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Breath-Triggered Aerosol Release and Real-Time Determination of the Delivered Aerosol for (Pre)term Neonates

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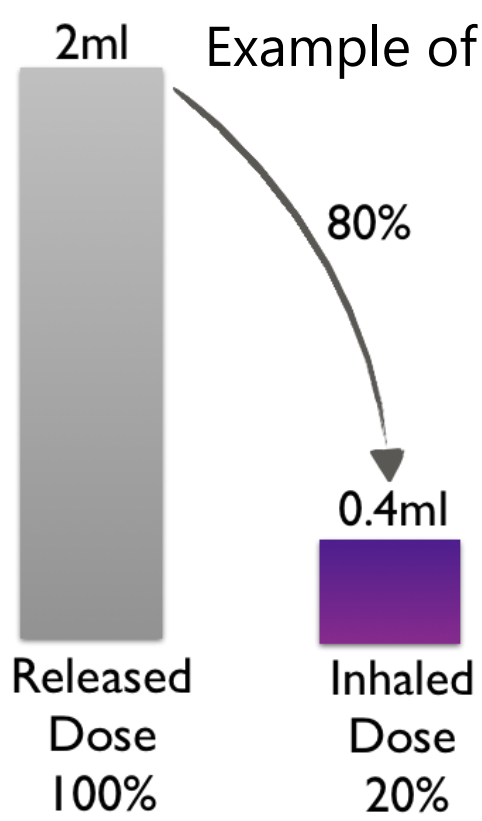
Motivation

Conventional System (without a Breath-Triggered Technology): High Drug Loss



Motivation

Without a Breath-Trigger Technology

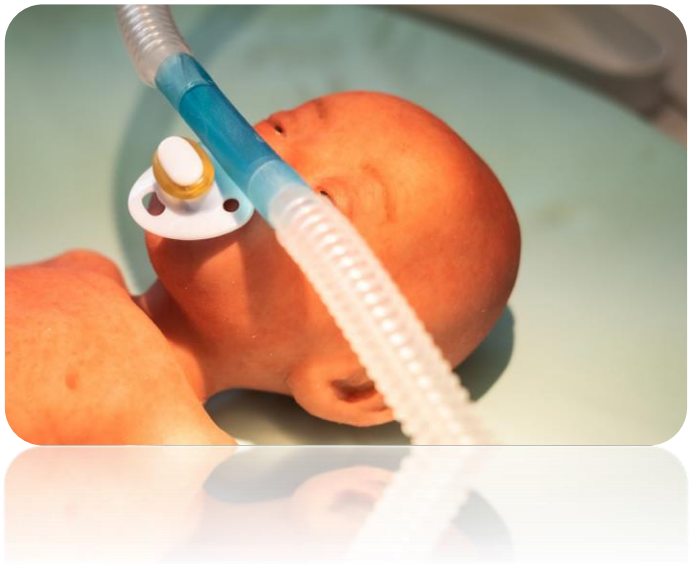
- Drug Loss: up to 80 %

With a Breath-Trigger Technology

- Drug Loss: ideally 0 %

But: Challenging Breathing Pattern

- Breathing Frequency: 60 breaths / minute
- Low Tidal Volume: 4-6 ml/kg
- Short Inspiration Time: 0.2-0.4 s

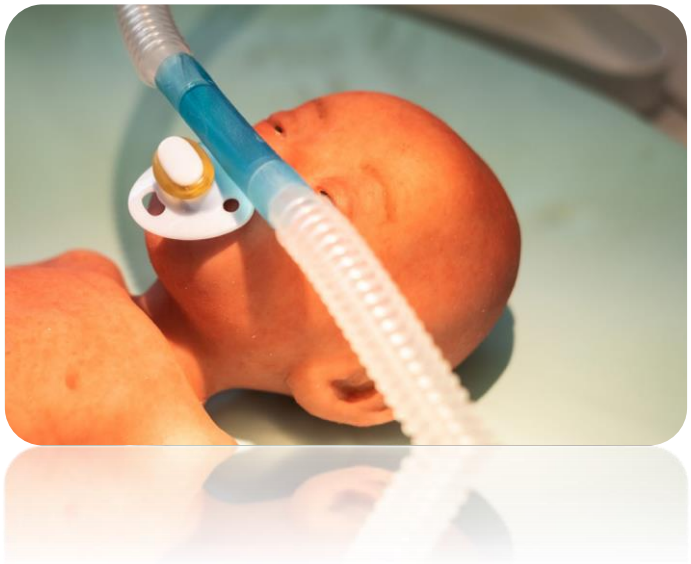


- ➢ No existing technology for breath-triggered drug release into the patient interface is currently available
- ➢ No standard test procedure to determine the aerosol output is accessible

Objectives

1) Develop a Modified Nasal Prong

- ❑ Integrated micronized valve
- ❑ Direct and fast aerosol release
- ❑ Aerosol release as targeted bolus
- ❑ Increase inhaled dose efficiency

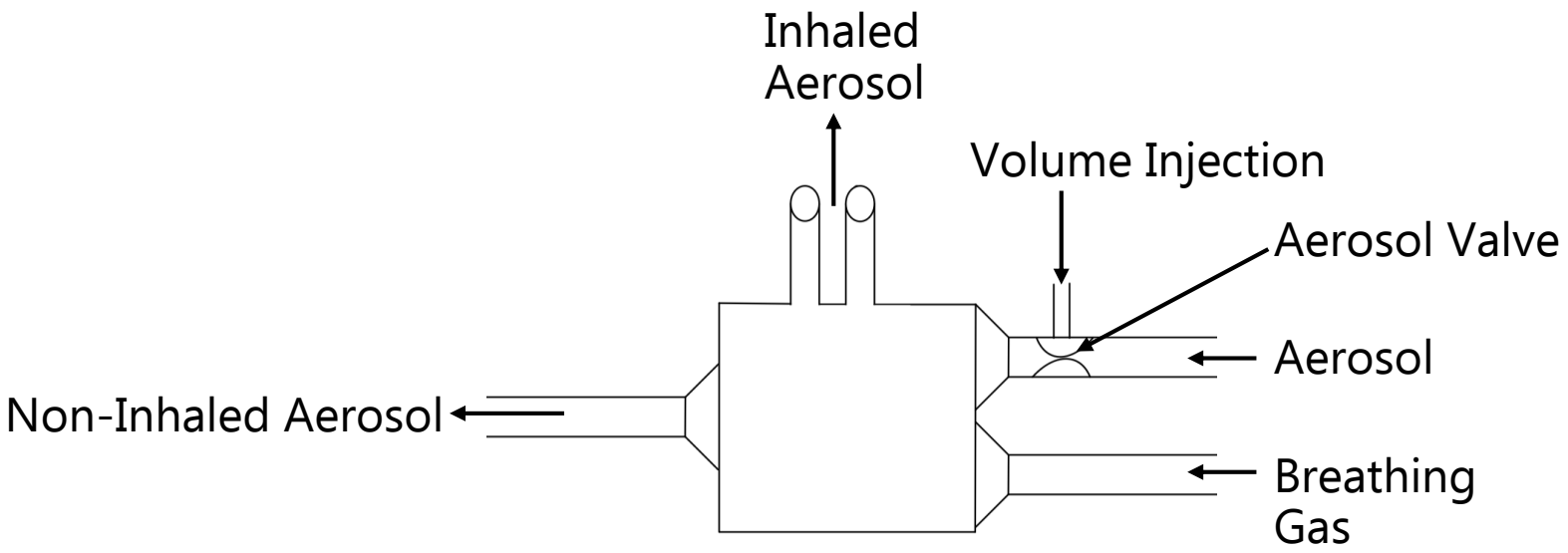


2) Develop a Test Bench

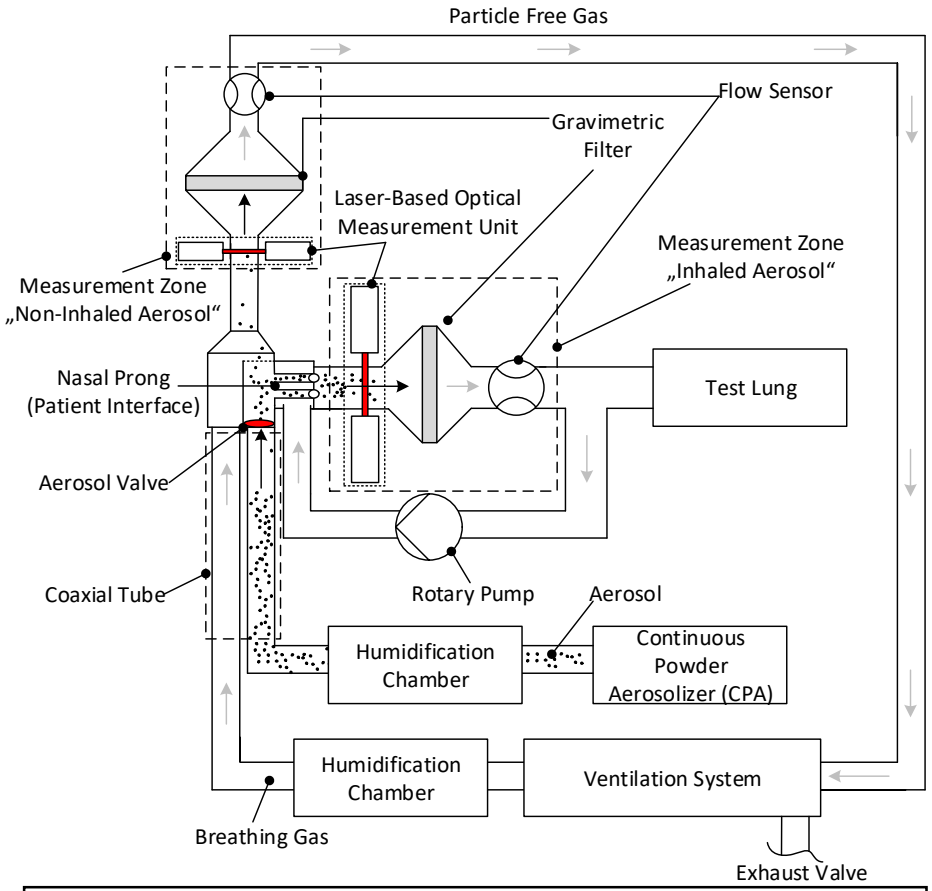
- ❑ Measuring aerosol output / inhaled dose
- ❑ Applicable for preterm neonate breathing pattern
- ❑ Enabling real-time measurement

Objective 1: Nasal Prong

Schematic Nasal Prong



Objective 2: Test Bench



$$E_{valve} = \frac{\Delta m_{filter\ inhaled}}{\Delta m_{filter\ inhaled} + \Delta m_{filter\ non-inhaled}}$$

Test Lung:

- Inhalation-exhalation ratio: 0.46:0.71
- Breaths per minute: 51
- Tidal volume: 12.3 ml
- Triggers the aerosol valve

Ventilation System:

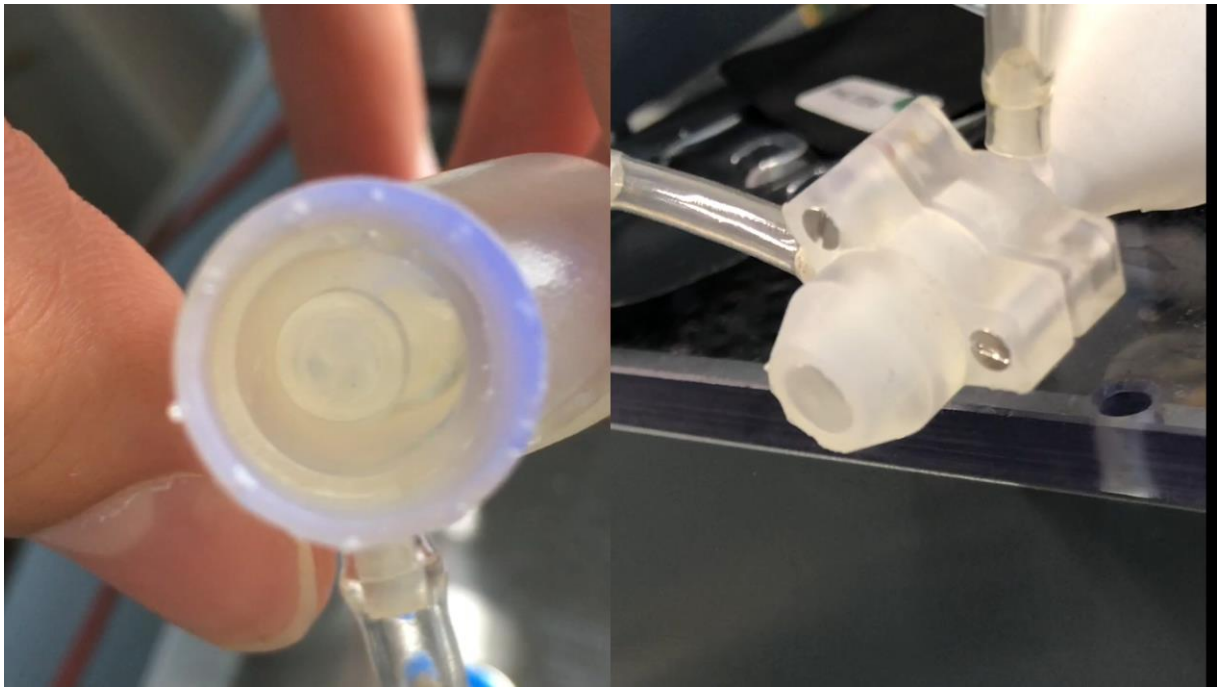
- Babylog® 8000 plus
- CPAP-mode
- PEEP: 5 mbar
- Breathing gas flow: 6 l/min

Continuous Powder Aerosolizer

- Continuous aerosol flow: 0.84 l/min
- Recombinant surfactant protein-C

Results: Nasal Prong

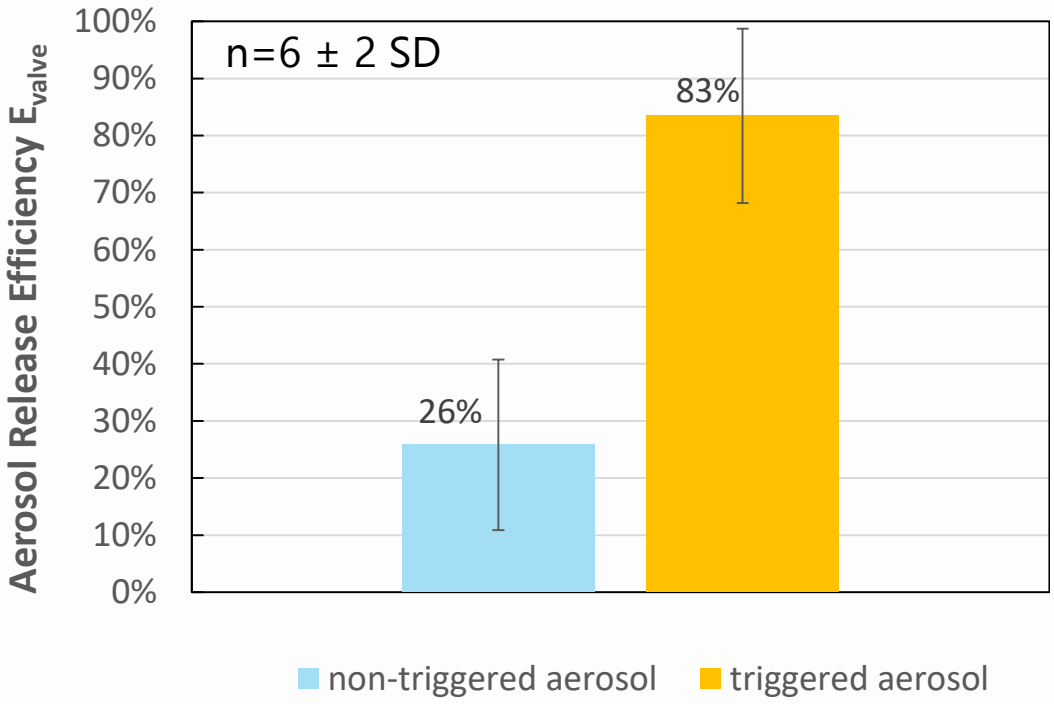
Triggered Aerosol Release Technology



- Valve Integrated in Nasal Prong
- Direct Aerosol Release as Triggered Bolus
- Valve Response Time <20 ms

Results: Test Bench

Aerosol Measurement



$$E_{valve} = \frac{\Delta m_{filter\ inhaled}}{\Delta m_{filter\ inhaled} + \Delta m_{filter\ non-inhaled}}$$

- Triggered Aerosol Release is more Efficient than Non-Triggered Aerosol Release
- Efficiency Increased by a Factor of 3.2
- Combination of Gravimetric and Optical Detection Enables Real-Time Measurements

Conclusion

1) Develop a Modified Nasal Prong
   - ✓ Integrated Micronized Valve
   - ✓ Direct and Fast Aerosol Release
   - ✓ Aerosol Release as Targeted Bolus
   - ✓ Increase Inhaled Dose Efficiency

2) Develop a Test Bench
   - ✓ Measuring Aerosol Output / Inhaled Dose
   - ✓ Applicable for Preterm Neonate Breathing Pattern
   - ✓ Enabling Real-Time Measurement

Thank You

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Especially to Dr. Gerhard Pohlmann

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