Evaluating the efficacy of a structured education package for improving and maintaining inhaler technique.

Steven Hickey [a] **(Corresponding author)**
Paul Beeson [b]
Sally Furniss [a]
Frances Mulligan-Evans [a]
Emma Ryan [a]
Jenny Keech [a]

a Chest Clinic, Northampton General Hospital, Northampton, NN1 5BD, UK steven.hickey@health.qld.gov.au
b School of Health, Park Campus, University of Northampton, Northampton, NN2 7AL, UK Paul.Beeson@northampton.ac.uk

Aim: To investigate the efficacy of 2 different education strategies for teaching and maintaining inhaler technique in older patients.

Methods: In a cluster randomised controlled trial 136 participants attending a pulmonary rehabilitation course had their inhaler technique assessed. The control group (normal care; n:63) received demonstrations of inhaler devices and their use. They were assessed on their technique following the education. The intervention group (n73) received normal care plus the addition of an inhaler technique information leaflet and 10 minute PowerPoint presentation on inhaler use. Participants were re-assessed 5 weeks after receiving inhaler training for prevalence of good technique.

Results: High numbers of poor inhaler technique at day 1 was observed. 115 participants attended the education sessions with 98% (control) and 100% (intervention) achieving the standards for good inhaler technique. At final assessment 91 participants were assessed (43 control, 48 intervention). No difference was found in the prevalence of good technique post training or at final assessment between the two groups.

Conclusion: Inhaler technique in older patients is often poor. They are often able to use inhalers correctly when instructed but maintenance of good technique is not prevalent across all devices. In older patients a more structured approach to teaching inhaler technique is no more effective than usual care.

Introduction

The use of inhaled medication is often the primary treatment choice in chronic obstructive pulmonary disease (COPD). There are thought to be over 3 million people living with COPD in the United Kingdom (UK), of which only about 900,000 have been diagnosed (NICE 2010). The significant proportion of people with COPD will be on at least one form of inhaled medication and sometimes more than one type of inhaler device. Unfortunately, a significant proportion of inhaler users continue to use them incorrectly regardless of any educational intervention.

Review of the literature

Earis and Bernstein (1978) in a letter to the editor of the British Medical Journal reported 25% of subjects in an outpatient setting used their inhalers incorrectly. It could be argued that with the advent of improved levels of clinical advice given to patients, and access to the internet that inhaler use has would have significantly improved during the last 35 years. They suggested that their survey *'undoubtedly underestimated the scale of the problem'* and that even after instruction some elderly patients are *'just incapable of using inhalers'*. Research into this phenomenon continues to date, yet despite studies identifying poor technique the faults continue to present themselves (AL-Jahdali *et al* 2013, Bryant *et al* 2013, Ovichinkova *et al* 2011, Basheti *et al* 2008).

The evidence suggests that used correctly inhalers are all as effective as each other (Brocklebank *et al* 2001). The way in which the devices are used does

differ considerably with a pressurised metered dose inhaler (pMDI) requiring slow and deep inhalation whilst a dry powdered inhaler (DPI) requires hard and fast inspiration (Crane *et al* 2014). A pMDI relies on propellant to get the drug out of the device therefor generating its own energy to assist drug delivery. DPI's rely solely on the inspiratory flow generated by the patient, effectively sucking the drug out of the device. Their correct use is by no means as simple as achieving the correct inspiratory flow with factors such as manual dexterity, co-ordination and health beliefs also affecting their correct use (Broeders *et al* 2009). The clinical consequences of poor inhaler technique are important as poor technique will lead to lower deposition of the medication within the lungs. The net effect of this is wasted medication and poorer disease control leading to reduced quality of life, increased hospital admissions and higher treatment costs (Giraud & Roche 2002).

The most frequent errors observed in a meta-analysis by Rau (2006) were failure to co-ordinate actuation with inspiration (timing) in pMDI use, failure to exhale to residual volume prior to use with all devices and incorrect inspiratory flow with both DPI's and pMDI's. What is unclear is whether patients are forgetting how to use their inhalers, choosing to use them how they feel is appropriate or taught incorrectly. The standards to classify good technique vary considerably within the literature although certain key elements are regularly included. The standards required to achieve good inhaler technique can vary but many key components

are consistent (Al-Jahadali *et al* 2013, Abley 1997, Navarre *et al* 2007, Kiser *et al* 2011, Basheti *et al* 2008).

Although incorrect inhaler use is seen across all age groups some evidence suggests that incorrect use is more prevalent in older people (Bryant *et al* 2013, Abley 1997, Allen *et al* 2003, Sahin *et al* 2014). Abley (1997) found that by educating elderly patients on inhaler use there was a significant initial improvement in technique.

Hesselink *et al* (2001) looked at determinants of incorrect inhaler technique and found that subjects with dependency, depression, confusion or helplessness were 70% more likely to use their inhalers incorrectly ($p<0.05$). Subjects with mental health decline and reduced cognition were included by Abley (1997) and Allen *et al* (2006) with varying success. Allen *et al* (2006) found a correlation between cognition and technique recollection citing that *'many elderly patients are unable to use inhalers correctly if their mini mental score is impaired'*. Gray *et al* (1996) also found that a reduced mini mental score as well as male gender and reduced hand strength were factors that predicted poor technique in elderly subjects. The evidence recommends inhaler technique checks and education must be reinforced to maintain correct use. The evidence also suggests that the benefits of education wane over time (Pothirat *et al* 2015, Steier *et al* 2003, Basheti *et al* 2008, Ho *et al* 2004, Hardwell *et al* 2011, and Yildiz 2014).

Primary research question

Will a structured education programme be more effective than an informal discussion in both teaching inhaler technique and reducing one month post-education prevalence of inhaler misuse?

Study design

The study adopted the methodology of a cluster randomised controlled trial measuring clearly defined standards when using inhalers (Appendix 1).

Methodology and Assessments

Participants had their inhaler technique checked on day 1 using placebo DPI devices (Table 6), a placebo pMDI or a pMDI and spacer. They were also assessed with the Vitalograph Aerosol Inhalation Monitor (AIM) model 4500. The AIM was used for all pMDI and DPI assessments. Participants were shown a selection of local formulary DPI placebo's and asked which device or devices they used. They were then asked to demonstrate inhaler technique with that placebo DPI prior to their AIM assessment. If they regularly used more than 1 type of DPI one device was chosen randomly for assessment by the principle investigator (SH).

Training day assessments were by visual assessments only. The education sessions included participants and non-participants at a pulmonary rehabilitation (PR) course (as part of their usual care) creating group sizes of approximately 20. Time resources would not allow for all attending the education sessions to be

trained, assessed until technique was good and then re-assessed on the AIM. The post education assessments were conducted by respiratory specialists. All were assessed and found competent in their ability to assess inhaler technique by the author and principle researcher. Uncertainty about inspiratory flow during visual assessment was confirmed using an 'In-Check DIAL' inspiratory flow meter (Clement Clarke International Ltd). All initial and final assessments were performed by the PI to avoid any inconsistencies in assessments and provide a standardised approach. The final inhaler assessments were performed approximately 5 weeks after the initial training, on the final day of the PR course (week 8).

Participants were graded as having good, fair or poor technique during the assessments as defined in appendix 1.

- Good: All criteria achieved
- Fair: All essential criteria achieved
- Poor: At least 1 essential criteria not achieved

Setting and participant recruitment

The research was conducted at four different sites (A,B,C,D) as part of a community based pulmonary rehabilitation (PR) course. The participants were randomised primarily on the geographical location of their usual residence. Participants usually opt for the PR course running nearest to their home address. To avoid any risk of bias each site (except site D) received both control and intervention. Each site is geographically linked to a certain set of general practitioner (GP) surgeries; it was felt that results may be affected if we allocated only one intervention to a specific site. There was potential for local GP surgeries

having employees who were particularly interested in respiratory medicine and use of inhaled devices. If this was to be the case by randomising the training at each location it would mean the effect, if any would be minimal. Site D only ran one course during the research period (January – October 2015) therefore only received the intervention.

Distribution of inhaler training sessions:

- Site A: 3 control, 2 Intervention
- Site B and C: 1 Control, 1 Intervention
- Site D: 1 Intervention

Inclusion Criteria

The inclusion criteria was anybody undertaking the PR course whose regular treatment required any form of inhaled medication delivered by a pMDI or DPI.

Ethics and R&D

The research proposal was approved by the National Research Ethics Service (NRES) Committee East Midlands - Northampton, the clinical governance committee at Northampton General Hospital NHS Trust and the School of Health at the University of Northampton. The study was also registered at clinicaltrials.gov (study NCT02283008).

Inhaler technique training

Control (usual care)

Participants randomised to usual care received their normal pulmonary rehabilitation inhaler technique training. This is evidence based and similar to that demonstrated in a clinical consultation. The evidence base was taken from Kiser *et al* (2011), Lenney *et al* (2000), Prabhakaran *et al* (2006), Bryant *et al* (2013), Ovchinikova *et al* (2011), and Navare *et al* (2007).

The PR group (both participants and non-participants) received a brief summary of all the different pMDI, DPI and spacer devices available on local prescribing formulary. Their correct use was then demonstrated by the researchers. Following the education the group was split into 3 or 4 smaller groups where more specific individualised training took place. Participants were asked to demonstrate inhaler technique using placebo inhalers. Any specific errors were highlighted and corrected enabling the researchers to confirm that the individual had demonstrated good inhaler technique. Any participants failing to achieve good technique during this assessment was marked according to appendix 1 criteria.

To reduce the risk of bias the education provided to both the control and intervention groups was by SH and SF. This was to ensure that both groups received equity in the education therefore avoiding any potential negative effect of the different teaching styles.

Intervention (structured education)

The intervention arm received identical inhaler training used in control but with the addition of a ten minute PowerPoint presentation. The purpose of the presentation was to explain why each inhaler use step is important with the evidence to support each step. The presentation consisted of 11 slides listed in the table below.

Slide title
1. Worldwide evidence for poor inhaler technique 2. Effect of age on technique 3. Most common errors 4. Significance of inspiratory flow 5. Inspiratory flow and how it affects drug deposition 6. Poor teaching of inhaler technique by healthcare professionals 7. Issues with education retention 8. Choosing the correct device 9. Correct use of a pMDI 10. Correct use of a DPI 11. Conclusion and recommendations

Participants in the intervention arm were also given a leaflet entitled ‘Information to use your inhaler device’.

Following completion of all of the assessments participants and non-participants in the control arm were also given a copy of the information leaflet used in intervention. It was felt unethical to withhold this leaflet from any of the attendees at the PR course.

Statistical analysis

The primary outcome measure is determining differential post-education prevalence of inhaler misuse at a set period of time post education. Statistical software (SPSS version 22) was used for data analysis to compare the two interventions. Independent samples t-tests used to test for differences in mean values. Chi-squared used to test for differences in the prevalence of pMDI or DPI misuse. Cohen's weighted Kappa used to compare assessment grades between the researcher and the Vitalograph AIM, and the two groups receiving training. Differences were considered statistically significant at the $p<0.05$ level.

Results

Over a 10 month period 136 participants were recruited (Table 1). The distribution of males and females was equal across the study (M69:F67) however distribution within the groups had a direct opposite 60/40 split ($p<0.001$). 115 participants attended the education sessions at week 2 and 91 attended the final assessment day at week 8 (Table 2). The reduction in numbers attending final assessment day was due to participants dropping out of the pulmonary rehabilitation course. The participant demographics in table 2 did not differ from table 1. The only statistically significant difference between the groups was found in the gender ($p=0.016$).

Despite 69% of participants reporting that they had previously received education on inhaler use and technique the frequency of participants that initially

demonstrated good technique was poor (Table 3). No differences were identified in the prevalence of poor inhaler technique when comparing those that had previously received inhaler training and those that had not (**pMDI** *p*0.360, **DPI** *p*0.444, **pMDI+Spacer** *p*0.739). The cohort were of an older population and there was also no correlation found between increasing age and poor technique with either the DPI (cc 0.138 *p*.248) or pMDI (cc -0.096 *p*.446). Participants reported that their previous inhaler training had primarily been performed by a nurse (89%). 7% reported training from their general practitioner and 4% from the local pharmacist.

Analysis of the post education inhaler assessments demonstrated that both control and intervention were equally effective. Of the 115 post training participants assessed 94% achieved the required standard with a pMDI, 98% with a DPI and 100% with a pMDI+Spacer. What is evident from the education day findings is that given the appropriate training, and device, almost all patients can use inhalers correctly. The initial assessments for the 91 participants completing all 3 assessments (Table 4) demonstrated a slightly higher percentage of good technique across the devices when compared to the 115 participants that attended the education sessions but not the final day.

Analysis of the effect of the training at week 8 demonstrated a statistically significant increase in the prevalence of good technique compared to week 1 across all devices (Table 4). A doubling of those achieving good technique in control and a 3 fold increase in intervention was observed in the pooled data of all assessments (Table 5).

Within control and intervention pMDI assessments there was a 70% fall in the prevalence of good inhaler technique at week 8 (Table 4). This still represented a 3 fold improvement in the control and 5 fold within the intervention. Direct comparison between control and intervention failed to show any statistically significant difference when comparing week 1 and week 8 (**pMDI** χ^2 .399 *p*0.819, **DPI** χ^2 .167 *p*0.920, **pMDI+Spacer** χ^2 1.188 *p*0.572) demonstrating that both interventions were equally effective. The use of a pMDI+Spacer was the most effective way of maintaining good technique in elderly participants with 96% achieving the required standard at week 8 however the high frequency of good technique may not be replicated in a larger cohort. The ratio of good technique when comparing a pMDI with a DPI was 1:3.4 on day 1 and 1:2.6 at week 8 which remains in keeping with Ovchinikova *et al* (2011).

The most consistent errors classified as 'essential' within the pMDI (Charts 1 and 2) and DPI (Charts 3 and 4) assessments were failure to exhale prior to use and incorrect inspiratory flow. Poor timing between actuation and inspiration was also frequently seen within the pMDI assessments. Only 28% of participants failed to generate sufficient inspiratory flow in the DPI assessments indicating that in most cases patients that use inhalers instinctively inhale hard and fast regardless of device. High inspiratory flow was also found to be one of the primary causes of poor technique when assessing pMDI+Spacer (Table 8). Failure to exhale fully to residual volume was also observed to be a consistent error within all 3 assessments. The rationale gently emptying the lungs of air being it allows the

user to take a longer and deeper breath therefore allowing drug deposition to be achieved in the smaller airways. The therapeutic effect of aerosolized therapies is dependent upon the dose deposited and its distribution within the lung (Labiris and Dolovich 2003).

Discussion

Participants were included regardless of age, disease, inhaler device used or cognition. It was felt that excluding participants who would be more difficult to teach creates a bias in experimental design. In a small study conducted by Davies et al (2015) 17 participants with intellectual disability whom were unable to use inhalers at all pre education demonstrated that with the correct device good technique could be achieved. While acquisition and initial demonstration of the correct use of inhalers is often good, retention of the training declines over time (Basheti *et al* 2008, Ovchinikova *et al* 2011, AL-Jahadi *et al* 2013). This could explain why the study identified no difference in the frequency of poor inhaler technique in participants regardless of whether they had previously received training. Although some authors have found that elderly people appear to have poorer technique compared to younger people (Bryant *et al* 2013, Abley 1997, Allen *et al* 2003) in this study a decline in the frequency of good technique was not seen as age increased. Issues around healthcare professionals ability to teach inhaler technique correctly have been observed with Basheti *et al* (2008) observing that 31–85% of health professionals have been reported to show incorrect inhaler technique when tested objectively, with similar results for

doctors, nurses, and community pharmacists. It is unlikely that the initial high frequency of poor technique was down to poor previous education alone. It was observed that a number of participants commented at each training session that the education received within the study differed from that which they had previously received. Practical training sessions where participants are able to use a placebo device was a particularly effective strategy yielding high numbers of good assessments.

The frequency of poor timing with pMDI use remained high at week 8. Some of this was due to poor co-ordination and nothing more although some participants did struggle with depressing the pMDI canister. When issues such as insufficient hand strength are involved co-ordinating a canister depression with the breath in are unlikely to consistently correlate. The errors in technique observed within the study were consistent with the previous research findings (Sahin *et al* 2014, Crane *et al* 2014, Vanderman *et al* 2015 and Rau 2006). More than 60% of participants failed to inhale at the correct speed when using a pMDI. This has a direct effect on the deposition of medication within the lung. The pMDI uses propellant to deliver the medication so slow inspiratory flow is necessary to direct the medication through the oropharynx and into the airways. Fast inhalation with a pMDI creates greater oropharyngeal drug deposition and reduced the amount reaching the lungs. The optimum inspiratory flow with a pMDI is 30L/min (Cheng *et al* 2001) although other researchers allow for a slightly greater margin of error recommending that one can accept 30-90L/min (Darquenne 2012, Laube *et al*

2011). Capstick (2012) when looking at ‘real life’ drug delivery found only 10% of the dose deposited in the whole lung when administered via pMDI at an inhalation flow of 30 l/min. The high inspiratory flow rates observed within the pMDI assessments were also seen within the DPI assessments where high flow is the ‘essential’ criteria (>30 l/min through the device). There is a direct correlation of low flow causing low drug deposition within DPI devices (Raid *et al* 2007). Uncertainty about sufficient inspiratory flow being achieved when DPI assessments were undertaken was measured using an In-check DIAL.

A statistically significant difference between male and female pMDI assessments within the intervention (*p*0.024) was identified that was not observed in control (*p*0.787). It was observed that all of the pMDI assessments identified as good on final ‘intervention’ assessment were male participants. The reasons for this are unclear and could be due to chance or the use of an information leaflet. The use of written material to encourage good inhaler technique is discussed in the literature but whether it improved outcomes over verbal information alone is unclear. Savage and Goodyer (2003) demonstrated a 19% increase in the frequency of ‘better’ inhaler technique when participants were given written information however 9% of participants also demonstrated worse inhaler technique at follow up. Crane *et al* (2014) observed that information leaflets were not sufficient to achieve improved inhaler technique in older patients. The week one intervention assessment of males and females demonstrating good/fair pMDI technique was identical and no differences between male and female was observed within the DPI assessments (*p*0.497).

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The role of the information leaflet remains unclear and possibly overstated given the findings in this study. It is unknown whether they are used and if so whether they are fully understood. It is also evident that DPI's are used correctly more often and the preferred choice of device in this study and that of Ovchinikova et al (2011). More device choice and hands on experience with placebos is recommended when commencing elderly patients on inhalers allowing them to choose a device that they feel confident with. Older people with chronic lung disease often believe that their inhaler technique is satisfactory but this is often found not to be the case. Further research is required to establish whether allowing patients to choose their own device is an effective way of maintaining good technique.

The Vitalograph AIM was found to be highly effective at identifying errors preventing good inhaler technique.

Strengths and limitations

A limitation identified within this study was that we also could not exclude the possibility of outside advice from other healthcare professionals being delivered to the participants during the study. A strength of this study was the use of a standard checklist with which the researcher assessed inhaler technique. Another strength was the use of two researchers conducting both styles of

education based on up to date evidence. Delivering both interventions at 3 of the 4 sites also reduced the risk of bias in the results.

Conclusion

Inhaler technique can be significantly improved in elderly subjects however as with other studies the benefits of the education did wane over time. The most effective way of achieving maintenance of technique when using a pMDI is the addition of a spacer device. Regular checks of inhaler technique are required to maintain the required standards of good use, ideally at every consultation. Our results demonstrate the informal training is as effective as a more structured approach. It also found that the Vitalograph AIM is an effective tool for identifying poor technique. The evidence from this study, and that conducted by Crane et al (2014) is that giving patients an information leaflet without the appropriate one to one training is unlikely to achieve good inhaler technique on its own. Why the participants that initially demonstrated poor technique dropped out of the pulmonary rehabilitation course is unclear and may be just down to chance. Colcombe and Kramer (2003) identified that fitness training increased performance in elderly subjects regardless of the type of cognitive task. Further analysis of the fitness levels of those who dropped out may identify a correlation between reduced activity and poor technique. Further research into this is required and may demonstrate differences between fitness levels and poor inhaler use.

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Appendix 1

Researcher's assessment criteria sheet

pMDI

1. Shake the inhaler
2. Remove cap (**essential**)
3. Gently breathe out as far as possible (**essential**)
4. Place mouthpiece between your teeth and close your lips around it (**essential**)
5. Begin to breathe in slowly and gently (**essential**)
    a. Insp flow 30-60 l/min with In-Check dial
6. Press canister and continue to breathe in fully (**essential**)
7. Remove MDI from mouth
8. Breath hold for 5-10 seconds

DPI

1. Open and load the device as per manufacturer's instructions
2. Hold the device horizontally prior to use
3. Breathe out gently and fully **(essential**)
4. Place the mouthpiece between your teeth sealing your lips around it (**essential**)
5. Suck in deeply and forcefully (**essential**)
    a. Insp flow >30l/min with In-Check dial
6. Do not exhale into the DPI (**essential**)
7. Remove device from mouth and breath hold for 5-10 seconds

pMDI and Spacer

1. Shake the inhaler
2. Remove cap
3. Insert inhaler into spacer
4. Gently breathe out as far as possible (**essentia**l)
5. Place mouthpiece between your teeth and close your lips around it (**essential**)
6. Spray one puff into the spacer
7. Begin to breathe in slowly and gently up to 5 tidal breaths (**essential**)
8. Remove spacer from mouth

Table 1: % of good and fair inhaler technique of all participants on day 1

Device	**% with good/fair technique**
pMDI	6.3% (6/95)
DPI	28.5% (32/112)
pMDI+Spacer	41.2% (14/34)

Table 2 Demographics of all recruited participants

		Control (n=63)	**Intervention** (n=73)	***p* value**
Diagnosis				
COPD		47 (74.6%)	58 (79.5%)	
COPD/Asthma		12 (19%)	7 (9.5%)	
Asthma		2 (3.2%)	4 (5.5%)	0.291
Bronchiectasis		1 (1.6%)	3 (4.1%)	
Pulmonary Fibrosis		1 (1.6%)	1 (1.4%)	
Mean age (years)		66.8 ± 9.23	68.5 ± 7.48	0.236
Gender	Female	37 (58.7%)	30 (41.1%)	<0.001
	Male	26 (41.3%)	43 (58.9%)	
Previous education	Yes	46 (73%)	59 (80.8%)	0.303
	No	17 (27%)	14 (19.2%)	
Mean years on inhalers		10.4 ± 11.6	10.32 ± 12.8	0.963

Table 3 Demographics of participants completing all 3 assessments

		Control (n=43)	**Intervention** (n=48)	***p* value**
Diagnosis				
COPD		31 (72.1%)	39 (81.3%)	
COPD/Asthma		9 (20.9%)	6 (12.5%)	
Asthma		2 (4.7%)	1 (2.1%)	0.590
Bronchiectasis		1 (2.3%)	2 (4.2%)	
Pulmonary Fibrosis		0	0	
Mean age (years)		67.6 ± 8.06	68.7 ± 7.75	0.516
Gender	Female	27 (62.8%)	18 (37.5%)	0.016
	Male	16 (37.2%)	30 (62.5%)	
Previous education	Yes	33 (76.7%)	30 (62.5%)	0.598
	No	10 (23.3%)	18 (37.5%)	
Mean years on inhalers		11.26 ± 13.40	9.56 ± 13.11	0.544

Table 4: Good technique pre and post education by device

	Week 1	Education day	Week 8	*p* value
pMDI				
Control (n33)	9%	100%	30%	0.003
Intervention (n33)	6%	100%	30%	<0.001
DPI				
Control (n32)	31%	97%	81%	0.022
Intervention (n40)	25%	100%	77%	<0.001
MDI+Spacer				
Control (n9)	45%	100%	100%	0.015
Intervention (n13)	31%	100%	92%	<0.001

P values are comparing week 1 and week 8

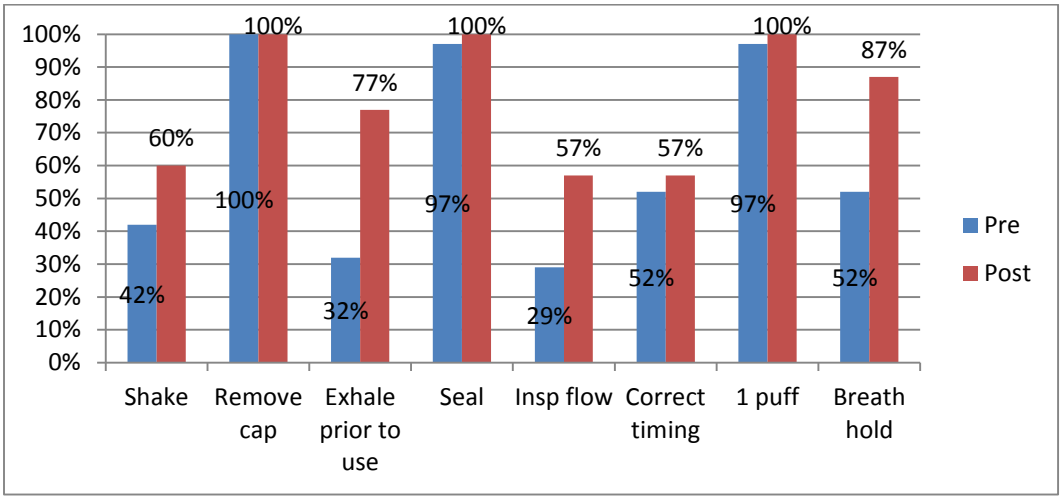
Table 5: Good technique in all devices combined (pMDI, DPI, MDI+Spacer)

	Week 1	Education day	Week 8
Control (n74)	29%	98%	60%
Intervention (n86)	19%	100%	62%

Table 6: Frequency of assessed DPI's

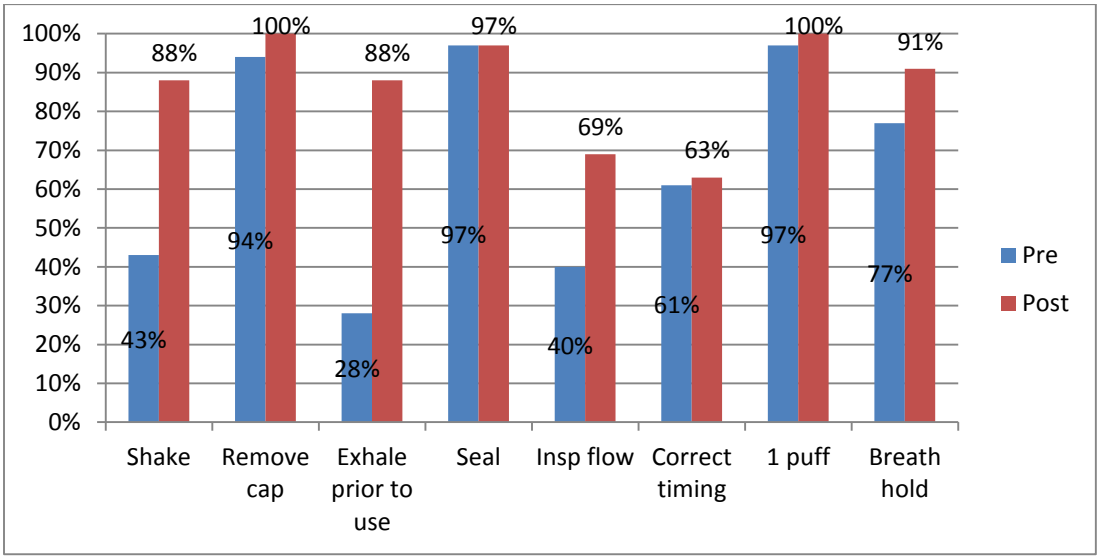
DPI device	Frequency
Turbohaler®	27 (24.1%)
Accuhaler®	34 (30.4%)
Handihaler®	42 (37.5%)
EasyHaler®	5 (4.5%)
Genuair®	4 (3.6%)

Chart 1 (Control): % of correct steps when using a pMDI (Pre and week 8)



Pre and post improvements *p*0.011

Chart 2 (Intervention): % of correct steps when using a pMDI (Pre and week 8)



Pre and post improvements *p*0.001

Table 7: % difference between week 1 and 8 assessments

pMDI technique step	**Control (n 31)**	**Intervention (n 33)**
1. Shake	↑43	↑104
2. Remove cap	0	↑6
3. Exhale gently and fully	↑140	↑214
4. Seal around mouthpiece	↑3	0
5. Correct inspiratory flow	↑96	↑72.5
6. Correct timing between inspiration and actuation	↑10	↑3
7. 1 puff and remove from mouth	↑3	↑3
8. Breath hold for 3-5 seconds	↑67	↑18
Mean improvement (%)	**↑45.25 (sd51.9)**	**↑52.5 (sd75.7)**

T: -0.2252; degrees of freedom 14; $p<0.05$

Chart 3 (Control): Prevalence of correct steps with DPI (Pre and week 8)

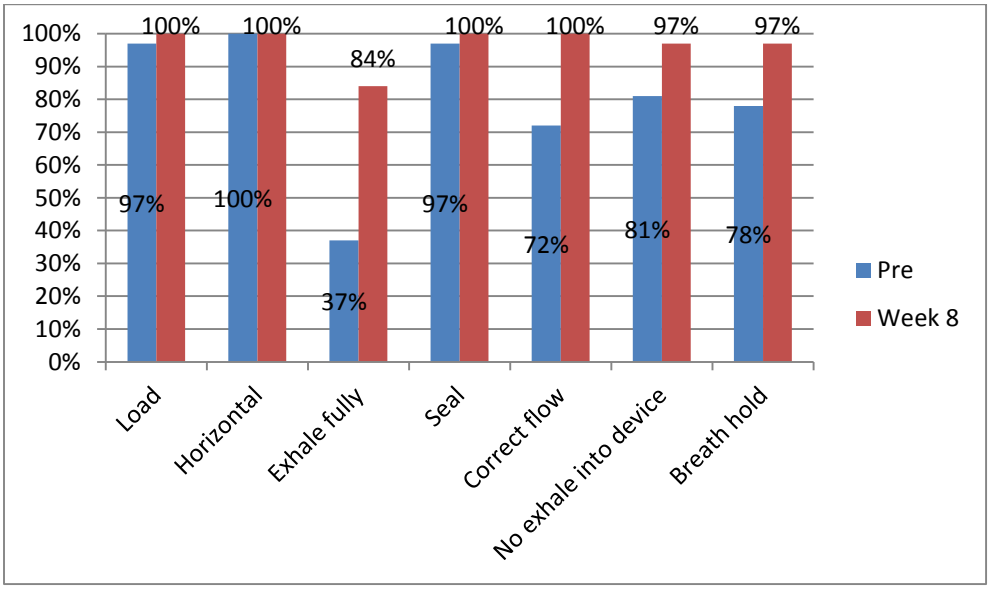
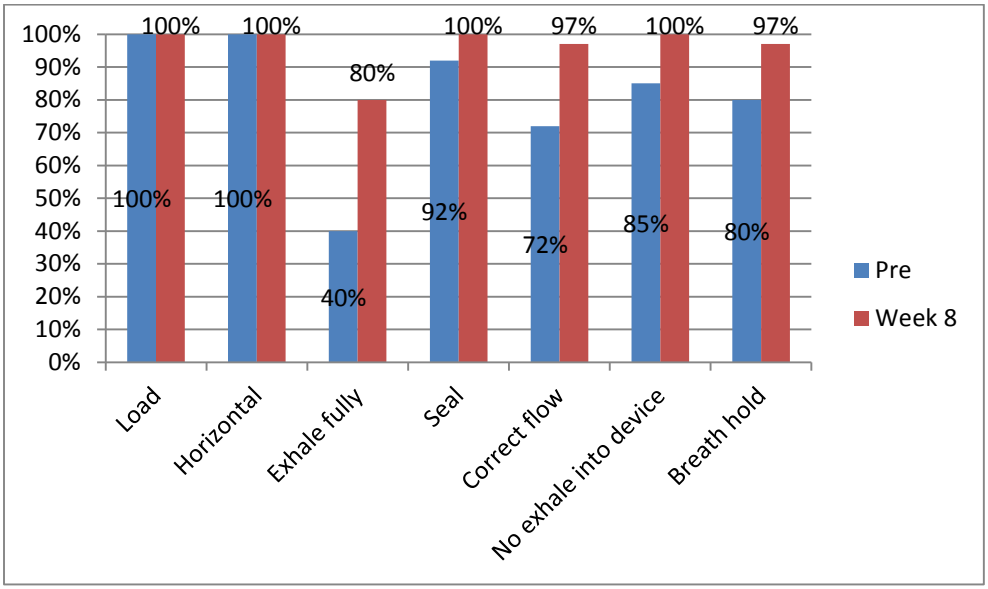


Chart 4 (Intervention): Prevelance of correct steps with DPI (Pre and week 8)



Control and intervention improvement $p<0.001$

Table 8: Prevalence of correct steps using a pMDI+Spacer (Pre and week 8)

pMDI+Spacer technique step	Control (n 9)		Intervention (n 13)	
	Pre	Week 8	Pre	Week 8
1. Shake MDI	78%	100%	100%	100%
2. Remove cap	100%	100%	92%	100%
3. Insert MDI	100%	100%	100%	100%
4. Exhale gently and fully	56%	100%	38%	100%
5. Seal around mouthpiece	100%	100%	92%	100%
6. 1 puff at a time	78%	100%	92%	100%
7. Tidal breaths	78%	100%	61%	92%

Control p0.009; Intervention p0.001

Table 9: Comparison of researcher pMDI assessment vs AIM assessment (n=161)

		AIM grading			
		Good	Fair	Poor	Total
pMDI Grade (Researcher)	**Good**	15	5	1	21
	Fair	2	5	0	7
	Poor	4	38	91	133
	Total	21	48	92	161

Kappa measurement of agreement 0.376 $p<0.001$

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