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REVIEW OF PRESSURIZED METERED DOSE INHALERS (pMDI)

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*Abstract:*Lung conditions including asthma and chronic obstructive pulmonary disease have long been treated with pressurized metered dosage inhalers, or MDIs. In order to atomize medication and excipient droplets that should ideally deposit in the lungs, MDIs rely on the propellant, which makes up the majority of the MDI formulation. Along with a better understanding of the effects of formulation variables on product performance, many advancements were made in the methods of formulating for MDI drug delivery during the phase-out of chlorofluorocarbon propellants and the introduction of more ecologically friendly hydrofluoroalkane propellants. Taking into account the physicochemical characteristics of different excipients and how their addition may affect the MDI's overall product performance, this paper surveys the difficulties involved in creating MDIs as solution or suspension products containing one or more medications.[1]

Index Terms-pMDI ,History, Uses, Parts of pMDI ,Advantages and Disadvantages.

I. Introduction

Asthma and obstructive airways disease have been effectively treated using pressurized metered dosage inhalers (pMDIs) for nearly 50 years. However, patient preferences and forgiving therapeutic indices of medications like salbutamol have contributed to success considerably more than the inherent qualities of the dosage form. Compared to other dosage forms, it is much less accurate as a delivery system. The dose is produced over a brief amount of time, usually 200 msec, at a high speed, usually 30 msec -r. Patients have significant difficulties coordinating dose generation with the right inspiration as a result, and the majority of the medication gets into their throats and is swallowed. Even while spacers can help with these issues, the dosage is still subject to variation based on usage patterns.[2]

Asthma patients can now get inhaled corticosteroids using a variety of inhaler devices and medication combinations. These consist of dry powder devices, breath-actuated pressurized metered dosage inhalers, and pressurized metered dose inhalers that are hydrofluoroalkane or chlorofluorocarbon-free. There are no clearly evidence-based recommendations regarding which medications are the most effective, despite the fact that the price of the drugs used in particular devices varies greatly. The therapeutic efficacy of the conventional

pressurized metered dose inhaler with chlorofluorocarbon vs other handheld inhaler devices in administering corticosteroids to patients with stable asthma was assessed by a systematic review.[3]

II. History

For thousands of years, people from many cultures have employed inhalation to deliver curative vapours and aerosols. In the Assassin section of the Theban necropolis, an ancient Egyptian papyrus scroll (Ebers's papyrus) allegedly found between a mummy's legs in 1554 BC is the earliest recorded mention of medicinal aerosol delivery.[4] The mid-1950s saw the advent of pressurized metered dose inhalers (MDIs), which revolutionized respiratory care. Poor pMDI user technique is still a problem even after decades of availability, healthcare support, and the introduction of educational aids and equipment to encourage superior use.[5].

The pressurized metered-dose inhaler (pMDI), the first contemporary inhaler for the treatment of asthma, entered clinical use 50 years ago this year. Adrenaline and isoprenaline, two non-selective beta-agonists, were first administered using the pMDI. However, the first inhaled corticosteroid (ICS), beclomethasone, and the selective short-acting beta-agonist salbutamol replaced these medications due to the epidemic of asthma mortality that occurred in the 1960s.[6]

III. Parts Of pMDI:-

VALVE DESIGN	An MDI valve functions somewhat like two independent valves, one at either end of the metering chamber. While formulation is permitted to enter the metering chamber, the exterior valve, which isolates the system from the outside world, remains closed. After that, the inner valve shuts, separating one dose of the appropriate volume from the MDI canister's bulk formulation. The outer valve is then let to open, allowing the dose to be dispensed under the vapor pressure of its own propellant when the proper volume has been sampled. In order to prepare for the subsequent dosage, the inner and outer valves then reopen and close, respectively.[3]
CANISTER DESIGNS	Although metals like stainless steel or aluminium are commonly used to make canisters, glass canisters have also been utilized. The size of the valve to be used and the total number of doses to be given determine the canister's size. Usually, a canister holds between 10 and 20 millilitres. The introduction of new internal coating materials, which are typically added to minimize formulation–canister interactions, is the most common recent innovation on MDI canisters.[3]
ACTUATOR DESIGN	The "expansion chamber," which also affects the atomization, is made up of the actuator sump, the valve metering chamber, and the volume of the valve stem through which the formulation passes after leaving the valve side puncture. The tip of the valve stem is fixed in place by a ledge in the actuator nozzle block.[3]
Spray Nozzle Design	When the patient releases the device, a very intricate and dynamic process takes place: the creation of aerosols. The propellant-based formulation leaves the valve-metering chamber through the side piercing in the valve stem, passes through the expansion chamber, and emerges out the spray nozzle after the valve stem is depressed. The dynamics of the atomized spray are greatly influenced by the actuator nozzle orifice diameter (OD), in addition to formulation factors.[3]

Mouthpiece Configuration and Airflow Manipulation	The arrangement of the actuator mouthpiece and the flow it creates can also have a big effect on the particle distribution. Increasing the length of the mouthpiece can transfer drug deposition from the USP inlet to the mouthpiece (46) in a manner similar to that of a spacer. The patient's oral cavity shape during inhalation may also be influenced by the actuator mouthpiece's shape, which may have an effect on deposition profiles.[3]

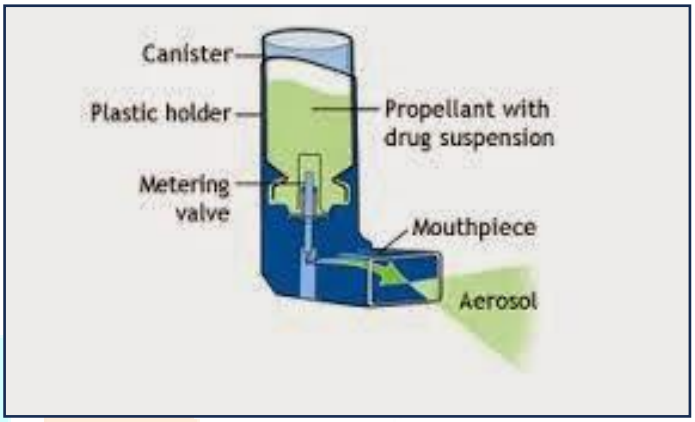

Fig.Parts Of pMDI

IV. National Institute of Health-Expert Panel 3 guidelines for inhaler usage technique:-[2]

Step 1: Take off the canister's mouthpiece cap and hold it upright with your thumb beneath the base and your finger on top.
Step 2: Shake and exhale one puff into the air for the first time or after more than seven days of use.
Step 3: Sit or stand upright. Exhale through your mouth.
Step 4: Insert the mouthpiece between your teeth and seal your lips tightly, leaving no space between them.
Step 5: Take a deep inhale and exhale one dose at the same time.
Step 6: Take out the inhaler and shut your mouth right away.
Step 7: Hold your breath for as long as you can, ten seconds.
Step 8: Do not take the second dose until at least one minute has passed.

V. Uses of pMDI:-

1) 1) Asthma and chronic obstructive pulmonary disease are commonly treated with pressurized metered dosage inhalers (pMDIs).[1]

2) Pressurized metered-dose inhalers may be preferred for people who meet all manual, cognitive, and coordination needs.[3]

3) Short acting β_2 agonists, or bronchodilators, are frequently administered by pMDIs to treat acute asthma symptoms.[5]
4) According to certain research, pMDIs can have an influence on lung deposition and function in COPD patients that is comparable to those of other devices when spacers are used.[5]
5) Children are treated with pMDIs; to facilitate delivery, spacers, holding chambers, or masks are frequently employed. Research indicates that pMDIs are just as effective at delivering short-acting β_2 agonists in children with stable asthma as dry powder inhalers (DPIs).[6]
6) To enhance lung delivery, decrease oropharyngeal deposition (which lessens adverse effects including candidiasis and throat irritation), and enhance coordination (actuation + inhaling). When taking pMDIs, spacers or VHCs are used as adjuncts.[7]
7) pMDIs, particularly when used with spacers or breath-actuated/coordinated devices, are helpful for patients who are unable to produce enough flow for DPIs or who struggle with inhalation actuation coordination. [8]
8) pMDIs are multidose, portable, reasonably priced, and, in some situations, less likely to be contaminated by microorganisms than nebulizers.[9]

Fig.Marketed pMDI

VI. Advantages And Disadvantages of pMDI

Advantages	**Disadvantages**
Compared to many other inhaler types (e.g. some dry powder inhalers or nebulisers), pMDIs are generally cheaper.[10]	The patient must coordinate actuation (pressing down) and inhalation (breathing in) properly. Poor coordination reduces effectiveness.[12]
They produce aerosol quickly and deliver medication fast into the airways. Good in emergencies.[11]	A lot of drugs may deposit in mouth/throat instead of reaching the deep lungs—this reduces efficacy and increases side-effects. Even with proper technique, only ~10-20% of emitted dose may reach the site of action.[15]
Each puff tends to deliver a reproducible dose, assuming technique & device are used correctly.[12]	Many devices don't show how many doses are left, so patients may run out or underdose without realizing.[16]
Unlike dry powder inhalers (DPIs), pMDIs don't need the patient to generate a high inspiratory flow, which helps patients who are weak or during acute exacerbations.[13]	Traditional propellants (CFCs) were phased out; newer ones (HFA) still have environmental impacts (greenhouse gas emissions).[17]
The propellant and sealed canister protect from moisture, oxidation, and contamination.[14]	Some pMDIs require shaking before use to mix drug properly, especially suspension formulations; also priming if not used for a period. If not done, dose and aerosol properties may be compromised.[17]
Most pMDIs contain many doses (often ~100-200) in one canister.[15]	Many patients misuse them. Studies show high rates of error, which correlate with poorer disease control.[19]
pMDIs are small, handheld, easy to carry and use in acute situations.[16]	Some pMDIs output depends on temperature, nozzle cleanliness; if not maintained or stored properly, performance suffers.[20]

VII. Conclusion:-

For optimal drug administration and therapeutic impact, actuation and breathing must be coordinated with pressurized metered-dose inhalers (pMDIs). Particle deposition in upper airways increases as a result of turbulent airflow brought on by the solution's quick inspiration [12]. These devices use liquid propellants, namely hydrofluoroalkanes (CFCs), to dissolve the medication. The propellant evaporates when it is activated, and the drug particles that have been aerosolized are inhaled. pMDIs are not regarded as appropriate devices for the delivery of inhaled liposomes because of their lack of stability, poor aerosol properties, and requirement for cosolvents that impair the robustness and deposition patterns of liposomal formulations.[19]

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