The impact of discussing exercise test results of young asthmatic children on adherence to maintenance medication

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Abstract

Objective: Parents’ awareness of their child’s asthma may improve by discussing an exercise challenge test (ECT) result with them. We investigated the influence of discussing an ECT result with parents on adherence to inhaled maintenance medication, parental illness perceptions and medication beliefs in young asthmatic children. Methods: A total of 79 children, 4–7 years old and enrolled in our standard comprehensive asthma care program, performed an ECT to assess exercise induced bronchoconstriction (EIB). The result of the ECT was immediately discussed with the parents. Median medication adherence level was measured with electronic medication loggers from six weeks before the ECT till six weeks afterwards. Parental beliefs about medicines and illness perceptions were measured with the Beliefs about Medicines Questionnaire (BMQ) and the Brief Illness Perceptions Questionnaire (B-IPQ). Results: The median baseline adherence level was high (83%) and showed a small significant decline after the ECT. There was no significant difference in the decrease in median adherence level between the children with or without EIB. Most parents (82.1%) showed a positive necessity–concern ratio at baseline, as measured with the BMQ. There was no clinical relevant change in medication concerns and necessity scores or in illness perceptions. Conclusion: Discussing ECT results with parents does not modify median adherence levels to inhaled maintenance medication nor medication beliefs of highly adherent young asthmatic children who are already enrolled in a comprehensive asthma care program.

Introduction

Most children with asthma can achieve well-controlled asthma if they use their inhaled corticosteroids (ICS) on a daily basis. Non-adherence, however, has a detrimental influence on the efficacy of ICS therapy [1–3]. One of the reasons for non-adherence is that patients (and their parents, if the patient is a child) do not understand the rationale for treatment. Although this can be overcome by providing appropriate information, studies consistently show that education alone is insufficient to improve adherence, indicating that other factors are more important in driving non-adherence [4]. A distinction can be made between unintentional and intentional non-adherence. Unintentional non-adherence is related to barriers to achieve adherence such as limited family routines and child-raising issues. Intentional non-adherence refers to patients who deliberately choose not to follow the doctor’s recommendations, based on their illness perceptions and medication beliefs. Such perceptions and beliefs have consistently been shown to be strong determinants of adherence [4]. For example, parents may overestimate disease control because they do not recognize symptoms belonging to their child’s disease, which may diminish their perception of the need of daily ICS use [1,5,6].

Exercise induced bronchoconstriction (EIB) is one such symptom, which is frequently not recognized by caregivers (especially in young children) as symptoms may be subtle [7]. An exercise challenge test (ECT) can be used for diagnosing and monitoring asthma, as well as educating parents about the symptoms of their child [8]. Our clinical impression is that discussing an ECT result with parents can have a significant impact on parent’s awareness of their child’s symptoms, especially when children are unexpectedly diagnosed with EIB [9,10]. We hypothesized that demonstrating EIB in a child may change parental perceptions about the need to use ICS and subsequently increase adherence.

The aim of our study was to evaluate the effects of discussing ECT results with parents on adherence to inhaled maintenance medication and on parental illness perceptions and medication beliefs.
Methods

Patients
We included young asthmatic children in a prospective intervention study, in which we assessed adherence to ICS, parental illness perceptions and medication beliefs before and after an ECT result was discussed with the parents. The children without a diagnosis of EIB served as controls for the children with EIB, as we wanted to assess the influence of the discussed outcome of the ECT on adherence.

Patients aged 4–7 years, with a doctor’s diagnosis of persistent mild to moderate asthma, a prescription of ICS and no experience with performing an ECT, were recruited from the outpatient clinic of the pediatric departments of three hospitals (Medisch Spectrum Twente, Enschede (MST) and Ziekenhuisgroep Twente (ZGT), Hengelo and Almelo. In our asthma clinics, comprehensive asthma management consists of 30 min consultation for newly referred patients and 15 or 30 min consultation for follow up visits, every 3–6 months to alternately a pediatrician or a nurse practitioner. During these consultations adherence is structurally assessed and education is provided to children and their parents on various aspects of self-management of asthma.

Children using metered dose inhalers (MDIs) not compatible with the adherence loggers or with other pulmonary or cardiac disorders were excluded. Children being admitted to the hospital or being prescribed systemic corticosteroids, because of an exacerbation in the last four weeks prior to the ECT, were excluded or included eight weeks later.

Exercise challenge test

The ECT was performed as previously described by van Leeuwen et al. [9]. In summary, children jumped for 6 min on a jumping castle in cold, dry air conditions (9.5–10°C) [21]. Leeuwen et al. [9]. The ECT was performed as previously described by van Leeuwen et al. [9]. The ECT was performed as previously described by van Leeuwen et al. [9]. The ECT was performed as previously described by van Leeuwen et al. [9]. The ECT was performed as previously described by van Leeuwen et al. [9]. The ECT was performed as previously described by van Leeuwen et al. [9]. The ECT was performed as previously described by van Leeuwen et al. [9].

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distribution for continuous variables, or as numbers with percentages (%) for categorical data.

Within-person changes in continuous variables (e.g. adherence) were analyzed with a paired T-test or a Wilcoxon signed rank test, as appropriate. Between-group differences in continuous variables were analyzed with the analysis of variance or a Kruskall Wallis test, as appropriate. Between-group comparisons of nominal or ordinal variables were performed by Chi-square tests. For the analysis of correlated proportions, a McNemar test was used. To assess the correlation between two continuous variables Pearson’s correlation coefficient or Spearman’s rho were computed, as appropriate.

Data were analyzed with SPSS® for Windows® version 15 (IBM, Chicago, IL) analytical software. A two-sided value of p <0.05 was considered statistically significant.

Ethical considerations
This study was approved by the hospital ethics review board. All patients provided written informed consent to participate in this study.

Results
Of the 124 eligible children, 91 entered the study after informed consent was obtained and 79 (median age 5.9 years) were analyzed (Figure 1).

Of these 79 children, 43 (54.4%) had been hospitalized because of an asthma exacerbation before. Approximately two-thirds of the parents had a low educational level. At inclusion 46 (59%) of 78 (1 missing questionnaire) had well-controlled asthma (Table 1).

Exercise challenge test
All the children achieved their target heart rate during the ECT. Forty-two children (53.2%) showed EIB after the ECT. They had a mean fall in FEV\textsubscript{0.5} of 23.9 ± 10.7% and a mean baseline FEV\textsubscript{0.5} of 79.1 ± 12.0% of the predicted value.

The children without EIB had a mean fall in FEV\textsubscript{0.5} of 7.4 ± 8.0% and a significantly higher baseline FEV\textsubscript{0.5} of 85.6 ± 11.6% compared to the children with EIB (difference 6.5% (95% CI 1.2%, 11.8%); p = 0.017).

Adherence
The median adherence in the baseline period before the ECT was 83.0% (IQR 75.1–94.4%) and was similar in children with (86.4%, IQR 71.9–92.4%) and without EIB (80.9%, IQR 59.3–97.0%; p = 0.753). Forty-four children (55.7%) showed good adherence (≥80%). The median adherence showed a small but statistically significant decrease in the period after the ECT (5.1%, 95% CI 1.4%, 8.9%; p = 0.008), which was more pronounced in the children without EIB compared to the children with EIB (2.8% vs. 7.7%, 95% CI −2.6%, 12.4%; p = 0.197). The change in adherence was similar in children with poor adherence (<80%) and good adherence (≥80%) at baseline (−4.1 ± 21.7% vs. −6.0 ± 11.7%, difference 1.9% (95% CI −9.5%, 5.7%), p = 0.62). Adherence before and after the ECT is shown in Figure 2.

Baseline adherence and change in adherence were not determined by patient characteristics (data not shown). Maternal and paternal educational levels were not related to baseline adherence (p = 0.185 and 0.845, respectively).

BMQ
At baseline 64 (1 missing, 82.1%) of 78 parents showed a positive necessity–concerns ratio as measured with the BMQ, indicating that their perceived necessity outweighed their concerns.

Table 1. Characteristics of study patients.

| Number of patients | 79 |
|--------------------|----|
| Patient characteristics |   |
| Age, years | 5.9 (5.4–6.9) |
| Boys | 45 (57%) |
| Hospitalization ever before study entry | 43 (54.4%) |
| Asthma diagnosis (years)a | 1.7 (0.3–3.2) |
| Maintenance medication |   |
| ICS | 76 (96.2%) |
| ICS + LABA | 3 (3.8%) |
| LTRAs | 11 (13.9%) |
| Asthma control |   |
| FEV\textsubscript{0.5} (% predicted) | 82.1 ± 12.2 |
| C-ACT baseline scoreb | 20.5 ± 4.2 |
| Questionnaires |   |
| BMQ positive necessity–concerns ratio | 64 (82.1%) |
| Low maternal educational levelc | 53 (67.1%) |
| Low paternal educational levelc | 54 (68.4%) |

Data expressed as mean values ± standard deviation, median with interquartile ranges or numbers (percentage).

aAsthma diagnosis: period of treatment for asthma by a pediatrician.
ICS: inhaled corticosteroid; ICS + LABA: inhaled corticosteroid and long-acting β2-agonist combination; LTRAs: leukotriene receptor antagonists. FEV\textsubscript{0.5}: forced expiratory volume in 0.5 s, percentage of predicted based on the reference values of Koopman et al. [12]; BMQ positive necessity–concerns ratio: 1 missing. The BMQ consists of 5 questions about perceived need and 5 questions about concerns (Likert scale with scores 1–5) about maintenance medication offering the possibility to calculate a necessity/concern ratio.

bC-ACT: Childhood-Asthma Control Test: a score ≤19 indicates uncontrolled asthma [9].

cLow educational level is defined as <9 years education post primary school.

[Figure 1. Flow chart of inclusion.]
concerns; at the end of the study this ratio increased to 68 (87.2%, \( p = 0.424 \)) of 78. There was a small, but significant decrease in the necessity–concerns ratio in the total study group (−1.24 ± 3.5 (95% CI 0.45, 2.04); \( p = 0.003 \)) and this decrease was similar in the EIB and non-EIB-group (\( p = 0.99 \)). The baseline BMQ necessity and concerns scores were neither associated with baseline adherence, nor were changes in necessity–concerns ratio associated with changes in adherence (all \( p \geq 0.064 \)).

**B-IPQ**

Of the eight illness perceptions at baseline (as assessed by the B-IPQ), only perceptions about treatment control showed a weak correlation with baseline adherence (\( r = 0.23, p = 0.042 \)). Nearly all illness perceptions showed a small statistically significant change from baseline of approximately 1 unit. All changes were towards less consequences, more personal and treatment control, less concerns and less emotional feelings. Only the decrease in concerns regarding the illness showed a weak correlation with less decrease in adherence (\( r = −0.22, p = 0.048 \)). These findings were similar for children with and without EIB. More details are shown in the online Supplement Table 1.

**C-ACT**

At baseline, 59.0% of the 78 children (1 missing) showed well-controlled asthma according to the C-ACT, compared to 85.9% at the end of the study (\( p < 0.001 \)). There was no correlation between baseline adherence and asthma control at the end of baseline period (\( r = −0.04, p = 0.72 \)), nor between adherence after the ECT and asthma control at the end of the follow up period (\( r = −0.02, p = 0.85 \)). During the study there were no significant differences in asthma control between the children with or without EIB (data not shown).

**Discussion**

We studied the influence of discussing an ECT result with parents on adherence to inhaled maintenance medication, in young children with asthma. We found no clinically relevant change in adherence after the ECT in children, irrespective of the presence of EIB and their baseline adherence. The median baseline adherence was high (83%) and similar in children with or without EIB. Medication beliefs of most parents (82.1%) reflected perceptions about necessity of ICS that outweighed their concerns about ICS. Medication beliefs showed a significant, but not clinically relevant, positive change after the ECT. Adherence was not related to illness perceptions, medication beliefs or asthma control.

To our knowledge, this is the first prospective intervention study investigating the effects of discussing an ECT result on adherence and parental illness perceptions and medication beliefs in asthmatic children. Our clinical impression was that when ECT results are discussed with parents they can become more aware of these symptoms, and start to realize their child’s limitations in play and sports. Two previous studies described a positive effect of lung function monitoring on adherence or asthma control.

Oei et al. [23] showed that monitoring of lung function tests every three months during one year, even without discussing the results, improved asthma control in asthmatic patients aged 14–70 years. They suggested this was due to better adherence, based on their questionnaires. Feldman et al. found a higher, electronically measured, adherence in a group of ethnic minority asthmatic children who received daily feedback on peak expiratory flow monitoring. Baseline adherence in this study group was around 60% [22]. Two reasons may explain the discrepancy between ours and previous studies. First of all, our high baseline adherence (83%) compared to that of Feldman et al. probably precluded an improvement in adherence after feedback on the ECT. Another reason could be the repetition of feedback on lung function tests which may be more effective than a single feedback intervention, as we did. We speculate discussing test results can only induce an increase in adherence in children with intentional non-adherence which is unusual in children enrolled in a comprehensive asthma care program. Potentially, our baseline adherence was high because of the Hawthorne effect, which leads to a transient increased adherence due to participation in a trial, which declines over time.

Most parents (82.1%) showed a positive necessity–concern ratio at baseline as measured with the BMQ. Parents showed a small, but statistical significant change in the necessity–concern ratio, which we interpreted as clinically not relevant. The change in their medication beliefs and illness perceptions was towards increased necessity beliefs and increased understanding of asthma after the ECT. Probably, our comprehensive asthma care program with regular visits to alternately the pediatrician and the nurse practitioner already convinced most parents of the daily use of ICS. This was reflected in a high adherence and many parents with a positive necessity–concern ratio as measured with the BMQ.

We observed similar scores of B-IPQ and BMQ items in children with a high and low adherence. This, together with the observation that children in our study with a low adherence did not improve, suggests that they experienced barriers to improvement that are difficult to influence by discussing ECT results (unintentional non-adherence). This is in line with the results of Klok et al. who showed that in a study population with a high adherence, especially family related barriers are the cause of unintentional non-adherence, for example child raising issues or missing family routines [24].
Previous literature is inconsistent about the relationship between educational level of parents and adherence [4,16]. We found no significant relation between these two, which may be due to the average high level of education in the Netherlands.

Limitations and strengths

The main strengths of our study include the objective, validated, quantitative assessment of adherence in a homogeneous group of asthmatic children. Also, all tests were performed and immediately discussed by the same investigator.

A limitation of our study is performing spirometry and ECT’s in young children. However, the investigator was very experienced in performing spirometry and ECT’s in this age group. The study protocol was designed and validated in our study center [9].

In retrospect, our study group had a high baseline adherence probably due to our comprehensive asthma care program. However, children with a lower adherence did not show an improvement in adherence either. Our results cannot be extrapolated to asthmatic children who are not in a comprehensive asthma care program, as these children probably have a higher intentional non-adherence. The unavoidable drawback of an initially adherence-improving effect of participating in a study may have influenced our findings, however because this effect was also present in children without EIB, we still can conclude that the ECT did not influence adherence.

Future research should be directed to investigate the effect of discussing ECT results with parents of children with a high intentional non-adherence, as can be found in newly referred patients who are not in a comprehensive asthma care program.

Conclusions

We conclude that discussing ECT results with parents does not influence adherence to inhaled maintenance medication in young asthmatic children who are followed up in a comprehensive asthma care program, even when these children have poor baseline adherence. The most likely explanation is that these programs are associated with low intentional non-adherence rates.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Supplementary material available online.
Supplementary Table 1