ORIGINAL ARTICLE

Learning and Recall of Metered Dose Inhaler Technique amongst Junior Medical Residents in a Teaching Hospital

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ABSTRACT

Objectives: To evaluate learning characteristics of MDI use amongst junior doctors and retention of the skills over few months' time.

Methods: Fifty residents during their first rotation in medicine department were evaluated for baseline performance of 13 individual steps of MDI use. They were evaluated after group demonstration and further individualized training of difficult to learn steps. Retention of technique was evaluated again at 3 months. Evaluation was done by looking at demonstration video and recorded as correct/incorrect.

Results: No candidate in the beginning could demonstrate all steps correctly. This improved to 100% ($P<0.05$ for all) correct performance at all steps only after one-to-one demonstration sessions following group lecture. Coordination of actuation of device with inspiration and continued inspiration thereafter were most difficult-to-learn steps requiring up to 3 demonstrations after group lecture in 62% and 68% of participants respectively. After 3 months, performance deteriorated ($P<0.05$) in 11 of 13 fully learned steps. In the above two difficult-to-learn steps it returned close to low level baseline

Conclusions: Junior-most medical residents have grossly sub-optimal performance at steps of MDI use which improves only after individualized demonstration sessions but deteriorate rapidly close to baseline low in difficult-to-learn steps.

Keywords: Technique, Inhalation, Coordination, Residents, Demonstration, Recall

INTRODUCTION

Inhaled bronchodilator and steroid therapy has become standard of practice in out-patient management of patients with asthma and Obstructive Pulmonary Disease (COPD)[1,2]. Correct use of inhalation device is important for optimal benefit. Incorrect use of inhalers is associated not only with objective evidence of reduced lower airway drug deposition[3], but also sub-optimal clinical benefit of airway obstruction and inflammation[4] Various factors associated with misuse of the inhaled therapy have been evaluated e.g. device characteristics (metered dose inhalers versus dry powder inhalers versus breath actuated devices etc.), patient educational status, age, vision, educational tools (verbal explanation, personal demonstration, video demonstration etc.) and setting (out-patient, in-patient or casualty etc.). Ultimate responsibility for prescription and accuracy of use lies with prescribing doctor and his knowledge and ability to demonstrate technique should be the starting point towards correct handling by patient. Sub-optimal or at times grossly inadequate knowledge and demonstration skills of inhalational devices have been well documented amongst medical personnel involved in patient education[5,6,7,8,9]. Unfortunately not many studies have addressed their learning characteristics, mostly addressing the present knowledge of technique of those involved in explanation to patient.

It has been noted that both the knowledge and demonstration skills are even poorer with new inhalational devices (Aerochamber and Turbohalers) though they are designed for patient convenience and to circumvent the problem of coordination of device actuation with inhalation[9,10]. Metered Dose Inhalers (MDI) remain the most commonly prescribed mode of inhaled medicine in south-east Asia as most of other inhalational devices are either not available or have started to be introduced. We evaluated the learning characteristics of the junior doctors in sessions of demonstration of MDI use and its long-terms retention in months.

MATERIAL AND METHODS

Fifty junior doctors at house officer level participated in the study during their first rotation in general internal medicine after graduation. The study was carried out in department of medicine Jinnah Hospital, a tertiary care teaching hospital in Pakistan. All of them had completed at least two months of residency and were available for at least next 3 months in the same department. Study was carried out in department of general internal medicine and doctors prescribed inhaled medicine in routine in consultation with senior doctors. It was seen that the

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participating doctors had to explain to patients the correct use of MDIs an average of 4-6 times a month.

Participating doctors were evaluated for demonstration of technique of MDI use individually and out of group setting. They then attended a "group demonstration" of correct use of MDI. Demonstration was carried out by a consultant who himself demonstrated technique first to his consultant colleagues from pulmonology department. All individual steps were explained in a non-hurried way overall taking 15-20 minutes to demonstrate steps of correct use. After this demonstration, participating doctors were evaluated by demonstrating the technique in isolation and without the presence of evaluators in front of two video cameras, one viewing from the front and the other from profile. Demonstration steps were scored by the two evaluating physicians from consultant staff who in spite of having long experience with MDI practised, evaluated and scored the technique for a month before start of study. Steps were scored after demonstration by a participant was seen from both angles by the assessors individually. In case of disagreement repeat video demonstration was run in front of both assessors together till an agreement was reached upon. This occurred in 4 observations after demonstration session and 3 observations at 3 month follow-up. Prior to the study, both evaluating physicians had practiced evaluating mock subjects on a trial basis until the demonstration scores they recorded were in agreement (±1/13 of steps) on multiple occasions[11]. Participants who failed to demonstrate one or more steps correctly after group demonstration attended another session of one-to-one, out-of-group demonstration afterwards. Such demonstration sessions continued for the late learners on to the following day until all participating doctors demonstrated the technique accurately. It was ensured and explained to participating doctors that this exercise is no way related to evaluation of their job performance and results as to the their identity would remain strictly confidential. All participating doctors remained blinded to the purpose of the study both at initial demonstration(s) and evaluation and at 3 month follow-up evaluation for which they were not for-warned.

Package inserts along with MDI generally recommend 7 steps of correct use. However, some of these steps combine more than one action e.g. breathe in and press MDI firmly once and continue to breathe in. This step combines 3 actions on part of patient/educator and in case of one wrong action whole step is technically faulty. The problem has been addressed previously by investigators splitting steps in 9[12] 11[9] or 12 steps[13]. We divided all the steps of inhalation technique in to 13 steps of single actions so they can be identified and marked easily, by splitting "Begin breathing then actuate canister once" into coordination of actuation with inhalation" and "Press inhaler firmly once without tilting" and adding "mouth rinsing" after inhaler use (Table1)

Statistical methods: All of our data were categorical and binomial. Results are described as percentage of participants performing a step correctly. Performance at three times of evaluation of technique was compared pairwise using McNemar's Test. P value of <0.05 was taken to indicate statistically significant results.

RESULTS

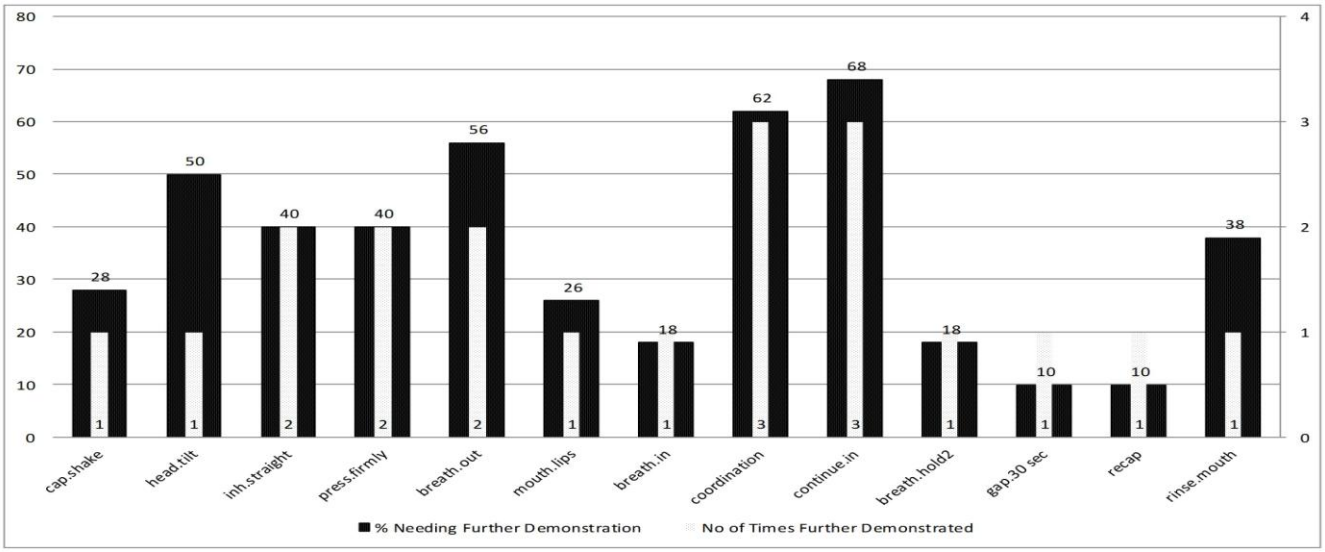
Graph 1 shows percentage of participants who needed further one-to-one demonstration of MDI technique and average number of times individual steps were demonstrated to these participants beyond initial group demonstration. More than 50% of participants had some difficulty learning head tilt, breathing out before inhalation, coordination of actuation with start of breathing in and continuing inhalation at slow rate. Of these, coordination and continued inhalation after actuation were the most difficult-to-learn steps.

Graph 2 depicts percentage of participant performing steps of MDI technique correctly in the beginning, after last demonstration and 3 months later. Demonstration was stopped only when all the steps were learned and demonstrated correctly by all the participants. The steps that were difficult to learn initially (coordination of actuation with inhalation and continued slow inhalation after actuation) were precisely the steps that were forgotten 3 months afterwards and performance of these steps reached almost back to their dismally low beginner's level.

Table 2 draws pair-wise comparison of performance of individual steps of MDI use in the beginning, after demonstration sessions ended and at three months. It should be noted that improvement or deterioration in performance in almost all cases was one sided i.e. initial performance versus performance at end of last demonstration (always improved), performance after last demonstration versus performance after 3 months (always deteriorated) and performance in the beginning versus that at 3 months (mostly better).

Table 3 depicts percentage of participants who could perform more than 8 steps of inhaler technique correct in the beginning (before demonstration), after last demonstration and 3 months afterwards. Although all steps are not equal in importance in the overall delivery of the inhaled drug, it gives an idea of overall performance and percentage who could demonstrate 70 per cent of steps correctly.

Graph 1 Percentage of participants needing further demonstration of MDI technique and average number of times individual steps were demonstrated beyond initial demonstration.



Graph 2. Percentage of participants correctly performing steps of MDI inhalation technique in the beginning, after final demonstration and 3 months later.

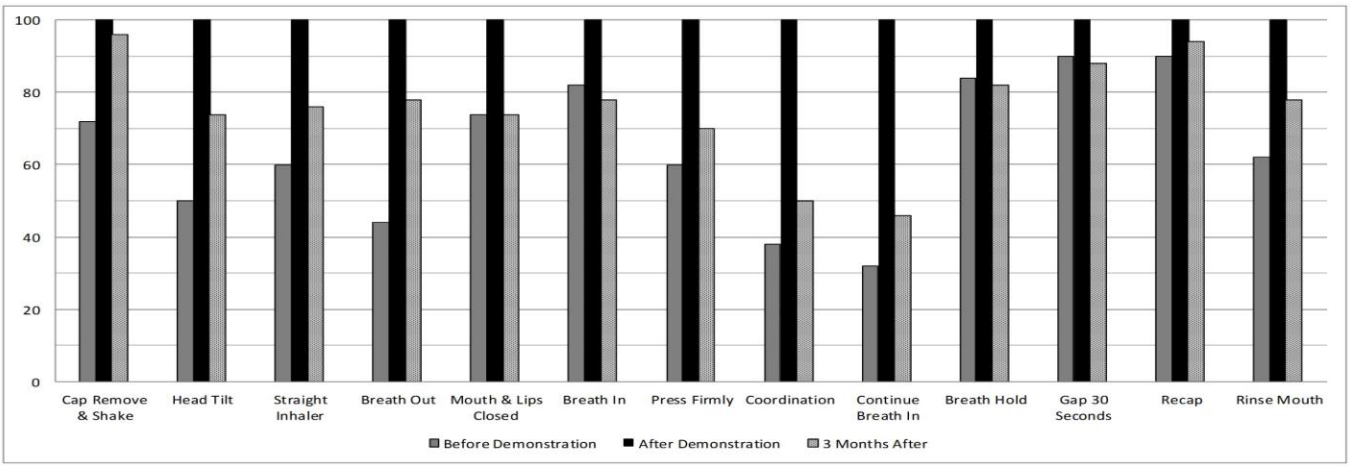


Table 1: Steps for inhalation technique for MDI

Count	Step	Alternative (R) Dolovich et al†
1	Remove cap and shake inhaler 3-4 times	
2	Tilt head slightly back	
3	Hold inhaler straight in front of mouth	
4	Breath out completely (RV)*	Breath out normally (FRC)†
5	Insert mouthpiece beyond teeth and close lips firmly	Hold inhaler 2-4 cm in front of wide open mouth
6	Breath in slowly	
7	Press inhaler firmly once without tilting	
8	Coordinate pressing with beginning of inhalation	
9	Continue slow breathing in after pressing	
10	Hold the breath at full inspiration for 5-10 seconds	
11	Gap of 30-60 seconds between inhalations	
12	Recap device	
13	Rinse mouth	

*Residual Lung Volume †Functional Residual Lung Capacity

Table 2: Pair-wise comparison of performance, in percentages of participants doing the step of MDI use correctly in the beginning, after end of demonstration sessions and after 3 months.

Step of MDI use	Initial Vs. Final Demonstration Performance		Final Demonstration Vs. After 3 Months' Performance		Initial Vs. After 3 Months' Performance	
	Initial vs Final in %ages	P value	Final vs 3m in %age	P value	Initial vs 3m in %age	P value
Remove cap and shake inhaler 3-4 times	72 Vs. 100	0.000	100 Vs. 96	0.500	72 Vs. 96	0.000
Tilt head slightly back	50 Vs. 100	0.000	100 Vs. 74	0.000	50 Vs. 74	0.000
Hold inhaler straight in front of mouth	60 Vs. 100	0.000	100 Vs. 76	0.000	60 Vs. 76	0.008
Breath out completely (RV)	44 Vs. 100	0.000	100 Vs. 78	0.001	44 Vs. 78	0.000
Insert mouthpiece beyond teeth and close lips firmly	74 Vs. 100	0.000	100 Vs. 74	0.000	74 Vs. 74	1.000
Breath in slowly	82 Vs. 100	0.004	100 Vs. 78	0.001	82 Vs. 78	0.791
Press inhaler firmly once without tilting	60 Vs. 100	0.000	100 Vs. 70	0.000	60 Vs. 70	0.227
Coordinate pressing with beginning of inhalation	38 Vs. 100	0.000	100 Vs. 50	0.000	38 Vs. 50	0.109
Continue breathing in after pressing	32 Vs. 100	0.000	100 Vs. 46	0.000	32 Vs. 46	0.143
Hold the breath at full inspiration for 5-10 seconds	84 Vs. 100	0.008	100 Vs. 82	0.004	84 Vs. 82	1.000
Gap of one minute between inhalations	90 Vs. 100	0.063	100 Vs. 88	0.031	90 Vs. 88	1.000
Recap device	90 Vs. 100	0.063	100 Vs. 94	0.250	90 Vs. 94	0.687
Rinse mouth	62 Vs. 100	0.000	100 Vs. 78	0.001	62 Vs. 78	0.008

Table 3: Percentage of participants demonstrating a minimum of 9 out of 13 steps of MDI technique correctly (n=50)

Evaluation Step	More than 8 correct Steps
Initial (Before Demonstration)	23 (46%)
After final demonstration	50 (100%)
Three months after	34 (68%)

DISCUSSION

Suboptimal or incorrect use of inhalational devices, including MDI is a well-recognized problem in patients with respiratory diseases. Knowledge and ability to demonstrate steps of inhalation correctly by medical personnel is a prerequisite for imparting patient education but has been found be often rudimentary or inadequate. In this study we demonstrate in addition that few select steps may take 1-4 demonstration sessions even for some medical personnel to master them and the same may be forgotten in a significant proportion over a 3 months' time, when their job entails 4-6 per month prescription and demonstration of these devices.

Kelling JS et al. were probably the first to widely create awareness of poor knowledge and skills of "canister nebulizer" (later MDI) in resident physicians and attending staff with no more than 40 per cent performing 4 of 7 steps correctly and only 10% of house-physicians and none of the attending staff performing all steps correctly[8]. Their findings were later corroborated by many other studies[7,9,12,13,14,15,16,17].

Guidry GG et al. at Louisiana State University School of Medicine evaluated both the technique demonstration and theoretical knowledge of MDI use in 61 medical personnel comprising a mix of respiratory therapists, resident medical staff, staff nurses involved in respiratory care and senior non-pulmonary faculty members all of whom were involved in patient education of MDI use[15]. On the performance portion no group could demonstrate all steps correctly and best performance (taken as at least 4 out of 7 steps correctly performed) was shown by respiratory therapists (92%-especially by modified technique by Dolovich et al[18] and worst by nurses (57%) and non-pulmonary faculty (50%), with residents in the mid (87%). Theoretical knowledge of the inhaler technique almost followed the same order. Worst knowledge was shown regarding slow continued breathing (overall 25% knew its important) and breath holding (18% for all groups). There was no separate break-up into individual actions as in our study but it appears that poor knowledge of slow

continued breathing might have included the step of coordination of pressing inhaler immediately after start of inhalation and continued inhalation at a slow rate, both of which were the worst performed and learned steps in our study as well. It's no surprise, therefore, that these steps of inhalation technique have been long recognized as most problematic steps in patient technique demonstration[4,19]. Guidry GG suggested that respiratory therapists were more likely to have received formal training or past session(s) in technique demonstration and be regularly involved in patient education then the other three groups.

The results were replicated in a study by Hanania NA et al. evaluating technique and knowledge of inhalational devices (MDI, MDI with spacer device and breath-actuated multi-dose dry powder inhaler (Turbohaler)who identified failure to coordinate actuation with inhalation and to breath-hold after inhalation as the most poorly demonstrated steps in MDI use by resident physicians and registered nurses[9]. We in addition have shown the two steps are the one most frequently forgotten in a few months' time. Hanania NA et al. suggest that involvement of respiratory therapist with formal training and routine patient education is more cost-effecting in patient education. Our study did not include such inter-group comparison of medical personnel, but does demonstrate rather poor initial skills in MDI use without past formal training and rapid decadence of such skills over time.

Patient education in MDI use has been shown to take 10-30 minute including first and successive repetitions of demonstrations followed by technique demonstration by patient[20]. Our initial demonstration to young doctors as group took 15-20 minutes and select steps were repeated to individual participants up to three times before all could be cleared finally ready to educate patients. Lee-Wong M also reports rather low level of learning after group lecture to new inductee medical house officer, with 13% demonstrating MDI technique perfectly after lecture from an initial 5%, which later improved to 73% of participants demonstrating perfect technique after intensive one-to-one, hands-on session[21]. Evaluation was done at first week after lecture session and 1-2 months after hands-on training session. Although a split of step performance is not detailed, we can conclude that a 27 per cent reduction in performance came within two months as authors mention, although not formally marked or reported, that hand-on session was stopped only when candidate could show perfect technique. Authors found coordination of actuation of inhaler with start of inspiration and slow continued inhalation as the two steps most difficult to master as formal group lecture training brought no improvement in the steps which could only be learned after an average of 20 minutes one-to-one hands-on training. The results exactly replicate our findings. Once again, we find in addition that these are precisely the steps most easily forgotten over time.

Rebuck D et al demonstrated improvement in demonstration skills with MDI, MDI plus Aerochamber and Turbohaler at 8 month's follow-up after a 25-35 minute hands-on training imparted to resident doctors by a nurse educator compared to a control group imparted no such training. [10] Although demonstration skills improved from baseline (before structured training) when evaluated for first time after training at 8 months, they were still below optimal level to impart patient education. As pointed out by authors themselves immediate evaluation after training was not done and it remains unknown if deficiency in steps was due to loss of skill or they were never learned in the first place. Our study shows rather rapid decline in essential steps of MDI technique over three months. In many of the previous studies it was not known how often the evaluated residents demonstrated inhaler use to patient. We quantitated it to 4-6/month. A control group in study by Rebuck D et al was established at 8 month evaluation only and not in the beginning. Moreover all steps of demonstration technique and components of knowledge have been given a score of one if correct. Some components are crucial and scores of all components cannot be equal, instead individual step performance should be reported as such[21]. This issue has been addressed by Plaza V who assigned different scores to steps of MDI use according to supposed importance totalling a score of hundred. Such scoring, however, remains arbitrary[12].

While we have tried to rectify few limitations in previous studies, our study still has its limitations. Inter-rater and intra-rater reporting variability has been pointed out by Gray SL in the evaluation process of such studies[11]. Many studies have used nurse educator, trained physicians or pulmonary therapists to train and evaluate. We found that a live visual scoring of steps of inhalation technique is a likely source of error as steps may be partially missed from observation, there is no repetition and there may be element of mental exhaustion. We circumvented the problem with videotaping from two angles so steps can be marked at ease and in case of difficulty be replayed. This reduced disagreement in scoring between the two observers in the pre-study exercise. We did not establish a control group. Ideally a control group should been evaluated in the beginning and after three months as house staff keep on learning during day to day practice. We have given results in percentages of participants doing a step correctly at

each stage of evaluation but have not tried to trace individual participant's performance at these stages as attempted by Rensick DJ et al which could further elaborate deterioration in performance over time occurred in slow learners[22].

In conclusion, early in their residency fresh medical graduates have dismally low baseline performance at steps of MDI use which is still the most commonly prescribed inhalational drug delivery system in respiratory diseases, while they are precisely the ones often entrusted to explain technique to patients. Group demonstration is often insufficient to impart requisite mastery of technique which may require more laborious and time intensive on-to-one hands-on demonstration, often a number of times before all steps of MDI technique can be learned. Coordination of actuation with beginning of inhalation and continued slow inhalation afterwards, are the steps most resistant to learning. Performance at all of the steps deteriorates in months and decays to close to baseline performance at steps that were difficult to learn in the first place.

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