NEMOURS CHILDREN'S HEALTH

BENCH ANALYSIS: CAN INHALED NITRIC OXIDE BE USED WITH A NON-INVASIVE SINGLE-LIMB CIRCUIT?

Kelly Massa[1], Angela Stump[1], Thomas Blackson[3], Katlyn L. Burr[1], Kimberly McMahon[1,2]
Respiratory Care Department[1], Division of Critical Care Medicine[2], Nemours Children's Health,
Nemours Children's Hospital- Delaware, Wilmington, DE, United States
Delaware Technical and Community College Respiratory Care Program[3], Wilmington, DE, United States

Disclosures: Ms. Burr has a relationship with Hill-Rom, as a patient contract trainer, no other authors have relationships to report

NEMOURS CHILDREN'S HEALTH

Original Abstract

BENCH ANALYSIS: CAN INHALED NITRIC OXIDE BE USED WITH A NON-INVASIVE SINGLE-LIMB CIRCUIT?

Kelly Massa RRT-NPS[1], Angela Stump RRT-NPS AE-C[1], Thomas Blackson RRT[3], Katlyn Burr RRT-NPS AE-C[1], Kimberly McMahon MD[1,2]

[1]Respiratory Department and [2]Division of Critical Care Medicine, Nemours Alfred I. DuPont Hospital for Children, Wilmington, DE. [3]DelTech Respiratory Program, Wilmington, DE.

Background: Invasive mechanical ventilation (IMV) is associated with costly complications such as ventilator-associated pneumonia, muscle atrophy and line sepsis[1]. For patients with persistent need for inhaled nitric oxide (iNO), extubation may be delayed by limited options for non-invasive (NIV) compatibility with iNO. Studies suggest that NIV with iNO may be appropriate and effective[2]. There is insufficient data on NIV iNO delivery via systems with leaks. Our current standard of practice is to utilize a non-vented mask (NVM) in conjunction with F&P Evaqua dual-limb circuit on a Maquet Servo-U ventilator in NIV mode to accommodate Mallinckrodt INOMax DSIR recommendations. The need for a leakless system enhances restrictions for appropriate mask options in pediatrics. We aimed to evaluate iNO delivery in a NIV bench model with a single limb circuit and leak to assess feasibility of iNO delivery for our pediatric population.

Method: iNO delivery was evaluated using three models for NIV delivery. In all models a Michigan test lung (infant 0.005 compliance) was interfaced with the pediatric head mannikin (open nostrils) via Philips PerforMax XS mask and spontaneous breathing was simulated via ventilator (RR 30). iNO injector module was placed immediately after the NIV outlet filter and iNO was sampled proximal and distal to the patient interface. Both a Philips Respironics V60 and the EV300 were trialed with three models: the mask with non-vented adapter (NV) and distal exhalation port (DEP), the mask with NV and Respironics Whisper Swivel, and the mask with the Philips vented port. NIV settings were S/T, IPAP 20, EPAP 10, RR 10, Ti 0.7, 100% FiO2. NIV leak maintained <60lpm and NIV pressures were allowed to stabilize and verified prior to trials. Each trial was completed over 30 minutes, with recordings every 10 minutes.

Results: In all models evaluated NO and NO_2 showed no statistical significance in set, delivered, or measured values (Table 1). iNO PSI showed no change over the trial period.

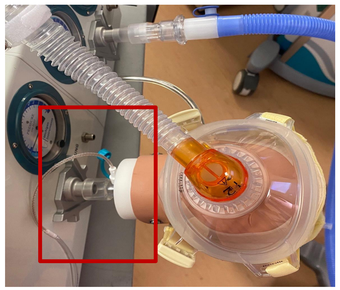
Conclusion: In our bench analysis of iNO and a NIV system with leaks, iNO delivery remained consistent and reliable. More studies should be done to assess implications related to iNO D-cylinder tank duration, patient response, and caregiver exposure.

References:

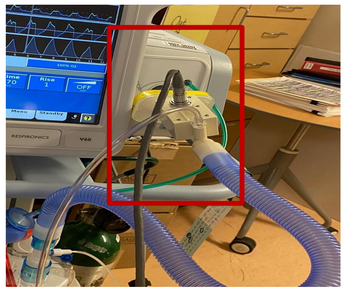
1. Cooke CRJcc. Economics of mechanical ventilation and respiratory failure. 2021;28(1):39-55.
2. Priyanka Patel, et al. Safety and Efficacy of Non-invasive Inhaled Nitric Oxide in Pediatric Cardiac Intensive Care Unit. Pediatrics August 2019, 144 (2 Meeting Abstract) 403.

BACKROUND: Invasive mechanical ventilation (IMV) is associated with costly complications such as ventilator-associated pneumonia, muscle atrophy and line sepsis[1]. For patients with persistent need for inhaled nitric oxide (iNO), extubation may be delayed by limited options for non-invasive (NIV) compatibility with iNO. Studies suggest that NIV with iNO may be appropriate and effective[2]. There is insufficient data on NIV iNO delivery via systems with leaks. Our current standard of practice is to utilize a non-vented mask (NVM) in conjunction with F&P Evaqua dual-limb circuit on a Maquet Servo-U ventilator in NIV mode to accommodate Mallinckrodt INOMax DSIR recommendations. The need for a leak free system enhances restrictions for appropriate mask options in pediatrics. We aimed to evaluate iNO delivery in a NIV bench model with a single limb circuit and leak to assess feasibility of iNO delivery for our pediatric population.

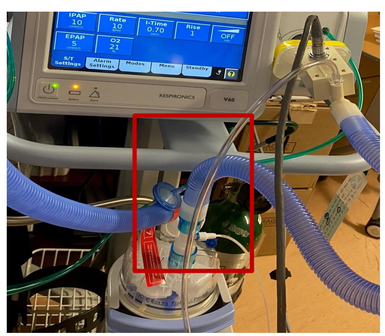
METHOD: iNO delivery was evaluated using three models for NIV delivery. In all models a Michigan test lung (infant 0.005 compliance) was interfaced with the pediatric head mannikin (open nostrils) via Philips PerforMax XS mask and spontaneous breathing was simulated via ventilator (RR 30). iNO injector module was placed immediately after the NIV outlet filter and iNO was sampled proximal and distal to the patient interface. Both a Philips Respironics V60 and the EV300 were trialed with three models: the mask with non-vented adapter (NV) and distal exhalation port (DEP), the mask with NV and Respironics Whisper Swivel, and the mask with the Philips vented port. NIV settings were S/T, IPAP 20, EPAP 10, RR 10, Ti 0.7, 100% FiO2. NIV leak maintained <60lpm and NIV pressures were allowed to stabilize and verified prior to trials. Each trial was completed over 30 minutes, with recordings every 10 minutes.



Picture 1: Interface distal sampling



Picture 2: NO injector module placement



Picture 3: Proximal sampling line placement

RESULTS: In all models evaluated NO and NO_2 showed no statistical significance in set, delivered, or measured values (Table 1). iNO PSI showed no change over the trial period.

Table 1

	NV-DEP EV300 Avg	NV-DEP V60 Avg	NV- Swivel EV300 Avg	NV- Swivel V60 Avg	Vented EV300 Avg	Vented V60 Avg
NO (ppm)	19.66667	19	19.66667	20	20	19.66667
NO2 (ppm)	0.133333	0.2	0.2	0.2	0.1	0.166667

Table 1: Displays the average NO and NO2 values for each exhalation valve used with the V60 and EV300.

CONCLUSIONS: In our bench analysis of iNO and a NIV system with leaks, iNO delivery remained consistent and reliable. More studies should be done to assess implications related to iNO D-cylinder tank duration, patient response, and caregiver exposure.

References

1.Cooke CRJcc. Economics of mechanical ventilation and respiratory failure. 2021;28(1):39-55.
2.Priyanka Patel, et al. Safety and Efficacy of Non-invasive Inhaled Nitric Oxide in Pediatric Cardiac Intensive Care Unit. Pediatrics August 2019, 144 (2 Meeting Abstract) 403.