



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## Correspondence

## Practical workflow recommendations for emergency endotracheal intubation in critically ill patients with COVID-19 based on the experience of Wuhan Union Hospital



Editor,

Patients with Corona Virus Disease (COVID-19) are likely to develop cold, pneumonia, or acute respiratory failure and some of them are requiring anesthesia care for emergency endotracheal intubation [1]. It would be an enormous challenge for perioperative care providers in providing optimal treatment for these patients and avoiding the cross-infection by SARS-CoV-2. We have recorded > 100 critically ill patients with COVID-19 receiving emergency endotracheal intubation in Wuhan Union hospital, from Feb 1, 2020 to April 1, 2020, and the success rate of intubation was 100% with no medical staff infected by SARS-CoV-2. Here, we summarized Chinese experience about practical workflow for emergency endotracheal intubation in critically ill patients with COVID-19.

### 1. Emergent endotracheal intubation indications for confirmed/clinical diagnosis/suspected cases in fever clinics or isolation wards

- 1) Under high-flow nasal catheter oxygen (HFNC) therapy, non-invasive mechanical ventilation (NIV), or 10–15 L/min via a face mask with reservoir bag, the patient's respiratory rate > 30 beats/min or hypoxemia ( $SpO_2 < 90\%$ ), if oxygenation index ( $PaO_2/FiO_2 < 200$  mmHg, endotracheal intubation can be considered;  $PaO_2/FiO_2 \leq 150$  mmHg, endotracheal intubation must be performed [2].
- 2) Respiratory and cardiac arrest patients.

### 2. Patient ward preparations before endotracheal intubation

- 1) Personnel preparation: the attending doctor or related medical staff familiar with the ventilator and the suction operation should give assistance;
- 2) Item preparation:
  - i. Sign on consent to the risk of endotracheal intubation;
  - ii. Open venous access (indwelling needle above 20G) and three-way valve, connect with 0.9% physiological saline;
  - iii. Monitor vital signs (ECG, respiratory rate,  $SpO_2$  and blood pressure);
  - iv. Well connected threaded tube, oxygen, power supply, and invasive ventilator with properly adjusted ventilator parameters;
  - v. Oxygen pack filled with oxygen;
  - vi. Connect the suction device;
  - vii. Prescribe in advance and prepare related drugs.

### 3. Precautions for anesthesia staff before endotracheal intubation

- 1) After receiving the notification, the anesthesiologist re-confirms the indications for endotracheal intubation and checks the patient's basic situation;
- 2) The anesthesiologist should check the ventilator, make sure the ventilator parameters are set properly and patient's venous access is open, and evaluate the airway condition.

### 4. Protection during endotracheal intubation (taking Level III protection measures)

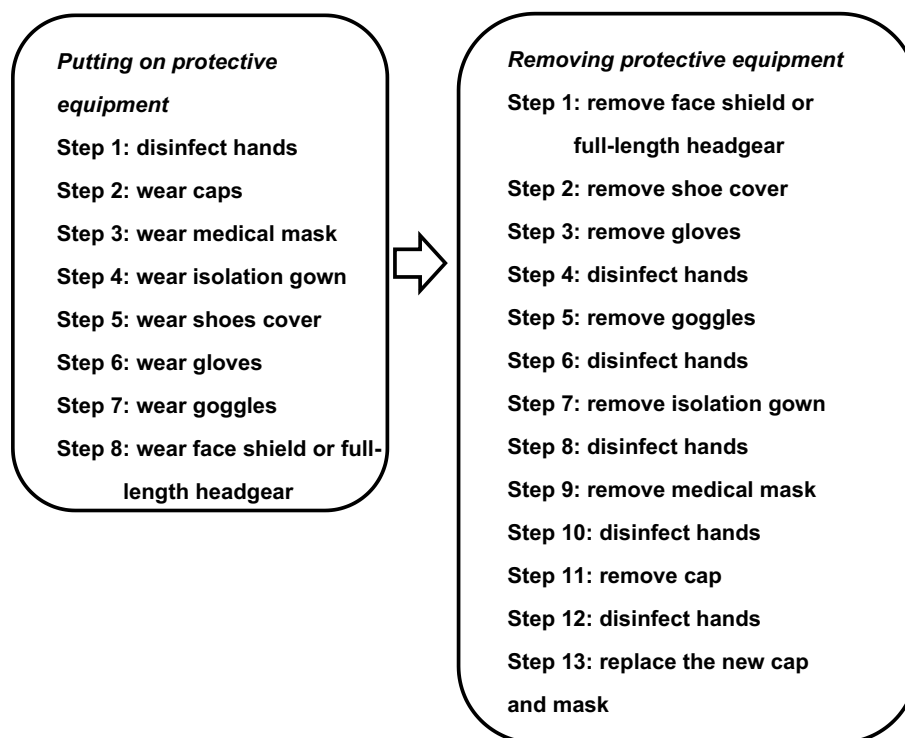
- 1) Personal protection should be done according to the hospital infection prevention and control requirements including hand-washing clothes or working clothes, medical protective masks, disposable work caps, disposable protective clothing, disposable latex gloves, disposable shoe covers, eye-protective medical surgical masks or goggles, medical protective masks, splash-proof screen or a full-face hood [3];
- 2) Putting on personal protective equipment or removing personal protective equipment, as shown in [Flow chart 1](#).
- 3) Avoiding shaking while removing the protective equipment. After the protective clothing is taken off, it should be rolled up by the inside and put into the yellow garbage can. The protective equipment should be discarded into the double yellow garbage bags and put to the designated area.

### 5. Procedure of endotracheal intubation

- 1) Before endotracheal intubation, it is necessary to check the monitoring equipment (ECG, respiratory rate, blood pressure and  $SpO_2$ ), intubation equipment (video laryngoscope, laryngeal mask, endotracheal tube, intubation stylet), auxiliary respiratory equipment (breathing balloon, mask), oxygen supply equipment, sputum suction equipment again, array the various instrument lines, and prepare first-aid drugs;
- 2) Pre-oxygenated with 100%  $FiO_2$  for 5 min through a mask via a face mask with reservoir bag, or breathing mask, or BIPAP ventilator, etc. Avoiding pressure-assisted ventilation before the patient's consciousness disappears [4].
- 3) Anesthesia induction (requiring at least one assistant throughout the process):
  - i. Patients in fever clinics, with unknown medical history, are treated as full stomach;
  - ii. For patients in the ICU, because most of them are performed with a BIPAP ventilator, airway assessment cannot be performed. It is recommended not to remove the patients' breathing mask for airway

<https://doi.org/10.1016/j.jclinane.2020.109940>

Received 17 April 2020; Received in revised form 19 May 2020; Accepted 26 May 2020  
0952-8180/© 2020 Elsevier Inc. All rights reserved.



Flow chart 1. The steps of taking Level 3 medical protection measures.

assessment, and treat them as the difficult airway patients. Taking propofol 1.0–1.5 mg/kg i.v., and then rocuronium 1–1.5 mg/kg i.v., fentanyl 2–4 µg/kg i.v.;

- 4) 60–90 s after drug administration and the patient's spontaneous breathing completely disappears, quickly remove the respiratory oxygen mask or BIPAP ventilator mask at the end of expiration, insert a video laryngoscope and complete the endotracheal intubation. The whole process should be done by one anesthesiologist as much as possible. If necessary, the assistant can provide appropriate assistance (deliver the endotracheal tube, pull the tube stylet, hand bite block, etc) to ensure the successful completion of endotracheal intubation;
- 5) Judgment of endotracheal tube depth: It is not easy to judge the tube depth of patients with severe pulmonary lesions by auscultation of respiratory sounds. It is recommended to observe the bilateral chest relief, ventilator breathing waveform and respiratory parameters for comprehensive judgment. Besides, end-respiratory carbon dioxide or fiberoptic bronchoscopy can also determine the position of the tube, or indirect judgment by bedside ultrasound to check whether the endotracheal tube has entered the esophagus by mistake [5];
- 6) For patients with oral secretions, if there is no airway obstruction, airway suction is recommended after completion of endotracheal intubation;
- 7) If repeated endotracheal intubation is not successful and the patient's SpO<sub>2</sub> is extremely low, it is recommended to quickly place the laryngeal mask for mechanical ventilation [6]. After the oxygenation improves, anesthesiologist can decide whether to re-intubate again.

## 6. Management after endotracheal intubation

- 1) Complete relevant prescription and endotracheal intubation records;
- 2) Routine sedation is recommended to prevent the tube from being bitten, collapsed or even prolapsed by the patient's struggle, and

avoid unnecessary secondary intubation. If necessary, using muscle relaxants to eliminate spontaneous breathing. Protect cornea with 0.5% erythromycin ointment;

- 3) Lung protective ventilation strategy: low tidal volume (6–8 mL/kg, ideal body weight) and low inspiration pressure (platform pressure < 30 cmH<sub>2</sub>O) for mechanical ventilation to reduce ventilator-related lung injury; breathing parameters can be adjusted by the result of arterial blood gas [7]. The whole workflow recommendations for emergency endotracheal intubation are shown in.

Although more data is needed to support our workflow, we do hope the frontline experience about emergency endotracheal intubation in critically ill patients with COVID-19 can help keep healthcare workers safe and provide optimal care to patients.

## Funding

This work was supported by the National Natural Science Foundation of China (No. 81701887; No. 81571075) and the National Key Research and Development Project (No. 2018YFC2001802).

## Contributors

Not applicable.

## CRediT authorship contribution statement

**Haifa Xia:** Writing - original draft, Validation. **Shiqian Huang:** Writing - original draft, Validation. **Weimin Xiao:** Writing - review & editing, Validation. **Yun Lin:** Writing - review & editing, Validation. **Xiaomin Hu:** Writing - review & editing, Validation. **Bingqing Nie:** Writing - review & editing, Validation. **Ken Lin:** Writing - review & editing, Validation. **Dongshi Lu:** Writing - review & editing, Validation. **Xueyin Chen:** Investigation, Validation. **Limin Song:** Investigation, Validation. **Li Wang:** Investigation, Validation. **Yuhong**

**Zhang:**Investigation, Validation.**Shanglong Yao:**Writing - review & editing, Validation.**Xiangdong Chen:**Writing - original draft, Writing - review & editing, Validation.

#### Declaration of competing interest

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

#### Acknowledgements

This work was supported by the National Natural Science Foundation of China (No. 81701887; No. 81571075) and the National Key Research and Development Project (No. 2018YFC2001802).

#### References

- [1] Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 Novel Coronavirus in Wuhan, China. *Lancet* 2020;395:497–506.
- [2] Fan E, Brodie D, Slutsky AS. Acute respiratory distress syndrome: advances in diagnosis and treatment. *JAMA* 2018;319:698–710.
- [3] Chen X, Liu Y, Gong Y, Guo X, Zuo M, Li J, et al. Perioperative management of patients infected with the novel coronavirus: recommendation from the Joint Task Force of the Chinese Society of Anesthesiology and the Chinese Association of Anesthesiologists. *Anesthesiology* 2020;132:1307–16.
- [4] Hanouz JL, Lhermitte D, Gérard JL, Fischer MO. Comparison of pre-oxygenation using spontaneous breathing through face mask and high-flow nasal oxygen: a randomised controlled crossover study in healthy volunteers. *Eur J Anaesthesiol* 2019;36:335–41.
- [5] Ahn JH, Kwon E, Lee SY, Hahm TS, Jeong JS. Ultrasound-guided lung sliding sign to confirm optimal depth of tracheal tube insertion in young children. *Br J Anaesth* 2019;123:309–15.
- [6] Higgs A, McGrath BA, Goddard C, Rangasami J, Suntharalingam G, Gale R, et al. Guidelines for the management of tracheal intubation in critically ill adults. *Br J Anaesth* 2018;120:323–52.
- [7] Fan E, Del Sorbo L, Goligher EC, Hodgson CL, Munshi L, Walkey AJ, et al. An official American Thoracic Society/European Society of Intensive Care Medicine/Society of Critical Care Medicine Clinical Practice Guideline: mechanical ventilation in adult patients with Acute Respiratory Distress Syndrome. *Am J Respir Crit Care Med* 2017;195:1253–63.

Haifa Xia<sup>1</sup>, Shiqian Huang<sup>1</sup>, Weimin Xiao, Yun Lin, Xiaomin Hu, Bingqing Nie, Ken Lin, Dongshi Lu, Xueyin Chen, Limin Song, Li Wang, Yuhong Zhang, Shanglong Yao, Xiangdong Chen\*

*Department of Anesthesiology, Union Hospital, Tongji Medical College, Huazhong University of Science and Technology, No. 1277, Jiefang Avenue, Wuhan 430022, China*

*E-mail address: xiangdongchen2013@163.com (X. Chen).*

\* Corresponding author.

<sup>1</sup> Haifa Xia and Shiqian Huang made equal contribution to this work.