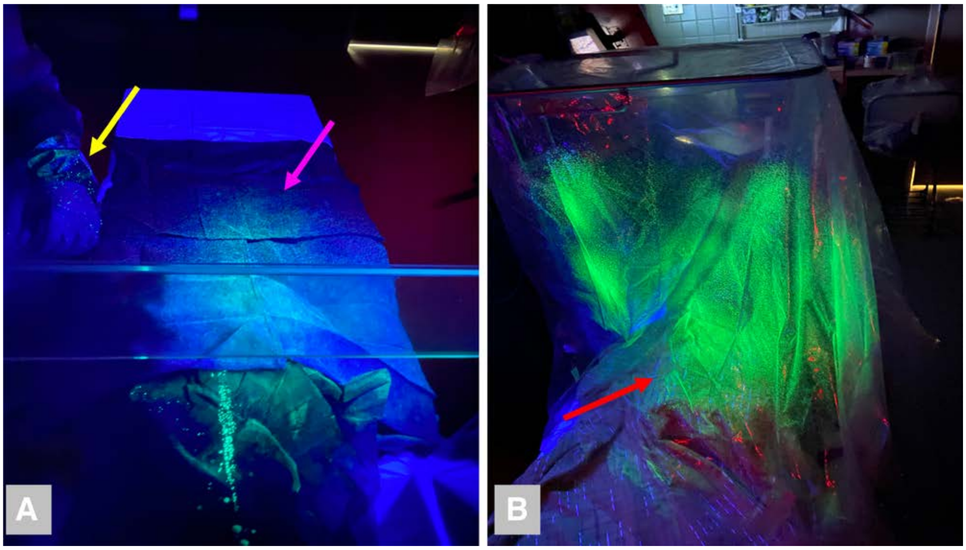

Fig. 2. Qualitative comparison of droplet spray when simulating extubation cough. (*A*) Droplet distribution using the aerosol box. *Yellow arrow*, droplet contamination of bedside assistant. *Pink arrow*, escape of droplets through the thoracic opening on the aerosol box. (*B*) Droplet distribution using the Mayo-draped containment setup. *Red arrow*, containment of droplets within the plastic draping.

positioned at the mannequin's mouth and aimed cephalad and caudad to reflect droplet spray during intubation and extubation, respectively. Qualitative examination by fluorescent lamp revealed no droplet spread beyond the laryngoscopist's forearms for either system. A significant difference was noted in the droplet distribution during the simulation of an extubation cough. The caudal opening of the aerosol box allowed considerable droplet spread, contaminating the bedside assistant (fig. 2A). With the Mayo-draped containment setup, the caudally directed droplets were contained within the drape (fig. 2B).

Future studies would need repeated and validated trials with assessment by various healthcare providers. Also, atomization of fluorescent fluid may not reflect respiratory droplets due to compositional differences. A shortcoming of both devices was the potential contamination area under the patient's head, as mentioned in the study of Matava *et al.*[1] For this, we recommend placing an additional plastic drape beneath the head. With concerns for nosocomial COVID-19 infection, we find the simple design of the Mayo-draped containment setup to have clinical value in facilitating ease of intubation and limiting droplet spread compared to the aerosol box.

Research Support

Support was provided solely from institutional and/or departmental sources.

Competing Interests

The authors declare no competing interests.

Huong Brown, M.D., David Preston, D.O., Ravi Bhoja, M.D.
University of Texas at Southwestern, Dallas, Texas (H.B.).
huong1.nguyen@utsouthwestern.edu

DOI: 10.1097/ALN.0000000000003422

References

1. Matava CT, Yu J, Denning S: Clear plastic drapes may be effective at limiting aerosolization and droplet spray during extubation: Implications for COVID-19. Can J Anaesth 2020; (in press)
2. Canelli R, Connor CW, Gonzalez M, Nozari A, Ortega R: Barrier enclosure during endotracheal intubation. N Engl J Med 2020; 382:1957–8

(Accepted for publication May 18, 2020. Published online first on May 29, 2020.)

Wearing an N95 Respiratory Mask

An Unintended Exercise Benefit?

To the Editor:

The N95 or higher-level respirator is an essential element of personal protective equipment to be worn

Table 1. Physiologic Implications of N95 Mask Use

Workload	Mask Type	Inhaled Carbon Dioxide (%)	Inhaled Oxygen (%)	Peak Inhalation Pressure (mmHg)	Peak Exhalation Pressure (mmHg)
2 Metabolic equivalents	Cup	2.49 ± 0.51	17.40 ± 0.81	−6 ± 1	8 ± 2
	Cup + surgical mask	2.93 ± 0.38	16.81 ± 0.54	−7 ± 2	8 ± 2
	Flat-fold	3.52 ± 0.93	16.10 ± 1.14	−5 ± 2	7 ± 2
	Flat-fold + surgical mask	3.14 ± 0.64	16.52 ± 0.79	−6 ± 2	8 ± 2
8 Metabolic equivalents	Cup	1.43 ± 0.60	19.33 ± 0.70	−35 ± 6	23 ± 7
	Cup + surgical mask	1.75 ± 0.33	18.96 ± 0.37	−41 ± 7	29 ± 7
	Flat-fold	1.81 ± 0.82	18.92 ± 0.84	−34 ± 10	24 ± 4
	Flat-fold + surgical mask	1.67 ± 0.33	19.05 ± 0.35	−43 ± 16	30 ± 8

Data from Sinkule *et al.*[2]

when in contact with patients with known or suspected coronavirus disease 2019 (COVID-19) infection. Three varieties are commonly available: preformed/cup, flat fold/duck bill, and elastomeric.[1] Wearing an N95 mask invokes a number of physiologic implications, particularly with prolonged use (greater than 1 h), higher workloads, or an overlying surgical mask (table 1).[2,3] Concomitant surgical mask use augments the impact of a cup mask due to further resistance to airflow, but diminishes the impact of a flat fold mask due to a reduction in deadspace.[2]

At 2 metabolic equivalents (*e.g.*, walking slowly during rounds), N95 mask use noticeably increases inhaled carbon dioxide, reduces inspired oxygen, and increases the work of breathing. The resulting inhaled carbon dioxide of 2 to 3% (normal, 0.04%) produces transient acidosis and compensatory increases in minute ventilation, work of breathing, and cardiac output.[2] Symptoms include sweating, visual changes, headache, dyspnea, increased irritability, and decreased reasoning, alertness, and exercise endurance.[3] Independently, the inspired oxygen of 17% (normal, 21%), yields headache, lightheadedness, drowsiness, muscular weakness, dyspnea on exertion, nausea, and vomiting.[4] Simultaneously, the augmented resistance to inspiratory (15% of maximum) and expiratory flow, when experienced for greater than 10 min, results in respiratory alkalosis, increased lactate levels, fatigue, and impaired physical work capacity.[5]

However, a number of exercise benefits can be achieved with surprisingly low effort while wearing an N95 mask. At 2 metabolic equivalents, the inspiratory resistance load of 6 to 7 cm H_2O (4.5 to 5 mmHg; normal, 1.3 mmHg [men] to 1.6 mmHg [women]) of an N95 mask creates a "respiratory pump" that decreases intrathoracic, central venous, and intracranial pressures,[6] and increases preload, cardiac output, and mean arterial pressure, particularly during hypotensive states.[7] At 4 metabolic equivalents, consciously taking 30 dynamic (fast in) inspiratory efforts twice daily for 4 weeks increases respiratory muscle strength. Maintaining 4 metabolic equivalents of activity for 10 to 30 min, 3 to 5 days/week for 4 weeks improves respiratory muscle endurance. Such conditioning of respiratory muscle strength and respiratory muscle endurance improves ventilatory efficiency (*e.g.*, ventilation–perfusion and alveolar capillary exchange), oxygen delivery/lactate removal at locomotor muscles, and overall exercise performance.[5]

Taken together, to inspire us as we don, sustain us as we wear, and cheer us as we doff our N95 masks, we should relish in the many beneficial attributes that are possible "all in a day's work."

Research Support

Support was provided solely from institutional and/or departmental sources.

Competing Interests

The authors declare no competing interests.

Bryan A. Davis, M.D., M.A., Lawrence C. Tsen, M.D. Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts (L.C.T.). ltsen@bwh.harvard.edu.

DOI: 10.1097/ALN.0000000000003421

References

1. Centers for Disease Control and Prevention (NPPTL): Respirator Trusted-Source Information. Section 1: NIOSH-Approved Respirators. Available at: https://www.cdc.gov/niosh/npptl/topics/respirators/disp_part/respsource.html. Accessed April 18, 2020.
2. Sinkule EJ, Powell JB, Goss FL: Evaluation of N95 respirator use with a surgical mask cover: effects on breathing resistance and inhaled carbon dioxide. Ann Occup Hyg 2013; 57:384–98
3. Rebmann T, Carrico R, Wang J: Physiologic and other effects and compliance with long-term respirator use among medical intensive care unit nurses. Am J Infect Control 2013; 41:1218–23

4. Schulte JH: Sealed environments in relation to health and disease. Arch Environ Health 1964; 8:438–52
5. Álvarez-Herms J, Julià-Sánchez S, Corbi F, Odriozola-Martínez A, Burtscher M: Putative role of respiratory muscle training to improve endurance performance in hypoxia: A review. Front Physiol 2018; 9:1970
6. Convertino VA: Mechanisms of inspiration that modulate cardiovascular control: The other side of breathing. J Appl Physiol (1985) 2019; 127:1187–96
7. Skytioti M, Søvik S, Elstad M: Respiratory pump maintains cardiac stroke volume during hypovolemia in young, healthy volunteers. J Appl Physiol (1985) 2018; 124:1319–25

(Accepted for publication May 18, 2020. Published online first on May 22, 2020.)

Easy and Accessible Protection against Aerosol Contagion during Airway Management

To the Editor:

The coronavirus disease 2019 (COVID-19) outbreak began in northern Italy in early February and quickly spread to the rest of the peninsula. It has been a major public health issue highlighting the challenges for the health system to quickly ramp up capacity in the face of a pandemic and in particular in accident and emergency departments, intensive care, and insufficient supply of critical equipment such as ventilators but also personal protective equipment. The shortage of personal protective equipment not only puts medical professionals' lives at risk (at the time of writing more than 60 Italian doctors have died as a result of COVID-19) but also increases the risk of contagion within the hospital. Although elective surgery has been reduced, emergency surgery has continued and thus so has general anesthesia, without availability of the necessary protection. The inability to know which patients have COVID-19 in an emergency setting where tests kits are scarce, response times to test are slow, and with shortages or rationing of personal protective equipment requires the medical team to act as though the patient is positive unless proven otherwise, even though asymptomatic. In this scenario our team has trialed an easy and accessible technique to protect the operator/anesthetist from predictable aerosol during oxygen mask ventilation, intubation, and extubation. Our patients arrived in the operating room wearing a surgical mask. The primary anesthetist has always strictly followed the correct doffing and donning procedures before and after intubation with surgical mask, goggle/visor, double gloves, and gown, not the appropriate personal protective equipment because of the shortage we faced at the beginning. After anesthesia induction, 3 min breathing 100% oxygen, propofol 2 mg/kg was given to put the patients asleep to avoid the sensation of being smothered. Once the patient was asleep we positioned the transparent plastic sheet over the chest and head fixed with a tape to the abdomen (fig. 1). Fentanyl 2 mcg/kg and

Fig. 1. Mask ventilation.