The practice's clinical computer system is EMIS PCS. The age-sex distribution of the practice population is slightly skewed to the elderly. The practice has two spirometers: a Spirolab II, and a Koko Legend (portable).

Timelines

The initial audit was performed in March 2009, the educational interventions took place in June 2009, and the follow-up audit took place in September 2009.

Spirometry criteria

The European Respiratory Society/American Thoracic Society spirometry guidelines,[7] and the more recent Primary Care Respiratory Society UK (PCRS-UK) Spirometry Standards document,[6] have set wide-ranging and comprehensive benchmarks for excellence in spirometry. However, there are many potential common errors when performing spirometry, and some simple precautions include:

- Looking at the start for a slow take-off
- Observing carefully the shape of the curve to identify maximal exertion or a cough.
- Watching the patient to confirm maximal effort for at least six seconds or until a plateau is reached for the vital capacity (VC).
- Checking for a poor seal around the mouth piece
- Checking for any leaks in the tubing
- Taking two measurements with less than or equal to 5% difference.
- Ensuring that the spirometer is regularly calibrated
- Careful measurement of height and weight to avoid erroneous calculation of %predicted values.

In the initial audit, spirometry reports were assessed retrospectively and a novel, numerical value was used as a proxy measure for an incomplete or poor exhalation. The recognised gold standard would have been to present pre- and post-intervention spirometry results to a panel of experts for assessment against current benchmarks. However, this option was not available. Instead, a forced expiratory volume in one second (FEV_1)/forced vital capacity (FVC) ratio of 1.0 (100%) was used as a marker for a possible incomplete expiratory manoeuvre. The rationale is as follows. In healthy adults the upper limit of normal (ULN) for FEV_1/FVC should be approximately 0.75-0.8. In obstructive lung diseases the FEV_1 will be diminished due to increased airway resistance, and the FVC may be normal or reduced due to gas trapping; hence, the FEV_1/FVC ratio will be < 0.7. In restrictive lung diseases the FEV_1 and FVC are both reduced proportionally – the prevalence of restrictive lung disease is about 2.5% and is therefore much less common than obstructive lung disease – and the FEV_1/FVC ratio may be normal or increased

as a result of reduced lung compliance. With decreasing lung compliance the FEV_1/FVC ratio will tend towards 1.0, but this would never normally be reached in life. Therefore, we took an FEV_1/FVC ratio of 1.0 as a marker for a technically incomplete short exhalation more akin to a peak flow manoeuvre than a prolonged forced expiratory spirometry manoeuvre. An FEV_1/FVC ratio greater than the ULN of 0.75-0.80 but less than 1.0 may indicate a restrictive pattern, but if the patient has an FEV_1 approaching 100% predicted it is more likely that the abnormally high ratio is as a result of poor spirometry technique rather than an underlying restrictive defect.

Therefore, for the purposes of this audit, we determined that poor spirometry technique was to be judged by the following:

- FEV_1/FVC ratio = 1.0 (100%); or
- FEV_1/FVC ratio $\geq$ 0.9 (90%) when FEV_1 % predicted is $\geq$ 75%.

Standards

The purpose of the initial audit was to see if current spirometry undertaken in the practice met the minimum standards, particularly in terms of exhalation technique. The aim was that less than 5% of spirometry performed would exhibit the proxy markers for poor technique (FEV_1/FVC = 1.0; or FEV_1/FVC $\geq$ 0.9 when FEV_1 %predicted $\geq$ 75%).

Educational intervention

The results of the initial audit were presented to the practice at a multidisciplinary clinical team meeting. The spirometry measurements which were considered to be technically flawed were discussed. The doctors were unaware that their diagnoses and referral patterns were based on investigations which potentially were technically flawed. As a consequence,[8] the doctors and nurses agreed that this was an urgent Doctors' Educational Need (DEN).[9] The following educational interventions took place:

1. Presentation by a General Practitioner with a Special Interest (GPwSI) in respiratory medicine who explained the initial findings and discussed possible improvements to spirometry performance.
2. A visit from a local secondary care specialist consultant to talk to all clinical staff about respiratory physiology and spirometry technique.
3. A visit from a local secondary care respiratory specialist nurse to talk to the nursing staff who performed spirometry, dealing with any specific issues that had come up following the earlier educational events.

Data collection

The EMIS computer records were searched using the search tool "Population Manager". Patients who had the Read code "Spirometry" and/or "Spirometry Screening" entered in the clinical record were identified from the population of current patients according to their practice registration number. Patients who had left the practice or had died were excluded. No age range was applied. The initial audit was performed in March 2009 with data collected from the preceding five

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months. The re-audit data were collected prospectively from June until November 2009. Following each spirometry procedure, a report sheet is scanned into the patient's electronic record and the numerical values entered into a COPD template. For each audit, the first 45 spirometry reports were chosen. Each patient's spirometry report sheet was assessed for the quality markers described above.

Secondary care referrals

The computer record was searched to identify patients who had the Read code "referred to chest physician" during both audit periods – i.e., from 1st January 2009 to 31st May 2009 (the initial audit period, the five months preceding the educational intervention) and from 1st June 2009 to 13th November 2009 (the re-audit period).

Results

Initial audit

12 out of the 45 spirometry reports were judged technically poor according to the first criterion – i.e., an FEV_1/FVC ratio of 1.0 (see Table 1).

A further seven spirometry reports showed an FEV_1/FVC ratio > 0.9; of these, five patients had an FEV_1 % predicted $\geq$ 75%, and thus the spirometries were judged technically poor according to the second criterion.

Therefore, 17 out of 45 (38%) first audit spirometry reports were judged to be technically flawed. This result fell well short of the ideal practice target of 5%.

Re-audit

Four months following the educational interventions, the quality of spirometry performance was re-audited. Again, the computer records were searched to identify patients who had the Read code "Spirometry" and/or "Spirometry Screening" entered after 1 July 2009. This search generated a list of 49 patients. The individual medical record for each patient was

Table 1. Spirometry results.

Pre-Intervention (n=45)			
	%pred FEV_1 > 75%	%pred FEV_1 < 75%	Total
FEV_1/FVC = 100%	6	6	12
FEV_1/FVC = 95-99.9%	4	1	5
FEV_1/FVC = 90-94.9%	1	1	2
		Total	19
		Potentially Flawed	17
Post-Intervention (n=44)			
	%pred FEV_1 > 75%	%pred FEV_1 < 75%	Total
FEV_1/FVC = 100%	0	0	0
FEV_1/FVC = 95-99.9%	1	0	1
FEV_1/FVC = 90-94.9%	0	0	0
		Total	1
		Potentially Flawed	1

Table 2. Chest Clinic Referrals.

Pre-Intervention (n=45)	1-Jan-09 to 31-May-09	28
Post-Intervention (n=44)	1-Jun-09 to 13-Nov-09	14

examined and 44 recent spirometry reports were identified.

None of the re-audit spirometries were found to be technically poor based on the first criterion (FEV_1/FVC = 1.0). A single patient had an FEV_1/FVC ratio of 0.99 with an FEV_1 % predicted value of 122%. No other spirometry sheets were identified with an FEV_1 % predicted > 90% (see Table 1).

Therefore, only one out of 44 (2%) spirometry reports in the re-audit could be judged to be technically flawed, a significant improvement from the initial audit result of 38%.

Secondary care referrals

Twenty-eight referrals had been made to the hospital chest clinic during the first audit period, compared to only 14 referrals during the re-audit period – a 50% reduction in chest clinic referrals (see Table 2).

Discussion

Spirometry is a valuable tool for the primary care clinician when making respiratory diagnoses, assessing progress and predicting prognosis. However, it needs to be part of the clinical assessment, and interpretation needs to be made at the time of the test in order to avoid unnecessary inconvenience to the patient if the spirometry tracing is found to be technically poor.[6]

We have shown that it is possible to identify technically poor spirometry measurements due to poor expiratory effort, by using a (currently) non-validated proxy marker. A subsequent simple educational intervention influenced the technical measuring process, improved the validity of the spirometry, and was associated with a 50% reduction in referrals to the local chest department.

Our use of the FEV_1/FVC ratio = 1.0 as a screening tool for identifying technically poor spirometry measurements might deserve further validation and correlation with a gold standard such as a panel of experts examining the spirometry report against currently agreed benchmarks.[10] In this audit there seemed to be an association with a sub-maximal expiratory effort which was causing the flawed test. The FEV_1/FVC = 1.0 criterion is simple and would be useful as a quality marker in primary care, particularly given the mass spirometry that is proposed in attempts to identify asymptomatic COPD.[11] However, the use of such a tool would require testing in different general practices; it may be that this marker highlighted a particular technical anomaly that was prevalent in our practice which might not be common in other practices given their different staff, training, and spirometers.

The way in which the educational interventions affected our primary care spirometry leading to reducing referrals, and use of

this possible new screening tool for identifying poor quality spirometry, suggests the need for further investigation and study.

Confounding factors which would influence the study findings, particularly with respect to the associated reduction in chest clinic referrals,[10] will include the timing of the study. Seasonal variation in the incidence of respiratory complaints that fail to resolve, prompting primary care clinicians to investigate and refer, is well recognised.[2] It is possible that the reduction in chest clinic referrals during the post-intervention period – i.e., during the summer months – was simply caused by there being less presentation of chest problems in the summer. In addition, our patient numbers were small. There may also be some normal variation in GP referral habits. However, although these factors may have served to potentiate the observed reduction in chest clinic referrals, they are unlikely to have influenced the technical quality of spirometry performed at the practice.

Expanding the audit to identify whether any of the poorly performed spirometry led to inappropriate management was not considered appropriate in this audit. However, our results suggest that this may be a useful exercise for a future larger-scale study.

There are multiple causes that can contribute to technically flawed spirometry,[6] and in this audit, with our use of the FEV1/FVC = 1.0 proxy quality marker, we have sought to identify only one form of technical error – i.e., an inadequate expiratory effort. It is important to note that there are many other potential errors, including a slow initial expiratory effort, identification of which would require careful examination of the spirometry curve.[10]

The methods used to collect the data could have produced a sampling bias, since we chose a specific number of patients and then selected the first patients on the computer-generated list. The potential bias will have been mitigated by selection of the patients according to their practice registered number, thus minimising the possibility of alphabetical or gender bias.

The number of spirometry sheets studied was chosen for practical purposes and is small; however, we believe the outcome to be significant. No power calculation was made before the study was performed, and the data were collected retrospectively in the initial audit. The results of the present study could help to inform the sample size calculation needed for a future prospective study.

As with any audit process, these improvements might represent just one-off changes, and it will therefore be necessary to repeat the audit at some point – perhaps on an annual basis – to ensure that spirometry standards have been maintained.

The Consultation on a National Strategy for COPD Services in England was published in February 2010,[12] and a supplement summarising the consultation document has just been published in this journal.[13] The Strategy recommends that action be taken to standardise primary care-based spirometry, and that there is accreditation of those involved in performing and interpreting spirometry. This will be a very positive step forward. However, there is no need to wait for the introduction of the Strategy to make improvements in this area. We believe we have demonstrated that, through simple educational measures delivered in the practice, it is possible to influence the quality of spirometry performance in primary care. There are simple things that can be done now to improve the technical quality of primary care-based spirometry, with corresponding benefits for patients, GPs, hospitals and Primary Care Trusts. Furthermore, there is a wide range of easily accessible educational material on spirometry, particularly that supplied by the PCRS-UK (see http://www.pcrs-uk.org/opinions/spirometry_revised_final_version_03.pdf).

References

1. Chavannes N, Schermer T, Akkermans R et al., Impact of spirometry on GPs' diagnostic differentiation and decision-making. Respir Med 2004;**98**(11):1124-30. http://dx.doi.org/ 10.1016/j.rmed.2004.04.004

2. Institute for Health and Clinical Excellence. Chronic Obstructive Pulmonary Disease. Management of COPD in adults in primary and secondary care. Ed, National Collaborator for Chronic Conditions. London. National Clinical Guideline Centre, Guideline 12. 2004

3. White P, Wong W, Fleming T, Gray B. Primary care spirometry: test quality and the feasibility and usefulness of specialist reporting. Br J Gen Pract 2007;**57**(542):701-05.

4. Calverley P. Fulfilling the promise of primary care spirometry. Eur Respir J 2008. **31**(1): 8-10. http://dx.doi.org/10.1183/09031936.00124507

5. Townsend, MC. Technique and equipment pitfalls in spirometry testing: serious threats to your respiratory surveillance program. Journal of Occupational and Eviromental Medicine 2004;**46**(3):307-09.

6. Levy, ML, Quanjer PH, Booker R, Cooper BG, Jolmes S, Small I. Diagnostic spirometry in primary care: Proposed standards for general practice compliant with American Thoracic Society and European Respiratory Society recommendations. Prim Care Respir J 2009;**18**(3):130-47. http://dx.doi.org/10.4104/pcrj.2009.00054

7. Celli BR, MacNee W; ATS/ERS Task Force. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. Eur Respir J 2004;**23**(6):932-46. http://dx.doi.org/10.1183/09031936.04.00014304

8. Sutherland, J.A. The Johari Window: a strategy for teaching therapeutic confrontation. Nurse Educ 1995;**20**(3):22-4. http://dx.doi.org/10.1097/00006223-199505000-00016

9. Eve, R. PUNs and DENs: Discovering learning needs in general practice. 1st ed. Vol 1, 2003. Radcliffe. pg 120.

10. Tuomisto LE, Jarvinen V, Laitinen J, Erhola M, Kaila M, Brander PE. Asthma Programme in Finland: the quality of primary care spirometry is good. Prim Care Respir J 2008;**17**(4):226-31. http://dx.doi.org/10.3132/pcrj.2008.00053

11. Price D, Crockett A, Arne M, et al. Spirometry in primary care case-identification, diagnosis and management of COPD. Prim Care Respir J 2009;**18**(3):216-23. http://dx.doi.org/10.4104/pcrj.2009.00055

12. Department of Health/Respiratory Team. Consultation on a Strategy for Services for Chronic Obstructive Pulmonary Disease (COPD) in England. London, Department of Health, Crown Copyright, 2010. 296481

13. Jones R, Gruffydd-Jones K, Pinnock H, et al. Summary of the Consultation on a Strategy for Services for Chronic Obstructive Pulmonary Disease (COPD) in England. Prim Care Respir J 2010;**19**(Suppl 2):S1-S17. http://dx.doi.org/10.4104/pcrj.2010.00081