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Metered Dose Inhaler (MDI) Versus Dry Powder Inhaler (DPI): Patient's Compliance Variation in Asthma Medication at Rural Bangladesh Perspective

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Abstract:
Objective*: To determine the patient,s compliance variation between pMDI & DPI in asthma medication at rural area of Bangladesh.*
Methodology: *A Cross sectional study including survey and interview was done at outpatient basis in Brahmanbaria Medical College, Concept Hospital, Feni & National Hospital, Dagonbhuiyan, Feni, Bangladesh and the sample was 100 Asthma patients over a period of six months from July 2016 to December 2016. The patients were diagnosed as Asthma patients by typical symptoms eg: wheezing. Breathlesness, Chest, tightness and coughing. Laboratory Criteria: Features of eosinophilic inflammation: Sputum eosinophilia. Pulmonary function test (PFT): Obstructive defects, at least partially reversible. Spirometry: The measurement of FEV1 & VC demonstrate airflow obstruction & following the administration of a bronchodilator, confirms the diagnosis when a 15% (and 200ml) improvement in FEV1 is noted. Subsequent follow up were done by Peak Flow Meter. Medication were used as single maintanence & reliever therapy (SMART Fashion) using Budesonide (ICS) & Formeterol (LABA). Devices used are Pressurized Metered Dose Inhaler (pMDI) & Dry Powder inhaler (DPI) eg: Aerolizer. Spacer were not included.*
Results: *Proper inhalation techniques were demonstrated to the patients by health care staffs. DPI is peak inspiratory flow rate (PIFR) dependent, usually 60L/min or higher, on the other hand MDI require a slow & deep inhalation with PIFR less than 60 L/min. MDI require patient-device co-ordination.* pMDI and DPI (Aerolozer) have no significant differences in compliance issue in patient's points of view in terms of rural Bangladesh perspective.
Conclusion: *DPI are flow dependent & require minimal patient-device co-ordination. pMDI require patient-device co-ordination. 'In-Check DIAL was used to measure inspiratory flow (PIFR) for optimal flow rate with a particular pMDI or DPI device.*
Key Words: *Compliance, MDI, DPI, In-Check DIAL, SMART*

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I. Introduction

Asthma is a chronic inflammatory disorder causing hyper-responsiveness of the airways to certain stimuli resulting in recurrent variable airflow limitation, at least partly reversible presenting as wheezing. Breathlesness, Chest, tightness and coughing. The etiology is complex, and multiple environmental and genetic determinants are implicated.

The exact etiology is still unknown. Genetically prone infant, exposure to bronchiolitis strongly correlates the development of asthma in future. The airways of the asthmatics are found to be inflamed and hyper responsive, some triggers induce an asthma attack if the inflamed airways are exposed to them. The prevalence of asthma increased steadily. Present estimation suggests that 300 million people worldwide suffer from asthma and by 2025 additional 100 million suppose to diagnose as asthma. [1] Asthma is more common in boys but after puberty more common in females. Poor control of asthma leads to days lost from school or work, hospital admission and premature death in some patients reflects the socio-economic impacts. Airways of asthmatics are highly sensitive to certain things, which do not bother people without asthma. These things are

called –**Triggers-**when an asthmatic comes in contact to them, an asthma episode starts. The airways become swollen, produce too much mucus and are tightened up.

Common triggers of asthma are Allergens (Outdoor, Indoor & Food eg: Molds, House dust mites, Dander or flakes, Insects, beef, prawn, hilsha), Irritants (eg: Tobacco smoke: Wood smoke: Air pollutants) Upper respiratory tract infection, Exercise: Certain drugs (B blocker, Aspirin, NSAID).[2,3] The goals of asthma management are to Achieve and maintain control of symptoms, Prevent asthma exacerbation , Maintain pulmonary function as close to normal as possible, Avoid adverse effects from asthma medication, Prevent development of irreversible airflow limitation, Prevent asthma mortality. Principles of management are: Patient education: Avoidance of aggravating factors: Medication with a stepwise approach to the management. Medications are reliever - eg: Short acting B2 agonist (SABAs), Long acting B2 agonist (LABA), Anticholinergic eg: Ipratropium: Controller medications are inhaled corticosteroid eg: Beclomethasone dipropionate, Budesonide, Fluticasone & Ciclesonide. Leukotrien e receptor antagonists: Montelukast, Zafirlukast. LABA & sustained release theophyline. Cromones: cromoglycate & Nedocromil. Although there are many routes of drug delivery including oral, Injectable & Inhalation. Inhaled medications are the main therapy for bronchial asthma because medications are directly delivered into the airways, which produces a high concentration with significantly less risk of systemic adverse effects. Among the inhaler devices available are pressurized metered dose inhaler (PMDI), Dry powder inhaler (DPI) which include Aerolizer, Diskus, Handihaler, Rotahaler etc. [4,5,6]

In-Check DIAL, pMDI & DPI:

The inhaler device technique is a frequent cause of treatment failure with asthma & COPD.

The In-Check DIAL is a hand held inspiratory flow measurement device with a dial top .The DIAL orifices have been designed to simulate the resistance of inhaler devices from the DPI & MDI categories. It enables clinicians to train patients to use more or less inspiratory force to achieve their optimal flow rate with a particular MDI or DPI device. Goal is better lung deposition with less medication waste. The dry powder inhaler (DPI) requires a maximum inspiratory flow rate (PIFR) optimal for the administration of drug, pMDI rather requires less inspiratory flow rate(PIFR).

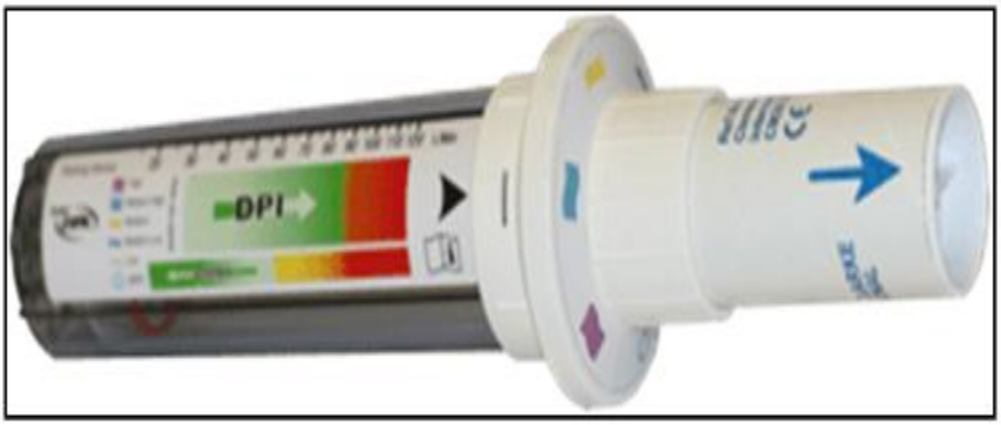


Figure1: Picture of In-Check DIAL

Pressurized meterd dose inhaler (podia):

The pressurized metered-dose inhaler (pMDI) was introduced to deliver asthma medications in a convenient and reliable multi-dose presentation. The key components of the pMDI device (propellents, formulation /Pharmceutical agent in suspension, metering valve, and actuator). All play roles in the formation of the spray, and in determining drug delivery to the lungs. Hence the opportunity exists to design a pMDI product by adjusting the formulation, metering-valve size, and actuator nozzle diameter in order to obtain the required spray characteristics and fine-particle dose. Breath-actuated pMDIs, breath-coordi-nated pMDIs, spray-velocity modifiers, and spacer devices may be useful for patients who cannot use a conventional press-and-breathe pMDI correctly. Modern pMDI devices, which contain non-ozone-depleting propellants, should allow inhalation therapy via pMDI to extend well into the 21stcentury for a variety of treatment indications.

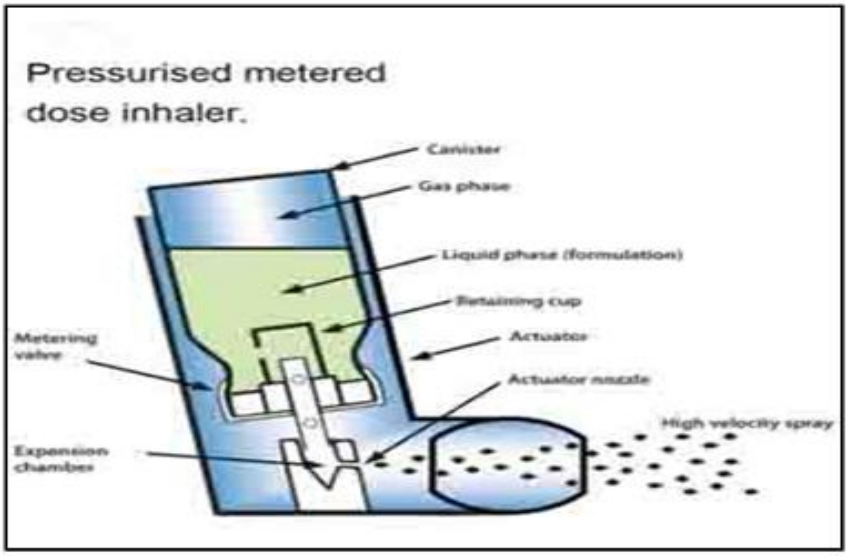


Figure 2: Schematic diagram of a pressurized metered dose inhaler

http://www.globalasthmareport.org/management/inhalers.php

The canister is housed in a plastic sleeve that has a mouthpiece for drug delivery. Actuation (ie, triggering of the canister) produces a fine atomized spray over 100-200 milliseconds that delivers the dose (the delivered dose varies with the particular medication). Most particles have high inertia, and most of the output at the orifice of the actuation consists of droplets that are large (25 microns) and have high velocities (30 m/s). This results in oropharyngeal deposition; only a minute fraction of the dose deposits in the lungs. The pharmacological agent in a suspension formulation results in a 10% respirable fraction; an agent in a dilute solution formulation with a volatile propellant blend may result in up to 40% respirable fraction. The surfactant stabilizes the suspension by preventing caking.[7,8,910]

Dry powder inhaler (DPI):

A dry powder inhaler (DPI) is a breath-actuated device that delivers the drug in the form of particles contained in a capsule or blister that is punctured prior to use. This type of inhaler requires an adequate inspiratory flow for the administration of drugs, since it does not include a propellant. Because of this inspiratory flow requirement, DPIs are not appropriate for the treatment of acute asthma attacks. The degree of resistance to inspiratory flow required to aerosolize the medication varies with each of the multiple versions of DPIs. For example, the Diskus is a low-resistance device and thus is suitable for treatment of children and those with decreased lung function (forced expiratory volume in 1 sec [FEV_1] < 30% predicted]), whereas the Turbuhaler is a high-resistance device that requires a higher inspiratory flow rate to aerosolize an equivalent drug dose.[11,12,13,14]

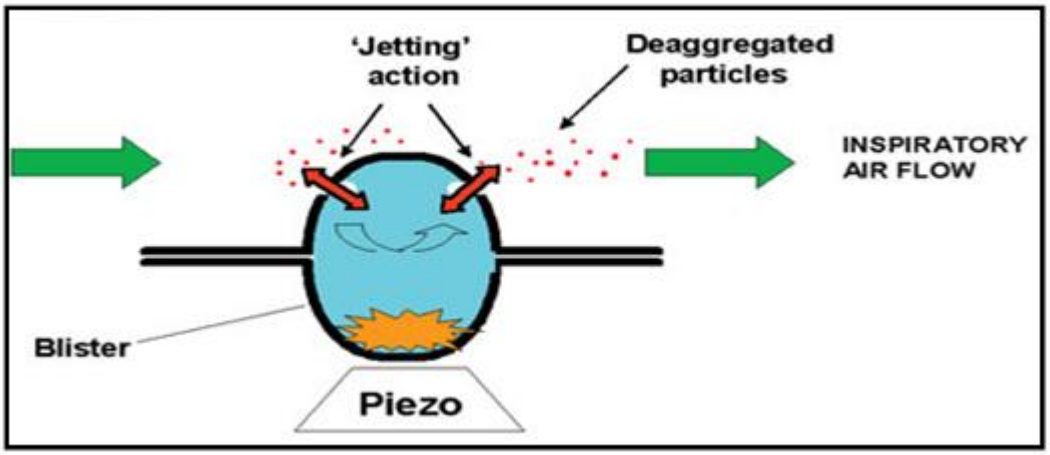


Figure 2: Schematic Representation of the mechanism of Powder Delivery from the Micro Dose DPI

http://drug-dev.com/Main/Back-Issues/A-PiezoElectronic-Inhaler-for-Local- Systemic-Appli-113.aspx

DPI devices include the following

- Diskus
- Aerolizer
- HandiHaler
- Twisthaler
- Flexhaler

Figure 3: Picture of Aerolizer

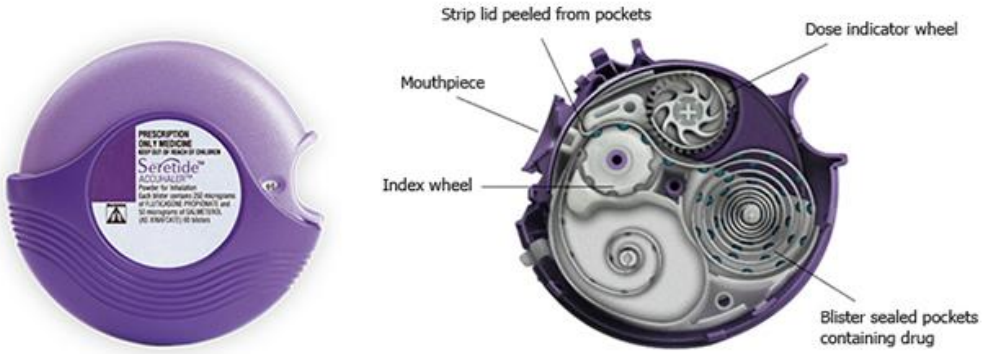


Figure 4: Diskus

Figure 5: Handihaler

Figure 6: Rotahaler

II. Objective of the study

The objective of the study is to determine the patient,s compliance variation between pMDI & DPI in asthma medication at rural area of Bangladesh.

III. Materials and Methods

A Cross sectional study was done at outpatient basis in Brahmanbaria Medical College ,Concept Hospital, Feni & National Hospital, Dagonbhuiyan, Feni, Bangladesh. A mixed method was applied for the study. A sample survey through survey questionnaire and interview was done on 100 Asthma patients over a period of six months from July 2016 to December 2016.

Inclusion Criteria:

Most of the cases the basic selection criteria of Astma patients as sample were either DPI user or MDI user. The patients were diagnosed as Asthma patients by typical symptoms eg: wheezing. Breathlesness, Chest, tightness and coughing. Laboratory Criteria: Features of eosinophilic inflammation: Sputum eosinophilia. Pulmonary function test (PFT): Obstructive defects,at least partially reversible. Spirometry: The measurement of FEV1 & VC demonstrate airflow obstruction & following the administration of a bronchodilator ,confirms the diagnosis when a 15% (and 200ml) improvement in FEV1 is noted. Subsequent follow up were done by Peak Flow Meter. Medication were used as single maintanence & reliever therapy (SMART Fashion) using Budesonide (ICS) & Formeterol (LABA). Devices used are Pressurized Metered Dose Inhaler (pMDI) & Dry Powder inhaler (DPI) eg: Aerolizer. Spacer was not included.

IV. Results

Profile of the Asthma Patients:

Table 2: Age group of the Asthma patient

Age group	Frequency	Percent	Valid Percent	Cumulative Percent
20-44	51	51.0	51.0	51.0
45-69	49	49.0	49.0	100.0
Total	100	100.0	100.0	

Table 2: Gender of the Asthma patient

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Male	79	79.0	79.0	79.0
Female	21	21.0	21.0	100.0
Total	100	100.0	100.0	

Table 3: Asthma problem starting period within age group

Asthma problem starting period			Types of inhaler used		Total
			Meter-dose inhaler (MDI)	Dry powder inhaler (DPI)	
5 to 15 years	Age of the	20-44	1	7	8
		45-69	7	0	7
	Total		8	7	15
16 to 35 years	Age of the	20-44	2	12	14
		45-69	14	1	15
	Total		16	13	29
36 to 50 years	Age of the	20-44	0	23	23
		45-69	10	0	10
	Total		10	23	33
51 to 70 years	Age of the	20-44	0	1	1
		45-69	9	0	9
	Total		9	1	10

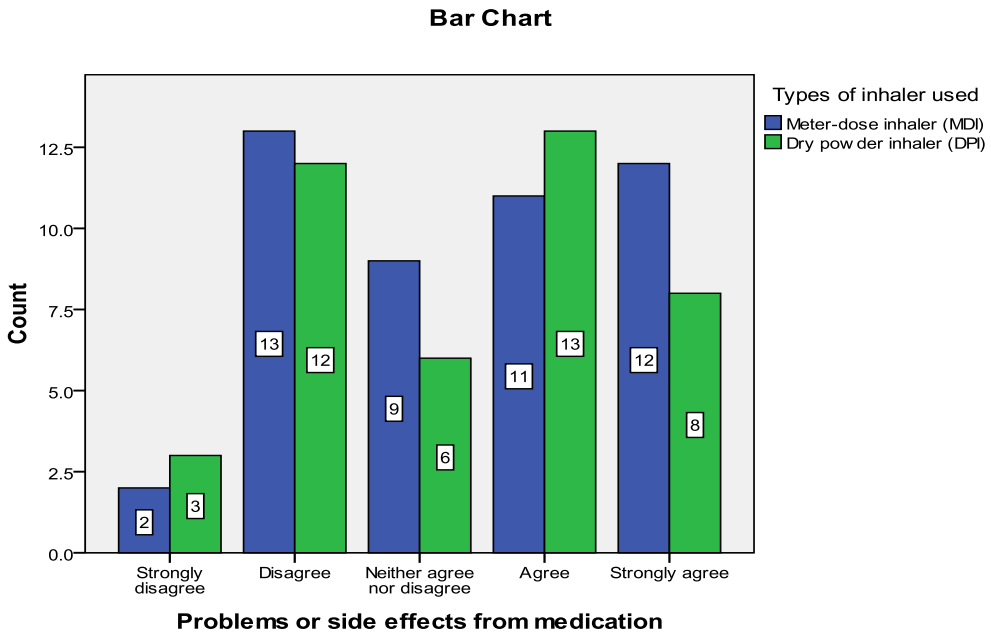
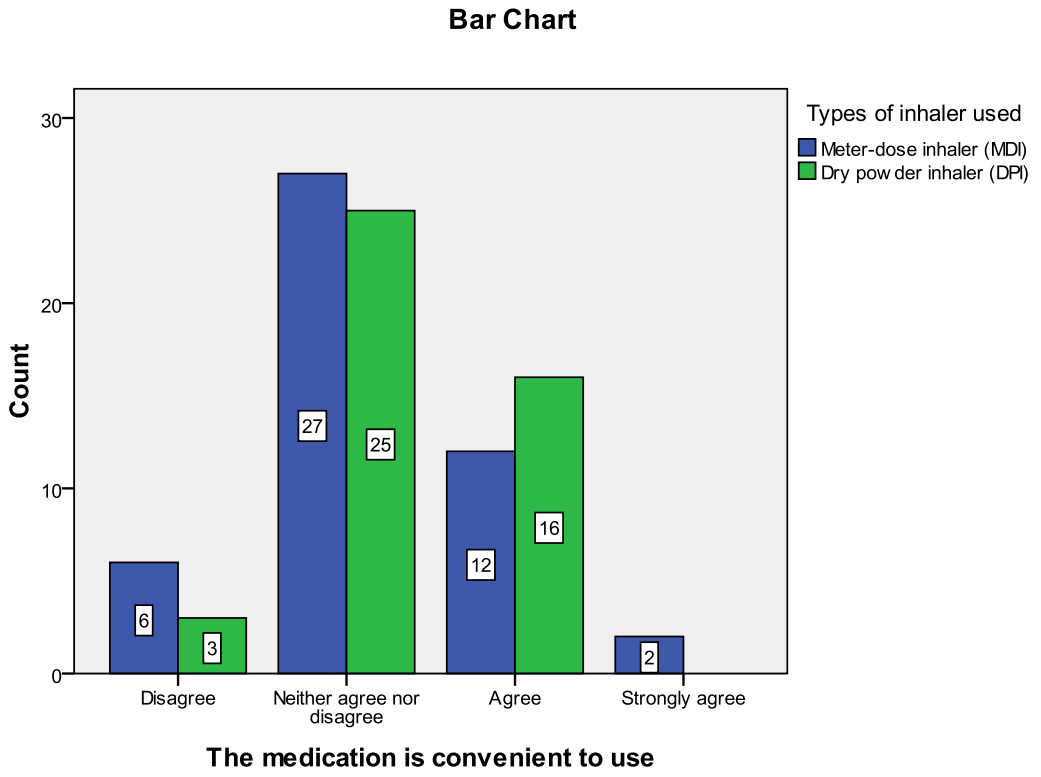


Figure 7



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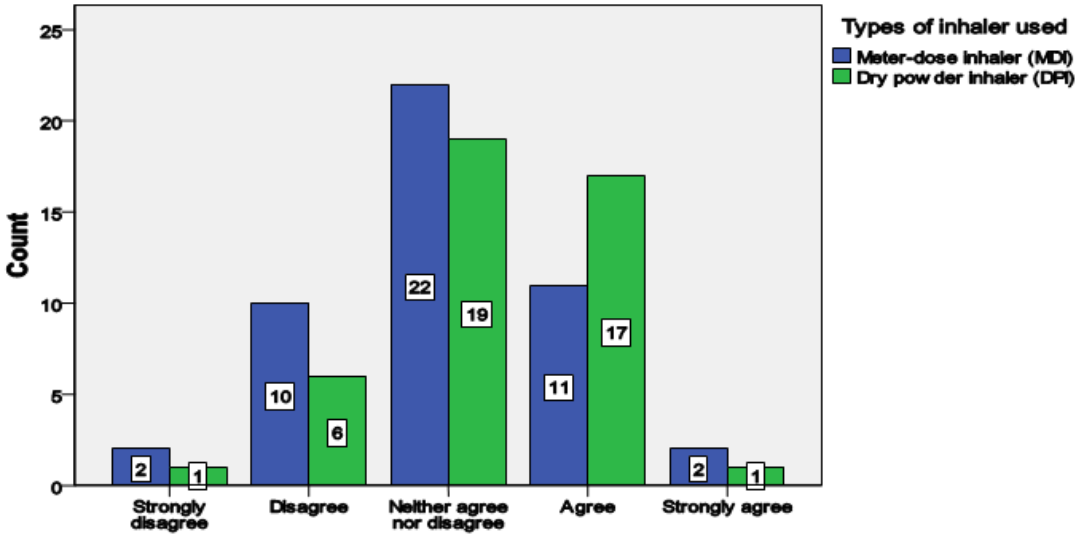

Co-operation status of heath care staffs

Figure 9

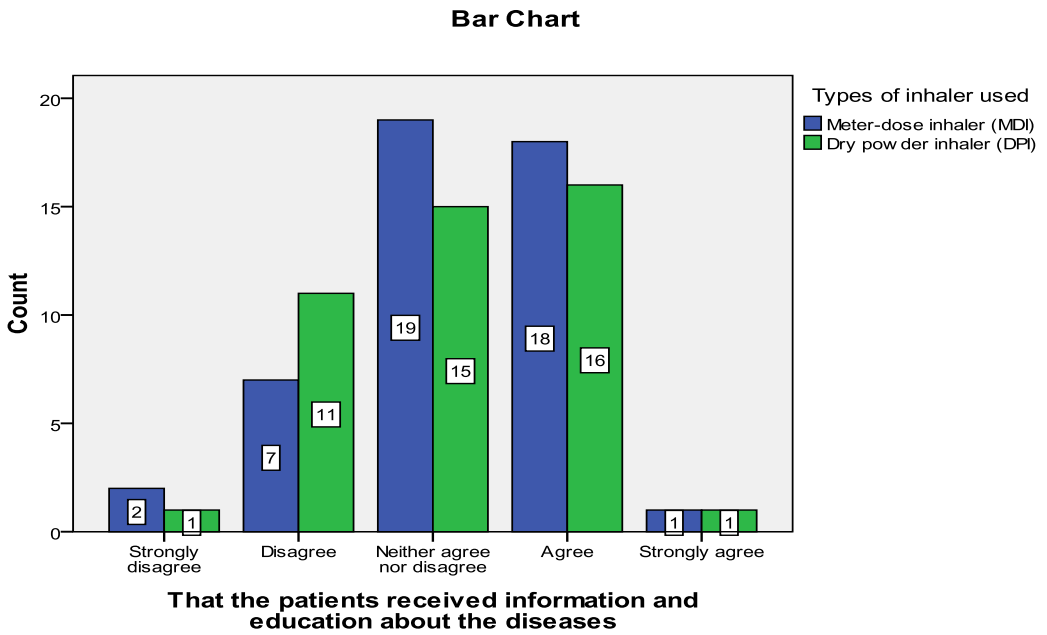

Figure 10

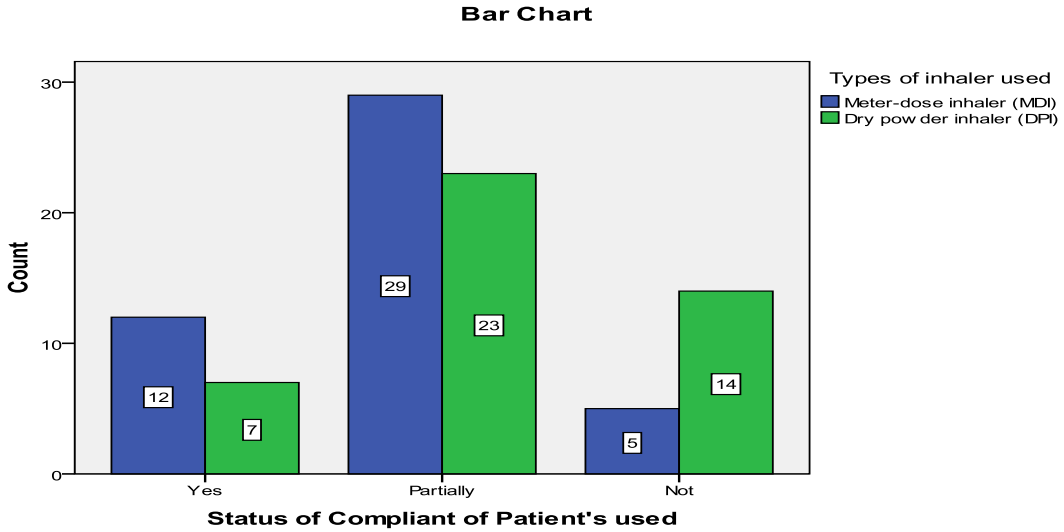

Figure 11

Proper inhalation techniques were demonstrated to the patients by health care staffs. DPI is peak inspiratory flow rate (PIFR) dependent, usually 60L/min or higher, on the other hand MDI require a slow & deep inhalation with PIFR less than 60 L/min. MDI require patient-device co-ordination.

Table: 4: ANOVA with Factor DPI and MDI

Description		Sum of Squares	df	Mean Square	F	Sig.
Good knowledge about medication	Between Groups	.086	1	.086	.087	.769
	Within Groups	87.585	89	.984		
	Total	87.670	90			
The medication is convenient to use	Between Groups	.155	1	.155	.354	.553
	Within Groups	39.031	89	.439		
	Total	39.187	90			
That the staff listen and take the patients view about asthma into account	Between Groups	.542	1	.542	.953	.332
	Within Groups	50.080	88	.569		
	Total	50.622	89			
That diseases is actively followed up	Between Groups	.751	1	.751	1.377	.244
	Within Groups	48.545	89	.545		
	Total	49.297	90			
That a health care worker is responsible for the patient and his/her asthma	Between Groups	1.189	1	1.189	1.622	.206
	Within Groups	65.229	89	.733		
	Total	66.418	90			
That the patients received information and education about the diseases	Between Groups	.138	1	.138	.176	.676
	Within Groups	69.708	89	.783		
	Total	69.846	90			

V. Discussion

Advantages of pMDIs are as follows:

- Portability
- Lower risk of bacterial contamination
- Multidose delivery capability

Disadvantages of MDIs are as follows:

- Needs correct actuation and inhalation coordination
- Flammability possibility of new HFA propellants
- Oropharyngeal drug deposition

DPI advantages include the following:

- Breath-actuated
- No need to hold breath after inhalation
- Spacer not necessary
- No propellant
- Portable

DPI disadvantages include the following:

- Adequate inspiratory flow required for medication delivery
- Humidity potentially causes powder clumping and reduced dispersal of fine particle mass
- May result in high pharyngeal deposition [15,16,17,18]

VI. Conclusion

From the ANOVA test result in SPSS we can identify the p value is greater than alpha value .05 which indicate that both pMDI and DPI (Aerolozer) have no significant differences in compliance issue in patient's points of view in terms of rural Bangladesh perspective. Data also shows that the pMDI is comparatively convenient than DPI. DPI are flow dependent & require minimal patient-device co-ordination. In-Check DIAL was used to measure inspiratory flow (PIFR) for optimal flow rate with a particular MDI or DPI device.

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