Patient Preference and Adherence

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ORIGINAL RESEARCH

The Impact of Biofeedback on Self-Efficacy in Adults with Asthma: A Cross-Sectional Descriptive Survey

Joanne Walsh[1,2], Zena Moore[1], Elaine Mac Hale[2], Garrett Greene[2], Frank Doyle[3], Richard W Costello[2], Bridget Murray[1]

[1]School of Nursing and Midwifery, RCSI University of Medicine and Health Sciences, Dublin, Ireland; [2]Clinical Research Centre, Beaumont Hospital and RCSI University of Medicine and Health Sciences, Dublin, Ireland; [3]Department of Health Psychology, RCSI University of Medicine and Health Sciences, Dublin, Ireland

Correspondence: Richard W Costello, Clinical Research Centre, Beaumont Hospital and RCSI University of Medicine and Health Sciences, Dublin, Ireland, Tel +353 01-8093761, Email rcostello@rcsi.com

Purpose: Educating patients to self-manage chronic diseases such as asthma is a key role for nurses. The success of this education is often limited by low patient self-efficacy. In this study, we hypothesized that the self-efficacy of patients could be enhanced if their education was based on biofeedback of their own self-management, following a nurse led educational intervention.

Patients and Methods: Patients with severe and uncontrolled asthma from one centre who participated in an eight-month, nurse-led asthma education and dose adjustment Randomised Control Trial (RCT) were studied (NCT02307669). Inhaler adherence and technique of use were objectively assessed using a validated digital device. The data recorded on this device was used as the basis for the individualised biofeedback. The Asthma Self-efficacy Questionnaire was used to assess self-efficacy.

Results: A total of 88 participants (44 in each group) completed the asthma self-efficacy questionnaire at the end of the study. The mean overall level of self-efficacy was high across both groups; 91 (8.7), with both biofeedback and standard care groups having similarly high levels of self-efficacy, biofeedback group: 89 (10) and standard care group 93 (6). Self-efficacy was not related to objective measures of adherence at either the start of the study, 68 (26), p=0.23, or the end of the study, 58 (32), p=0.62. It was also not related to peak expiratory flow (PEF) at the end of the study in either group (r^2= 0.0245, p=0.14). Self-efficacy was related to asthma control test (ACT), 18 (5.5), p=0.0014 and quality-of-life measures; EuroQol (EQ5D3L) 6.4 (1.5) p=0.02.

Conclusion: Repeated nurse-delivered education results in high levels of self-efficacy among patients with severe asthma. A high level of perceived self-efficacy should not be assumed to result in higher inhaler adherence.

Keywords: nursing education, patient education and self-management

Introduction

Asthma is a chronic disease that can be effectively controlled by regularly taking inhaled medications.[1] Among patients with asthma, both poor adherence to preventer treatment and incorrect inhaler technique are often the explanation for a patient's poor asthma control.[2] Hence, education on inhaler adherence and instruction on inhaler technique are central components of asthma self-management.[3] Educating patients on this aspect of self-management requires a variety of adherence promoting behaviour change techniques, as well as techniques, such as teach to goal.[4] However, delivering these aspects of self-management is time consuming, requires considerable skill and the benefits are often not sustained.[5]

Recently, a number of remote monitoring devices have been developed as a means of objectively assessing both treatment adherence and inhaler technique.[6–8] In clinical trials, both adherence and inhaler technique have been shown to be significantly improved when the data recorded on these devices are used as biofeedback for patient education.[2,8–10] Successful self-management of asthma requires sufficient knowledge of the condition, its treatment and steps involved in how to use the treatment. Aside from these practical issues, it also requires that the patient is both committed to the

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changes required and has the ability to organise and execute individual actions.[11,12] Self-efficacy is a measure of an individual's ability to manage situations and it is considered to be a critical ingredient for effective disease management.[13] Low patient self-efficacy is a recognised factor in poor treatment adherence.[13,14]

Since biofeedback of inhaler use leads to improved adherence and inhaler technique, we hypothesized that this improvement in treatment adherence may be due to increased patient self-efficacy. To address this hypothesis, we compared patient reported self-efficacy among patients who had participated in a multi-site RCT. In the trial, patients were randomised to have education delivered either using standard methods or with personalised biofeedback on the time and technique of inhaler use.

Materials and Methods

Patients

Ethical approval was granted for the Inhaler Compliance Assessment in Severe Uncontrolled Asthma (INCA Sun) study by an Independent Medical Research Ethics Committee at Beaumont Hospital and is registered on clinicaltrials.gov (NCT02307669). Once ethical approval had been granted by Beaumont Hospital Ethics Committee for this survey, participants who fulfilled the inclusion criteria were invited to take part, and written informed consent was sought and freely given by all patients before enrolment. Full details of the study have been published and are also available online.[2] This study complies with the Declaration of Helsinki. Actual adherence was calculated as previously described with a score of ≥80% considered to be fully adherent.[15,16]

Intervention

Upon completion of the INCA Sun study, participants were invited to complete an adapted version of the previously validated closed-ended questionnaire, the Asthma Self-efficacy Questionnaire, at one time point.[17] This questionnaire is a 27-item scale in total with each item marked between 0 and 100 with a higher score indicating a higher level of self-efficacy for the participant. There were four sub-scales within the questionnaire: medication, symptom management, asthma beliefs and friends, family, and school, however data was analysed using total score. The questionnaire was previously tested for reliability and validated.[17] However, as it was previously validated in an adolescent population, modifications to the questionnaire were made to focus on an adult population.

No modifications were made to the first section of "medication" from the original questionnaire. One item was removed from the second section "symptom management", "I know how to control my asthma when I am having trouble breathing". Three items were added in as these were more appropriate for this study, "I know how to use my asthma management plan", "I know how to measure my peak flow daily" and "I know how to control my asthma when my peak flow goes lower than it should be". No alterations were made to the third subsection "asthma beliefs" from the original questionnaire. The name of the fourth section was altered to just state "friends and family". The sentence, "I can take my inhalers around other people at school" was changed to "I can take my inhalers in front of my family", The sentence, "I can talk honestly to my parents about my asthma" was modified to "I can talk honestly to my family about my asthma". The sentence, "I can ask my parents for help if I am having trouble breathing or having an asthma attack" was removed. Two items added in "I can ask my friends for help if I am having trouble breathing or having an asthma attack" and "I can ask my family for help if I am having trouble breathing or having an asthma attack". A sensitivity analysis was conducted, omitting the new items added to the adapted questionnaire (Appendix 1). The adapted version of the Asthma Self-efficacy Questionnaire (Appendix 2) was then re-assessed for content validity using an expert survey group. The Content Validity Index (CVI) was calculated for all questions, exploring both appropriateness and relevance. The CVI scores for all items for appropriateness was 0.99 ± 0.03 and CVI scores relevance was 0.98 ± 0.04 all of these indicate a good CVI score.[18]

Objective Assessment of Adherence

Objective personalised biofeedback on inhaler skills and adherence was generated using Inhaler Compliance Assessment (INCA) technology. This was used as the basis for the nurse-led biofeedback inhaler training. The INCA technology is a digital audio recording device that is attached to the outside of a discus inhaler. It has been validated as a means of assessing treatment

adherence and inhaler technique. A validated summary measure of adherence to asthma preventer treatment, calculated from the data recorded on the INCA device, was used to relate adherence and measures such as self-efficacy.[8,19]

Data Collection

Data were collected and maintained in line with the new General Data Protection Regulations (GDPR). Baseline and study data that had been collected in the INCA Sun Study, such as demographics, co-morbidities, duration of asthma along with study clinical markers of PEF and adherence and questionnaires for self-efficacy, ACT and EQ5D3L were used in this study. For the purpose of this study, all participants were selected from one site, see Figure 1.

Data Analysis

The modified Asthma Self-efficacy Questionnaire remained as a 27-item scale, and this was re assessed for content validity. The data collected were analysed using PRISM software version 8.4.2. Descriptive statistics (mean and standard deviation) were conducted, and a Pearson Correlation was conducted with a 95% CI and p= <0.05 was considered significant.

Results

Eighty-nine subjects from one site completed the assessment, and the flow of participants is shown in Figure 1. The baseline characteristics of the participants are shown in Table 1. The study population were predominantly female (66%) with features of increased Body Mass Index (BMI), anxiety, and depression. The duration of asthma, along with study clinical markers of PEF and Adherence and questionnaires: Self-efficacy, ACT and EQ5D3L indicate that the population was quite representative of severe asthma populations that have been published.

Asthma Self-Efficacy Questionnaire

The questionnaire is scored from 0 to 100 with a lower score indicating a lower level of self-efficacy. The questionnaire contains four subsections: “Medications”, “Symptom Management”, “Asthma Beliefs” and “Family and Friends”. The asthma beliefs subsection had the lowest overall mean score of 81 (23); 75 (27) in the biofeedback group, and 88 (15) in the standard care group, which was statistically significant p=0.004. Both the biofeedback and standard care group scored

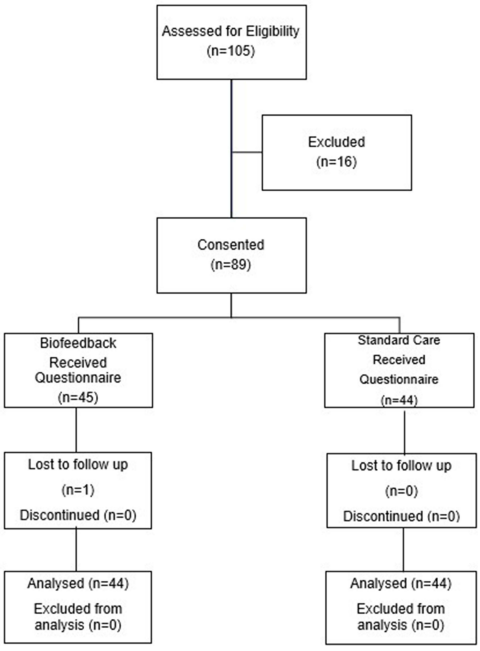

Figure 1 Flow of study participants through the study.

Table 1 Demographic Data of Study Population

Demographics	Overall (n=88)	Biofeedback (n=44)	Standard Care (n=44)
Sex (F)	66% n=58	64% n=28	68% n=30
Age	51.1 (14.3)	50.5 (14.8)	51.7 (13.9)
Height (cm)	166.7 (9.4)	167.2 (9.2)	166.2 (9.8)
Weight (kg)	82.0 (20.3)	81.6 (20.6)	82.3 (20.3)
BMI kg/m^2	29.5 (6.9)	29.1 (6.4)	29.8 (7.4)
Anxiety	8% n=7	9% n=4	7% n=3
Depression	11% n=10	9% n=4	14% n=6
Asthma Onset (yrs)	27.2 (21.4) n=87	24.5 (17)	32 (28.3)
PEF Month 8	420 (134.5)	416.8 (145.8)	423.3 (123.7)
Self-efficacy Score	91.5 (8.4)	89.8 (9.8)	93.3 (6.2)
Adherence Month 1	68 (26.3)	67.4 (25.4)	68.5 (27.4)
Adherence Month 8	57.8 (32.5)	66.7 (29.6)	49 (33.7)
ACT Month 8	17.8 (5.5) (n=85)	16.7 (6.1) (n=42)	19 (4.6) (n=43)
EQ5D3L Month 8	6.4 (1.5)	6.5 (1.6)	6.2 (1.3)

Note: Mean scores and (standard deviation) are shown for all data collected.
Abbreviation: Sex (F), Female.

highest in the medication subsection biofeedback 97 (6) standard care and 96 (6), see Table 2. None of these were statistically different.

Factors Related to Self-Efficacy

There was no significant relationship between patient reported self-efficacy and actual adherence at both month 1 (68 (26); r^2= 0.033, p=0.23) and month 8 (58 (32); r^2=0.005, p= 0.62), see Figure 2A and B below. The mean difference in actual adherence between month 1 and month 8 in relation to self-efficacy for all participants in both biofeedback and standard care groups is shown in Figure 2C below. Self-efficacy was significantly related to the ACT at month 8 in both biofeedback and standard care groups (r^2= 0.1167, p<0.001), see Figure 2D. Similarly, self-efficacy was related to the EQ5D3L (r^2= 0.05; p=0.02) in the biofeedback and standard care group. This is shown in Figure 2E. Self-efficacy was not related to PEF at month 8 in both biofeedback and standard care groups (r^2= 0.0245, p=0.14), shown in Figure 2F.

Table 2 Mean Self-Efficacy Scores for Each Subsection

Subsections	Biofeedback n=44	Standard Care n=44	P values
Medication	96.7 (5.5)	98 (4.0)	p=0.214
Symptom Management	90.2 (10.5)	90.9 (10.4)	p=0.785
Asthma Beliefs	74.6 (26.8)	88.2 (15)	p=0.004
Friends & Family	95 (12.1)	97 (5.9)	p=0.338

Note: Mean scores and (standard deviation) are shown for all data collected.

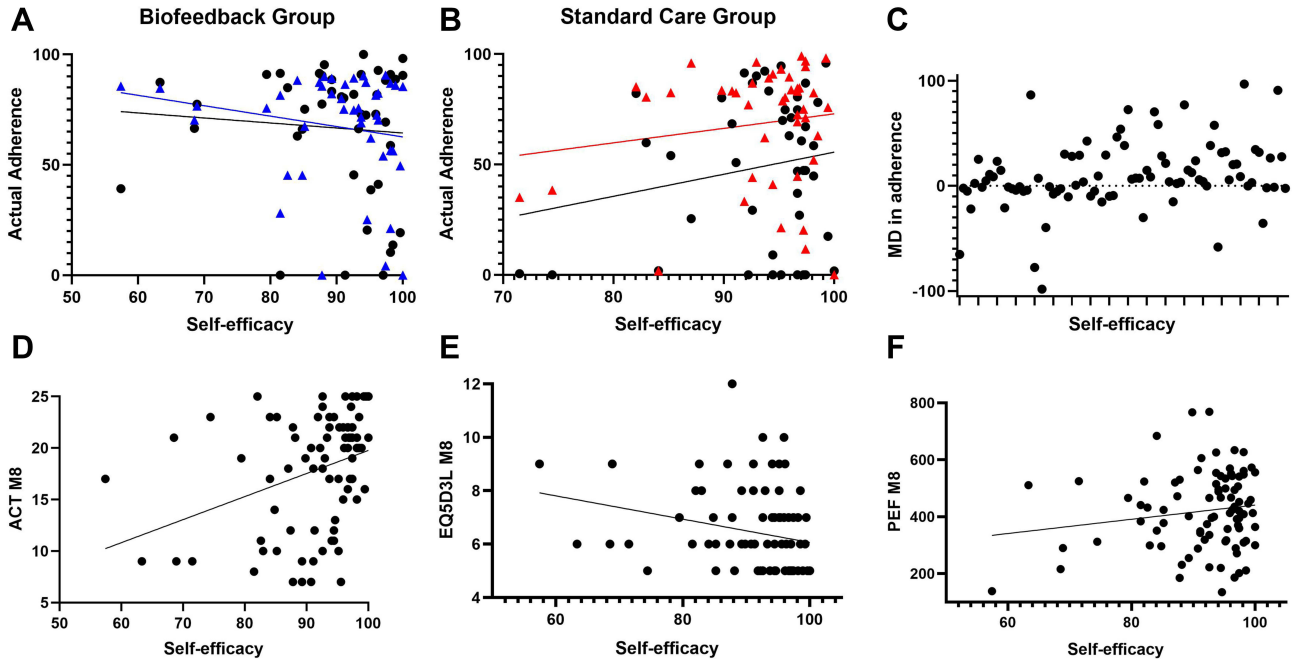

Figure 2 Scatter plots showing; (**A** and **B**) mean actual adherence for month 1 (blue and red triangles) and month 8 (black dots) for both groups, (**C**) mean difference in actual adherence between month 1 and month 8 in relation to self-efficacy in both groups, (**D**–**F**) relationship of self-efficacy to ACT, EQ5D3L and PEF.

Discussion

Effective communication, education and support from healthcare professionals are crucial in building confidence in asthma self-management (GINA, 2021). Since self-efficacy is a measure of confidence in self-management, we assessed this measure in a cohort of patients with severe asthma who participated in a nurse-led asthma education study. The results of this study showed that at the end of the study there were high levels of self-efficacy among the patients regardless of trial allocation, the overall mean self-efficacy level was higher than that found in previous studies.[14] Unexpectedly, among the participants, high levels of self-efficacy were associated with declining levels of objectively measured adherence, and we can see this clearly displayed in Figure 2A and B with a between-group difference in the correlation. We believe this is related to the biofeedback group having a more realistic perception of their own self-efficacy due to receiving objective biofeedback about their adherence habits. However, the data clearly shows us that the standard care group perceives themselves to have a higher level of self-efficacy, but this does not translate into behavioural change as shown by their decline in adherence between month 1 and month 8 of the study.

This data suggests that an education program results in high levels of patient perceived self-efficacy, but this does not translate to other aspects of self-management such as treatment adherence.

The results of this study also show that both groups felt most confident in the "medication" subsection of the self-efficacy questionnaire. This was due to the nature of the educational intervention that all groups received during the study. However, both the biofeedback and standard care groups reported feeling least confident in the "asthma beliefs" subsection, which examined individuals' perceived ability to control asthma and its effect on daily life. We are unsure of the significance of this finding, but it may reflect the unpredictable nature of daily life and exacerbations, when they occurred despite overall excellent treatment adherence.

Patient reported self-efficacy related more to the patient's own level of perceived health status and their asthma control. This was demonstrated by the standard care group who reported feeling most confident and knowledgeable in the medication subsection and overall self-efficacy but displayed a decline in actual adherence over the course of the study. A loop of reinforcement may arise when the healthcare professional is reassured by the patient's apparent confidence after an educational program, suggesting that educational programmes should include an objective intervention of

effectiveness over and above simple demonstration.[8] Encouraging patients to change behaviours is an important role of the nurse; this is done through education, communication, and support and building confidence to self-manage.

Previous research has shown that personalised biofeedback improves and sustains adherence,[8] as demonstrated by the biofeedback group in month 8, compared with the standard care group who showed a decline in adherence. The results of these studies suggest that it is better directly assessed with an objective tool such as a digital adherence device. Objectively measured adherence was not related to self-efficacy in our study. This is a new finding from this study as it has been stated in the literature previously that self-efficacy could influence adherence.[14]

Strengths

A major strength of this study is that it is the first to directly assess the impact of biofeedback on the self-efficacy of adults with asthma using a digital adherence technology. The findings clearly show that patient education using biofeedback on personal data does not enhance self-efficacy over that of repeated re-enforcement of standard self-management.

Limitations

A limitation of this study was that there were no previous questionnaires developed to specifically measure the self-efficacy of adults in asthma self-management. The Asthma Self-efficacy Questionnaire used was originally validated for use in adolescents with asthma and was adapted for the purpose of this research study. Another limitation of this study is that there were no pre-intervention measurements of self-efficacy recorded in both groups. However, it is generally recognised that self-efficacy is low among patients with severe asthma, so it is arguably more important that it was good at the end of the study. All participants were selected from one site, this is another limitation of this study.

Conclusion

The results of this study reiterate the importance of educational interventions in improving self-efficacy among adults with asthma. However, clinicians cannot assume that this will in turn lead to increased self-management. Instead, aspects of self-management should be directly assessed with an objective assessment of the process, such as digital measures of treatment adherence.

Abbreviations

RCT, Randomised Control Trial; PEF, Peak Expiratory Flow; ACT, Asthma Control Test; EQ5D3L, EuroQol; INCA Sun, Inhaler Compliance Assessment in Severe Uncontrolled Asthma; CVI, Content Validity Index; INCA, Inhaler Compliance Assessment; GDPR, General Data Protection Regulation; BMI, Body Mass Index.

Data Sharing Statement

Individual anonymised data pertaining to this study will be available upon written request from the corresponding author for five years post publication.

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Disclosure

Dr Frank Doyle reports a pending patent “A method for monitoring adherence to medication” to European Patent Office. The author reports no other conflicts of interest in this work.

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