Quality Improvement

Innovative Conservation of Inhaled Medication Devices During the COVID-19 Pandemic Through a Canister Reassignment Process

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Abstract

Background
The ideal practice for patients requiring metered-dose inhalers (MDI) with coronavirus disease 2019 (COVID-19) is to use patient specific MDIs. However, this practice may not be possible during a time of increased usage throughout the country and limited availability of the medication. Nebulized medications are a concern due to the potential for aerosolized virus and increased exposure for health care workers. An alternative program of canister reassignment is proposed to address concerns for infection prevention, cross-contamination of MDI canisters and the shortage of MDI's due to the COVID-19 pandemic.

Methods
A comprehensive MDI canister reassignment process was developed for facilities affiliated with a large health care system in response to the COVID-19 pandemic. The MDI canister reassignment process consisted of 4 components: preservation of supply, reassignment workflow, canister cleaning and operational integration. Albuterol MDI administration data was monitored from January 1st to August 31st, 2020.

Results
Following development and rapid implementation of a comprehensive canister reassignment process, albuterol MDI administration data was reviewed from 162 hospitals affiliated with a large health care system. At baseline (prior to the COVID-19 pandemic), 98% of patients received a nebulizer vs. an MDI. After the implementation of the MDI reassignment process (during the COVID-19 pandemic), nebulizer usage decreased by 60% from March 6th to March 31st and was sustained with >50% reduction through August 31st.

Conclusion
MDI canister reassignment was an instrumental process to allow the continued delivery of pharmacologic bronchodilator therapy for COVID-19 patients. It also represents an important infection prevention strategy needed to protect our health care providers from the potential aerosolized virus associated with nebulizers.

Keywords
metered dose inhalers; nebulizers and vaporizers; aerosols; pandemics; COVID-19; SARS-CoV-2; Coronavirus infection, equipment contamination; infectious disease transmission/prevention & control, bronchodilator agents

Background
Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a novel coronavirus first identified in late 2019 that led to a pandemic designated by the World Health Organization as coronavirus disease 2019 (COVID-19). With ongoing efforts to understand COVID-19 and determine optimal treatment for affected patients, it is important to develop enhanced response and preparedness strategies to address critical needs.

Patients with severe COVID-19 may develop acute respiratory distress syndrome (ARDS) requiring mechanical ventilation. However, patients with ARDS often do not respond to treatment with bronchodilators unless there is the presence of an underlying chronic respiratory disease, such as asthma or chronic obstructive pulmonary disease (COPD).[1,2] In a meta-analysis, COPD was among the most common types of comorbidities found in COVID-19 patients.[3] Patients with underlying conditions were also found to have worse outcomes.[4]

Administration of nebulized medications is associated with generating aerosolized particles.[5-7] While some may consider it controversial, there is concern for an increased risk of disease transmission with the use of nebulizers in patients with COVID-19 and may put health care workers (HCW) at increased risk.[5-7] To minimize aerosolized particles and the subsequent spread of disease as well as protect our HCW, a metered-dose inhaler (MDI) is the recommended delivery device if bronchodilator use is necessary for the treatment of patients with a confirmed or suspected COVID-19 infection.[8] With the nationwide supply of MDIs compromised due to increased demand, bronchodilator therapy should be reserved for those patients where it will be the most effective. Therapy should be prioritized for patients with chronic respiratory disease or for the treatment of patients with ongoing bronchoconstriction, increased airway resistance or obstruction. The need for this therapy can be assessed through direct observation of respiratory effort and breath sounds that indicate a significant decrease in air movement, such as audible wheezing or stridor.

In patients who require bronchodilator therapy for COVID-19, the ideal practice is to use patient-specific MDIs. This typical practice may not be possible during a time of increased use of MDIs throughout the country and with limited availability of the medication. As a result, alternative strategies must be considered. Several approaches have been proposed to conserve the supply of MDIs, including using a patient's own supply whenever possible and evaluating common canister protocols.[8] The common canister process uses a single MDI canister with a patient-specific spacer device to administer doses of bronchodilator medication to multiple patients after being disinfected with an alcohol prep pad before and after each treatment. However, there is concern of spreading infection between patients if the MDI is not properly cleaned or stored correctly when using the common canister method.[9] Patients who receive MDIs while hospitalized often do not require the full amount of drug contained in the canister, leading to significant drug waste when these patient-specific MDIs are discarded after hospital discharge.

An alternative program of canister reassignment is proposed to address concerns for infection prevention, HCW safety, cross-contamination of MDIs and the impending shortage of MDIs due to the COVID-19 pandemic. Canister reassignment is distinguished from common canister protocols by utilizing both a patient-specific MDI and spacer during the inpatient stay. After hospital discharge, the inhaler is deconstructed and cleaned per hospital protocol. This process minimizes waste of any remaining drug and aids in enhanced infection prevention by allowing a patient-specific MDI to remain secured with the patient in the room until discharge. Here we describe our development and rapid implementation of a MDI canister reassignment process during the COVID-19 pandemic and the effect of this process on the use of MDIs.

Methods

We developed a MDI canister reassignment process in response to the COVID-19 pandemic. This guidance process was intended for facilities affiliated with our health care system. This system includes 185 locally-managed hospitals ranging in size from 26 to 1,000 beds across 21 states; facility types include community hospitals, academic health centers and large, tertiary-referral hospitals.

The comprehensive MDI canister reassignment process consists of 4 components: preservation of supply, reassignment workflow, canister cleaning and operational integration.

Preservation of Supply

Criteria were established to identify patients appropriate for MDI use. (**Table 1**) These criteria minimized the use of inhalers in patients who

Table 1. Delivery device recommendations for specific patient populations during the COVID-19 pandemic.

Age	Specific Population	Nebulizer†	MDI	Canister Reassignment*	Common Canister†
Adult Patients	Non-COVID-19 Patient	Option	Option – Reserve for PUI or Confirmed COVID-19 Pts	Option	Not Preferred
	COVID-19 Person Under Investigation (PUI)	Avoid Use	Option	Option	Not Preferred
	Non-ventilated COVID-19 Patient	Avoid Use	Option	Option	Not Preferred
	Ventilated COVID-19 Patient	Optional in a closed circuit ventilator‡	Option	Option	Not Preferred
Pediatric Patients	Pediatric Confirmed Non-COVID-19	Option	Option – Reserve for PUI or Confirmed COVID-19 Pts	Option	Not Preferred
	Pediatric COVID-19 Person Under Investigation or Confirmed**	Avoid Use	Option	Option	Not Preferred

*Note Canister Reassignment is DIFFERENT than Common Canister

**Pediatric patients are less likely to be hospitalized for COVID-19 than adults

†Nebulizer and common canister have limited utility in a post-COVID-19 health care system with limited available testing and the potential delay in diagnosis.

‡Nebulizer for ventilated COVID-19 patients: if using aerosol, ensure use of closed circuit system with filtered exhalation and must not require breaking the circuit to administer. Consider using timed delivery device (such as in line MDI) in order to minimize time spent in the room.[6-7]

are not suspected of or confirmed as having COVID-19 to conserve supply.

Bronchodilator utilization was evaluated for opportunities to optimize ordering and prescribing practices. Patients with underlying respiratory diseases like asthma and COPD were continued on their maintenance medications. As severe COVID-19 generally results in ARDS, bronchodilators are typical of little benefit in ARDS for patients without underlying lung disease, and their use was not recommended.[1,2] Bronchodilators were recommended to be reserved for bronchoconstriction. If a bronchodilator was used and not found to be effective (e.g., due to the patient having ARDS rather than bronchoconstriction), discontinuation was considered.

Whenever possible, the use of the patient's home MDI was recommended in both the emergency department and inpatient areas. This recommendation reduced demand and impact on hospital MDI supply but required a process for verification and patient-specific labeling of home MDIs to ensure safe medication use.

Finally, the elimination of one-time use orders for MDIs was encouraged. One-time orders were considered a waste of resources in all but emergent circumstances. Such orders increased the burden of cleaning and reassignment for short term therapy.

MDI canister reassignment process

Reassignment workflow

Canister reassignment differs from common canister use. Common canister programs use individual patient spacers but use the same canister for multiple patients. Canister reassignment programs, however, use a patient-specific MDI during the inpatient stay. The guidelines for the recommended workflow

Table 2. Guidelines for canister reassignment workflow.

Canister reassignment workflow
Patient-specific MDI is used for the duration of inpatient stay
MDI is labeled and remains secured in the room with the patient during the stay
Upon discharge the canister is removed, entire MDI (canister, outside plastic portion, etc.) is cleaned thoroughly per facility-specific process and returned to pharmacy
Spacer is disposed of after discharge
Pharmacy reassigns the canister for a different patient
A new spacer is used for each patient

for canister reassignment is provided in **Table 2**.

MDI canister cleaning process

The recommended MDI canister cleaning process involves deconstructing the inhaler by separating the metal medication canister and actuator/mouthpiece and cleaning the device parts with 70% alcohol.[10] Other disinfecting solutions, such as quaternary ammonia compounds, were not recommended as a soak for cleaning the MDI canister or parts of the delivery device. These products (undiluted or diluted) may be harmful if ingested and may compromise the integrity of the plastic pieces.[11]

In addition to cleaning, hospitals were encouraged to allow a rest period after disinfection using the process outlined above and before reassignment of the MDI canister. Of note, the rest time may vary based on the viral pathogen; for SARS-CoV-2, a rest period of 72–360 hours (3–5 days) was recommended. This rest period allowed time between disinfection and re-use, providing an additional opportunity for the virus to expire on surfaces and was dependent on MDI supply and utilization. If the nozzle could not be appropriately cleaned, the MDI was not used for canister reassignment.[12]

Operational integration

Current administration, billing, storage and infection control practices were evaluated to identify gaps in processes and workflow. Based on this evaluation, policies were created to address workflow, protocol development, infection control practices, education and outcome metrics.

Results

As a health system, we incorporated innovative strategies to conserve our MDI supply. The guidance was distributed across the health system for the MDI reassignment process, as described in this article.

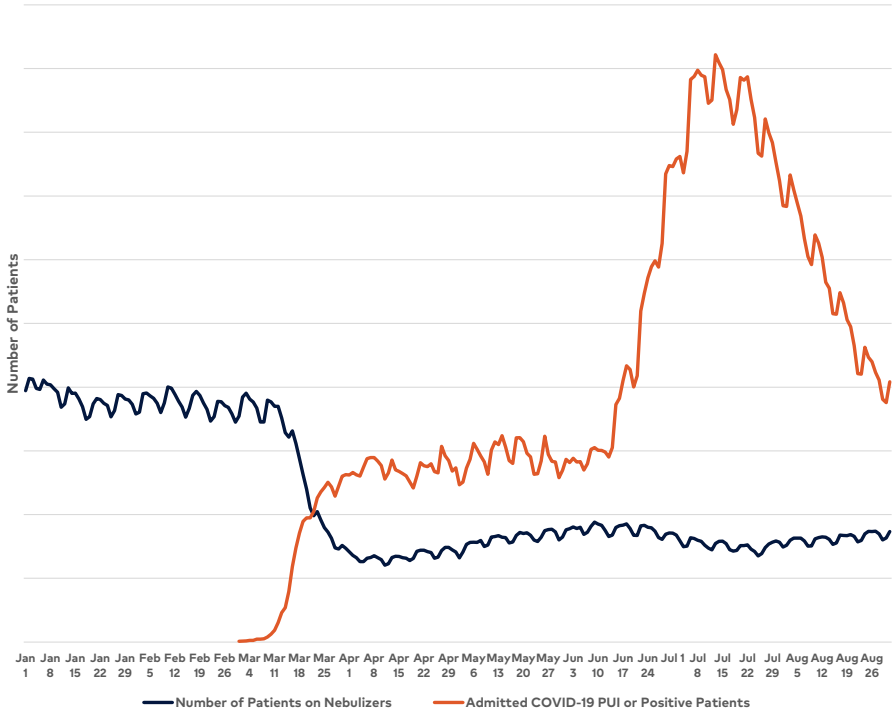
To evaluate the use of the MDI reassignment process and nebulizer use, administration data was reviewed from 162 hospitals across the health system from January 1st to August 31st, 2020. (**Figure 1**) On average, 98% of patients received a nebulizer vs. an MDI prior to March 6. The initial guidance released March 6th recommended to discontinue using nebulizers in COVID-19 persons under investigation (PUIs) or positive patients. From March 6th to March 31st, patients receiving nebulizers decreased by 60%. Nebulizer usage was at its lowest on April 11th, which was 67% of the usage on March 6th. This decline was sustained with a greater than 50% reduction through August 31st. The reduction in nebulizers followed the COVID-19 trends that were seen within the affiliated hospitals.

Discussion

During the COVID-19 pandemic, the rapid implementation of the MDI reassignment process has proved vital for the continued support of clinical care and infection prevention. The number of patients on a nebulizer decreased by 60% from March 6th to March 31st and stayed reduced by >50% for the entire monitoring period. This significant reduction in nebulizer utilization correlates with the initial surge of COVID-19 patients seen across the health care system.

From our experience with the development of the MDI reassignment process, we have observed a need for collaboration between various groups. For others considering a similar process, interdisciplinary planning teams should be formed that include, at a minimum, nursing,

Figure 1. Nebulizer Use and COVID-19 Persons Under Investigation or Positive Patients



respiratory therapy, infection preventionists, providers and pharmacists. Collaboration between nursing and respiratory therapy can help ensure patient-specific inhalers remain with a patient upon transfer within the hospital. Pharmacists and providers should be engaged in the selection of therapeutic interchanges based on MDI product availability. For low use areas, MDIs should be dispensed from the pharmacy, rather than stocked in automated dispensing cabinets, to conserve inventory and consolidate stock. If MDIs are stocked in automated dispensing cabinets, someone should do a blind count for removal so that accurate inventory tracking occurs and diversion is prevented. This careful tracking aids in monitoring utilization and in proactive inventory management.

The interdisciplinary team should assess policies and procedures to ensure basic infection prevention and control practices occur between patients to minimize cross-contamination risk when using reusable medical devices.[12] Canisters should be restricted to 1 patient at a time, cleaned thoroughly upon discharge and placed back into common stock for use. The canister should be labeled and remain secured in the patient room during the inpatient stay. Only spacers with a one-way exhalation valve should be used. After discharge, the hospital process should be followed to clean MDI canisters outside of the medication room, and then return them to the pharmacy for reassignment. We recommend spacers be discarded.

Several key lessons have been learned following the implementation of this process. First, we observed a need to communicate that 70% isopropyl alcohol is an effective disinfection agent that kills the virus that causes COVID-19 infection, as a common misconception is that alcohol would not be virucidal.[5,10,12-15] This misconception has undermined the confidence of frontline health care workers in the effectiveness of the MDI disinfection process. Additional education has been necessary to combat this misconception.

Another challenge was a lack of formal guidance statements from trusted medication safety organizations on MDI disinfection steps, particularly soaking procedures. The literature has primarily focused on common canister use rather than canister reassignment. Common canister disinfection does not incorporate a soaking step, which limits the evidence that can be drawn upon to support the cleaning process of MDIs with soaking.

Conclusion

We were able to develop a MDI reassignment process that allows for increased MDI use during the COVID-19 pandemic. This process allows the continued delivery of pharmacologic bronchodilator therapy for COVID-19 patients. It also represents an important infection prevention strategy needed to protect our healthcare providers.

Conflicts of Interest

The authors declare they have no conflicts of interest.

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