

## Use of 3D printer for face mask production to protect endoscopy unit personnel in contact with high-risk patients during COVID-19 pandemic

Endoscopy unit personnel are exposed to COVID-19 infection from inhalation of airborne droplets [1, 2]. Peri-endoscopic aerosolized infections have indeed been reported, making upper gastrointestinal endoscopy a high-risk procedure [3, 4]. In the current situation, infection prevention represents the only way to ensure the safety of both endoscopy unit personnel and patients. Whenever possible, patients who are considered at high risk or who have confirmed COVID-19 infection should undergo endoscopy in a negative-pressure room [5]. However, such a dedicated facility is not universally available to all endoscopy units, thus limiting the degree of preventive measures in most centers to protective clothing for endoscopists, specialist nurses, and technicians.

We had an idea to create a negative pressure micro-environment inside a ventilation mask, which was modified to allow easy passage of the endoscope into the mouth while allowing simultaneous administration of oxygen and use of suction. Two separate holes of appropriate size were therefore drilled into the original disposable ventilation mask for oxygen inflow and/or suction respectively. Sealed passage of the endoscope was achieved by use of a soft-valve adapter that fits to the existing built-in plastic cylinder of the original mask (► Fig. 1, ► Fig. 2). In order to provide sufficient gas flow for effortless respiration and low intra-mask negative pressure, disposable gas flow adapters were also manufactured using the 3D printing technology, which was available at our clinical laboratory for 3D printing, 3D4Med. The STL files of the described adaptors are downloadable for free at [www.3d4med.eu](http://www.3d4med.eu).

An oxygen inflow rate of 8L/min and vacuum suction at a negative pressure of 200 millibar (with safety filter interposition) (► Fig. 3) provided the best toler-



► Fig. 1 The 3D-printed adapters.

ability and function of the device, as tested on healthy volunteers.

A modified ventilation mask provides a low-cost alternative when negative-pressure room facilities are not available. It proved effective in creating a micro negative-pressure environment around the



► Fig. 2 The modified ventilation mask.

patient's mouth and nose. This device can be easily manufactured by hospitals at a relatively low cost using available 3D printing technology.

Although long-term data are needed to confirm the efficacy of this mask in providing protection against COVID-19 transmission, we believe that it could represent a suitable alternative when negative-pressure endoscopy rooms are not available.



► Fig. 3 Device in use.

## Competing interests

The authors declare that they have no conflicts of interest.

## The authors

**Federico De Grazia<sup>1</sup>, Stefania Marconi<sup>2</sup>, Marco Bardone<sup>1</sup>, Aurelio Mauro<sup>1</sup>, Gianluca Alaimo<sup>2</sup>, Ferdinando Auricchio<sup>2</sup>, Andrea Pietrabissa<sup>3</sup>, Antonio Di Sabatino<sup>1</sup>**

- 1 Unit of Digestive Endoscopy, Department of Internal Medicine, San Matteo Hospital Foundation, Pavia, Italy
- 2 ProtoLab, Department of Civil Engineering and Architecture, University of Pavia, Pavia, Italy
- 3 University of Pavia and San Matteo Hospital Foundation, Pavia Italy

## Corresponding author

**Federico De Grazia, MD**

Unit of Digestive Endoscopy, Department of Internal Medicine, San Matteo Hospital Foundation, Viale Camillo Golgi 19, Pavia 27100, Italy  
Fax: +39-038-2501602  
f.degrazia@smatteo.pv.it

## References

- [1] Huang C, Wang Y, Li X et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020; 395: 497–506
- [2] Gu J, Han B, Wang J. COVID-19: gastrointestinal manifestations and potential fecal-oral transmission. *Gastroenterology* 2020; doi:10.1053/j.gastro.2020.02.054
- [3] Tang J, Li Y, Eames I et al. Factors involved in the aerosol transmission of infection and control of ventilation in healthcare premises. *J Hosp Infect* 2006; 64: 100–114

- [4] Endoscopy activity and COVID-19: BSG and JAG guidance – update 03.04.20. The British Society of Gastroenterology; 2020: Accessed: 19 May 2020. <https://www.bsg.org.uk/covid-19-advice/endoscopy-activity-and-covid-19-bsg-and-jag-guidance/>
- [5] Calderwood AH, Day LW. ASGE Quality Assurance in Endoscopy Committee. et al. ASGE guideline for infection control during GI endoscopy. *Gastrointest Endosc* 2018; 87: 1167–1179

## Bibliography

*Endoscopy* 2020; 52: 1146–1147  
**DOI** 10.1055/a-1206-0937  
**ISSN** 0013-726X  
**published online** 26.10.2020  
© 2020. Thieme. All rights reserved.  
Georg Thieme Verlag KG, Rüdigerstraße 14,  
70469 Stuttgart, Germany