INHALER DEVICES

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WHAT IS AEROSOL ?

- Suspension of solid or liquid particles in gas
- Generated with inhalers and nebulisers

- **Indications :**

  Locally acting drugs

  Route for systemic absorption

  Enhancement of secretion clearance

  Sputum induction

  Humidification of respired gases

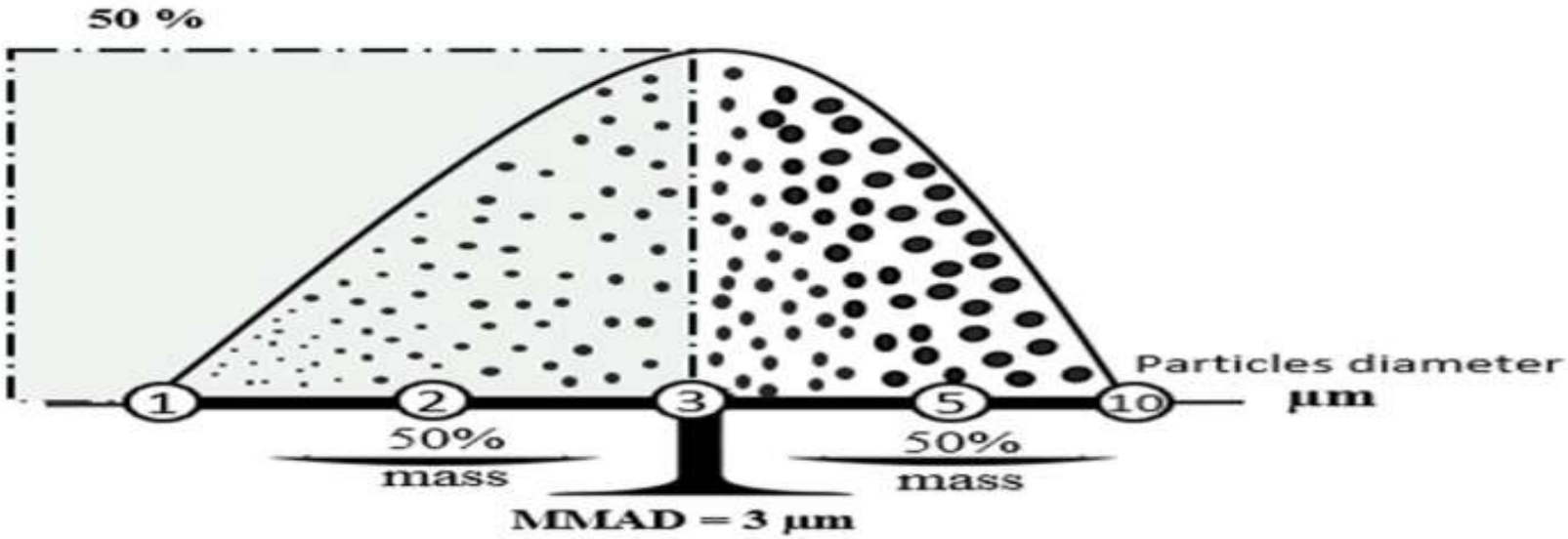
ADVANTAGES

- Good therapeutic index
- Selective treatment of lung disorders
- Rapid onset of action
- Minimum systemic adverse effects
- Painless and convenient
- Large surface area : may be used for systemic therapy

DISADVANTAGES

- Specific inhalation technique needed
- Less than optimum technique : significant reduction in efficacy
- Too many devices : confusing

Characteristics of Therapeutic Aerosols



- **<u>Particle size : Monodisperse vs Heterodisperse</u>**

  MMAD (Mass Median Aerodynamic Diameter)

  GSD (Geometric Standard Deviation)

  FPD (Fine particle dose)

  FPF(Fine particle Fraction)

- **Deposition**:

a) Inertial impaction : larger than 5 microns

b) Gravimetric sedimentation : 1 to 5 microns

c) Brownian diffusion: <3 microns

- **Aging:**

Grow, shrink, coalesce or fall out of suspension

Factors affecting drug deposition

- **Device related factors** : Type of device and its usability
- **Formulation related factors** : nature and size of drug particle
- **Patient related factors** :

a) Airway anatomy (Airway obstruction, artificial airways)

b) Ventilatory pattern : Inspiratory flow rate
Inhaled volume
Breath holding

c) Technique

MMAD >5 µm

2 <MMAD< 5 µm

0.5 <MMAD< 3 µm

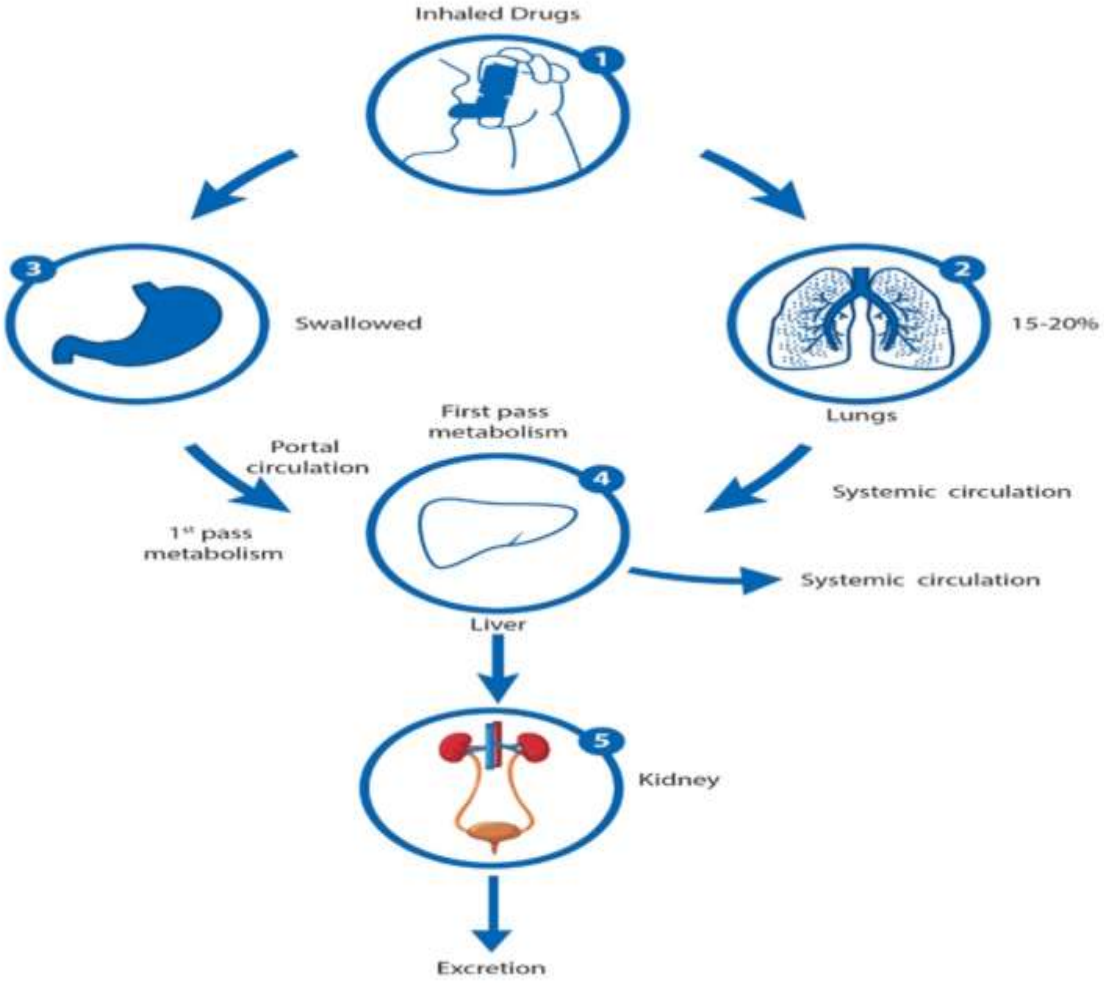
MMAD< 0.5 µm

Exhaled

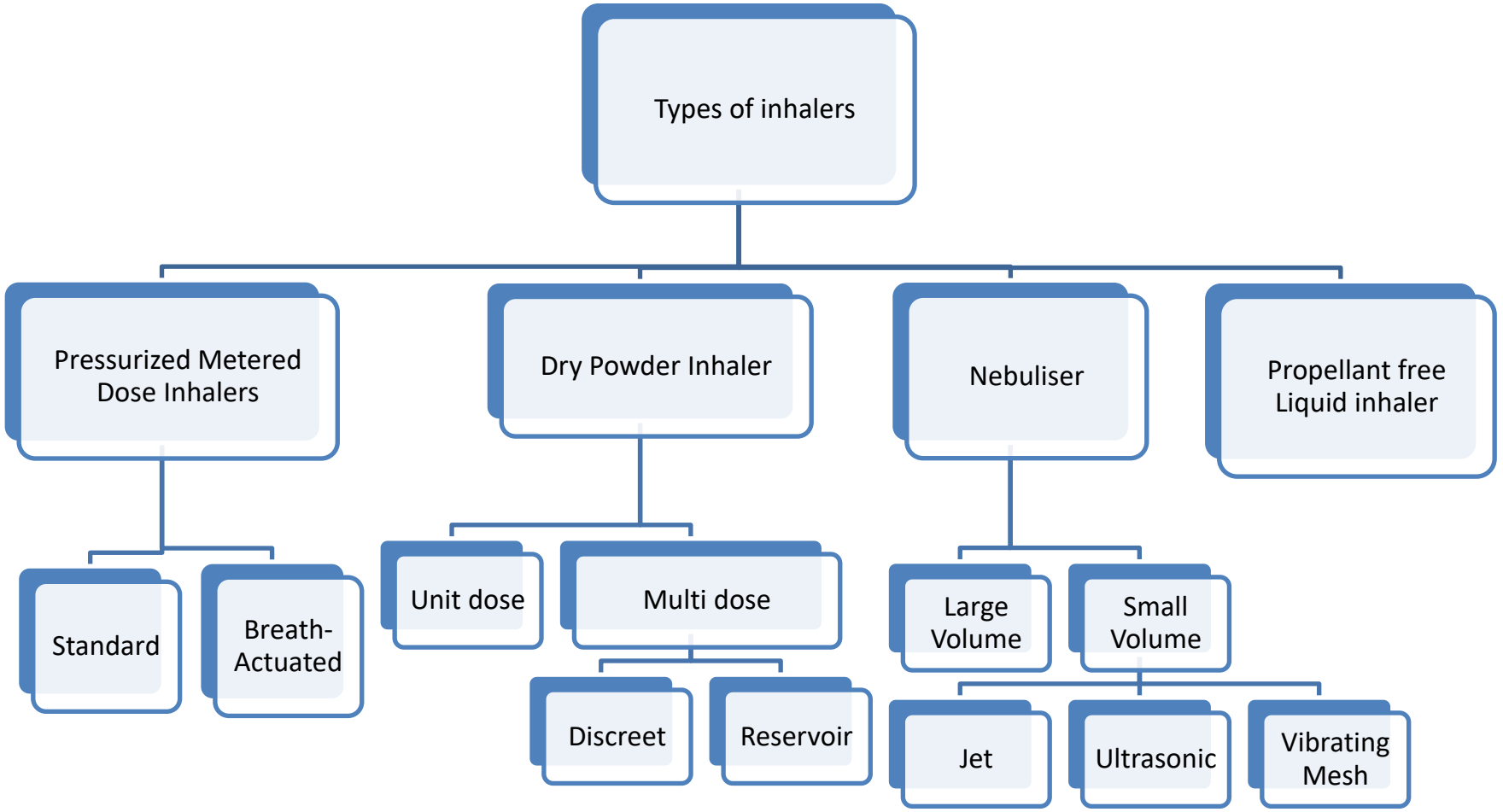
1< MMAD< 5 µm

Therapeutic interest

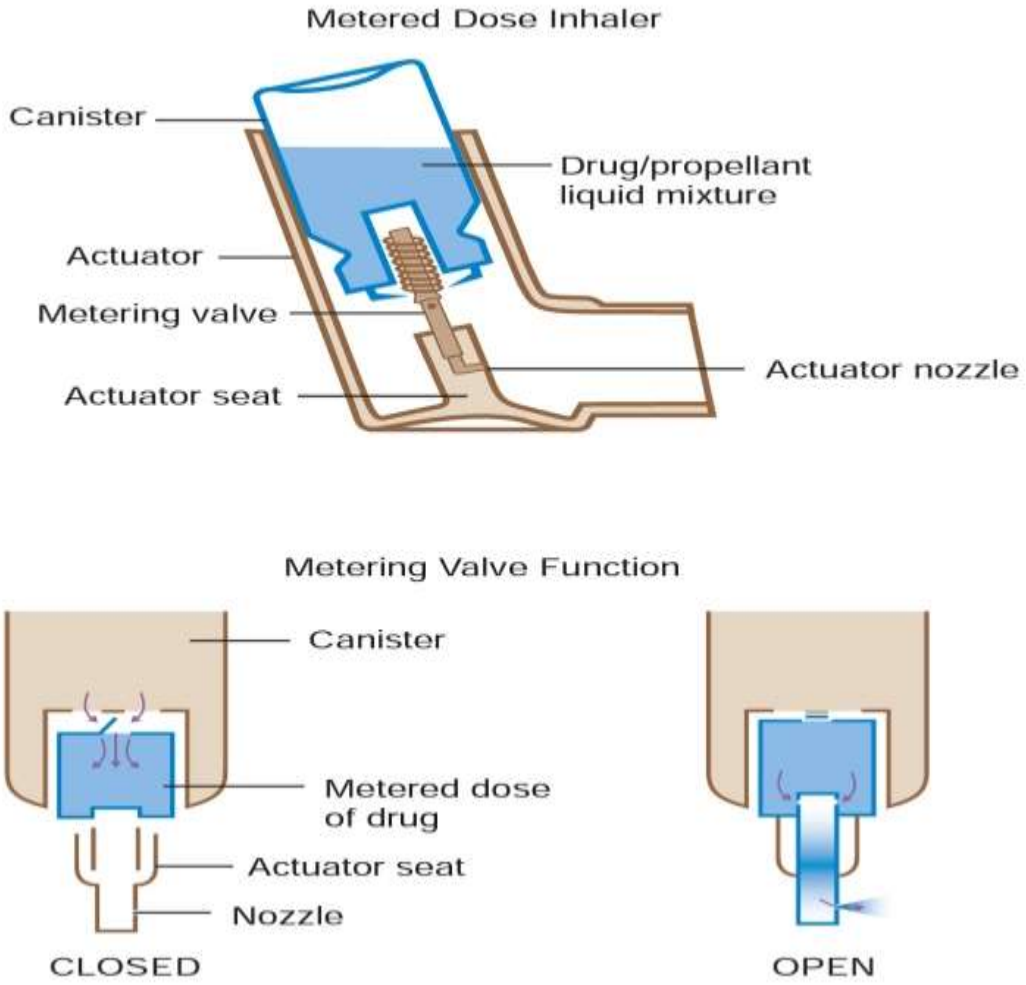
PHARMACOKINETICS



Chrystyn H.Methods to identify drug deposition in the lungs following inhalation.Br J Clin Pharmacol 2001;51:289-99


Types of inhalers
Pressurized Metered Dose Inhalers
Dry Powder Inhaler
Nebuliser
Propellant free Liquid inhaler
Standard
Breath-Actuated
Unit dose
Multi dose
Large Volume
Small Volume
Discreet
Reservoir
Jet
Ultrasonic
Vibrating Mesh

pMDIs



Gradenhire DS:Rau's respiratory care pharmacology, ed 8, St. Louis, 2012, Mosby.

Components of pMDI

- Metering valve : Specified unit dose
- Container : Inert material like aluminium
- Propellant : CFCs vs HFA 227 and HFA 134a
- Actuator : Nozzle diameter

SOME COMMON MISTAKES

- Priming : First time use

  Using after a gap of few days (4 or more days)
- Exhale up to FRC before using inhaler
- Tight seal
- Coordination
- Slow and deep inhalation (4-5 seconds)
- Breath hold (10 seconds or as long as possible)
- Interval between 2 actuations : At least 30 seconds
- Post inhaler use : Gargling with water and spitting out

SIDE EFFECTS OF pMDI

- Dysphonia
- Oropharyngeal candidiasis
- Cold Freon Effect
- Systemic side effects (sympathetic side effects for beta agonists and systemic side effects for corticosteroids)

COLD FREON EFFECT

- When propellant, which is under pressure in canister , is released out through nozzle , temperature of aerosol drops to around -30 C and by the time it hits throat , temp is around 0C
- Causes pharyngeal spasm and stimulates cough
- Overcome with Spacer and HFA propellant

SPACERS

- Allow patient some extra time to inhale drug

- Advantages :

  Eliminates need for hand breath coordination

  Decreased oropharyngeal impaction

  Eliminates cold freon effect

  Reduced dysphonia

  Valved holding chambers : Low tidal volume patients

Factors affecting efficiency of Spacers

- Spacer shape : Pear shaped preferred
- Size : Small (<100 ml) , medium (130-300 ml), large (>700 ml) . Medium volume preferred
- Static vs anti static (Anti static preferred) (Implication of washing technique)

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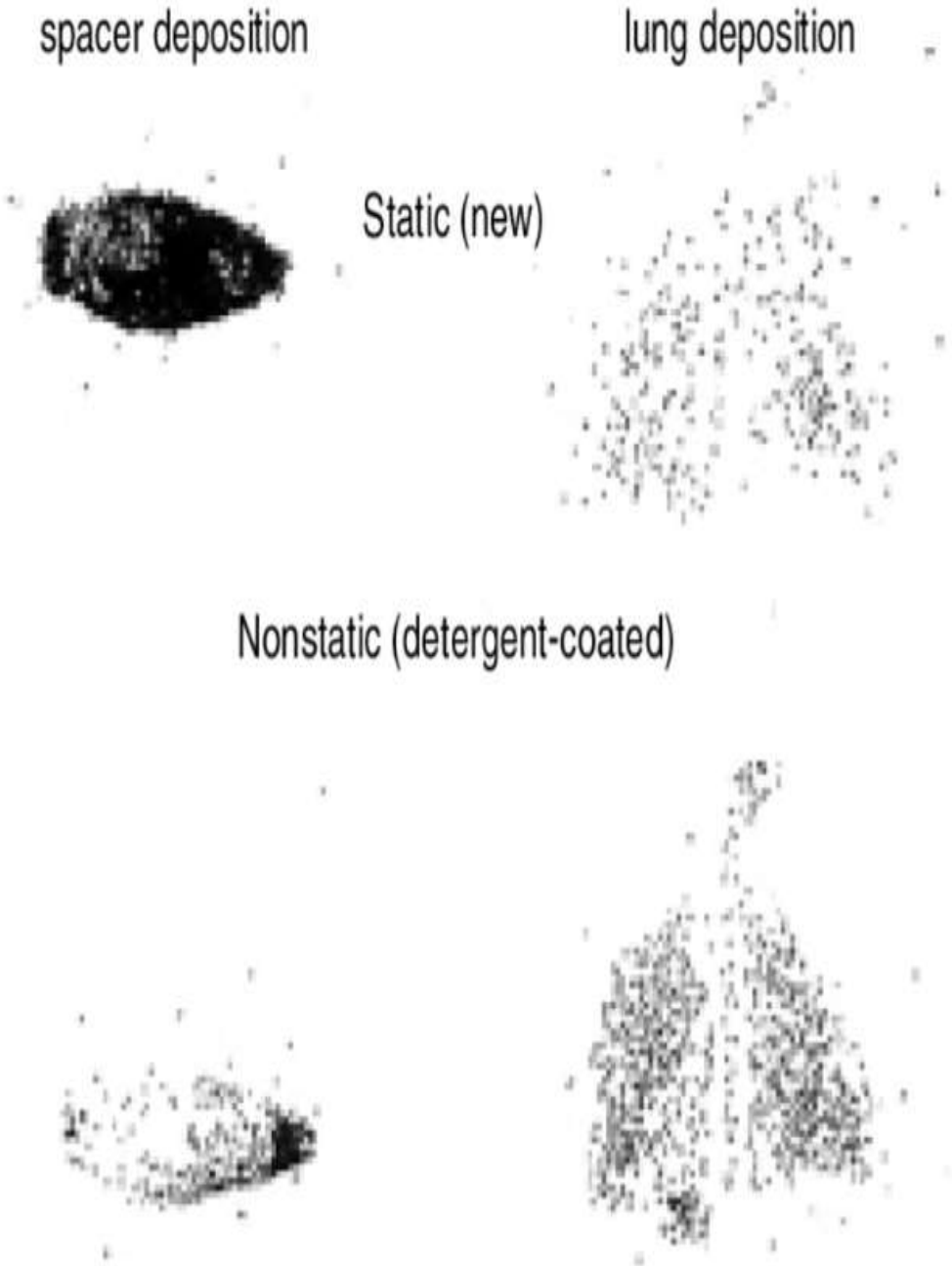
STATIC VS ANTI STATIC

- Plastic/polycarbonate/polymer spacers do not conduct electricity → Susceptible to electrostatic charging → Attracts aerosol particles → Reduces dosage availability

STATIC VS ANTI STATIC

Metallic and some plastic spacers have antistatic inner lining made of electrostatic charge dissipative material → Do not accumulate electrostatic charge


spacer deposition
lung deposition
Static (new)
Nonstatic (detergent-coated)

Breath Actuated pMDI

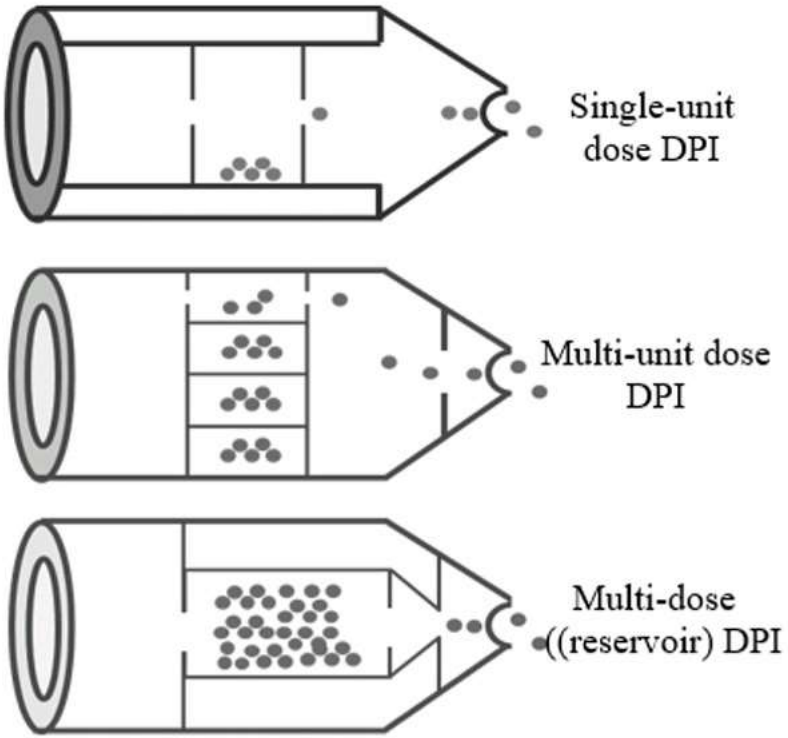
- Devised to overcome challenge of hand breath coordination
- Sensing mechanism : Actuated when inspiratory flow rate of 23-25L/min (Much less than flow of 50-90 L/min required for DPI)
- Example - Synchrobreath

Education material from Cipla

DRY POWDER INHALER

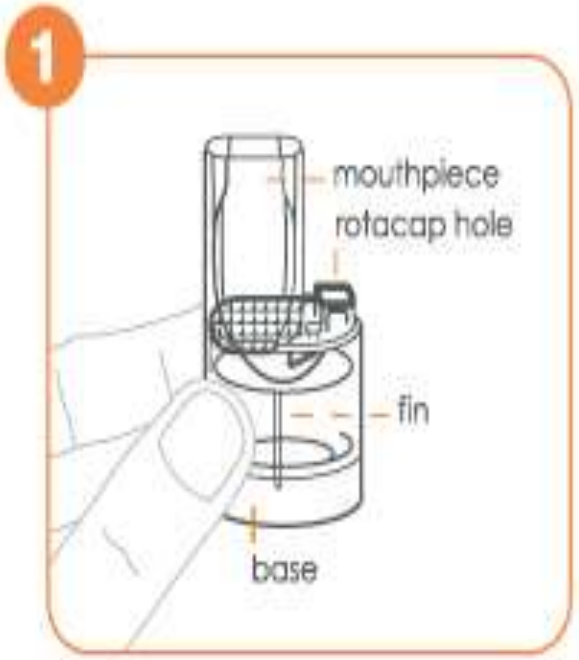
- No propellant (have carrier: lactose or glucose)
- Requires patient’s own inspiratory effort to form aerosol
- Useful in children above 5 years

- 3 categories : Unit dose DPI ,
  Multiple unit dose DPI
  Multiple dose drug reservoir DPI



Unit Dose DPI

Eg : Rotahaler , Revolizer (Cipla Ltd.)



Education material from Cipla

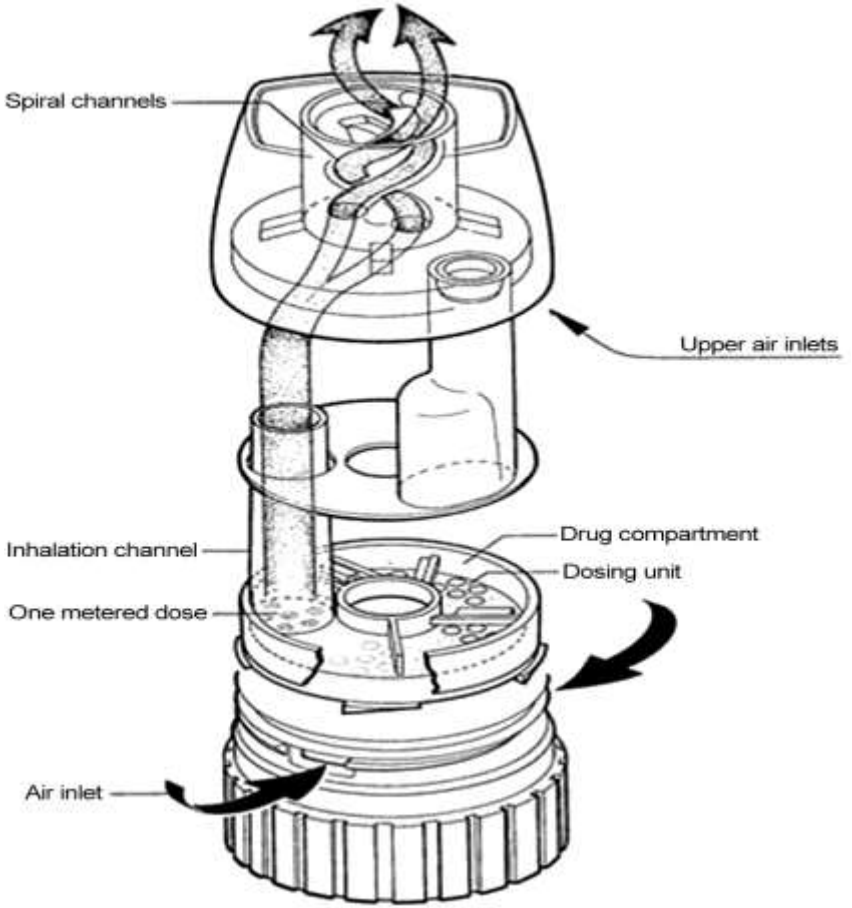
Multidose Discreet

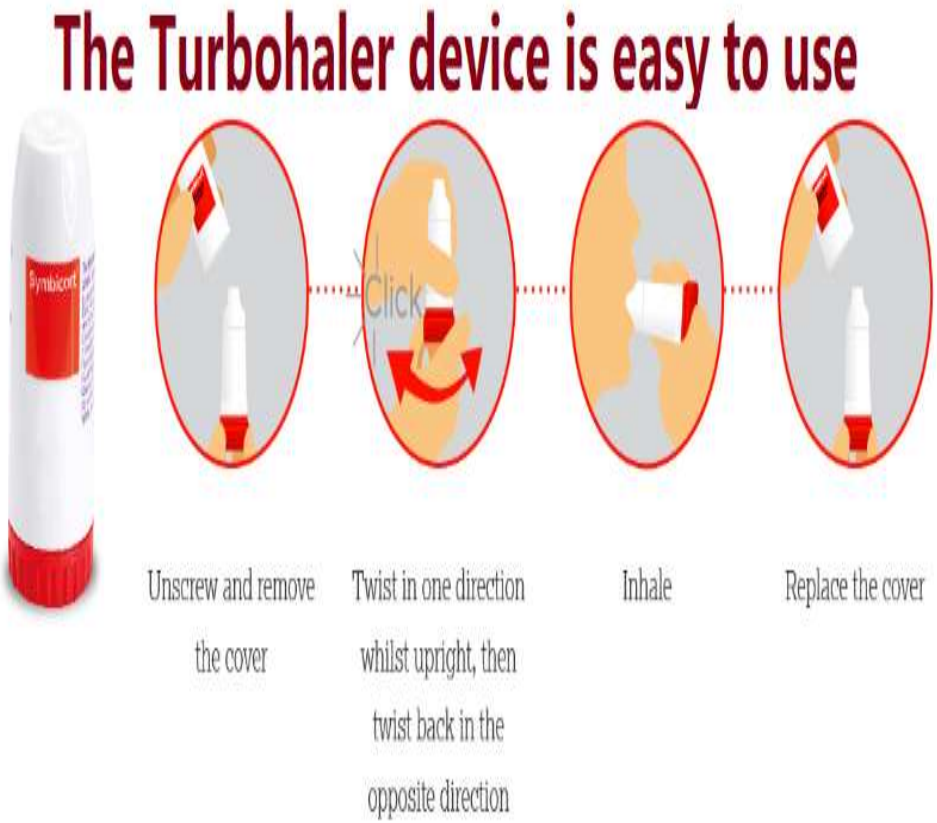
- Eg: Ciphaler , Multihaler(Cipla Ltd.)

Education material from Cipla

Multidose (Reservoir)

- Eg : Turbuhaler





Education material from AstraZeneca

PRINCIPLES OF WORKING

- During inhalation, inspiratory flow creates turbulence in DPI and deagglomerates drug particles from carrier lactose molecules
- Turbulent energy : product of resistance by device and inspiratory flow rate

Cleaning of Devices

- pMDI : Mouthpiece should be cleaned with a soft cloth or tissue paper after each actuation
- Static spacers : Mild detergent once a week; air dry
- Anti static spacers : Plain room temperature water once a week; air dry
- Unit dose DPI : Disassemble ; under running water once a week and left to air dry
- Multi dose DPI : Mouthpiece should be cleaned with dry cloth

NEBULISERS

	Jet (conventional) nebuliser	Ultrasonic nebuliser	Vibrating mesh nebuliser
Features			
Power source	Compressed gas or electrical mains	Electrical mains	Batteries or electrical mains
Portability	Restricted	Restricted	Portable
Treatment time	Long	Intermediate	Short
Output rate	Low	Higher	Highest
Residual volume	0.8–2.0 ml	Variable but low	≤0.2 ml
Environmental contamination			
Continuous use	High	High	High
Breath-activated	Low	Low	Low
Performance variability	High	Intermediate	Low
Other Characteristics			
Cleaning	Required, after single use	Required, after multiple use	Required, after single use
Cost of the device	Very low (approx. Rs. 1,000–4,000)	High (approx. Rs. 6,000–25,000)	High (approx. Rs. 10.000–25.000)

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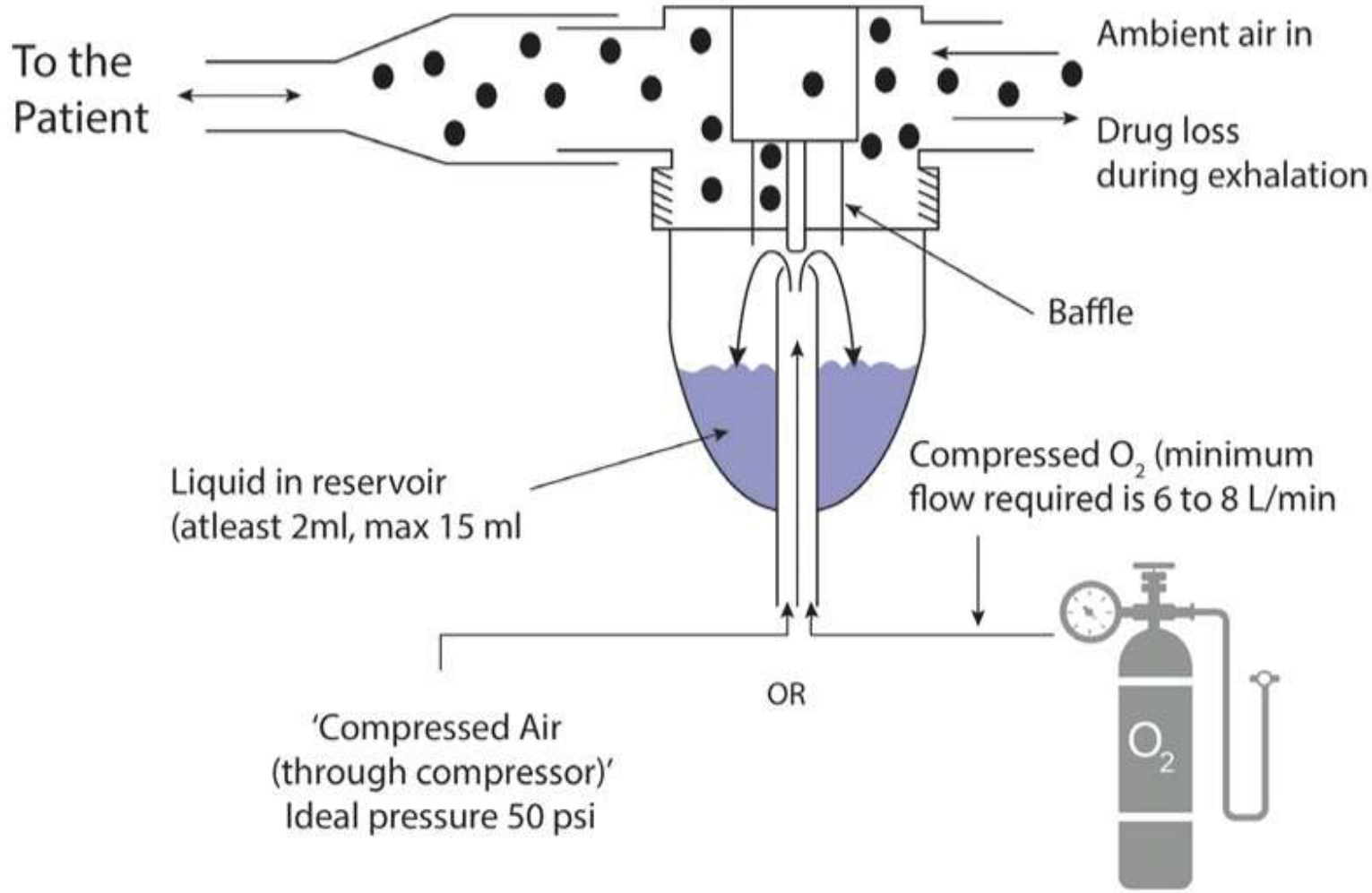

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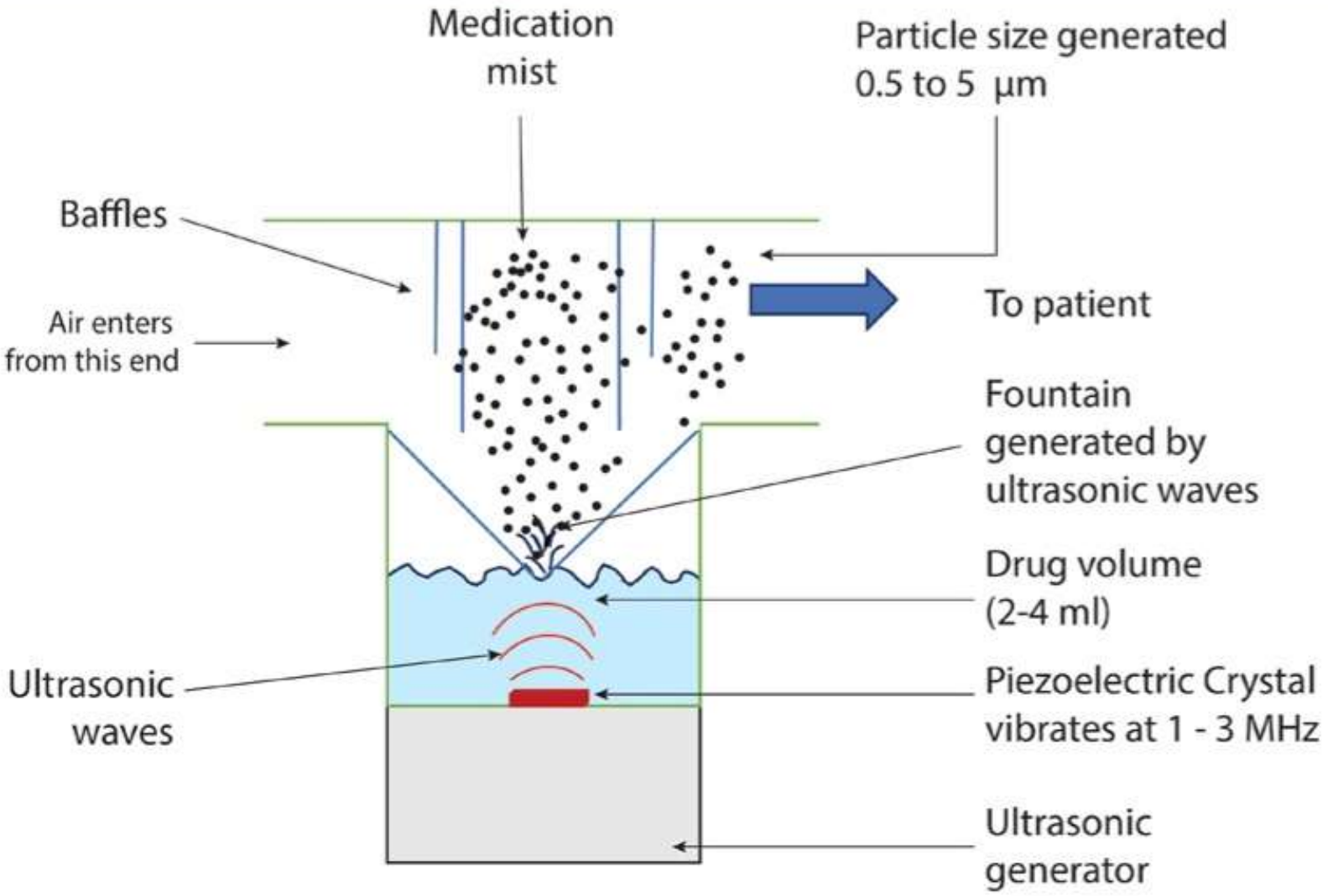

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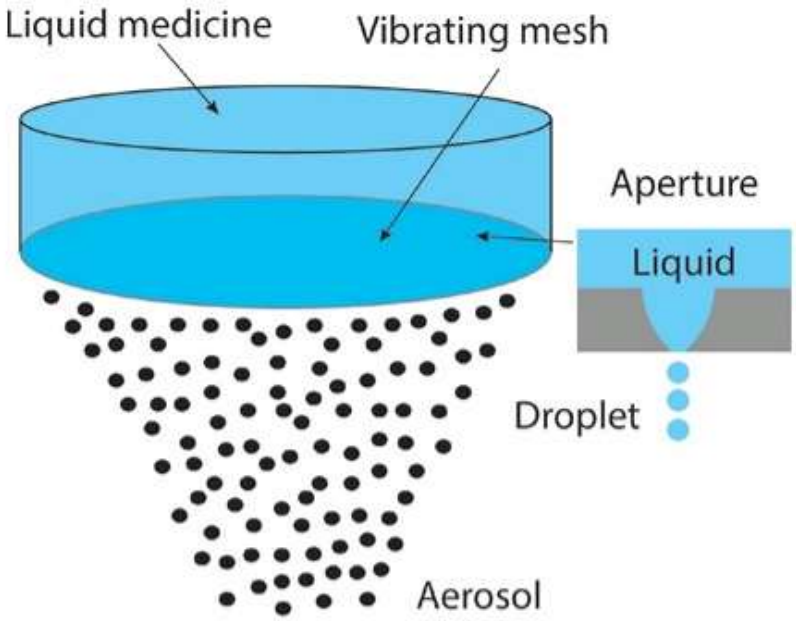

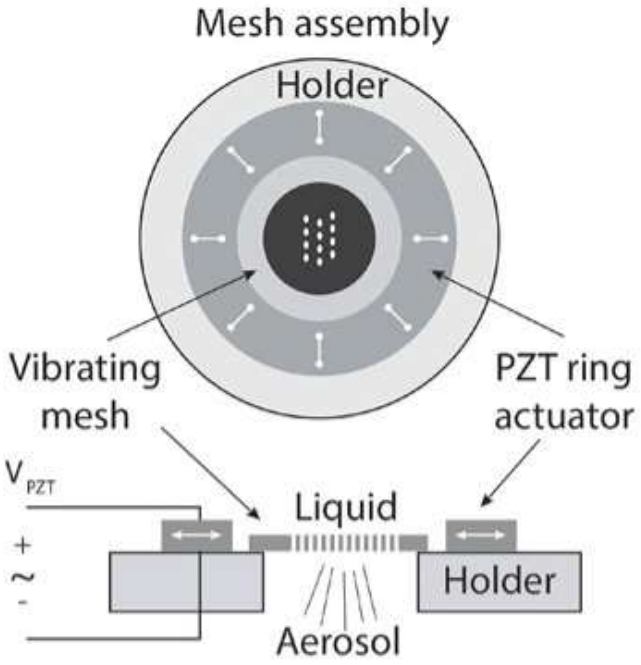

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COMPARISONS

pMDIs

Advantages

- Portable
- Reproducible dosing
- Independent of inspiratory effort
- Useful for all ages (with add on devices such as spacers and face masks)
- Economical
- No contamination

Disadvantages

- Hand-breath coordination
- Propellants and excipients (environmental concerns and side effects)
- Local and systemic side effects

BAIs

Advantages

- No need of coordination
- No need to use spacer
- Low inspiratory effort required
- Delivered dose independent of inspiratory effort
- Simple to learn and use

Disadvantages

- More expensive than pMDIs and DPI
- Patients may stop inhaling as soon as they hear a click (as with some BAI)

DPIs

Advantages

- No need for coordination
- Easier to use

Disadvantages

- High oropharyngeal deposition
- Vulnerable to ambient humidity and exhaled air
- If held incorrectly after dose preparation , dose may fall
- Dependent on inspiratory flow rate and hence not useful in small children

Nebulisers

Advantages

- Can be used during acute exacerbations when patient is critical or unconscious and when required medication is not available in inhaler format
- Can be used when high doses of bronchodilators required to be given along with supplementary oxygen

Disadvantages

- Possible toxicity due to high dosages
- Risk of airborne infection transmission
- Require longer time for drug delivery
- Regular maintenance
- Mostly require electrical mains and so not handy to use

DEVICE SELECTION

- In what devices is desired drug available ?
- What device is patient likely to be able to use properly ?
- Cost
- Can all prescribed drugs be delivered by same type of device ?
- Durability
- Patient and clinician preference

Good Hand-Breath coordination

Inspiratory flow > 30 L/min

- MDI
- Breath actuated MDI
- DPI
- Nebuliser

(AVERAGE ADULT)

Inspiratory flow < 30 ml/min

- MDI
- Nebuliser

(Severe Obstruction)

Poor Hand Breath coordination

Inspiratory flow >30 L/min

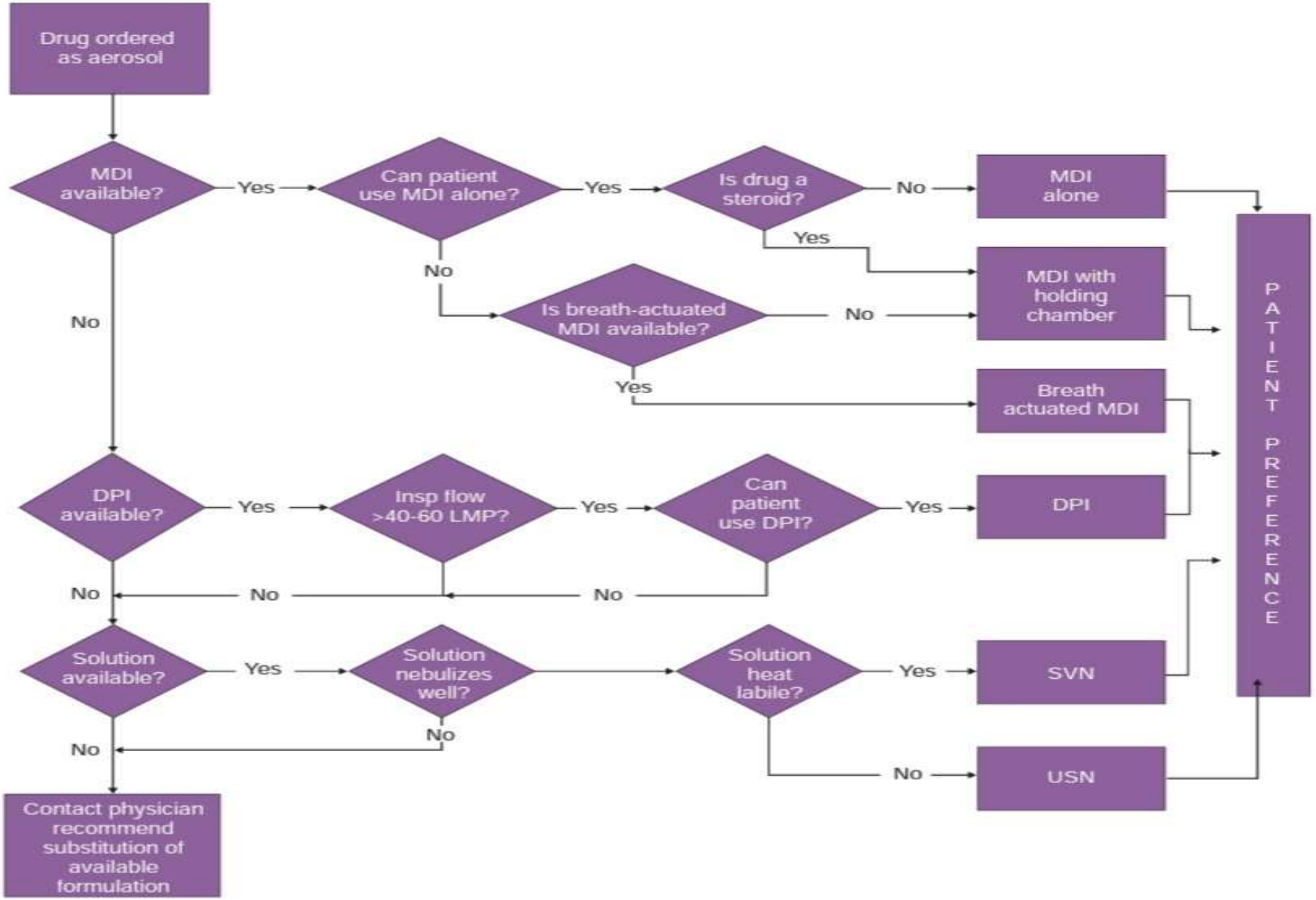
- MDI with spacer
- Breath actuated MDI
- DPI
- Nebuliser

(Elderly , children)

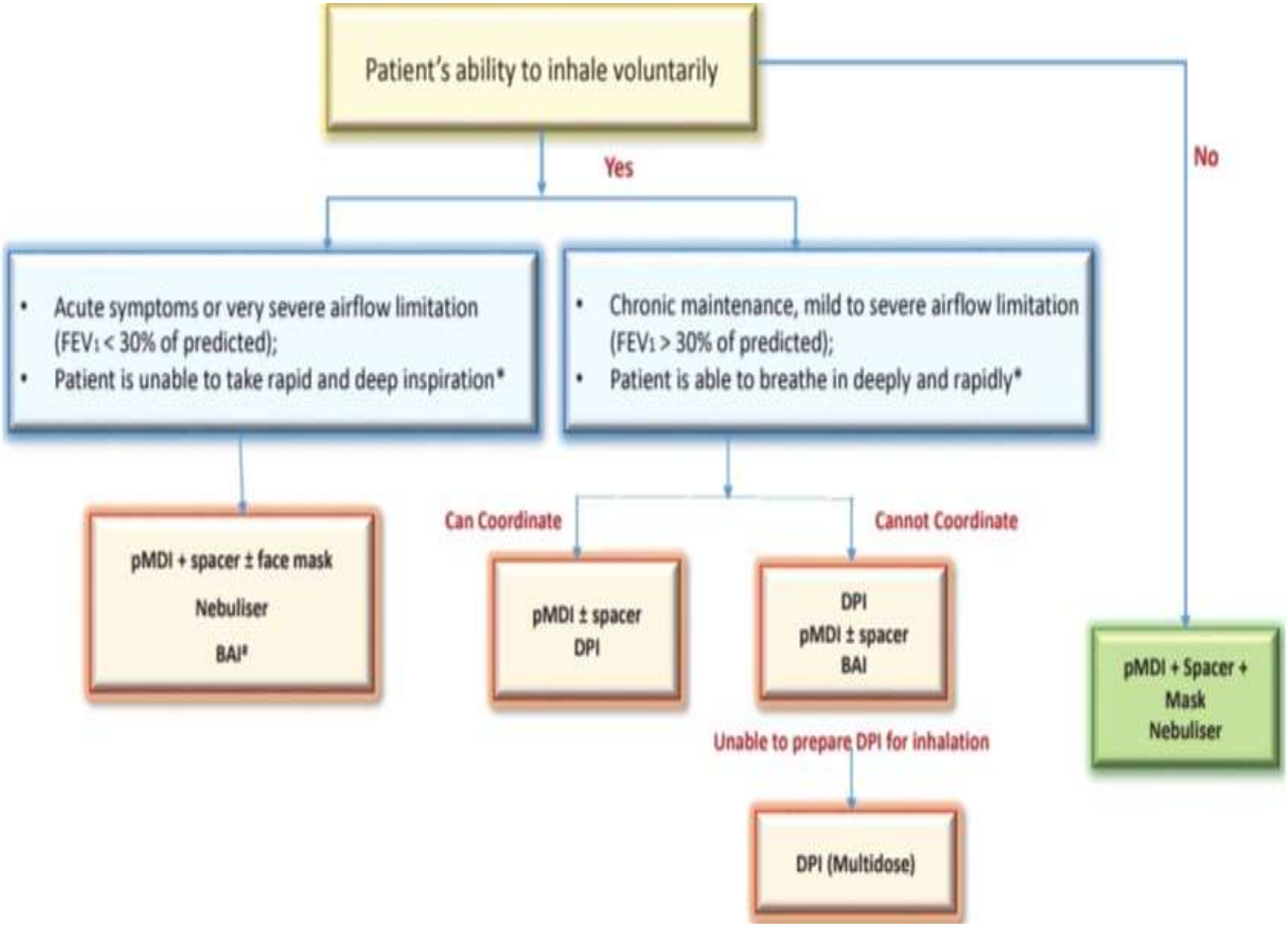
Inspiratory flow < 30 L/min

- MDI with spacer
- Nebuliser

(Small children)



EGAN'S Fundamentals of Respiratory Care ; 12th edition



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Take Home Message

- Inhalational therapy: Safest, Fastest and most effective way (Patient myths must be debusted)
- Different devices available: Choose most appropriate device based on context
- Periodically check technique of patient