

ORIGINAL ARTICLE

Assessing adherence and factors associated with adherence in young children with asthma

SCOTT W. BURGESS,¹ PETER D. SLY,² ALINA MORAWSKA³ AND SUNALENE G. DEVADASON⁴

¹Department of Paediatrics, Redland Hospital, Cleveland, ³School of Psychology, University of Queensland, Brisbane, Queensland, and ²Centre for Child Health Research and ⁴School of Paediatrics and Child Health, The University of Western Australia, Perth, Western Australia, Australia

Assessing adherence and factors associated with adherence in young children with asthma

BURGESS SW, SLY PD, MORAWSKA A, DEVADASON SG. *Respirology* 2008 13: 559–563

Background and objective: Adherence with preventive asthma medication by young children is an important factor when evaluating a suboptimal response to treatment. However, few data exist regarding the accuracy of subjective measures of adherence and factors associated with adherence in young children.

Methods: Fifty-one asthmatic children aged 18 months to 7 years had their use of preventive asthma medication monitored using an electronic monitoring device (Smartinhaler) for 1 month. At a follow-up visit the child's parent was asked how often medication had been given and they also completed a confidential questionnaire that included questions about medication usage, barriers to optimal adherence and parenting. The treating physician made an estimate of the child's likely use of medication.

Results: The median use of medication as determined by the Smartinhaler was 70.5% (range 21.4–100%). The parents' verbal reports (85.1%) and questionnaire responses (84.2%) overestimated medication usage. The physician was not able to determine which parents correctly estimated their child's use of medication ($P = 0.28$). The child's age, level of parental education and annual family income did not influence adherence. Parents reported simply 'forgetting' or their child's 'reaction to being given medication' as the principal barriers to adherence. There was a significant association between how stressful the parent found parenting and adherence ($P = 0.05$).

Conclusion: Adherence with preventive medication, even within the context of a research study, was generally low and highly variable. Subjective measures of adherence were found to overestimate adherence in young asthmatics.

Key words: adherence, asthma, compliance, paediatric.

INTRODUCTION

A critical component in the management of a child with poorly controlled asthma is an assessment of their adherence with prescribed preventive medication. Low levels of adherence with asthma management plans and treatment regimens have been associated with increased exacerbations,¹ an increased risk of hospital admission² and increased

mortality.³ There are a number of methods that may be used in clinical practice to provide insights into a child's use of medication. However, there are limited data regarding their accuracy in comparison with more objective measures of adherence.

The most common method used in clinical practice to determine adherence is simply to ask the patient how often they took their medication. A recent review recommended that physicians pose such questions in a non-judgmental fashion and that their question be prefaced by a normalizing statement, allowing the patient to feel more comfortable about telling the truth.⁴ Despite the inherent logic of this approach, the accuracy of this strategy has not been objectively evaluated.

Physicians are frequently influenced by their impressions of a patient's level of adherence.

Correspondence: Scott Burgess, Redland Hospital, Department of Paediatrics, Weippin St, Cleveland, Qld 4163, Australia. Email: scott_burgess@health.qld.gov.au

Received: 1 July 2007; invited to revise: 22 July 2007; revised: 25 July 2007; accepted: 2 August 2007 (Associate Editor: Takahide Nagase).

However, available data suggest that these judgements are often inaccurate. Junior hospital staff,⁵ general practitioners⁶ and consultant paediatricians⁷ have all demonstrated an inability to predict which patients will comply with their prescribed medication or attend follow-up appointments.

Diary cards and questionnaires are inexpensive and relatively anonymous methods for measuring adherence. On the other hand they rely on accurate recall and willingness of the subject to provide a true report of their use of medication. Three studies in asthmatic children aged 7–16 years and one in preschool children have compared the accuracy of diary card entries with actuations recorded by an electronic monitoring device attached to the child's preventive medication over periods ranging from 1 to 3 months. These studies showed that the mean number of doses taken, as recorded in the diaries, was significantly higher than the number actually taken, as recorded by the monitoring devices, and that up to 90% of parents overestimated their child's use of medication.^{1,8–10} There have been no similar studies examining the accuracy of questionnaires.

Electronic monitoring devices potentially provide a more objective measure of adherence. The Smartinhaler (Nexus 6, Auckland, New Zealand) replaces the plastic casing of the metered dose inhaler and incorporates a switch that is activated each time the canister is depressed, recording a time stamp.¹¹ It is conceded that the device does not evaluate whether the patient inhaled the medication or that their technique was effective.

This study compared the relative accuracy of three commonly used subjective measures of adherence in young children with asthma, with an objective measurement made using a Smartinhaler; a verbal report by the child's parent following a non-judgemental question prefaced by a normalizing statement, a confidential questionnaire and an estimate made by a physician. This is the first study to examine these commonly used methods in this population with reference to an objective measure of adherence. A secondary aim was to examine the relationship between objectively measured adherence and factors relating to the parent and their parenting, which has also not been previously explored.

METHODS

Children diagnosed with asthma, aged 18 months to 7 years, and taking preventive asthma medication on a regular basis, were recruited from private and public paediatric respiratory clinics. All participants were reviewed by a paediatric respiratory physician (SB). They received personalized asthma education with specific focus on their concerns as well as generic written asthma information. Their medication regimen and an asthma management plan were devised collaboratively with the parent. Parents completed a questionnaire that included questions relating to parental education, total annual family income and smoking in the household. All subjects were provided with the same spacer device (Aerochamber

Plus, Trudell Medical International, London, Canada) and the correct use of the device was demonstrated. The child was provided with preventive medication (Fluticasone or Fluticasone/Salmeterol, Allen and Hanburys, Melbourne, Australia) loaded into a Smartinhaler. The parent was informed that the Smartinhaler would 'count' the number of doses dispensed but that the data would remain confidential.

The subjects were reviewed after 4 weeks. During this consultation parents were asked sympathetically about their child's use of medication, 'Most children don't take their preventive medication all of the time. In the last month what percentage of the time would your child have taken their medication?' After hearing the parent's response the physician wrote down an estimate of medication usage. The parent also completed a confidential questionnaire that included the same question about medication usage, asthma symptoms, barriers to optimal adherence, their concerns about corticosteroid side-effects, and who was responsible for remembering to take the medication. A Parenting Experience Survey that contains 11 questions, rated on 5-point scales, about how difficult the child's behaviour has been, how the parent felt about parenting and the degree of support they had received from their partner was also completed. The items for this survey were derived from the *Living with Children Survey*.¹²

Adherence was evaluated as a percentage of prescribed doses registered by the Smartinhaler either between midnight and midday or between midday and midnight for morning and evening doses, respectively, or at any time during the day for once daily dosing.

Statistical analysis was performed using the Statistical Package for Social Sciences V12.0.1 (SPSS, Chicago, IL, USA). The statistical significance of an association was assessed using the chi-square test for categorical variables. Spearman's rank-order correlation coefficient was used to assess the relationship between two continuous variables when at least one of the variables was not normally distributed. The Mann-Whitney U and Kruskal-Wallis tests were used to assess the relationship between two, or three or more categorical variables, respectively, and continuous variables that were not normally distributed. A two-tailed *P*-value < 0.05 was taken as statistically significant. Previous studies involved small numbers of subjects. Data from Milgrom *et al.* (24 children)¹ and Gibson *et al.* (27 children)⁸ suggested that adherence rates might be in the order of 58–77%, with SD of 25% or more. Power calculations were made using PASS (Power Analysis and Sample Size Software; NCSS, Kaysville, UT, USA). It was calculated that a sample size of 37 subjects would be required to demonstrate a correlation coefficient of 0.5, with an alpha of 0.05 and power of 0.9, whereas 48 subjects would be required for a two-sample *T*-test to demonstrate a 10% difference in means allowing for a SD of adherence in both groups of 30%, with an alpha of 0.05 and power of 0.8.

Approval for the study was provided by the Mater Health Services Research Ethics Committee and informed written consent was obtained from all study participants.

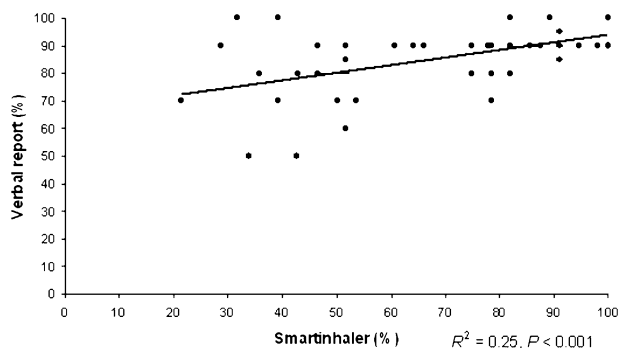


Figure 1 Adherence according to Smartinhaler (objective) compared with parental verbal report. R^2 , correlation coefficient; %, percentage adherence (see text).

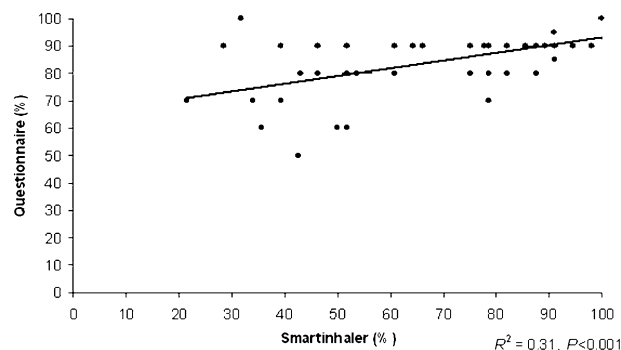


Figure 2 Adherence according to Smartinhaler (objective) compared with parental questionnaire. R^2 , correlation coefficient; %, percentage adherence (see text).

RESULTS

Fifty-one children were enrolled and 50 children attended the follow-up visit. The mean age of the subjects was 3.4 years (range 18 months to 7 years). There were 31 boys. Forty-one subjects were prescribed Fluticasone and nine were prescribed Fluticasone/Salmeterol. The median dose of Fluticasone was 125 µg/day (range 100–500 µg/day). Twelve subjects (24%) reportedly used salbutamol 1–2 times per week and three subjects (6%) 3 or more times per week in the month prior to enrolment. Twelve subjects reported having been prescribed a course of prednisolone for an exacerbation of asthma in the previous month.

The median percentage of doses taken during the study period, as determined by the Smartinhaler, was 70.5% (range 21.4–100%). Thirty-two subjects (64%) took less than 80% and 13 (26%) took less than 50% of the prescribed number of doses.

The median percentage of doses reportedly taken in response to a qualified non-judgmental question was 85.1%. When plotted against the data from the Smartinhaler (Fig. 1) the relationship, although statistically significant, was found to be weak (correlation coefficient 0.25). Thirty-two subjects reported that their child took 90% or more of the prescribed number of doses. However, adherence was 90% or better in only four subjects.

The median percentage of doses reportedly taken using an anonymous questionnaire was 84.2%. Eleven subjects reported a different level of adherence, eight were more accurate. However, adjustments were generally small and five subjects still overestimated adherence by 19% or more (range 19.3–50.7%). The correlation between the questionnaire and Smartinhaler data was stronger than the other two measures (correlation coefficient 0.31), but remained relatively weak (Fig. 2).

The physician's estimates were generally lower than the verbal reports (median 70%). However, the physician correctly identified only 12 of the 21 subjects whose reports were within 10% of their actual use, and only 16 of the 29 subjects whose estimates differed by 10% or more from their actual use of

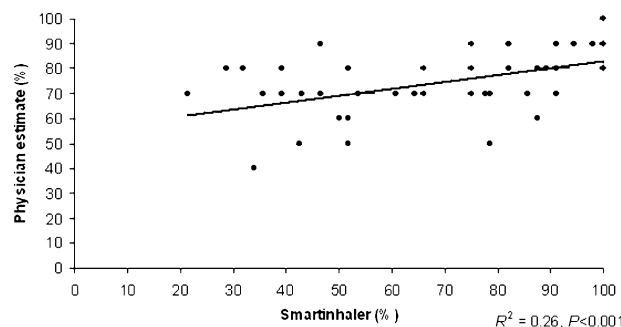


Figure 3 Adherence according to Smartinhaler (objective) compared with physician estimate. R^2 , correlation coefficient; %, percentage adherence (see text).

Table 1 Accuracy of parental report and physician's estimate of adherence compared with the SI

Parental report compared with SI	Physician's estimate compared with SI		Total
	Within 10%	Greater than 10% difference	
Within 10%	12	9	21
Greater than 10% difference	13	16	29
Total	25	25	50

$\chi^2 = 0.74$, d.f. = 1; $P = 0.28$, SI, Smartinhaler (objective adherence).

medication (Table 1). Using this as a measure of accuracy, it may be demonstrated that the physician was not able to accurately predict which parents correctly reported their child's use of medication ($P = 0.28$). The correlation between the physician's estimate and Smartinhaler data was weak (correlation coefficient 0.26; Fig. 3).

There was no relationship between the age, sex of the child and prescribed dose of medication and adherence. Interestingly, two of the three least adherent children were prescribed the highest dose of

Table 2 Barriers to optimal adherence

	Most important barrier		Barrier	
	Subjects (<i>n</i>)	%	Subjects (<i>n</i>)	%
Busy and forgot	24	49	34	69
Child's reaction to being given medication	14	29	19	39
Trouble incorporating medication into daily routine	4	8	12	24
Asleep before remembering to give evening dose	4	8	4	8
Concerns about side-effects	2	4	3	6
Cost of medication	1	2	4	8
Miscommunication with other parent	—	—	1	2

medication. Children taking Fluticasone/Salmeterol had a lower median level of adherence (61%, range 32–98%) compared with children taking Fluticasone alone (75%, range 21–100%). However, the difference was not statistically significant ($P = 0.77$). The median adherence was higher in those taking medication once daily (75%, range 21–100%) compared with those taking it twice daily (66%, range 29–95%). However, this difference was also not significant ($P = 0.44$).

The cohort included mothers whose level of education was generally quite high, two having completed grade 10, eight grade 12 and 40 having tertiary qualifications. Adherence by the children of the two mothers who had only completed grade 10 was lower (39% and 43%) than the median for the other two groups (secondary 79%, tertiary 66%), but the relationship between adherence and maternal education was not statistically significant ($P = 0.18$). There was no relationship between paternal levels of education or total annual family income and adherence. Only three mothers were smokers and only eight subjects had a father or other household member who smoked. There was no relationship between adherence and there being a smoker in the home. Despite all smoking mothers reporting that they only smoked away from the child, there was an association between smoking and the reported frequency of wheeze ($P = 0.04$).

The reported frequency of wheeze appeared to rise as adherence fell. However, the relationship was not significant ($P = 0.19$). Twelve subjects experienced an exacerbation of asthma requiring a course of oral prednisolone. The median adherence in those experiencing an exacerbation was lower (50%, range 32–100%) than in those subjects who did not experience an exacerbation (75%, range 21–100%), but again the association was not significant ($P = 0.12$). No parent reported that their child was solely responsible for remembering to take their medication, but seven believed their child was jointly responsible. Adherence was generally lower if the child was felt to share the responsibility (61% vs 78%), but this was not statistically significant ($P = 0.2$). Thirteen parents reported that they were uncertain if the benefits of corticosteroids justified their potential side-effects. Those who were uncertain had a median adherence of 52% compared with 75%, but the difference was not statistically significant ($P = 0.2$).

Forty-nine parents provided reasons as to why doses were sometimes missed. The most commonly reported reasons were 'forgetting' and being dissuaded by their 'child's reaction to being given medication' (Table 2). There was also a decline in adherence as parents reported finding their child's behaviour difficult and parenting more depressing, demanding or stressful. However, the only relationship that reached statistical significance was that between reduced adherence and finding parenting increasingly stressful ($P = 0.05$).

DISCUSSION

Significant efforts were made to provide optimal circumstances for high levels of adherence as outlined above, and adherence was monitored over a short period with subjects being aware that adherence was being monitored. Despite these factors, adherence was generally low (median 70.5%) with more than a quarter of subjects taking less than 50% of the prescribed number of doses.

All three subjective measures of adherence were found to correlate poorly with an objective measure of adherence, with the correlation coefficients ranging from 0.25 to 0.31. The physician was not able to predict which patients were providing an accurate estimate of their child's use of medication. Most patients were not well known to the physician. However, previous studies have not demonstrated this to be an advantage.⁶ The anonymous questionnaire provided the most accurate assessment of medication usage, possibly indicating that patients felt more comfortable reporting reduced adherence in an anonymous fashion. However, most parents continued to significantly overestimate their child's use of medication and an anonymous questionnaire would not be helpful in a clinical setting.

The provision of medication to young children involves a complex interplay between the child, the parent and the nature of the treatment. Difficult child behaviour has been associated with poorer adherence to preventive medication, although adherence was not measured using an electronic monitoring device.¹³ Reduced adherence with anti-rejection medication following renal transplantation has also been correlated with increased stress associated with parenting.¹⁴ A study that examined the use of a

child-friendly spacer device, incorporating a whistle and spinning disk, reported improved adherence as assessed by parental reporting, indicating that strategies that seek to overcome these problems may be beneficial.¹⁵

The two most common reasons parents identified as contributing to reduced adherence were simply forgetting, or their child's reaction to being given medication. There was also a statistically significant relationship between finding parenting stressful over the previous month and reduced adherence. This relationship was independent of the child's age, and age itself was not related to adherence. Previous studies that have found an association with age have included older children and had broader age ranges.^{10,16,17}

Subjects were not randomized to receive a given dose, frequency or type of medication. Thus reduced adherence in those taking doses more frequently, those taking higher doses and those taking combination medication may have been confounded by reduced adherence leading to ongoing symptoms, rather than an impact of these factors on adherence. These factors were not taken into account in the present study and should be addressed in randomized controlled studies with objective measures of adherence.

Data from this study suggest that suboptimal adherence should be suspected in all cases of poorly controlled asthma. This study confirms findings from different populations that subjective measures of adherence are unreliable and that objective measures are required to accurately gauge a patient's use of medication. It reveals that parental reporting is an inaccurate measure of adherence, even when the recommended method of questioning is used. This is the first study to establish a link between parenting and an objective measure of adherence in children with asthma. Strategies that aim to make it easier to give medication to children or provide parents with increased skills or support may result in improved adherence but need to be evaluated using objective measures.

REFERENCES

- Milgrom H, Bender B, Ackerson L, Bowry P, Smith B *et al*. Noncompliance and treatment failure in children with asthma. *J. Allergy Clin. Immunol.* 1996; **98**: 1051–7.
- Ordonez GA, Phelan PD, Olinsky A, Robertson CF. Preventable factors in hospital admissions for asthma. *Arch. Dis. Child.* 1998; **78**: 143–7.
- Robertson CF, Rubinfeld AR, Bowes G. Pediatric asthma deaths in Victoria: the mild are at risk. *Pediatr. Pulmonol.* 1992; **13**: 95–100.
- Osterberg L, Blaschke T. Adherence to medication. *N. Engl. J. Med.* 2005; **353**: 487–97.
- Mushlin AI, Appel FA. Diagnosing potential noncompliance. Physicians' ability in a behavioral dimension of medical care. *Arch. Intern. Med.* 1977; **137**: 318–21.
- Gilbert JR, Evans CE, Haynes RB, Tugwell P. Predicting compliance with a regimen of digoxin therapy in family practice. *Can. Med. Assoc. J.* 1980; **123**: 119–22.
- Finney JW, Hook RJ, Friman PC, Rapoff MA, Christophersen ER. The overestimation of adherence to pediatric medical regimens. *Child Health Care* 1993; **22**: 297–304.
- Gibson NA, Ferguson AE, Aitchison TC, Paton JY. Compliance with inhaled asthma medication in preschool children. *Thorax* 1995; **50**: 1274–9.
- Coutts JA, Gibson NA, Paton JY. Measuring compliance with inhaled medication in asthma. *Arch. Dis. Child.* 1992; **67**: 332–3.
- Jonasson G, Carlsen KH, Sodal A, Jonasson C, Mowinckel P. Patient compliance in a clinical trial with inhaled budesonide in children with mild asthma. *Eur. Respir. J.* 1999; **14**: 150–4.
- Burgess SW, Wilson SS, Cooper DM, Sly PD, Devadason SG. In vitro evaluation of an asthma dosing device: the smart-inhaler. *Respir. Med.* 2006; **100**: 841–5.
- Sanders M, Tully L, Baade P, Lynch M, Heywood A *et al*. A survey of parenting practices in Queensland: Implications for mental health promotion. *Health Promot. J. Austr.* 1999; **9**: 112–21.
- Demore M, Adams C, Wilson N, Hogan M. Parenting stress, difficult child behaviour and use of routines in relation to adherence in paediatric asthma. *Child Health Care* 2005; **34**: 245–59.
- Gerson AC, Furth SL, Neu AM, Fivush BA. Assessing associations between medication adherence and potentially modifiable psychosocial variables in pediatric kidney transplant recipients and their families. *Pediatr. Transplant.* 2004; **8**: 543–50.
- Watt PM, Clements B, Devadason SG, Chaney GM. Funhaler spacer: improving adherence without compromising delivery. *Arch. Dis. Child.* 2003; **88**: 579–81.
- Bender B, Wamboldt FS, O'Connor SL, Rand C, Szeffler S *et al*. Measurement of children's asthma medication adherence by self report, mother report, canister weight, and Doser CT. *Ann. Allergy Asthma Immunol.* 2000; **85**: 416–21.
- McQuaid EL, Kopel SJ, Klein RB, Fritz GK. Medication adherence in pediatric asthma: reasoning, responsibility, and behavior. *J. Pediatr. Psychol.* 2003; **28**: 323–33.