Amid COVID-19 drug shortages: proposed plan for reprocessing and reusing salbutamol pressurized metered dose inhalers (pMDIs) for shared use

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Salbutamol pressurized metered dose inhaler (pMDI) shortages: causes and problems

Nebulized medication therapy is the standard of care for bronchodilation in respiratory patients. However, the use of salbutamol nebulers generates aerosol, which increases the risk of droplet contamination that can remain in the air and spread virus particles. The use of salbutamol pressurized metered dose inhalers (pMDIs) reduces the risk of aerosol-generating particles [1]. Therefore, pMDIs (Fig. 1) are preferred when trying to reduce viral transmission.

During the COVID-19 pandemic, there has been a drastic increase in the use of MDIs containing short-acting bronchodilators, such as salbutamol, in hospitals, leading to a decrease in their availability. Salbutamol pMDIs have become the first line of defense in emergency rooms to treat respiratory distress in COVID-19 patients.

The current critical shortage of salbutamol MDIs may be the result of stockpiling, hoarding, and panic buying of this life-saving inhaler due to fears of medication shortages during the COVID-19 pandemic [2–4]. The availability of alternatives to salbutamol pMDIs, such as ipratropium or long-acting β -agonists, is becoming limited, and ordering of new stock is starting to become restricted.

Salbutamol pMDI shortages are especially worrisome for patients with asthma or chronic obstructive pulmonary disease (COPD), as they are at higher risk of poor clinical outcomes if they contract COVID-19.

Suggested conservation strategies

Finding a safe and creative strategy to optimize the use of salbutamol pMDIs is essential during the COVID-19 pandemic. Many hospitals implement conservation strategies to decrease drug waste, which could include policies to reprocess or reuse the salbutamol pMDIs to treat multiple patients. To minimize the risk of contamination, each institution should have discussions with multidisciplinary representatives [e.g. physicians, doctors, pharmacists, and members of the infection control and sterile processing departments (SPDs)] to agree on the best way to implement a salbutamol pMDI reprocess/reuse strategy and ensure patient safety.

There is considerable literature regarding the reprocessing and reuse of used salbutamol pMDIs for shared use in the hospital setting [5–7]. Liou et al. assessed the degree of contamination of the mouthpiece and canister spray tips of recycled pMDIs and demonstrated that out of the 33 recycled pMDIs evaluated, none grew bacteria when adequately cleaned with 70% isopropyl alcohol [5]. Therefore, with strict quality control measures, one could effectively and safely reuse pMDIs [5]. Dunlew et al. took cultures from salbutamol pMDI nozzles before and after disinfection with an alcohol prep pad, as well as after administration [6]. Growth of *Staphylococcus epidermidis* occurred in at least 5% of the cultures with all three types of specimens, including those taken after the nozzle was disinfected with an alcohol prep pad [6]. In an experiment by Hinson and Rau [7], failure to wipe the canister nozzle with an alcohol prep pad before patient use in the hospital was assessed; one of 18 cultures (5.5%) resulted in the growth of *Streptococci* group D (*Enterococci*).

Although a debatable practice, several hospitals have successfully implemented pMDI conservation programs, while ensuring to properly comply with procedures for disinfecting the salbutamol pMDI nozzles. One pMDI may contain

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Fig. 1 Pressurized metered dose inhaler (pMDI)

enough medication to last anywhere from 2 to 4 weeks; however, since most patients are hospitalized for a short period of time, much of the medication goes to waste [8]. It is in a hospital's best interest to move towards this conservation strategy, as it would not only save money and supplies, but also patient lives.

Proposed steps to reprocess and reuse the salbutamol pMDIs for shared use

Hospital teams need to be proactive in collecting used salbutamol pMDIs when appropriate, sterilizing the various parts following an appropriate procedure, and storing them separately to be used as required. The following sections outline the proposed steps for the reprocessing/reuse of the salbutamol pMDIs for shared use [5, 9, 10].

Steps to be performed by a registered nurse on the ward and in the Emergency Room (ER)

1. Collect the salbutamol pMDI that has been used to treat a patient.
2. Determine whether the salbutamol pMDI is eligible for reprocessing/reuse; only those salbutamol pMDIs used with an attached aerochamber and administered to non-immunosuppressed and COVID-19-negative patients are eligible. Reuse of spacer devices by the same patient may be considered; 70% isopropyl alcohol disinfectant and proper SPD protocols must be followed to ensure adequate disinfection.
3. Wearing gloves, take the canister out of the actuator and take the cap off the mouthpiece.

4. Thoroughly wipe the external surface of the canister and nozzle with sporicidal wipes (e.g. Virox®).
5. Once the surface is dry, thoroughly wipe the external surface of the canister and nozzle with 70% isopropyl alcohol wipes and allow to air dry.
6. Do not submerge the canister or nozzle in liquid as this can block the nozzle.
7. Place the pMDI with the canister in the ward medication room for pickup by the pharmacy technician.
8. Safely discard the aerochamber or spacer. Of note, inhalation spacer devices may be reused by the same patient, given that they are appropriately soaked and cleaned in a disinfectant solution.

Steps to be performed by the pharmacy technician

1. Pick up the pMDI with the canister from the ward medication room.
2. Wipe canister and nozzle with sporicidal wipes before returning them to the stock in the pharmacy.
3. Place actuator and mouthpiece in a ziplock bag and deposit to a soiled room for pickup by the SPD.

Steps to be performed by sterile processing department personnel

1. Pick up the ziplock bag containing the actuator and mouthpiece and return to the SPD for cleaning.
2. Prepare a solution of Valsure® neutral pH detergent, ensuring the appropriate dilution rate is followed.
3. Set a timer for 10 min, then soak the actuator and mouthpiece cap in the diluted Valsure® solution until the time is up (10 min of contact is vital for effective disinfection).
4. Using a nylon brush, scrub away any visible soiling or medication build-up in and on the actuator and mouthpiece.
5. Rinse the actuator and mouthpiece with warm running water to remove any residual detergent.
6. Shake off as much water from the actuator and mouthpiece as possible.
7. Soak the actuator and mouthpiece cap in 70% isopropyl alcohol for 10 min.
8. Remove the actuator and mouthpiece cap from the alcohol and allow them to dry in the high-efficiency particulate air (HEPA) dryer.
9. Once dry, thoroughly wipe all the surfaces of the actuator and mouthpiece cap with Virox® sporicidal wipes and allow them to air dry once again.
10. Once dry, place the actuator and mouthpiece in a ziplock bag and return the bag to the pharmacy.

Steps to be performed by pharmacy staff

1. Obtain the canister and nozzle from bins labeled “Return to the Pharmacy” located in the medication room on the inpatient wards or emergency rooms.
2. Wipe the canister and nozzle with Virox® sporicidal wipes.
3. Place the reprocessed canister into the reprocessed actuator and attach the reprocessed mouthpiece cap.
4. Return the reprocessed pMDI to a separate stock in the pharmacy to be reused only if no new salbutamol pMDIs are available.

What else can hospital pharmacists do to limit salbutamol pMDI use?

- As the COVID-19 pandemic is still unfolding and the duration of salbutamol pMDI shortages cannot be predicted, consider discussing the shared use of reprocessed salbutamol pMDIs with physicians and infection control teams at each hospital.
- Collaborate closely with the nursing and SPD teams to ensure efficient and safe reprocessing of salbutamol pMDIs.
- To prevent excessive usage of salbutamol pMDIs at home, counsel patients prior to discharge on the importance of using their maintenance inhalers (e.g. Symbicort®, Flovent®, and Advair®) daily and define the appropriate amount of medication they should have on hand.
- Remind patients of the importance of nonpharmacological options that may decrease the use of salbutamol pMDIs, including [11]:
- Quitting smoking (essential).
- Avoiding known precipitating factors (e.g. environmental allergens and occupational irritants).
- Avoiding the use of acetylsalicylic acid and nonsteroidal anti-inflammatory drugs (NSAIDs) [including cyclooxygenase-2 (COX-2) inhibitors] when possible.
- Receiving the annual flu vaccine (unless contraindicated).
- Using pulmonary rehabilitation-focused breathing techniques.

Compliance with ethical standards

Conflict of interest The authors declare no known conflicts of interest.

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