Taibah University

Journal of Taibah University Medical Sciences

Original Article

Effectiveness of a reminder card system versus a mobile application to improve medication adherence among asthma patients in a tertiary care hospital

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الملخص

أهداف البحث: الربو مشكلة صحية عامة رئيسة تؤثر على عدد كبير من الأفراد حول العالم. وتعتمد فعالية الأدوية على الالتزام بتعليمات الواصف. هدفت هذه الدراسة إلى تقييم ومقارنة فعالية نظام بطاقة التذكير مقارنة بتطبيق الجوال لتحسين التزام مرضى الربو بالدواء في مستشفى للرعاية الثالثية.

طرق البحث: أجريت هذه الدراسة التداخلية الاستطلاعية في مستشفى للرعاية الثالثية، لمقارنة مدى الالتزام بين مجموعة تطبيق الهاتف الجوال ومجموعة البطاقة. وتم الحصول على الدرجات باستخدام مقياس "مورسكي" للالتزام بالدواء.

النتائج: في مجموعة البطاقة، أظهرت مقارنة الدرجة الأساسية من الالتزام بالدواء بدرجة المتابعة، فارقا متوسطه ٣.٤٤. وأظهرت مجموعة التطبيق فارقا متوسطه ٤.٠٢ الذي يعكس ارتباطا عالي الأهمية. وأظهرت مقارنة فعالية بطاقة التذكير بفعالية تطبيق الجوال فارقا متوسطا قدره ٠.٧٢ عند خط الأساس، مما يدل على عدم وجود اختلاف كبير عن حالة الالتزام قبل التدخل. وبعد التدخل أظهر فارقا متوسطا قدره ٠.٨٦؛ مما يعكس اختلافا كبيرا في حالة الالتزام بعد التدخل.

الاستنتاجات: يمكن لتوفير الأدوات التداخلية المناسبة أن تحسن الالتزام الدوائي بالنسبة للربو. وبمقارنة التدخلين، وُجد أن تطبيقات الهاتف الجوال لها فعالية أكبر من بطاقات تذكير الدواء.

الكلمات المفتاحية: الالتزام العلاجي للربو؛ بطاقة تذكير الدواء؛ تطبيقات الهاتف الجوال

Abstract

Objectives: Asthma is a major public health problem affecting a large number of individuals worldwide. The effectiveness of medications depends on adherence to the instructions of the prescriber. This study aimed to assess and compare the effectiveness of a reminder card system versus a mobile application to improve the medication adherence of asthma patients in a tertiary care hospital.

Methods: This prospective interventional study was conducted at a tertiary care hospital. The scores were obtained from the Morisky medication adherence scale.

Results: In the card group, comparison of the baseline and follow-up scores for medication adherence showed a mean difference of 3.44, $p = 0.001$. The application group showed a mean difference of 4.02, $p = 0.001$, which reflects a highly significant association. Comparison of the effectiveness of reminder cards and the mobile application showed a mean difference of 0.72, $p = 0.088$ (>0.05) at baseline, showing no significant difference in adherence status before intervention. After intervention there was a mean difference of 0.86 ($p = 0.001 < 0.05$), indicating a significant difference in adherence status.

Conclusion: Provision of proper interventional tools can improve asthma medication adherence. In this study, the mobile application was found to be more effective than medication reminder cards.

Keywords: Asthma adherence; Medication reminder card; Mobile application

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Introduction

Over the past century, rapid advances have been made in the management of many chronic and acute health problems requiring medication therapy, including diabetes, hypertension, high cholesterol, tuberculosis, and asthma. When left untreated or undertreated, these conditions often lead to complications that decrease patients' quality of life and increase the risk of death.[1]

To successfully treat a medical condition with medication, three equally important elements must be present and work synchronously. First, the condition has to be properly diagnosed; second, medications must be available; and last, treatments must be followed according to the prescriber's instructions. Strong evidence shows that many patients with chronic illness have difficulty adhering to their recommended medication regimen.[2] Adherence to medication is the process by which patients take their medication as prescribed, further divided into three quantifiable phases: initiation, implementation, and discontinuation.[3] Non-adherence encompasses a wide range of behaviours, both intentional and unintentional, that lead to either underuse, overuse, or erratic use of prescription medications.[4] Special effort and attention should be devoted to addressing the issue of nonadherence in chronic disease patients, as a WHO report estimates that 50% of patient with chronic diseases in developed countries do not take their medications as prescribed.[3]

Asthma is a major public health problem affecting a large number of individuals of all populations. The most recent reviewed global estimate of asthma suggests that as many as 334 million people have asthma and that the burden of disability is high (global burden of disease study (GBD); 2008−2010).[5] In asthma, adherence rates are particularly challenging and range from less than 30% to 70−80%, with less than 50% of children adhering to their prescribed inhaled medication regimen. The main causes of non-adherence in asthma patients include anxiety regarding side effects, dependence, overdosage, awkwardness of taking medication via a large volume spacer, denial of being asthmatic or of the severity of the illness, the inconvenience of treatment, forgetfulness, laziness, or carelessness, and unwillingness to adapt their lifestyle, e.g., to quit smoking.[6] Integration of personal effort with technology-driven medication adherence reminders may improve medication adherence and have a positive effect on chronic disease outcomes.

There are four types of intervention groups suggested by Kripalani et al. for improving medication adherence: informational interventions, behavioural interventions, family and social interventions, and combined interventions. A medication reminder card is a simple, visual way to show all of the medications that a person needs to take on a regular basis using pictures and simple phrases to show each medicine and its purpose, how much to take, and when to take it. It is easier to understand than the complicated information and instructions which typically come with medicines. Interventions using reminders are primarily based on the principles of behaviour learning theory. Mobile applications for medication adherence are regarded as an innovative, non-invasive approach to evaluating and improving adherence rates in patients.[7] These can potentially consolidate all the medication-specific information in a repository for the patient which is constantly accessible, and thereby provides a systematic and efficient process to coach patients about their disease condition and care. Currently available medication adherence apps include MedCoach, Medisafe, Medi-Prompt, and My Med Schedule.

Various methods have been reported to measure adherence which can be divided into direct and indirect methods of measurement. Self-report measures are simple and economical tools which can provide real-time feedback regarding adherence behaviour and potential reasons for poor adherence, including social, situational, and behavioural factors affecting adherence. To measure medication adherence, one method is the medication adherence questionnaire by Morisky et al., the best known and most widely used scale for measuring medication adherence, which identifies barriers to nonadherence but not set efficiency. Items in the scale address barriers to medication taking and permit health care providers to reinforce positive adherence behaviour.[8] This study was conducted to assess and compare the effectiveness of a medication reminder card system versus a mobile application to improve the medication adherence of asthma patients in a tertiary care hospital.

Materials and Methods

A prospective interventional study was carried out for a period of six months in 100 asthma patients of age greater than or equal to 18 years in the pulmonology department of a tertiary care referral hospital at Malappuram. Male and female patients who had been receiving drugs for asthma for one month who were willing to participate were enrolled in the study. Patients whose first language is not Malayalam, health care professionals and pregnant women, and patients with psychiatric co morbidities were excluded from the study. A data collection form was designed and validated to collect information necessary for the study. The Adherence Survey Form was developed based on the MMAS-8 for self-reporting of medication adherence by patients. The survey form consists of eight questions, each with a yes or no answer. Scoring for each question was as follows: For each 'yes' option a score of 0 was given, and for each 'no' option, 1 was given. A high adherence score was set as > 8, medium adherence scores were set in the range 6−8, and a low adherence score was set as < 6.

A medication remainder card was designed for asthma patients based on a review of the literature to improve adherence towards medication. The mobile application named Medisafe was selected. It is an offline application of 16.07 MB, and its version 5.2.8 (Build 225, Medisafe Project Ltd.) was used. This app allows patients to manually program the alerts. Medisafe also allows users to adhere to their medication schedules with a clean and simple interface. In the pre-intervention phase, the design of the study and target area identification (outpatients in the department of pulmonology) were carried out first. A data collection form was designed and questionnaires developed to assess adherence. Patients' demographic details were collected during their

outpatient visit, and upon enrolment, patients were evaluated for medication adherence using the adherence survey form.

In the intervention phase, proper interventional tools were selected in this phase suited to the patient. Patients were divided into two groups. The first group were provided with a medication reminder card which contains details about the order in which the medications are to be taken, and the second group were provided a mobile application which gives alert messages to patients at their administration time. The post-intervention phase mainly consisted of follow-up visits. Most of the patients were followed up in subsequent appointments at an interval of one month to reassess their adherence score, and the others were followed up by telephone interviews. The adherence score at the time of follow-up was recorded using the same adherence survey form, on the basis of which statistical analyses were carried out. Data collected from the study were tabulated in Microsoft Excel 2010 and keyed into the Statistical Package for Social Science (SPSS Inc. Chicago, II, USA) computer software version 20 for windows and analysed by appropriate statistical methods. Statistical analysis was both descriptive at 95% confidence level. Continuous variables were analysed using means, percentages, and standard deviations, while discrete variables were analysed using proportions. Chi-square tests, independent *t*-tests, and paired *t*-tests were used for the statistical analysis of the follow-up clinical data variables. A two-tailed probability value < 0.05 was considered statistically significant.

Results and discussion

This study was designed to compare the effectiveness of the medication reminder card and mobile application in improving the medication adherence of asthma patients. During the six-month study period, a total of 100 patients were identified and enrolled in the study, of whom 50 patients were provided with medication reminder cards and the other 50 patients with the mobile application. Of the patients in the card group, 40% were male and 60% were female, while in the application group, 50% patients were male and 50% were female. No significant difference between male and female patients was found between the groups ($\chi^2 = 1.01$, $df = 1$, $p > 0.05$), so there was no significant relationship between asthma and gender ($p > 0.05$) in our study population. In the card group, the highest number (20%) of patients belonged to the age group above 45, and the fewest patients (1%) belonged to the 36–40 age group. In the application group, the highest number (15%) belonged to age group 25–30 and the fewest (3%) to the 41–45 age group. There is no significant difference in the numbers of patients in different age groups ($p > 0.05$).

Usually the development of asthma in adults is associated with a past medical history of either childhood asthma or allergic rhinitis. In the card group 86% of patients had allergic rhinitis and 42% had childhood asthma, while in the application group 64% had allergic rhinitis and 40% had childhood asthma (Figure 1). In both groups, the number of patients with allergic rhinitis was higher than that with childhood asthma, and there was no significant correlation between childhood asthma and adult asthma ($p > 0.05$).

However, there was a significant association between allergic rhinitis and asthma ($p < 0.05$). This study correlates with Compalati et al.,[9] in which association between allergic rhinitis and asthma was found to be significant. In the card group, 30% had a history on the maternal side and 14% on the paternal side, while in the application group, 28% had a history on the maternal side and 16% on the paternal side. Here the association between asthma and family history is slightly greater on the maternal side. This matches the results of Augusto et al.[10]

In the card group, the highest number of patients had GERD (60%), followed by DM (32%), and 30% had HTN. In the application group, the highest number of patients had GERD (48%) followed by 12% of patients had DM and HTN respectively. There were more patients with GERD than HTN and DM in both groups (Figure 2), and the association between asthma and comorbidities is greater for GERD than for DM and HTN. This corresponds to the findings of Subhashini et al.,[11] and shows that the prevalence of GERD in asthmatics was 51.9% and higher in female asthmatics than in men. Moreover, out of 100 patients in the selected population, 25% were smokers, showing that there was no significant association between smoking and asthma ($p > 0.05$) in our study population.

Pills, inhalers, and aerosols are the most common dosage forms of asthma medications. In this study we evaluated the patients' adherence to these dosage forms. Out of 100 patients, 56% patients showed high, 42% medium, and 2% low adherence to pills. In the case of inhalers, 64% had medium, 29% low, and 7% high adherence, but in the case of aerosols, only 4% showed high adherence, while 62% had medium and 34% low adherence. Out of 100 patients, only 2% showed high adherence to spacers, 43% medium, and 55% low adherence (Figure 3). Adherence status showed a highly significant difference before and after intervention. Before intervention, 'low' adherence was significantly higher than 'medium' and 'high' adherence, while after intervention there was a significant increase in 'medium' and 'high' adherence. According to this study, adherence to inhalers and spacers is lower than for other dosage forms. This matches the findings of Bender et al.[12]

To assess the adherence score of patients, the 8-item Morisky medication adherence questionnaire (MMAS-8) was used. This self-reporting scale contains a series of eight questions. In the card group, 90% of the patients responded that they are forgetful in taking their medication, which after intervention was reduced to 8%. In the application group 92% showed forgetfulness, while after the application
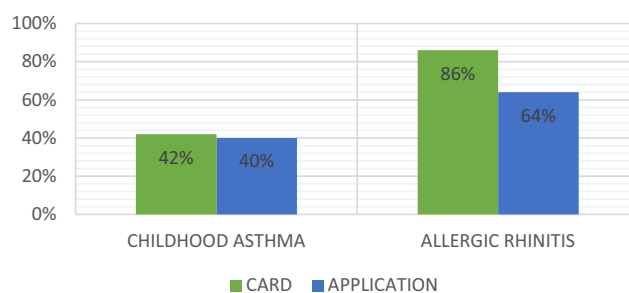

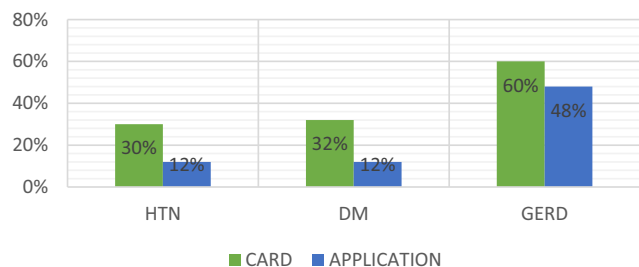**Figure 1:** Past medical history of asthma.

Figure 2: Comorbidities of asthma.

Figure 4: Comparison of adherence status in card group before and after intervention.

was installed nobody responded 'yes'. At baseline, 50% of the patients in both the card group and the application group agreed that they sometimes miss taking their medication for reasons other than forgetting, while after intervention only 12% responded 'yes'. In the card group, 42% of the patients agreed that they sometimes stop their medication without telling their doctor, which after intervention was reduced to 4%. After intervention, the application group showed a significant decrease in stopping medication: Almost 74% of the patients had forgotten to take their medicine when travelling or leaving home, and this was reduced significantly after intervention. Most of the patients (54% in the card group and 68% in the application group) stopped taking their medication when they felt like the symptoms were under control, while after intervention this was reduced to 20% in the card group and nobody stopped their medication in the application group. Both the card group and application group indicated that it was inconvenient to stick to their treatment plan even after the provision of intervention. Question 8 in the MMAS-8 scale was used to assess the patient's level of difficulty in remembering their medication. In the card group, 34% choose the option 'sometimes' and 34% 'usually' at baseline, while after intervention, 52% choose the option 'once in a while'. In the application group, on the other hand, 50% of the patients agreed that they usually forget to take their medicine, but after intervention 60% agreed that they forget to take it only once in a while.

We conducted this study to compare the change in the adherence status of asthmatics before and after the provision
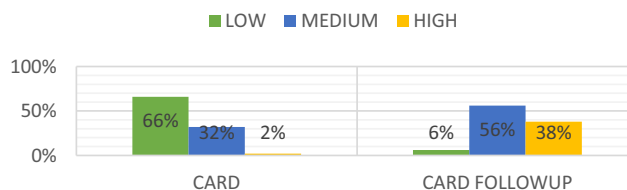
of the respective interventions. In the card group, rates of low adherence (66%) were higher than medium and high adherence (2%) before intervention, while after intervention the rate of low adherence was reduced to 6% and high adherence increased to 38% (Figure 4). Comparison of the baseline score of medication adherence with that at follow-up revealed a mean difference of 3.44, $p = 0.001$ (Table 1), which shows a highly significant association (at a 5% level of significance) between medication adherence and the intervention provided (pill reminder card). This finding is comparable to that of the study conducted by Hayenes et al.[13] In the application group, low adherence (82%) was higher than medium and high adherence (0%) before intervention, while after intervention medium (48%) and high (52%) adherence showed significant increases and nobody showed low adherence (Figure 5). Comparison of the baseline score of medication adherence with the follow-up revealed a mean difference of 4.02 ($p = 0.001$) (Table 2), which showed a highly significant association at a 5% level of significance between medication adherence and the intervention provided (mobile application). This matches the study findings of Ganger et al.[14]

Comparison of the effectiveness of the pill reminder card and the mobile application in improving the medication adherence of asthma patients showed a mean difference of 0.72 and a p value of 0.088 (>0.05) at baseline, which reveals no significant difference in adherence status before intervention. After intervention, comparison of the card and application groups showed a mean difference of 0.86, and a p value of 0.001 significant at a 5% level of significance (Table 3), which indicates a significant difference in adherence status after intervention. This study concludes
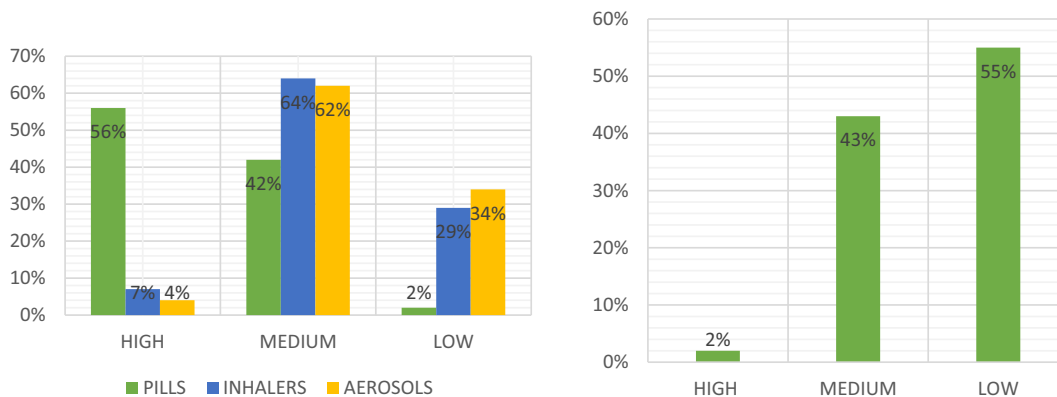

Figure 3: Adherence behaviour to different dosage forms.

Table 1: Score obtained − comparison of card group (*n* = 50).

	Mean	*SD*	*t* value	*p* value
Card	4.28	2.17	14.17	0.001[a]
Card follow up	7.72	1.40		

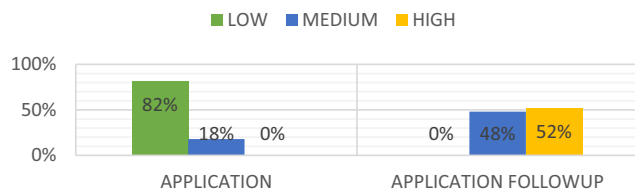[a] Significant at 5% level of significance.

Figure 5: Comparison of adherence status in application group before and after intervention.

Table 2: Score obtained − comparison of application group (*n* = 50).

	Mean	*SD*	*t* value	*p* value
Application	3.56	2.00	16.64	0.001[a]
Application follow up	8.58	1.07		

[a] Significant at 5% level of significance.

Table 3: Comparison between card and application group.

Score obtained	Group	Mean	*SD*	Mean difference	*t* value	*p* value
Before	Card	4.28	2.17	0.72	1.726	0.088
(*n* = 100)	Application	3.56	2.00			
After	Card	7.72	1.40	0.86	3.45	0.001[a]
(*n* = 100)	Application	8.58	1.07			

[a] Significant at 5% level of significance.

that the mobile application is more effective than the pill reminder card in improving medication adherence in asthma patients.

Conclusion

From this study, it was found that the medication adherence was very low among asthma patients before intervention and the overall adherence was significantly increased after intervention. Forgetfulness is a major barrier to adherence, which can be significantly reduced with either the pill reminder card or the mobile application. The majority of asthma patients had a past medical history of allergic rhinitis. Among the major comorbidities, the prevalence of GERD was the highest among this sample of asthma patients. This study confirms the need for patients with asthma to be evaluated for GERD and to be treated to reduce morbidity.

This study concludes that the provision of proper interventional tools can improve asthma medication adherence,

and of the two interventions, the mobile application was found to be more effective than the medication reminder card.

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

The study was approved by the institutional ethics committee of KIMS Al Shifa Hospital in accordance with a dissertation proposal as per letter reference KAS/ADMN/AC/EC/158/2016.

Authors' contributions

Linu Mohan P and Swaliha Shaji conceived and planned the work. Linu Mohan P supervised the experiment and all others collected the data. All are contributed in the preparation of results, manuscript and its revision. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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