

Summary

It was revealed that a number of different variables had an effect on the efficiency of delivery to the alveolar region. One of these variables is the necessity of incorporating an aerosol generator into the breathing circuit, which necessitates the use of add-on devices. The current study was designed to measure the performance of two newly developed spacers (Combihaler and Minimhal) during non-invasive mechanical ventilation (NIV).

Three add-on devices were evaluated: Combihaler, Minimhal, and standard T-piece which were connected to a vibrating mesh nebulizer (VMN), jet nebulizer (JN), or pMDI within the NIV circuit.

The in-vitro method included three experimental settings: the first involved the nebulization of 1 ml of salbutamol respirable solution by VMN using Combihaler and Minimhal after the actuation of two pMDI puffs; the second involved the actuation of 10 pMDI puffs alone; and the third involved the nebulization of 1 ml of respirable solution by either VMN or JN without the preceding High-performance liquid chromatography was used to measure how much aerosol was deposited on the inhalation filter. Two experimental sets were assessed in-vivo. The first involved administering two pMDI puffs prior to nebulizing one millilitre of a salbutamol solution using VMN and Minimhal and Combihaler. The second used VMN nebulization of 1 ml of salbutamol respirable solution utilizing a regular T-piece, Minimhal, and Combihaler.

After aerosol delivery, two urine samples were collected: one after half an hour (USAL0.5) and one after a day (USAL24) to demonstrate aerosol transport to the lung and systemic absorption, respectively. To collect the entire amount of inhalable dosage, a collecting filter was placed before the face mask within the NIV circuit.

Finally, using the HPLC approach, salbutamol could be extracted from urine samples and filters and evaluated.

The in-vitro study showed that Jet nebulizer either connected to Minimhal or T-piece

Significantly delivered the least TID ($p < 0.05$); however, Minimhal + JN showed a relative increase in TID compared with T-piece + JN with no significant difference.

Combihaler + pMDI showed a significantly higher aerosol delivery than Minimhal + pMDI, and T-piece + pMDI ($p = 0.025$, and 0.009 , respectively). Also, the TID from Minimhal + pMDI showed a significantly

higher aerosol delivery than T-piece + pMDI ($p = 0.025$), while the in-vivo study showed that Combihaler+pMDI+VMN delivered a higher significant amount of salbutamol dose than Combihaler+VMN according to the data of (USAL0.5) (USAL24) and ex-vivo filter (TED)($p=0.0$). Also, Minimhal+pMDI+VMN delivered a highly significant amount of salbutamol dose compared to Minimhal+VMN according to data of (USAL0.5)($p=0.0$)

Salbutamol delivered by Combihaler+pMDI+VMN was significantly higher than that delivered by Minimhal+pMDI+VMN ($p=0.0$.) Combihaler+VMN delivered a higher significant dose than both Minimhal+VMN and T-piece+VMN($p=0.0$) Minimhal +VMN delivered a significantly higher amount of salbutamol than T-piece+VMN in both USAL0.5 and USAL24($p=0.039$, $p=0.0$ respectively).

Combihaler+pMDI+VMN delivered the highest significant salbutamol dose of USAL0.5, USAL24, and ex Vivo among the whole connections followed by Combihaler+VMN ($p=0.0$).

The lowest significant delivered salbutamol dose among the 5 connections was by T-piece+VMN of USAL0.5 and USAL24($p<0.05$).

Finally , it was concluded that the aerosol output of the Combihaler was greater than that of the Minimhal and the conventional T-piece when using VMN and pMDI. The pMDI used by Minimhal was more effective in delivering aerosol than a regular T-piece. Use of Minimhal is not limited to either JN or VMN. Both the Minimhal and the Combihaler demonstrated a larger significant effect on aerosol delivery when preceded by two puffs of pMDI prior to the nebulized dose.