

Recommended Approaches to Minimize Aerosol Dispersion of SARS-CoV-2 During Noninvasive Ventilatory Support Can Cause Ventilator Performance Deterioration

A Benchmark Comparative Study

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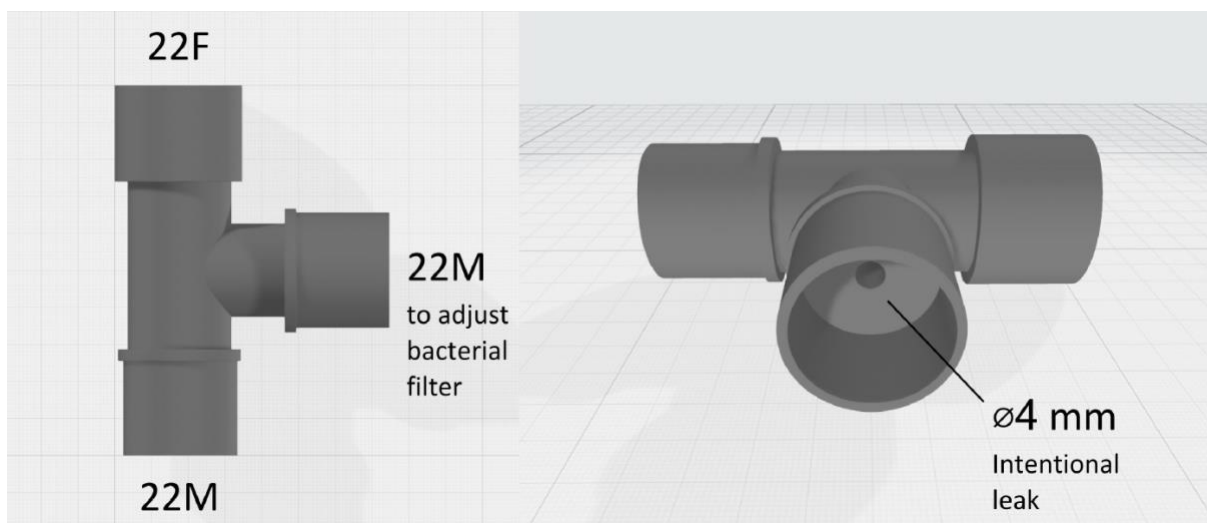
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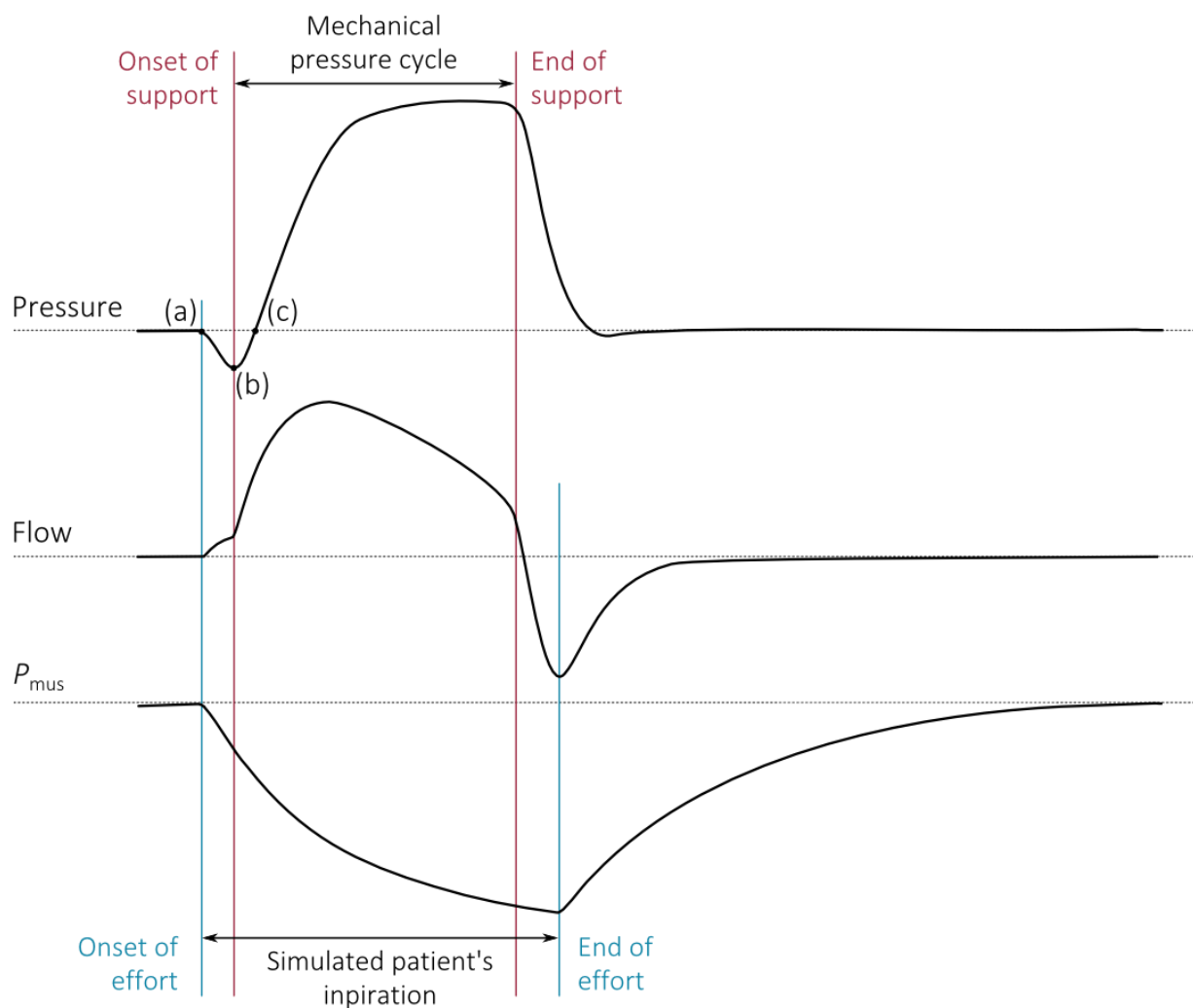
e-Figure 1: 3D-printed head model with setup 4 test.



e-Figure 2: 3-D model of the connector used in setup 4.



e-Figure 3: Simulated assisted breathing cycle with ASL 5000 (airway pressure, patient flow and muscular pressure). Point (b) is indicative of the sensitivity of the trigger, while keeping in mind that this value is affected, on one hand, by the intensity of the inspiratory effort and, on the other hand, by the characteristics of the patient-ventilator interface, such as the length of the circuit, its compliance, the presence of a humidifier or the type of mask. In our case, the inspiratory effort and the ventilatory settings are the same in all simulations. Therefore, the only variable for which we assessed the impact on ventilator performances is the circuit setup.



Experimental model: Circuit setups:

The dead space between the mask and the exhalation valve was*:

- Setup 1: 1 filter + 1 elbow connector (ResMed) \approx 65 ml
- Setup 2: 1 filter + 1 Whisper Swivel II (Respironics) \approx 75 ml
- Setup 3: 1 T connector (Intersurgical) + 1 filter + 1 Whisper Swivel II \approx 105 ml
- Setup 4: 1 3D connector (Phoenix effect) \approx 25 ml (3-D printed connector available here: <http://www.kernelbiomedical.com/3dleak>) (efigure 5)
- Setup 6: 1 T connector + 1 expiratory valve (Intersurgical) \approx 45 ml
- Setup 7: 1 filter + 1 expiratory valve (Intersurgical) \approx 75 ml

For setups 5 and 8, there was no additional dead space given the dual limb circuit.

* an average volume of 50 ml was used for the filter dead space

e-Table 1: Proportion of synchronized and asynchronized cycles during non-invasive ventilation without the use of any filter or with the use of low resistance filter (Low filter) and with heat and moisture exchange (HME). Results reported as percentage of cycles (p:0.3240)

	No filter	Low filter	HME
Ineffective efforts	1.7	2.5	2.8
Auto-triggering	0.0	1.4	1.7
Double triggering	0.0	0.0	0.0
Early cycling	1.1	0.0	0.0
Late cycling	0.0	5.0	3.3
Synchronized cycles	97.2	91.1	92.2

e-Table 2: Proportion of synchronized and asynchronized cycles during non-invasive ventilation with the different type of circuit setups. Results reported as percentage of cycles (p<0.0001)

	Setup 1	Setup 2	Setup 3	Setup 4	Setup 5	Setup 6	Setup 7	Setup 8
Ineffective efforts	0.0	0.0	0.0	0.0	0.0	5.9	0.0	12.6
Auto-triggering	1.5	1.5	0.0	0.0	1.5	0.7	1.5	1.5
Double triggering	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Early cycling	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
Late cycling	0.0	3.0	0.0	0.0	0.0	0.7	0.0	18.5
Synchronized cycles	98.5	95.6	100.0	100.0	98.5	92.6	98.5	64.4