

Vibrating Mesh Nebulisation During Non-invasive Ventilation in COPD: Systemic Review – Yusuf Ahmad & Shauryan Kandi

Background

- Acute exacerbations of chronic obstructive pulmonary disease (AECOPD) are a leading cause of emergency department attendance, hospital admission, and acute hypercapnic respiratory failure. Non-invasive ventilation (NIV) is the standard treatment for patients with respiratory acidosis due to AECOPD, reducing intubation rates, mortality, and hospital length of stay.
- Short-acting bronchodilators, including salbutamol and ipratropium bromide, remain fundamental to the management of AECOPD. However, aerosol drug delivery during NIV is technically challenging because medication can be lost within the ventilator circuit, mask interface, exhalation ports, and upper airways before reaching the lungs.
- Jet nebulisers (JNs) have traditionally been used during NIV but have several limitations, including high residual drug volume, additional gas flow requirements, and inefficient aerosol delivery. Vibrating mesh nebulisers (VMNs) generate aerosol using a vibrating perforated membrane, producing smaller particles with minimal residual volume and no additional gas flow, potentially improving pulmonary drug deposition.
- Although VMNs are increasingly used in clinical practice, their superiority over conventional nebulisation remains uncertain.

Aim

To systematically evaluate the current evidence comparing vibrating mesh nebulisers with alternative aerosol delivery methods during NIV in adults with COPD, focusing on:

- Pulmonary aerosol deposition
- Physiological outcomes
- Clinical outcomes
- Safety

Objectives

- Compare aerosol deposition between VMN and comparator devices
- Assess physiological improvements following bronchodilator therapy
- Evaluate clinical outcomes including NIV failure and intubation
- Identify current evidence gaps

Search strategy

Databases searched included:

- PubMed
- MEDLINE
- Embase
- Scopus

Search terms included:

- ("COPD" OR "acute exacerbation")
 - AND
- ("non-invasive ventilation" OR NIV OR BiPAP)
 - AND
- ("vibrating mesh nebuliser" OR Aerogen OR VMN)
 - AND
- ("jet nebuliser" OR aerosol therapy)

Eligibility criteria

PICO Component	Eligibility Criteria
Population	- Adults (≥18 years) - COPD or acute exacerbation of COPD (AECOPD) - Receiving non-invasive ventilation (NIV)
Intervention	- Vibrating mesh nebuliser (VMN) - Aerogen Solo - Aerogen Pro - Other electronic mesh nebulisers
Comparator	- Jet nebuliser (JN) - Metered-dose inhaler (MDI) ± spacer - Placebo (saline) - Standard nebulisation
Primary Outcomes	- Pulmonary aerosol deposition - Forced expiratory volume in 1 second (FEV₁) - Forced vital capacity (FVC) - Partial pressure of arterial carbon dioxide (PaCO₂)
Secondary Outcomes	- Respiratory rate - Dyspnoea score - Borg dyspnoea scale - Intubation/NIV failure - Mortality - Duration of NIV - Adverse events
Eligible Study Designs	- Randomised controlled trials (RCTs) - Randomised crossover studies - Comparative observational studies - Physiological/deposition studies

Results

Study	Population	Design	Comparator	Key Findings
Galindo-Filho 2015	Healthy volunteers on NIV	Randomised crossover	Jet nebuliser	VMN increased lung deposition (>3×) and reduced residual drug volume
Hassan 2017	COPD patients on NIV	Comparative	Jet nebuliser + MDI	VMN improved inhaled dose and fine particle delivery
Avdeev	AECOPD on NIV	Randomised crossover	Jet nebuliser	Greater improvements in FEV ₁ , FVC, PaCO ₂ and dyspnoea
Cinesi-Gómez	Hypercapnic AECOPD	Observational	Jet nebuliser	Improved tidal volume and gas exchange with VMN
Bodet-Contentin 2019	ICU patients with AECOPD	Double-blind RCT	Placebo	Significant delayed FEV ₁ improvement with VMN-delivered salbutamol

Discussion

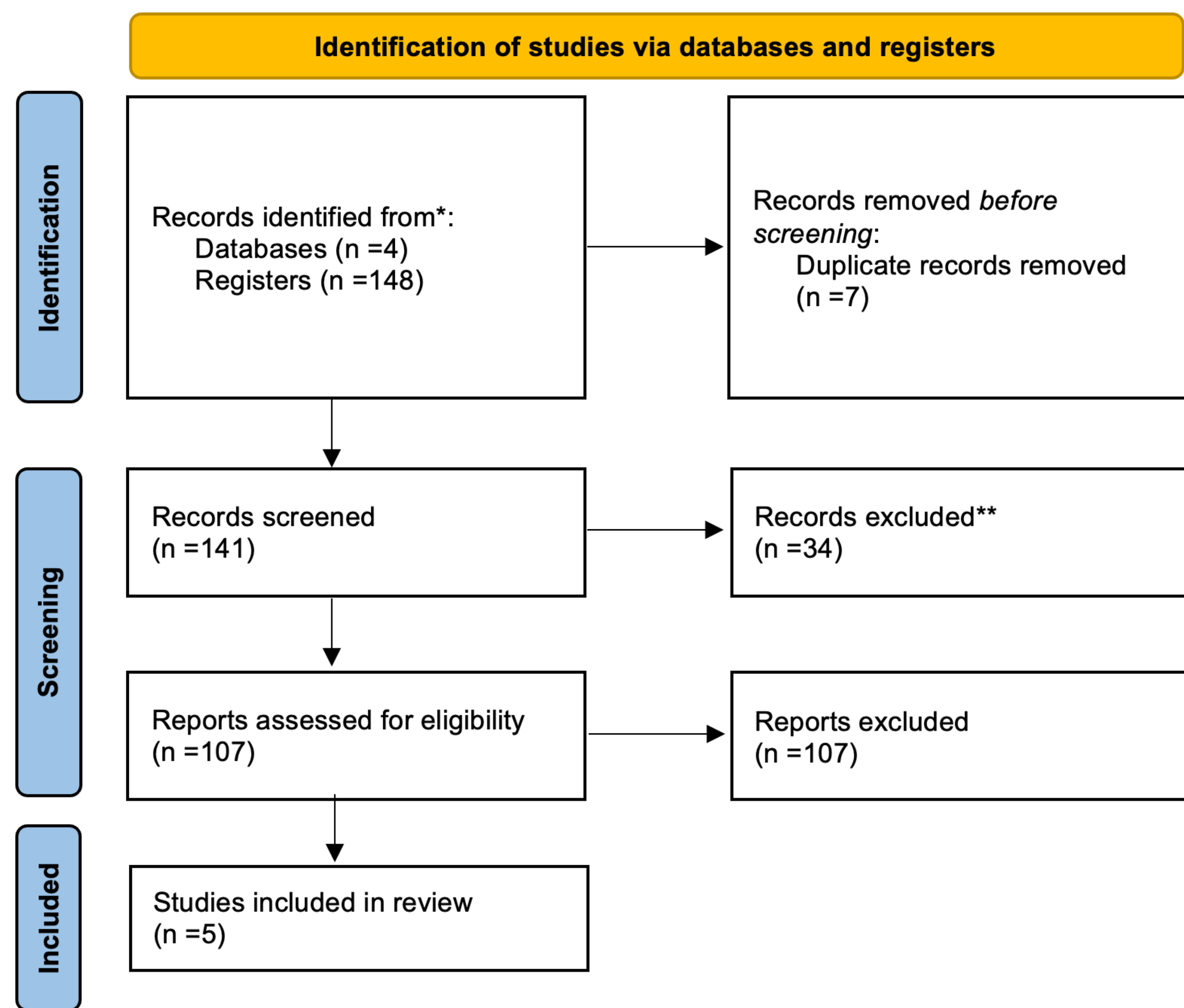
Across the included studies, VMNs consistently improved aerosol delivery compared with conventional JNs during NIV. The deposition findings provide a plausible mechanistic explanation for the better short-term physiological response seen in COPD studies.

However, the evidence base remains small and heterogeneous. No adequately powered multicentre trial has yet shown that improved aerosol delivery translates into better patient-centred outcomes such as lower intubation rates or reduced mortality.

Strengths and limitations

Strengths	Limitations
Included mechanistic, physiological, and clinical evidence	Small number of eligible studies
Focused on modern VMN technology used during NIV	Small sample sizes
Used comparative studies rather than device description alone.	Heterogeneous populations and NIV setting.
	Short follow-up and limited patient-centred outcomes

PRISMA



Conclusion

VMNs improve aerosol delivery and short-term physiological outcomes during NIV in COPD, but current evidence remains insufficient to confirm major clinical benefits such as reduced intubation, mortality, or hospital stay.

Clinical take home message

VMNs appear superior to JNs for aerosol delivery during NIV, but stronger randomised evidence is still needed before routine replacement can be justified on clinical outcome grounds

References

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- Bodet-Contentin L, Guillon A, Boulain T, et al. Salbutamol nebulization during NIV in exacerbated COPD: randomized trial. *J Aerosol Med Pulm Drug Deliv*. 2019;32:149-155
- Cinesi-Gómez C, Garcia-Palacios M, Bernabé-Vera L, et al. Vibrating mesh nebulization increases tidal volume relative to jet nebulization during NIV in COPD exacerbation. *Respir Med Res*. 2026;89:101248
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