

Pitfalls of inhalation technique in chronic asthmatics

Effect of education program and correlation with peak expiratory flow

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ABSTRACT

Objectives: To determine the pattern of pitfalls of inhalation technique in chronic asthmatics; to assess whether an educational program can reduce the pitfalls of inhalation technique; and to evaluate whether reduction of the pitfalls could have a positive correlation with peak expiratory flow (PEF) measurements.

Methods: The pitfalls of inhalation technique in 106 chronic asthmatics using either metered dose inhaler (MDI) (65%) or turbuhaler (35%) were studied prospectively. The pitfalls of inhalation technique and PEF measurement were recorded before and after an educational program at first and second visit. It was performed in the outpatient's asthma clinic of the King Abdul-Aziz University Hospital, Jeddah, Kingdom of Saudi Arabia, from October 2001 until March 2002.

Results: Among the MDI group; failure to breath hold for 5–10 seconds (52.2%) and failure to breath in slowly and deeply after inhaler activation (46.4%) were the most

common pitfalls that have been reduced after education (20.3%, 21.7%). While in the turbuhaler group; failure to breath hold for 5-10 seconds (23.1%) and failure to twist the grip forward and backward before use (21.1%) were the most common pitfalls that have been reduced after education (0%, 0%). In both groups, the education program has been significantly contributed in reducing the mean number of pitfalls among MDI and turbuhaler users with $p < 0.001$ and $p = 0.002$. Moreover, the mean PEF has been improved significantly from 312.4 ± 109.9 l/minute to 331 ± 105.8 l/minute ($p = 0.003$).

Conclusion: An educational program used in the outpatient's asthma clinic has been significantly reduced the pitfalls of inhalation technique. The reduction of the pitfalls correlated positively with an increase in the PEF measurement. Therefore, we recommend such an education to be used in patients using such inhalers.

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The inhaled aerosols have become the most effective therapeutic intervention used in the management of chronic asthma.¹⁻³ From our observation, the 2 most commonly used inhaler devices

in our asthmatics are metered dose inhaler (MDI), and dry powder inhaler (turbuhaler). Metered dose inhaler were introduced in 1956 as the first portable source of therapeutic aerosols.³⁻⁵ Since then, it has become the

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most widely used method of delivery of B2 agonists and inhaled corticosteroids in asthmatics.⁶⁻⁹ Poor inhalation technique has been recognized for many years as one of the major disadvantages of using MDI in asthmatics.^{3,10-16} For effective drug deposition in the lungs, accurate coordination between actuation of MDI and inhalation by the patients is essential.¹⁷ Turbuhaler was the first multi dose dry powder inhaler that introduced in the 1970s.⁴ Turbuhaler is capable of supplying as many doses as conventional MDI, and the maneuver required for its use is easier than that for MDI.⁴ Turbuhaler eliminates coordination problem as aerosol is generated by the force of patient's inspiration. However, the loading dose of turbuhaler as with any inhaler requires understanding and skill, and the patient must learn the correct technique.⁴ The importance of patient's instruction and training in correct usage of the inhalers has often been underestimated.¹⁸ Poor inhalation technique is not limited to the patients themselves, but medical personnel responsible for educating patients in their proper use may not understand the factors responsible for optimal aerosol delivery.^{19,20} In a recent study from Riyadh, Kingdom of Saudi Arabia (KSA), up to 53% of asthmatics were unable to use their inhalers correctly.²¹ The latest national and international guidelines for management of asthma have stressed the importance of educating each asthmatic on how to use inhalers correctly to achieve a better control of asthma.⁶⁻⁹ A previous study from our center showed asthmatics that have been taught repeatedly on using their inhalers correctly as a part of a protocol for asthma management had significant reduction of emergency visits (ER) and hospitalization.²² However, there was no previous study in KSA to evaluate the pitfalls of the inhalation technique, and to assess the effect of an educational program on our asthmatics. Therefore, the aims of this study were to determine the pitfalls of inhalation technique in chronic stable asthmatics using 2 different inhalers (MDI or turbuhaler), to assess whether an educational program could reduce the pitfalls of the inhalation technique and in addition, to correlate whether the improvement of inhalation technique, if any, could reflect on the peak expiratory flow (PEF) measurements.

Methods. This study was performed prospectively in the outpatient's asthma clinic of King Abdul-Aziz University Hospital (KAUH), Jeddah, KSA. The duration of the study was 6 months; from October 2001 to March 2002. Among 130 asthmatics with poor inhalation technique recruited for this study, 24 patients were excluded as 15 have lost follow up while 9 have developed an acute exacerbation of asthma between the 2 visits that required changes in the doses of medications. All patients were fulfilling the American Thoracic Society definition and diagnosis of asthma.²³ The inclusion criteria were: chronic stable asthmatics, on regular use of inhaled devices (MDI, or

turbuhaler), incorrect inhalation techniques, non-smoker, aged >13 years and a signed consent form. The exclusion criteria were: asthmatics with correct inhalation technique, smoker, development of acute exacerbation of asthma between the 2 visits that required changes in the doses of their medications, and subjects with chronic obstructive airway disease even if they were using MDI or turbuhaler devices. Each patient has visited the asthma clinic twice. The duration between each visit was approximately 6-8 weeks. On arrival to the asthma clinic in the first visit, the author was clinically evaluated each patient. The personal data that include age, sex, nationality, duration of asthma, doses, and types of medications used were recorded. The inhalation technique was checked. The peak flow rate was measured and the best of 3 readings was taken. Patients were asked to report any acute exacerbation of asthma or any changes in the medications have been taken place between the 2 visits.

The education program. A full time nurse interested in asthma education has provided the educational program. She has been involved in the entire period of the study. All patients referred from the asthma clinic with incorrect inhalation technique were asked initially to demonstrate the way of using their inhalers before starting the educational program. It consisted of the followings: 1) to check and record each pitfall that the patients have been committed during demonstration of their inhalation technique, 2) to record the pitfalls in the checklist for each device (1-11 for MDI and 1-7 for turbuhaler), 3) to inform the patients on the pitfalls that has been made at the end of their own demonstration, 4) to demonstrate the correct way of using the inhaler device step by step and to stress on the various points of pitfalls that have been carried out, 5) to check again the inhalation technique at the end of education and 6) to repeat demonstration for patients still having difficulty until they master the technique without error. The importance of using the inhalers correctly was stressed to each patient at the end of the visit. The duration of the education was approximately 15-20 minutes that has been repeated at each visit. Placebo samples or patients own devices were used for demonstration.

Scoring of the pitfalls of inhalation technique. The score of the pitfalls of inhalation technique was recorded in each patient at each visit. Asthmatics were considered to have a correct inhalation technique for MDI or turbuhaler if they have performed all the steps correctly. The pitfalls of inhalation technique were recorded from one to 11 for MDI and from one to 7 for turbuhaler. A checklist containing the correct steps of inhalation technique for devices has been used to assess the pitfalls of inhalation technique. The pitfalls were checked and recorded in the first visit and after the educational program at the second visit. The MDI technique checklist has included the following steps; 1) remove

the cover from the mouth piece, 2) shake the inhaler before use, 3) hold the inhaler in a correct position (hole down), 4) breath out to functional residual capacity before inhalation, 5) raise the head, 6) place the inhaler in the mouth with lips seals tight around it, 7) activate inhaler during inhalation, 8) continue to breath in slowly and deeply after activation, 9) breath hold for 5-10 second, 10) wait 30 second before activation of the second dose and 11) take a single inhalation at a time. The turbuhaler technique checklist has included the following steps; 1) unscrew and lift off the inhaler cover, 2) twist the grip forward (to the right) and backward (to the left), 3) start inhalation only after hearing the click, 4) breath out to functional residual capacity, 5) breath in slowly and as deeply as possible, 6) hold breath for 5-10 second after inhalation and 7) stop using turbuhaler when it becomes empty (red indicator at the bottom of the window). On the second visit, 6-8 weeks later, each patient was clinically evaluated. The doses of the medications used, measurement of PEF and the pitfalls of the inhalation technique were checked again and compared with the records of the first visit.

Results. A total of 106 patients were studied, 54.7% were Saudis and almost three quarters (76.4%) were females. Their mean age was 40.2 ± 14.2 years and the mean duration of asthma was 11.2 ± 10.4 years. They were using 2 different devices in the form of MDI (65%) and turbuhaler (35%). Among the MDI group, the 3 most common pitfalls that observed in using the inhaler at the first visit were failure to breath hold for 5-10 seconds (52.2%), failure to breath in slowly and deeply after the inhaler activation (46.4%), and activation the inhaler while breathing out (42%) that have been reduced after education to 20.3%, 21.7%, 15.9%. While the corresponding pitfalls among the turbuhaler group were also failure to breath hold for 5-10 second (23.1%), failure to twist the grip forward and backward before use (21.1%), and inhale only after twisting the grip forward (18.4%) that have been reduced after education to 0%, 0%, 2.7% (Tables 1 & 2). After administering the education program there was a great reduction in all pitfalls for both groups (Tables 1 & 2). The mean scores of pitfalls before and after education were administered for both groups are shown in Table 3. In both groups, the education program significantly contributed in reducing the mean number of pitfalls among asthmatics using MDI and turbuhaler ($p < 0.001$ and $p = 0.002$). Moreover, the mean PEF has improved significantly from 312.4 ± 109.9 L/minute to 331 ± 105.8 L/minute ($p = 0.003$) (Table 3).

Data management and statistical analysis. Data was entered on the computer using database and verified for coding errors. Statistical analysis was carried out using Statistical Package for Social Sciences. Descriptive statistics (namely, mean, standard deviation and frequencies) were performed to

Table 1 - Percentage distribution of asthmatic patients on metered dose inhaler who had pitfalls before and after the education program (N=69).

Pitfalls	Before %	After %
Failure to remove the inhaler cover	2.9	0
Failure to shake the inhaler before use	13	2.9
Hold inhaler upside down (hole up)	5.8	1.4
Failure to breath out to functional residual capacity	39.1	13
Inhalation while head in flexed position	10.1	0
Failure to place the inhaler in the mouth with lips tight around it	10.1	4.3
Activate medication during breathing out	42	15.9
Failure to breath in slowly and deeply after activation	46.4	21.7
Failure to breath hold for 5 - 10 seconds	52.2	20.3
Failure to wait 30 seconds before next inhalation	27.5	11.6
Activate inhaler more than once at a time	29	8.7

Table 2 - Percentage distribution of asthmatic patients on turbuhaler devices who had pitfalls before and after the education program (N=37).

Pitfalls	Before %	After %
Unscrew, failure to lift off the cover of the inhaler	0	0
Failure to twist the grip forward (to right) and backward (to left)	21.1	0
Inhalation after twisting the grip forward	18.4	2.7
Inhalation before hearing the click	10.8	0
Failure to breath out to functional residual capacity	7.7	2.7
Failure to inhale slowly and deeply	7.7	2.7
Failure to breathhold for 5-10 seconds	23.1	0
Used inhaler while empty (red indicator)	5.4	0

Table 3 - Paired t-test statistical analysis for mean scores of pitfalls and peak expiratory flow (PEF) among asthmatic patients before and after the education program.

Group/score type	Mean \pm SD	Paired t-test	p value
Metered dose			
Pitfall score before	2.8 \pm 2.0	8.597	<0.001
Pitfall score after	1.0 \pm 1.29		
Turbuhaler			
Pitfall score before	0.76 \pm 1.34	3.292	0.002
Pitfall score after	0.081 \pm 0.28		
Both groups			
PEF before education	312.4 \pm 109.9	-2.994	0.003
PEF after education	331.0 \pm 105.8		

describe the studied variables. For each patient a score corresponding to the number of pitfalls before and after the education program was defined. Then paired t-test was used as appropriate. Level of significance was set to be <0.05 throughout analysis.

Discussion. This is a prospective study in which the pitfalls of inhalation technique in chronic asthmatic using MDIs and turbuhaler were detected before and after an educational program. A total of 106 patients were included in the study that has shown 3 important findings. First, failure to hold breath for 5-10 second was found the most common pitfalls in asthmatics using MDIs and turbuhaler up to 52.2% and 23.1%. Second, the educational program has been associated with significant reduction of the pitfalls of inhalation technique in both groups (MDIs and turbuhaler) $p<0.001$, $p=0.002$. Third, the reduction of the pitfalls of inhalation technique has been associated with significant increase in the peak flow rate from 312 L/minute before education to 331 L/minute afterwards ($p=0.003$). Meter dose inhalers have become the most convenient and widely used method of delivery that introduced for management of asthma.¹⁻³ They are small, portable and relatively unaffected by the external environment.⁴ There is an increasing evidence that the dose delivered by MDIs is far from constant.⁴ The way the device is handled by the patient may have a major influence on the delivered dose.⁴ Patient's errors in their use have been recognized for many years as a major disadvantage.^{3,10-16} Several studies have shown that 24-89% of asthmatics have poor inhalation technique when using MDI.^{3,11,24} A study from Riyadh, KSA has shown that 53% of the asthmatics have poor inhalation technique.²¹ For effective drug deposition in the lungs, accurate coordination between actuation of MDI and inhalation by the patient is essential.¹⁷ The importance of patient's instruction and training on the correct usage of MDI has often been underestimated.¹⁸ The 3 main reasons for poor inhalation technique have been identified. The patient has not been taught to use the device, or the patient has not been able to master the technique or the previous good technique may have been lapsed.²⁵ If doctors expect maximum therapeutic effect from inhaler therapy, they must be prepared to spend time informing their patients on how to use the inhaler.²⁵ Giving written and oral instructions alone was resulting in 50% of patients using an MDI effectively.^{24,26} Demonstration of appropriate technique and observation by health professional was the most effective means of teaching appropriate inhaler.^{26,27} In this study, an experienced medical educator was involved to demonstrate the correct usage of the inhaler devices and to record the pitfalls of inhalation technique in each patient. Recognition in advance the pitfalls of the inhalation technique will be very helpful for the medical educator to concentrate more on the troublesome pitfalls during demonstration in the

subsequent visits for each particular asthmatic. Therefore, it is advisable to keep a record of the pitfalls of inhalation technique for each patient to be used as a reference in the subsequent visit.

In this study, the 3 most common pitfalls for MDI before education were failure to hold breath for 5-10 second after inhalation 52.2%, failure to breathe in deeply and slowly after inhaler activation 46.4% and puff medications while breathing out 42% that have been significantly reduced after education to 20.3%, 21.7%, and 15.9%. These findings were similar to previous studies in which failure to activate the MDI properly and to breathe hold were found the most frequent problems.^{3,10,11,14} It is clearly that failure to perform these steps correctly will lead to failure of medications to be inhaled into the lungs properly and consequently will lead to failure of asthma control. In this study, almost 3% of the patients did not remove the cap of the inhaler while 13% did not shake their inhalers before use. This indicates clearly, that there was either a poor education or no education whatsoever has been given to the patients by their primary physicians at the time of prescribing their inhalers. Patients using MDI should always be instructed to shake their inhalers immediately before using it to avoid the phenomenon of separation of MDI content that has unpredictable effects.^{4,28} Repeated failure to shake will have a cumulative effect on the concentration of the remaining content of the MDI. The dose immediately follows failure to shake in unlikely to be affected.^{4,28} Turbuhaler eliminates coordination problems because the force of the patient's inspiration generates aerosol. The amount inhaled is so small that patient has no sensation of having inhaled anything. Patients must be informed of this and of how to tell when the turbuhaler is empty.⁴ It is clearly discussed that the percentage of the pitfalls for turbuhaler was lesser than that for MDI before the educational program. Nevertheless, the percentages of the pitfalls of the inhalation technique in asthmatics using turbuhaler have almost reduced to zero percent after education comparing with MDI. This indicates clearly that turbuhaler device was much easier to be used and learned by patients than MDI. Therefore, it might be advisable to select turbuhaler device rather than MDI to start with for treating asthmatics. Peak expiratory flow monitoring is an important clinical tool that can be used in the asthma clinic to evaluate severity of asthma, and to monitor response to therapy during management of acute and chronic asthma. Peak expiratory flow measurement is an effort dependent, and patients need to be coached initially to give best effort.^{29,30} In this study, measurement of PEF was used to correlate with pitfalls of inhalation technique before and after education; taking into consideration that no change in the medications whatsoever has been taken place between the measurements of the 2 readings. There have been a significant increase in the PEF measurement from 312 liter/minute before education to

331 liter/minute afterward with p value of 0.003, and this was correlated positively with the reduction of the pitfalls of the inhalation technique. There were no previous studies that have been correlated between the improvement of inhalation technique and PEF measurements to compare it with our result. However, Pedersen et al have shown a significant increase in the forced expiratory volume in the first second (FEV₁) after demonstration the correct way of the inhalation technique among children.¹⁴ The significant increase of PEF measurements after education was most likely due to the significant reduction in the pitfalls of the inhalation technique. Therefore, better inhalation technique in asthmatics may lead to more deposition of inhaled medicine into the lungs that consequently may lead to a better control of asthma.

In conclusion, this study has shown clearly that a simple educational program used in the outpatient's asthma clinic can reduce significantly the pitfalls of inhalation technique and reflect positively on PEF measurements. Therefore, we recommend its use for all asthmatics at the time of prescribing their inhalers and in the subsequent visits to achieve better control of asthma.

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