

# Does Technology Matter? One Intensive Care Unit's Experience

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## Abstract

### Does Technology Matter? One Intensive Care Unit's Experience

**Background:** Pneumatic nebulizers (PN) can add significant flow to the circuit can harbor harmful pathogens<sup>1</sup>. Use of a PN with mechanical ventilation (MV) often results in incomplete nebulization of medication with retrograde contamination from the patient. Vibrating mesh nebulizers (VMN) have a physical barrier between the aerosol pathway and the medication reservoir, reducing risk of contamination. We hypothesized VMN would provide more effective therapy and potentially reduce the risk of VAP. **Method:** The Neuroscience ICU Respiratory Therapists initiated a QI project, trialing a VMN (Aerogen, Galway, Ireland), locating one controller in each room to avoid cross-contamination issues as part of a VAP reduction strategy. All medicated aerosol was performed by VMN. Cumulative data was compiled for the 12 months prior. The new method (VMN) was used for 9 months, resuming the old method for an additional 60 day period (to serve as an additional control). **Results:**

	12 months prior	9 months	60 days post
Average Vent Days	5.62	3.95	4.87
ICU Length of Stay	4.52	3.51* (p<0.05)	3.72
VAP Rate (per 1000 vent days)	4.05	3.87	3.83

Use of the VMN resulted in a 30% drop in ventilator days, with a 19% increase during the 60 day return. LOS decreased by 22% during the study period. There was no statistically significant change in VAP rate, possibly due to the change in weighted value from the decreased vent days. **Conclusions:** VMN was preferred by the therapists. In this instance, the advent of technology was felt to make a significant impact on patient care. Further study of the impact of the choice of aerosol delivery device on patient outcome is indicated.

<sup>1</sup> Respir Care 2005;50(6):725-741

## Background

The delivery of aerosolized medications during mechanical ventilation has a long history, with pneumatic nebulizers integrated with ventilators dating back to the 1950's. The science of Aerosol Therapy has progressed significantly, from pneumatic nebulizers to the introduction of ultrasonic nebulizers and even more recently the advent of Vibrating Mesh technology.

During mechanical ventilation most nebulizers are placed in the inspiratory limb of the ventilator circuit. Pneumatic and ultrasonic nebulizers generate aerosol from a gravity dependent medication reservoir. Consequently, any contaminated secretions or condensate in the inspiratory limb of the ventilator circuit preferentially drains into the medication cup, contaminating medication. These nebulizers typically contain up to 1 mL of medication after nebulization is complete, presenting a breeding ground for bacterial growth. Consequently, jet or ultrasonic nebulizers left in situ in the ventilator circuit may harbor and transmit harmful pathogens to the deep lung. Removing the nebulizers for cleaning between treatments requires breaking the circuit with potential derecruitment of the airways. During aerosol administration via mouthpiece patients tend to drool into the medication reservoir.

In contrast, the medication reservoir of the vibrating mesh nebulizer is positioned superior to the circuit and is separated by an "aperture plate" or mesh that generates aerosol into the circuit with greatly reduced risk of contamination.



Jet Nebulizer



Vibrating Mesh

We hypothesized that use of a single patient use vibrating mesh nebulizer to supply individual patients with all aerosol administration on and off the vent would reduce contamination and associated infections and improve aerosol delivery efficiency.

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## Methods/Materials

The Neuroscience Intensive care unit (NICU) is a 32 bed unit, with a high ventilator census. Patients in the NICU previously received aerosol therapy with pneumatic jet nebulizers. Respiratory Care Staff routinely perform >500 medicated aerosol therapies per month. We instituted a 9 month trial substituting all aerosol therapy previously done with jet nebulizer with administration via Vibrating Mesh (Aeroneb Solo<sup>®</sup>, Aerogen, Galway, Ireland) on and off the ventilator.

Electronic controllers were mounted in each Neuro ICU Room, and all therapy on and off the ventilator was provided with the same single patient use vibrating mesh nebulizer (Fig 2) after in-service education of Respiratory Care Staff. Placement of a Controller Unit in each ICU room was intentional, to reduce risk of cross-contamination between patients.

Data collection performed via ongoing Quality Improvement Data with database initiated and maintained within the Respiratory Care Department. Initial working hypothesis was that the Vibrating Mesh Nebulizer would profoundly impact VAP rate and efficacy of therapy. Length of Stay and Ventilator Days were secondary outcome measures.



Figure 2 – Nebulizer Electronic Controller and Mounting Location in NICU

All modes of medicated aerosol therapy were converted from Jet nebulizer to Vibrating Mesh Nebulizer:

- In-Line nebulization with Conventional Mechanical Ventilation  
Nebulizer placed in the inspiratory limb
- Via mask/mouthpiece with:  
High Frequency Percussive Ventilation  
Positive Expiratory Pressure Therapy  
Standard intermittent nebulizer treatments

All aerosolized medications were included in the conversion:

- Beta-adrenergic/sympathomimetic
- Parasympathetic/anticholinergic
- Antimicrobial
- Glucocorticoids

Expected finding(s):

- Reduction in VAP (primary outcome)
- Improved efficacy of therapy (primary outcome)
- Staff satisfaction (secondary outcome)

## Results

NICU census and number of ventilated patients was similar to higher during the trial period than preceding period.

Cumulative findings illustrated in Table 1

A trend to reduced VAP Rate (5%), but not as expected (Table 2)...

A trend to decreased Ventilator days 30% (Table 3)...  
- A good finding, but not quite statistically significant.

ICU Length of Stay decreased by 22% (Table 4)  
- An unexpected finding  
- Statistically significant

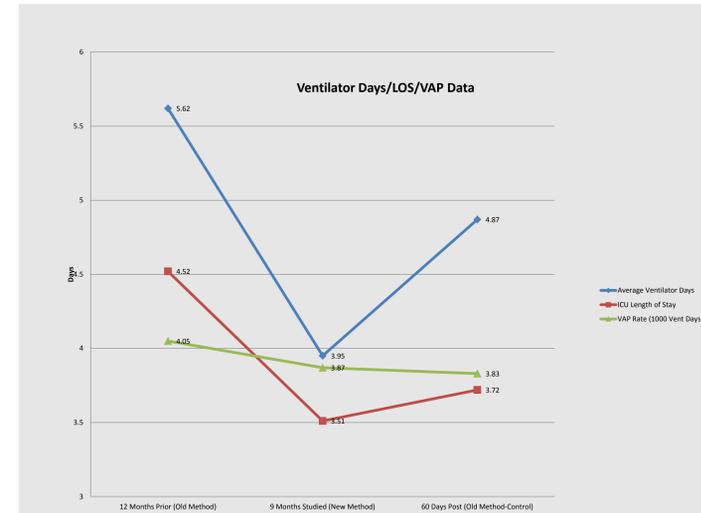


Table 1 – Comparison of average ventilator days, NICU LOS and VAP rates

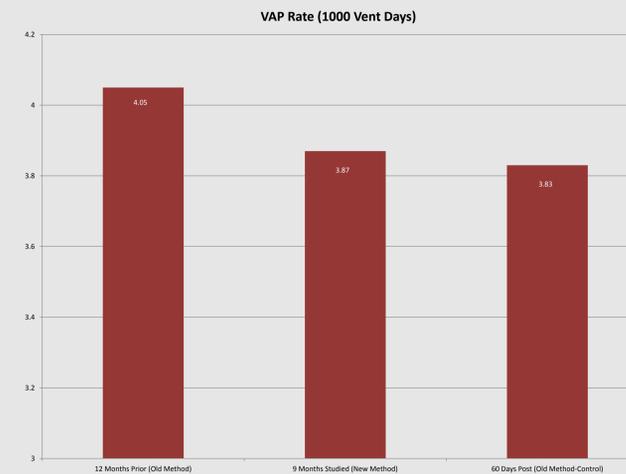


Table 2 – Trend toward reduced VAP not significant

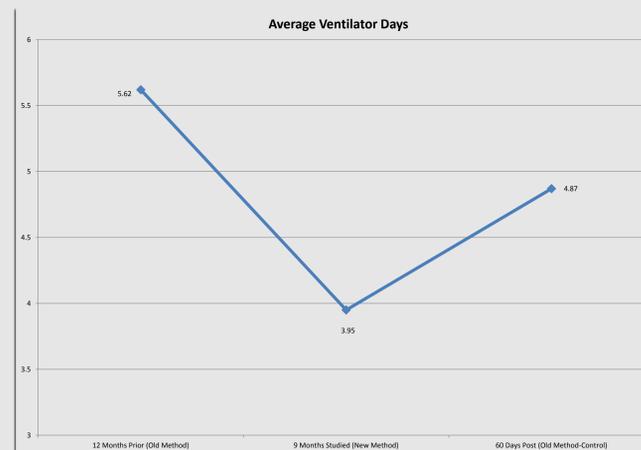


Table 3 - Average ventilator days per patient were reduced from previous 12 months with use of VM nebulizer (p<0.05)

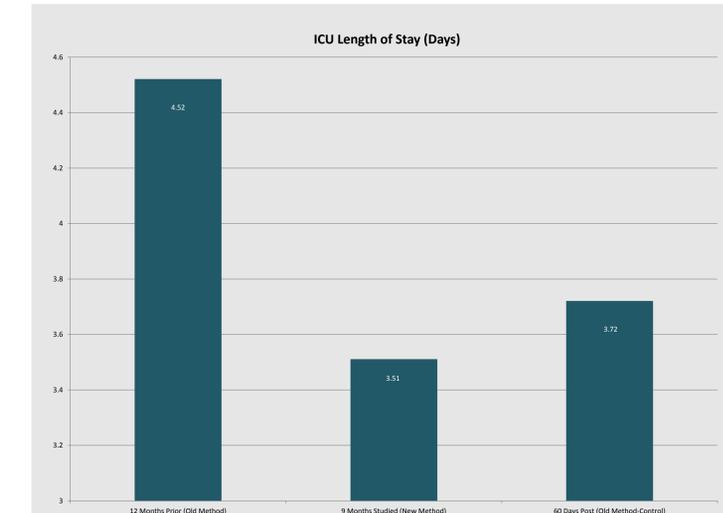


Table 4 - Average NICU length of stay was reduced during study period compared to prior 12 months, before use of VM nebulizer (p<0.05)

## Discussion

- VAP Rate trended lower but did not decrease significantly.
  - Reduced VAP may have become significant had average Vent days not also decreased at the same time.
  - Census of ventilated patients actually increased during the study period.
- LOS decreased dramatically during the study period
  - Exhibited indicators of increasing during the return to control.
  - May or may not be solely attributable to use of the vibrating mesh technology.
  - This decrease would appear indicative of an increased efficacy of therapy. These findings, especially the decrease in LOS pose some interesting questions and warrant further study.
- While it may be difficult to truly determine statistical significance by retrospective review:
  - Indicators for LOS and Vent Days both began to increase when the study period ended.
  - Finding support the realization that "good" technology should be considered as integral to the form and function of every ICU.
  - In this case, placing a device in each room to ensure ready availability may have attributed directly to outcomes.
  - The Respiratory Care Staff readily embraced this technology, greatly improving staff satisfaction as well.

Available technology improves almost daily, but presents an enigma as it relates to value and quality. While some technology may truly advance clinical practice, other technologies may simply be trying to re-purpose an old idea and may not function as intended or add benefit.

## Conclusions

In our experience, Vibrating Mesh technology demonstrated a significant increase in the quality of Respiratory Care provided, markedly improved the efficacy of patient care, and in all probability improved measurable outcomes. Further study to better quantify these outcomes is indicated.