# Lec. 3 | Inhalation therapy

*Prof. MOHAMED MOSTAFA METWALLY*

***Educational Aims***

1. To review the main types of hand-held inhalers available in Egypt, together with current understanding about the correct inhalation techniques for each device.
2. To discuss problems that can lead to poor inhaler techniques, which in turn could contribute to poor asthma control.
3. To present recommendations for inhaler selection, as well as an algorithm for asthma therapy adjustment.

## Introduction

- Asthma remains a poorly controlled disease, despite the availability of guidelines and effective medications. The incorrect use of inhalers contributes to the lack of asthma control.
- The pressurized metered-dose inhaler (pMDI) is still the most frequently used device worldwide, but many patients fail to use it correctly, even after repeated tuition.
- Dry powder inhalers (DPIs) are easier to use than pMDIs, as they are breath-actuated but still some patients fail to use it correctly.

## Reasons of poor asthma control

- **Poor compliance** with the prescribed asthma therapy as less than one-third of patients were taking ICS in accordance with the guidelines, even those patients with severe persistent asthma.
- Patients are deriving incomplete benefit from their inhaled medication, primarily because they are unable to use their inhalers correctly.

## Asthma Control

The principles of modern asthma therapy are to achieve control of the disease with the lowest possible dose of medication.

*Table 1 Treatment goals of the GINA recommendations and the AIRE results*

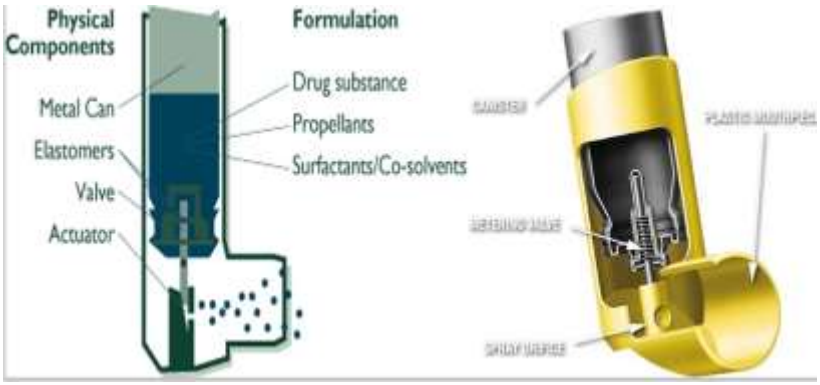
| GINA treatment goals | AIRE findings | Patients % |
|---|---|---|
| Minimal (ideally no) symptoms | Daytime symptoms | 50 |
| | Night-time symptoms | 31 |
| Minimal (infrequent) episodes of asthma | Reported episodes of asthma | 57 |
| No emergency visits | Emergency visits | 11 |
| Minimal (ideally no) use of as-needed $\beta_2$-agonists | Use of as-needed $\beta_2$-agonists | 64 |
| Normal professional life | Missed work | 17 |
| No limitations on activities | Limited sports | 47 |

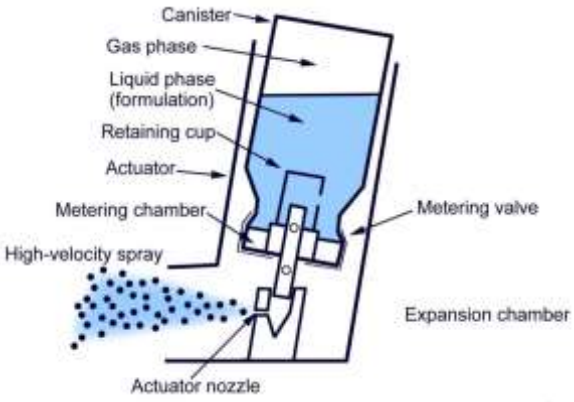
## Types of inhalers

1. **Pressurized metered dose inhaler (pMDI)**
2. **MDI with spacers or holding chambers**
3. **Breath actuated MDI**
4. **Dry powder inhaler (DPI)**
5. **Soft Mist inhalers (SMI)**
6. **Nebulizers**

## 1. Pressurized Metered dose inhalers (pMDI)

- pMDIs are the **most widely prescribed** inhaler devices as they are cheap and include a uniform technology that can deliver a variety of asthma medications.
- Despite numerous advantages, **most patients cannot use pMDIs correctly**, even after repeated tuition.




**Propellants:** Provides the force to generate the aerosol cloud and is also the medium in which the active component must be suspended or dissolved. Propellants in MDIs typically make up **more than 99%** of the delivered dose

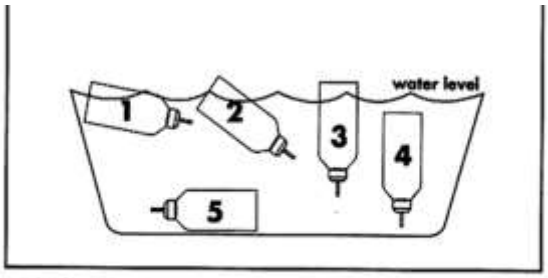
1. **Chlorofluorocarbons (CFCs):** most commonly used propellants were the chlorofluorocarbons CFC-11, CFC-12 and CFC-114. Banned due to adverse effect on ozone layer.
2. **hydrofluoroalkanes (HFA):** HFA 134a (1,1,1,2,-tetrafluoroethane) These new devices are more effective.

   The HFA propellant produces an aerosol with smaller particle size, resulting in improved deposition in the small airways and greater efficacy at equivalent doses compared with CFC MDIs.

- When the valve is actuated propellant and drug leave the inhaler at high velocity
- Majority of drug impacts in oropharynx
- **Less than 25% reaches the lung**

## Most efficient way of using MDI- steps:

1. Shake the canister
2. Place the mouthpiece of actuator between the lips
3. Breathe out steadily
4. Release the dose while taking a slow deep breath in
5. Hold the breath in while counting to 10



*The Float Test: 1. empty; 2. 1/4 full; 3. 1/2 full; 4. 3/4 full; 5. full.*

## Common mistakes during MDI

- ❖ Patients frequently fail to inhale continuously, to inhale slowly after activation of the inhaler and to exhale fully before inhalation
- ❖ Patients often activate the inhaler before inhalation or at the end of inhalation by initiating inhaler actuation while breath-holding

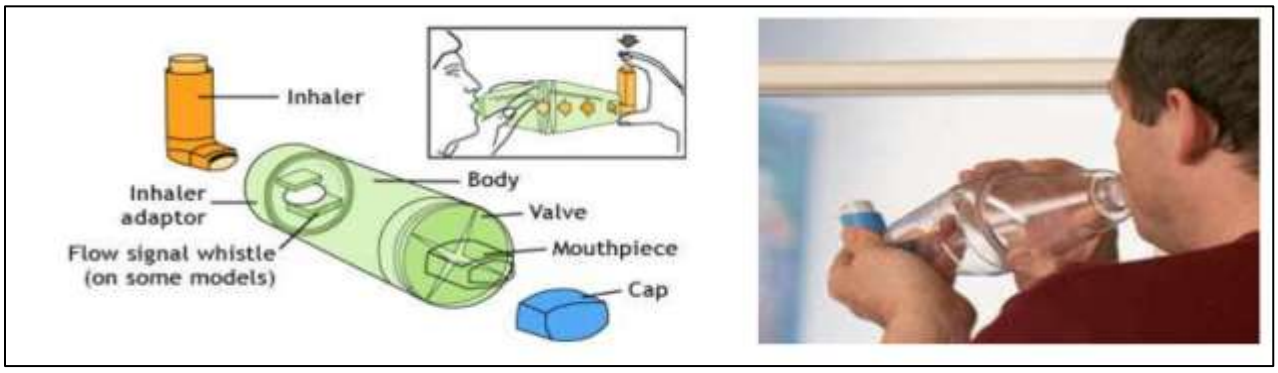
- In a large study (n=4,078), 71% of patients were found to have difficulty using pMDIs, and almost half of this group had poor coordination.
- Incorrect inhalation technique was associated with poor asthma control. (Giraud V et al., 2002)
- Incorrect usage of pMDIs is not confined to patients: it has been demonstrated that both nurses and physicians also use pMDIs incorrectly. (Crompton GK, 2004)

## Advantages and Disadvantages of MDI

| Device | Advantages | Disadvantages |
|---|---|---|
| pMDI | • Portable and compact<br>• Multi-dose device<br>• Quick to use<br>• Relatively cheap<br>• Cannot contaminate contents<br>• Available for most inhaled medications | • Contain propellants<br>• Not breath actuated<br>• Many patients cannot use it correctly (e.g. coordination difficulties)<br>• Cold Freon effect<br>• High oropharyngeal deposition |

## 2. pMDI with Spacer

- ➤ Spacers constitute a volume into which the patient actuates the pMDI and from which the patient inhales, **without necessarily having to coordinate the two maneuvers**.
- ➤ Moreover, spacers trap large particles so, only a small fraction is deposited in the oropharynx, thereby reducing side-effects, such as throat irritation, dysphonia and oral candidiasis.




## Advantages and Disadvantages of MDI + Spacer

| Device | Advantages | Disadvantages |
|---|---|---|
| pMDI + Spacer | • Easier to coordinate inhaler actuation with inspiration than pMDI alone<br>• Large drug doses delivered more conveniently than pMDI alone<br>• Less oropharyngeal deposition<br>• Higher lung deposition than a pMDI | • Bulkier and less portable than pMDI alone<br>• Plastic spacers may acquire static charge<br>• Additional cost to pMDI |

## 3. Dry Powder Inhalers DPIs

Modern dry powder inhalers include models were **single-dose devices** containing the powder formulation in a gelatin capsule, which the patient load into the device prior to use and **multi-dose DPIs**.

**Single dose inhalers**

***Aerolyzer***


***Breezhaler***

***Handihaler***

**Multi-dose inhalers**


***Turbuhaler***



***Ellipta***

***Discus***

## Advantages and Disadvantages of DPI

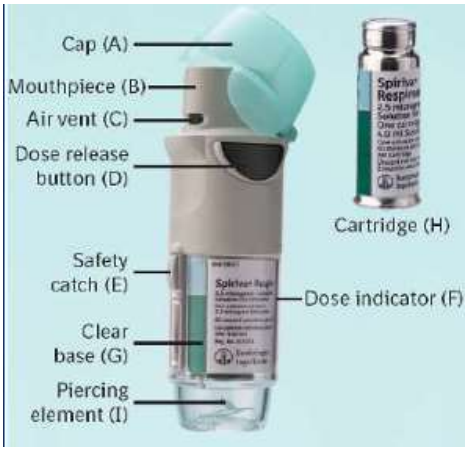
| Device | Advantages | Disadvantages |
|---|---|---|
| DPI | • Portable and compact<br>• Quick to use<br>• Breath actuated (No coordination needed)<br>• Usually higher lung deposition than a pMDI<br>• Does not contain propellants | • Require high inspiratory flow to be triggered<br>• May not be appropriate for emergency situations<br>• Many patients cannot use them correctly<br>• Most types are moisture seneitive |

## Common mistakes during DPI

- ❖ Lack of exhalation before inhalation.
- ❖ Incorrect positioning and loading of the inhaler.
- ❖ Failure to inhale forcefully and deeply through the device.
- ❖ Failure to breath-hold after inhalation.
- ❖ Some patients do not know that they must seal their lips firmly around the mouthpiece, causing them to attempt an "open mouth" inhalation that will not deliver any dose.
- ❖ Exhaling into the device.
- ❖ All these errors may lead to insufficient drug delivery, which adversely influences drug efficacy and may contribute to inadequate asthma control

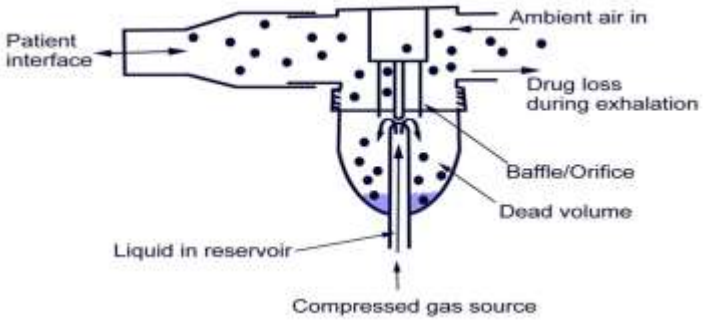
## 4. Respimat SMI

| Device | Advantages | Disadvantages |
|---|---|---|
| SMI (Respimat) | • Portable and compact<br>• Multi-dose device<br>• Probably easier to use correctly than pMDI<br>• High lung deposition<br>• Does not contain propellants | • Not breath actuated<br>• Not currently available in most countries<br>• Relatively expensive |



## 5. Nebulizers

- **Pneumatic Jet Nebulizer:** Delivers compressed gas through a jet, causing an area of negative pressure and drawing the liquid up the tube by the Bernoulli effect. The solution is broken into **droplets by surface tension forces**. The fundamental concept of nebulizer performance is the conversion of the medication solution into droplets in the respirable range of 1-5 microns.


- **Ultrasonic Nebulizer:** **Generates high-frequency ultrasonic waves (1.63 MHz**) from electrical. These ultrasonic waves are transmitted to the surface of the solution to create an aerosol. Aerosol delivery is by a fan or the patient's inspiratory flow.

### Advantages Of Nebulizers

1. Provide therapy for patients who cannot use other inhalation modalities (eg, MDI, DPI)
2. Allow administration of large doses of medicine
3. Patient coordination not required
4. Effective with tidal breathing
5. Dose modification possible
6. Can be used with supplemental oxygen
7. Saline inhalation itself is a mucolytic

### Disadvantages Of Nebulizers

1. Decreased portability
2. Longer set-up and administration time
3. Higher cost
4. Electrical power source required
5. Contamination possible

## Which inhaler device should we choose?

**Figure 3-3: Choosing an Inhaler Device for Children with Asthma***

| Age Group | Preferred Device | Alternate Device |
|---|---|---|
| Younger than 4 years | Pressurized metered-dose inhaler *plus* dedicated spacer with face mask | Nebulizer with face mask |
| 4 – 6 years | Pressurized metered-dose inhaler *plus* dedicated spacer with mouthpiece | Nebulizer with mouthpiece |
| Older than 6 years | Dry powder inhaler, *or* breath-actuated pressurized metered-dose inhaler, *or* pressurized metered-dose inhaler with spacer and mouthpiece | Nebulizer with mouthpiece |

## Choosing inhaler device for adults with asthma

The **patient's preferences and acceptance** of the inhaler should also be considered when deciding on a specific inhaler, since these will have major implications for compliance.

### Device Selection and Outcomes of Aerosol Therapy: Evidence-Based Guidelines*

**American College of Chest Physicians/American College of Asthma, Allergy, and Immunology**

*Myrna B. Dolovich, PEng; Richard C. Ahrens, MD; Dean R. Hess, PhD, RRT, FCCP; Paula Anderson, MD, FCCP; Rajiv Dhand, MD, FCCP; Joseph L. Rau, PhD, RRT; Gerald C. Smaldone, MD, PhD, FCCP; and Gordon Guyatt, MD, FCCP*

*Aerosol Delivery of Short-Acting $\beta_2$-Agonists in the Hospital ED*

*Aerosol Delivery of Short-Acting $\beta_2$-Agonists in the Inpatient Hospital Setting*

**Recommendations:**

1. Both the nebulizer and MDI with spacer/holding chamber are appropriate for the delivery of short-acting β2-agonists in the ED. Quality of evidence: good; net benefit: substantial; strength of recommendation: A.
2. Because data for DPIs are limited, and high-quality data for standard MDIs (without spacer/holding chamber) and breath-actuated MDIs are unavailable, we are unable to recommend the use of these devices in the ED until more information is available. Quality of evidence: low; net benefit: none; strength of recommendation: I.
3. For the treatment of asthma in the outpatient setting, both the MDI with a spacer/holding chamber and the DPI are appropriate devices for the delivery of inhaled corticosteroids.

## For adult patients with asthma in the outpatient setting

- The patient's ability to use the device correctly.
- The preferences of the patient for the device.
- The availability of the drug/device combination.
- Cost of therapy.

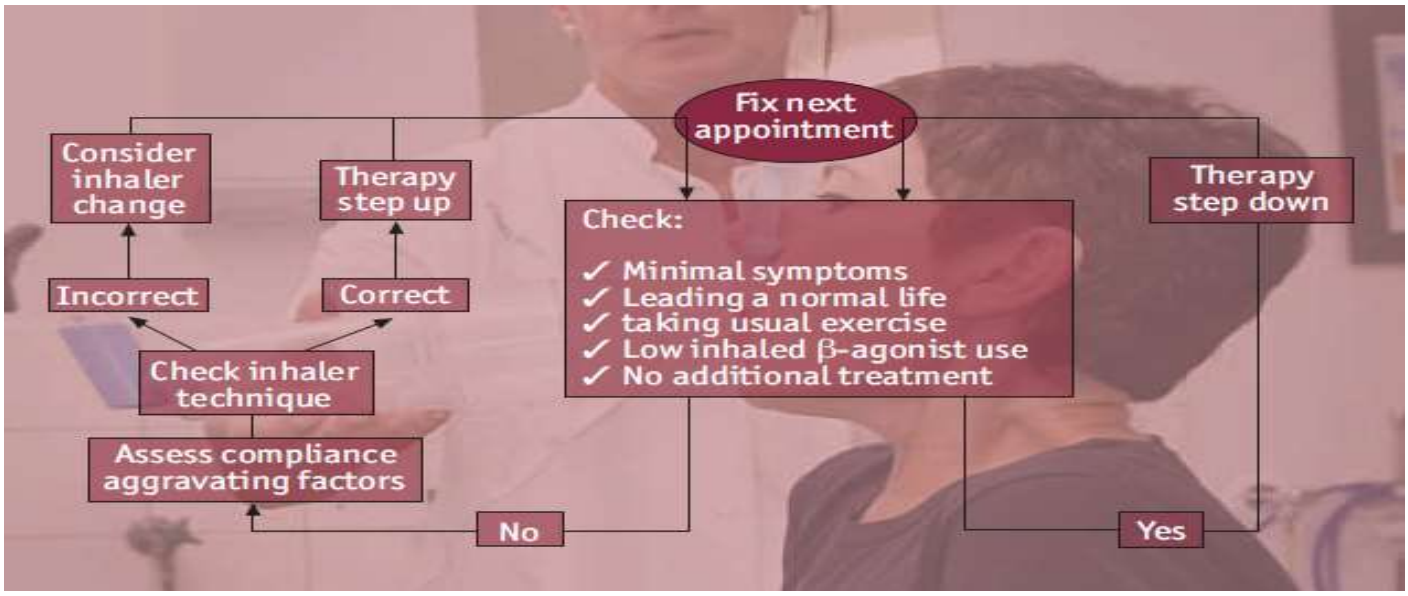
***The most expensive inhaler is the one that is not used correctly.***

## Inhaler devices.. Which one?

***Table 4 Suitability of inhaler devices according to the patient's inspiratory flow rate and ability to coordinate inhaler actuation and inhalation***

| | Good hand–lung coordination | | Poor hand–lung coordination | |
|---|---|---|---|---|
| | Inspiratory flow >30 L per min | Inspiratory flow <30 L per min | Inspiratory flow >30 L per min | Inspiratory flow <30 L per min |
| Inhalers | pMDI<br>BA-MDI<br>DPI<br>Nebuliser<br>SMI | pMDI<br><br><br>Nebuliser<br>SMI | pMDI+spacer<br>BA-MDI<br>DPI<br>Nebuliser<br>SMI | pMDI+spacer<br><br><br>Nebuliser<br>SMI |

***Asthma therapy adjustment flow chart by Aerosol Drug Management Improvement Team***




## Conclusion

A number of inhalation devices are available for the treatment of pulmonary diseases, each with its own advantages and disadvantages. None has proven to be superior to the others in any of the clinical situations tested. Whichever device is chosen, the key to successful treatment lies at a proper inhaler technique