ORIGINAL RESEARCH

Assessing asthma control in routine clinical practice: use of the Royal College of Physicians '3 Questions'

*Mike Thomas^{a,b}, Kevin Gruffydd-Jones^{c,d}, Carol Stonham^e, Sabbi Ward^f, Tatiana Macfarlane^g

^a Asthma UK Senior Research Fellow, Department of General Practice and Primary Care, University of Aberdeen, Scotland

^b General Practitioner, Minchinhampton Surgery, Gloucestershire, UK

^c Honorary Research Fellow, Department of General Practice and Primary Care, University of Aberdeen, Scotland

^d General Practitioner, Box Surgery, Wiltshire, UK

^e Asthma Nurse Practitioner, Minchinhampton Surgery, Gloucestershire, UK

^f Research Nurse, Box Surgery, Wiltshire, UK

^g Senior Lecturer in Medical Statistics, Department of General Practice and Primary Care, University of Aberdeen, Scotland

Originally submitted 18th December 2007; resubmitted 27th February 2008; revised version received 23rd May 2008; accepted 16th June 2008; online 12th August 2008

Abstract

Aims: To evaluate the Royal College of Physicians (RCP) '3 questions' in the assessment of asthma control.

Methods: This was a prospective observational study. Subjects (20 adults and 15 children) were assessed 2-weekly over 12 weeks, with data collection on RCP scores (yes/no for each question, 0-3), lung function, asthma control questionnaire (ACQ), asthma quality of life questionnaires (AQLQ), bronchodilator use, and exhaled nitric oxide level.

Results: Between-subject analysis showed that the RCP score correlated strongly with the ACQ (correlation coefficient 0.79, $p < 0.001$), AQLQ (-0.71 , $p = 0.001$) and bronchodilator use (0.52 , $p = 0.02$) in adults, although in children the correlations were weaker and non-significant. Within-subject analysis showed strong correlations between changes in the RCP score and ACQ score in adults (0.67 , $p < 0.001$) and children (0.61 , $p < 0.001$), between quality of life scores in adults (-0.67 , $p < 0.001$) and children (-0.69 , $p < 0.001$), and changes in bronchodilator use in adults (0.49 , $p < 0.001$) and children (0.48 , $p < 0.001$). Weaker or absent correlations existed with lung function and no correlations with exhaled nitric oxide levels. An RCP score of 1 or more identified 89% of occasions when the ACQ was > 1 .

Conclusions: The RCP 3 questions reliably quantify current asthma control in this dataset, with a negative response to all 3 questions indicating good control. These data support the use of the 3 questions, but larger validation studies are needed.

© 2009 General Practice Airways Group. All rights reserved.

M Thomas, *et al.* *Prim Care Resp J* 2009; 18(2): 83-88.

doi:10.3132/pcrj.2008.00045

Keywords asthma, control, quality of life, assessment, general practice, RCP 3 questions

Introduction

Asthma is a common chronic disease treated principally in the community.^{1,2} In spite of effective treatments, potentially avoidable morbidity from asthma remains high.³ There is evidence that clinicians frequently over-estimate asthma control and under-estimate the impact of asthma on patients' lives.⁴⁻⁶ The British Thoracic Society and Scottish Intercollegiate Guidelines Network UK guidelines for the management of asthma⁷ recommend that the Royal College of Physicians (RCP) '3 questions'⁸ should be asked at all asthma clinical

assessments to assess patient morbidity. This simple, quick, and easy-to-use questionnaire has, however, never been validated as a useful tool for routine clinical practice. Although more detailed and longer questionnaire tools have been validated for assessing asthma control in adults (e.g. the Asthma Control Questionnaire, (ACQ)⁹) and asthma-related health status in adults (e.g. the Asthma Quality of Life Questionnaire, (AQLQ)¹⁰) and in children (e.g. the Paediatric Caregivers Quality-of-life Questionnaire (PQLQ)¹¹) in the context of clinical trials, the usefulness of these tools in

* Corresponding author: Dr Mike Thomas, Cotswold Cottage, Oakridge, Stroud, Gloucs GL67NZ, UK. E-mail: mikethomas@doctors.org.uk

routine clinical practice has not been established, and their length and relative complexity may limit their use in routine practice. As part of a pilot study investigating the feasibility of monitoring exhaled nitric oxide levels in general practice asthma clinics reported in this journal recently,¹² we aimed to assess the use of the RCP 3 questions in a routine primary care asthma clinic setting.

Materials and methods

Study design

This was a prospective observational study. Consenting subjects attending primary care nurse-led asthma clinics were assessed by their usual asthma nurse at 2-weekly intervals over 12 weeks (a total of seven visits for each subject). Daily diary cards were completed by subjects and/or parents, recording symptoms and morning pre-bronchodilator peak expiratory flow rate (PEF) using a Wright's mini peak flow meter. At each visit the following assessments were made:

- The RCP 3 questions score (each question scored 0 (no) or 1 (yes))
- Fraction of Exhaled Nitric Oxide (FeNO): measurements were performed on the Niox chemiluminescence eNO analyser (Aerocrine Ltd, Sweden) at an expiratory flow of 50ml/sec as per guideline recommendations¹³
- Spirometry (Vitalograph).
- Health status: adults – Asthma Mini Quality of Life Questionnaire (AQLQ);¹⁰ children – Paediatric Caregivers Quality-of-life Questionnaire (PQLQ)¹¹
- Short-term symptomatic asthma control – Asthma Control Questionnaire⁹

Normal care was allowed to continue through the 3-month study period, with medication changes made according to nurse and GP assessments of asthma control and severity. Ethical approval was provided by the Bath Local Research Ethics Committee.

Subjects

Consenting adults (17 years and older) and children (6 to 16 years) attending the nurse-led asthma clinics in two general practices in the South-West of England were invited to participate in the study. Inclusion criteria were: willingness to attend for the study monitoring visits; documented evidence of asthma (by characteristic symptomatology, variable or reversible airways obstruction, and response to treatment); current use of inhaled β_2 -agonists (usage $\geq$ one prescription in previous six months); and provision of informed consent. Exclusion criteria were: current maintenance treatment with inhaled corticosteroids at a dose exceeding 2000mcg/day of beclomethasone or equivalent (1000mcg fluticasone); or maintenance oral corticosteroid requirement.

Statistical analyses

Data were entered in an Excel spreadsheet and analysed using

SPSS version 15 (SPSS Inc., 2006) and Stata 10.0 for Windows (Stata Corp LP, 2007). Analysis was performed separately for adults and children. Non-parametric data are presented as medians and interquartile ranges (IQR). Wilcoxon signed ranks test was used to compare between first and last visits. Significance level was set to 0.05.

Correlation coefficient *within* subjects was used to assess whether longitudinal changes in individual RCP 3 questions scores at different visits were associated with changes in other parameters of asthma control using the Bland-Altman methodology to allow for repeated observations on subjects.¹⁴

In order to investigate the cross-sectional relationship between the RCP 3 questions scores and other asthma control parameters *between* subjects, weighted correlation between subject means was used using the Bland-Altman methodology to allow for repeated observations on subjects.¹⁵ The RCP 3 questions score was used as a predictor in the modeling, with normality confirmed by examination of histograms of residuals of each model.

Results

Subjects

15 children and 20 adult subjects entered the study. The demographic details are shown in Table 1.

All 15 children and 16 of the adults completed all seven

Table 1. Baseline demographic data on study participants.

	Children (n=15)	Adults (n=20)
Age, median (range) yrs	9 (6-15)	56.5 (19-71)
Male sex (%)	11 (73%)	6 (30%)
BDP equivalent ICS dose (mcg/day), median (range)	200 (0-800)	400 (0-2000)
FEV ₁ % predicted (L), median (range)	82 (60-109)%	86.5 (41-120)%
PEF l/min, median (range)	310 (240-430)	435 (310-570)
AQLQ/PQLQ score (median, range)	6.1 (3.7-7.0)	5.5 (1.3-7.0)
ACQ score (mean, range)	1.0 (0-3.0)	1.1 (0-57)
Daily bronchodilator use doses/day (median, range)	0 (0-4.0)	0 (0-3.0)
Exhaled nitric oxide, ppb, median(range)	55.4 (6.5-162.6)**	31.2 (3.6-140.2)*
RCP score, median (range)	1.0 (0-2)	1.5 (1-3)

*n=19; **n=14

Figure 1. Percentage of subjects having a RCP score of 0 at each study visit.

study visits; of the remaining adults, one attended no visits after visit 1 and one after visit 6 (having missed visits 3 and 4) for personal reasons. Two further adults missed one visit each for non-medical reasons.

RCP scores were measured on 105 occasions in children and 129 occasions in adults. FEV₁, PEF, ACQ, AQLQ/ PALQ and bronchodilator use were measured on all occasions. Exhaled nitric oxide (FeNO) was measured on all visits other than visit 1 for one child and visit 7 for one adult (inability to perform satisfactory expiratory effort for analysis).

The distribution of RCP scores overall showed a score of 0 on 53% of occasions, 1 on 19% of occasions, 2 on 19% of occasions and 3 on 9% of occasions. Overall there was an improvement in RCP scores over the duration of the study; the proportion of subjects having a score of 0 increased from 47% children and 21% of adults at visit 1 to 73% of children and 57% of adults at visit 7 (Figure 1), and the median (Interquartile range IQR) score reduced non-significantly from 1 (0-2) to 0 (0-1) in children ($p=0.096$) and from 1.5 (1-2.75) to 0 (0-2) in adults ($p=0.011$). There was a similar overall improvement in the ACQ scores, in children from 1.0 (0.3-1.5) (median (IQR)) to 0.2 (0-0.8), and in adults from 1.1 (0.4-2.3) to 0.4 (0.1-1.3) from the first to the seventh visit.

The change in RCP score between visits was assessed on 196 occasions in all subjects; the change was -3 on 3% of occasions, -2 on 5%, -1 on 22%, 0 on 49%, 1 on 12%, 2 on 7% and 3 on 1%, indicating that changes in asthma symptoms (either spontaneously or in response to changes in treatment) occurred in over 50% of occasions.

Table 2. Between-subjects correlation coefficient of RCP 3 questions score and parameters of asthma control.

Parameter correlated with RCP score	Between subjects correlation coefficient (p-value)	
	Children	Adults
Exhaled nitric oxide	0.28 (0.303)	-0.003 (0.989)
Mean daily bronchodilator use in the past 2 weeks	0.45 (0.090)	0.72 (0.001)
Mean morning peak expiratory flow rate in previous 2 weeks	-0.06 (0.839)	-0.52 (0.023)
% predicted forced expiratory volume in the 1st second (FEV ₁)	-0.16 (0.574)	-0.07 (0.756)
Asthma Quality of Life Questionnaire, AQLQ (adults) / Pediatric Caregivers Quality-of-life Questionnaire, PALQ (children)	-0.38 (0.169)	-0.71 (0.001)
Asthma Control Questionnaire score (ACQ)	0.41 (0.134)	0.79 (<0.001)

Relationship between RCP score and asthma control questionnaire (ACQ) scores

The cross-sectional relationship between the RCP score (0-3) and the ACQ score (1-7) was estimated for each of the seven study visits for adults (in whom the ACQ has been validated) and as an exploratory analysis in children (in whom the ACQ has not currently been validated) by assessing the between-subjects correlation coefficient (see Table 2). In children a moderate strength of correlation (correlation coefficient 0.41, $p=0.134$) was observed between the RCP score and the ACQ score, but this relationship did not achieve statistical significance so it could have occurred through chance, while in adults there was a strong and statistically significant correlation (0.79, $p<0.001$).

The longitudinal relationship between changes in the RCP and the ACQ scores over time was estimated by calculating within-subject correlation coefficients (Table 3). In this analysis, a strong relationship was observed between changes in the RCP and ACQ scores in children (0.61, $p<0.001$) and in adults (0.67, $p<0.001$).

Using an ACQ of 1.0 as a cut-off for differentiating between 'well controlled' and 'not well controlled' asthma as reported by Juniper,¹⁶ an RCP score of 1 or more had a sensitivity of 94.0% and a specificity of 67.1% in identifying occasions at which patients had 'not well controlled' asthma; the positive predictive value was 88.7% and the negative predictive value was 94.6%.

Table 3. Within-subject correlation coefficient of RCP 3 questions score and parameters of asthma control.

Parameter correlated with RCP score	Within subjects correlation coefficient (p-value)	
	Children	Adults
Exhaled nitric oxide	0.08 (0.458)	0.16 (0.091)
Mean daily bronchodilator use in the past 2 weeks	0.48 (<0.001)	0.49 (<0.001)
Mean morning peak expiratory flow rate in previous 2 weeks	-0.31 (0.007)	-0.31 (0.002)
% predicted forced expiratory volume in the 1st second (FEV ₁)	-0.31 (0.003)	-0.24 (0.011)
Asthma Quality of Life Questionnaire, AQLQ (adults) / Pediatric Caregivers Quality-of-life Questionnaire, PALQ (children)	-0.69 (<0.001)	-0.67 (<0.001)
Asthma Control Questionnaire score (ACQ)	0.61 (<0.001)	0.67 (<0.001)

An RCP score of 2 or more resulted in less false positive but more false negative identification of episodes of 'not well controlled' asthma (sensitivity 66.0%, specificity 84.8%, positive predictive value 73.3%, negative predictive value 79.8%).

Relationship between RCP score and asthma-related health status (AQLQ adults, PALQ children)

The cross-sectional relationships between the RCP (0–3) score and the PALQ score (1–7) for children and the AQLQ score (1–7) for adults were estimated by assessing the between-subjects correlation coefficient between these parameters (Table 2). In children a moderate relationship was observed, although this could have occurred through chance since statistical significance was not achieved (-0.38 , $p=0.169$), while in adults, a strong and statistically significant correlation was observed (correlation coefficient 0.71 $p=0.001$). Note that negative correlations can occur since a higher RCP score indicates worse symptoms whereas a higher AQLQ or PALQ score indicates better health status.

Strong and statistically significant longitudinal relationships were seen over time between changes in the RCP score and changes in the AQLQ/PALQ scores as shown by strong within-subject correlation coefficients in children (-0.69 , $p<0.001$) and in adults (-0.67 , $p<0.001$) (see Table 3).

Relationship between RCP score and mean daily bronchodilator use over previous two weeks.

The cross-sectional relationship between the RCP score and the mean daily bronchodilator use in the previous two weeks

(puffs/day) was estimated by assessing the between-subjects correlation coefficient. In children a moderate and non-statistically significant correlation (0.45 , $p=0.09$) was seen, and in adults a strong correlation was observed (0.72 , $p=0.001$) (see Table 2). The longitudinal relationship between changes in RCP score and changes in bronchodilator use assessed by the within-subject correlation coefficient was moderate in children (0.48 , $p<0.001$) and in adults (0.49 , $p<0.001$).

Relationship between RCP score and lung function

In cross-sectional analysis there were no significant between-subject correlations between RCP score and percentage predicted FEV₁ in children (-0.16 , $p=0.574$) or in adults (-0.07 , $p=0.756$). A moderate correlation was seen between the mean morning peak expiratory flow (PEF) rate over the previous two weeks in adults (-0.52 , $p=0.023$) but not in children (-0.06 , $p=0.839$) (see Table 2).

Weak but statistically significant relationships were seen longitudinally between changes in FEV₁ and changes in RCP score, with within-subject correlation coefficients in children of -0.31 ($p=0.003$) and in adults of -0.24 ($p=0.011$). A similar longitudinal relationship was seen between changes in RCP score and changes in mean morning PEF over the previous two weeks in children (-0.31 , $p=0.007$) and in adults (-0.31 , $p=0.002$) (Table 3).

Relationship between RCP score and exhaled nitric oxide level

No significant relationship was found between the RCP score and the FeNO in cross-sectional or longitudinal analysis. The between-patients correlation coefficient was 0.28 ($p=0.303$) in children and -0.003 ($p=0.989$) in adults, and the within-patients correlation coefficient was 0.08 ($p=0.458$) in children and 0.16 in adults ($p=0.091$).

Discussion

There is a need for simple practical tools to assess asthma control in the context of routine clinical care, particularly in time-pressured primary care asthma consultations. Although a number of symptom questionnaire tools have been validated for assessing symptomatic control in asthma clinical trials, the practical utility of using such instruments in routine clinical care has been infrequently investigated.

The BTS SIGN UK guidelines for the management of asthma recommend that the 'RCP 3 questions' should be assessed at each clinical review as a measure of asthma control. As a simple 'yes/no' 3-question tool that can be administered in a very short time, this is indeed a feasible simple and practical tool for use in a clinical context; however, the '3 questions' have never been validated as a clinically useful and reliable instrument, and the interpretation of the result of the enquiry has not been formally assessed. In this study we monitored the RCP score at 2-weekly

intervals over a 12-week period in adults and children with asthma attending primary care asthma clinics in two UK general practices, and we compared the results with other parameters of asthma control measured at the same visits including bronchodilator use and PEF assessed by patient-completed diaries. Positive responses to each question were scored as 1 and negative responses as 0, giving a score of 0 to 3 at each assessment. Normal care continued over this period, and fluctuations in asthma control parameters were seen between patients at individual study time points and over time in individual patients. As a consequence, it was possible to assess the discriminative (cross-sectional) and evaluative (longitudinal) relationships between the RCP 3 questions score and other control parameters. Strong correlations were observed between the RCP score and validated asthma symptom questionnaires as well as quality of life instruments and bronchodilator use; weaker relationships were seen with lung function; and no meaningful relationship was observed with FeNO levels. It should be stressed that this study was not specifically structured as a validation exercise for the RCP 3 questions and cannot be viewed as such; however, the strength and the statistical significance of the correlations observed can provide clinicians with reassurance that this simple tool is providing useful information.

The ACQ is a widely used tool in adult asthma clinical trials and is a very well validated asthma control instrument. Very strong correlations were observed between the RCP score and ACQ score in adults, both cross-sectionally at each study visit and longitudinally over time. The strength of this relationship suggests that the RCP score does indeed have validity as a discriminative and evaluative tool in assessing short-term asthma control in adults, and is able to distinguish control at single moments in time between patients and to measure changes in control over time in individual patients. The ACQ has not been formally validated in children (although a validation exercise is currently underway¹⁷), so the data presented on the relationship between ACQ and RCP score in children need to be interpreted with considerable caution. A moderate and non-significant cross-sectional relationship was seen, although a strong and significant longitudinal relationship was seen, suggesting that the RCP score has use in monitoring asthma control in individual children over time.

An ACQ of 1 has previously been reported to be a suitable cut-off point for discriminating between 'well controlled' and 'not well controlled' asthma.¹⁶ In this study, an RCP score of 0 was found to be a good predictor of well controlled asthma, correctly identifying 95% of occasions on which good control occurred by ACQ criteria, and only falsely suggesting good control in 6% of episodes in which inadequate control was found. An RCP score of 1 or more identified most episodes with poor control (94%), but on 35% of occasions was associated

with good control by ACQ score and so may over-estimate inadequate control. The 'false positive' rate of estimation of poor control was reduced to 27% by using 2 or more as the RCP cut-off score, but 20% of occasions when 0 or 1 were scored were found to have ACQ scores indicating inadequate control. These findings suggest that a negative response to all 3 RCP questions can reassure the clinician that good control is being achieved, that any positive responses may indicate sub-optimal control, with more than 1 positive response likely to be associated with recent poor control.

Strong relationships were seen cross-sectionally and longitudinally between the RCP score and asthma-related health status scores (particularly in adults), and this relationship also supports the validity of the RCP score as a patient-centered measure of asthma control. Further support is provided by the moderate correlations observed between the level of rescue bronchodilator use over the previous two weeks and the RCP scores.

The relationships between the RCP scores and lung function parameters were much weaker or absent. This is perhaps unsurprising, as a poor relationship has previously been reported between asthma symptoms and lung function in cross-sectional analysis,¹⁸ and lung function may relate more strongly to asthma severity rather than asthma control.¹⁹ However, it was observed in this study that a significant if relatively weak longitudinal relationship was observed between changes in lung function and changes in RCP score, in keeping with evidence from controlled trials that changes in lung function do correlate with changes in symptom scores.²⁰ We found no significant cross-sectional or longitudinal relationship between FeNO levels and RCP scores, indicating that short-term symptom control has no, or a weak, correlation with parameters of airways inflammation in mild to moderate asthma. This is in keeping with studies reporting that inflammatory parameters appear to relate more strongly to the risk of exacerbations than to short-term symptom control,²¹⁻²⁴ and indicates that these parameters are measuring different domains in the complex spectrum of asthma control.

There are several weaknesses to this study. A relatively small number of patients with asthma were studied. The monitoring occurred in the context of a prospective observational study, and so the subjects consenting to participate and the frequent monitoring visits are not necessarily typical of routine care. Validation exercises for questionnaire tools in asthma have, however, frequently been performed in low numbers of patients, and the demographic profile of participating subjects is typical of those seen in primary care asthma clinics. In this study – albeit not a formal validation study – 35 subjects were observed, compared to a sample of 50 subjects in the validation of the Asthma Control Questionnaire.¹⁰ This is a post-hoc analysis, and the study was not specifically structured to provide formal validation of the RCP scoring system. A formal validation would

require additional exercises such as test-retest reliability. However, in spite of these limitations, we feel that the strong correlations noted in cross-sectional and longitudinal analysis warrant reporting and provide support for the use of this simple morbidity assessment tool in routine practice.

In summary, we report data on the use of the RCP 3 questions in primary care asthma assessments in subjects undergoing close clinical observation while volunteering for a clinical research study, correlating the RCP score with validated physiological and questionnaire-based asthma control parameters. We observed that in this dataset, a negative response to all 3 RCP questions was associated with good asthma control as measured by other validated tools, that any positive responses were associated with sub-optimal control, and that more than one positive response was likely to be associated with poor control. These data support the use of this instrument in routine clinical care, although further assessments and formal validation in larger datasets are advisable.

Conflicts of interest

The authors have declared that there are no conflicts of interest.

References

- Masoli M, Fabian D, Holt S, Beasley R. The global burden of asthma: executive summary of the GINA Dissemination Committee report. *Allergy* 2004;**59**(5):469-78. <http://dx.doi.org/10.1111/j.1398-9995.2004.00526.x>
- Smith NM. The 'Needs of People with Asthma' survey and initial presentation of the data. *Asthma J* 2000;**5**:133-6.
- Rabe KF, Adachi M, Lai CKW, *et al.* Worldwide severity and control of asthma in children and adults: the global asthma insights and reality surveys. *J Allergy Clin Immunol* 2004;**114**:40-7. <http://dx.doi.org/10.1016/j.jaci.2004.04.042>
- Haughney J, Barnes G, Partridge M, Cleland J. The Living & Breathing Study: a study of patients' views of asthma and its treatment. *Prim Care Respir J* 2004;**13**(1):28-35. <http://dx.doi.org/10.1016/j.pcrj.2003.11.007>
- Horne R, Price D, Cleland J, *et al.* Can asthma control be improved by understanding the patient's perspective? *BMC Pulm Med* 2007;**22**:7:8.
- Holgate ST, Price D, Valovirta E. Asthma out of control? A structured review of recent patient surveys. *BMC Pulm Med* 2006;**6** Suppl 1:S2. doi:10.1186/1471-2466-6-S1-S2
- British Thoracic Society, Scottish Intercollegiate Guideline Network. British Guidelines on the Management of Asthma. *Thorax* 2003;**58**:1-94.
- Pearson MB (ed). Measuring clinical outcomes in asthma: a patient-focused approach. London: Royal College of Physicians; 1999.
- Juniper EF, O'Byrne PM, Guyatt GH, Ferrie PJ, King DR. Development and validation of a questionnaire to measure asthma control. *Eur Respir J* 1999;**14**(4):902-07.
- Juniper EF, Guyatt GH, Cox FM, Ferrie PJ, King DR. Development and validation of the Mini Asthma Quality of Life Questionnaire. *Eur Respir J* 1999;**14**(1):32-8.
- Juniper EF, Guyatt GH, Feeny DH, Ferrie PJ, Griffith LE, Townsend M. Measuring quality of life in the parents of children with asthma. *Quality of Life Research* 1996;**5**:27-34. <http://dx.doi.org/10.1007/BF0043596>
- Gruffydd-Jones K, Ward S, Stonham C, Macfarlane TV, Thomas M. The use of exhaled nitric oxide monitoring in primary care asthma clinics: a pilot study. *Prim Care Respir J* 2007;**16**:349-56. <http://dx.doi.org/10.3132/pcrj.2007.00076>
- American Thoracic Society. Recommendations for standardized procedures for the on-line and off-line measurement of exhaled lower respiratory nitric oxide and nasal nitric oxide in adults and children-1999. *Am J Respir Crit Care Med* 1999;**160**:2117.
- Bland JM, Altman DG. Calculating correlation coefficients with repeated observations: Part 1 - correlation within subjects. *BMJ* 1995;**310**:446.
- Bland JM, Altman DG. Calculating correlation coefficients with repeated observations: Part 2 - correlation between subjects. *BMJ* 1995;**310**:633.
- Juniper EF, Bousquet J, Abetz L, Bateman ED; GOAL Committee. Identifying 'well-controlled' and 'not well-controlled' asthma using the Asthma Control Questionnaire. *Respir Med* 2006;**100**(4):616-21.
- Juniper E, Gruffydd-Jones G, Ward S, Thomas M. Developing an interviewer-administered version of the asthma control questionnaire (ACQ) for children under 10 years. *ERJ Conference Supplement* 2007; P2274.
- Teeter JG, Bleecker ER. Relationship between airway obstruction and respiratory symptoms in adult asthmatics. *Chest* 1998;**113**(2):272-7. <http://dx.doi.org/10.1378/chest.113.2.272>
- Stoloff SW, Boushey HA. Severity, control, and responsiveness in asthma. *J Allergy Clin Immunol* 2006;**117**(3):519-21. <http://dx.doi.org/10.1016/j.jaci.2006.01.005>
- Reddel HK. Peak flow monitoring in clinical practice and clinical asthma trials. *Curr Opin Pulm Med* 2006;**12**(1):75-81. <http://dx.doi.org/10.1097/01.mcp.0000198065.65704.08>
- Taylor D, Pijnenburg MW, Smith AD, De Jongste JC. Exhaled nitric oxide measurements: clinical application and interpretation. *Thorax* 2006;**61**:817-27. <http://dx.doi.org/10.1136/thx.2005.056093>
- Green RH, Brightling CE, McKenna S *et al.* Asthma exacerbations and sputum eosinophil counts: a randomised controlled trial. *Lancet* 2003;**360**:1715-21. [http://dx.doi.org/10.1016/S0140-6736\(02\)11679-5](http://dx.doi.org/10.1016/S0140-6736(02)11679-5)
- Smith AD, Cowan JO, Brassett KP, Herbison GP, Taylor DR. Use of exhaled nitric oxide measurements to guide treatment in chronic asthma. *N Engl J Med* 2005;**352**:2163-73. <http://dx.doi.org/10.1056/NEJMoa043596>
- Pijnenburg MW, Bakker EM, Hop WC, De Jongste JC. Titrating steroids on exhaled nitric oxide in children with asthma: a randomized controlled trial. *Am J Respir Crit Care Med* 2005;**172**:831-6. <http://dx.doi.org/10.1164/rccm.200503-458OC>

COMMENTARY

Re: Thomas M *et al.* *Prim Care Resp J* 2009;**18**(2):83-88 Assessing asthma control using the RCP 3 questions

*Jane Upton^a

^a Research Project Manager, Education for Health, Warwick, UK

The Royal College of Physician's (RCP) 3 key questions ask about the patient's experience of their asthma symptoms; these include night-time waking, day-time symptoms and

interference with activity – questions routinely asked during clinical consultations. Fourteen groups of UK clinicians developed these questions through consensus; their aim was