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Tracheal intubation in patients with coronavirus disease 2019 (COVID-19): a cross-sectional survey in China

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Coronavirus disease 2019 (COVID-19) has caused a dramatic loss of human life worldwide. The rate of tracheal intubation is estimated to be 2.3% in hospitalized patients.[1] As an aerosol-generating procedure, intubation may increase the risk of COVID-19 infection in healthcare workers. Avoiding the generation of aerosol and improving the oxygenation during intubation is sometimes conflicting, which makes the intubation in patients with COVID-19 different from that in other patients with acute respiratory distress syndrome (ARDS). We conducted a survey to collect information on preoxygenation, induction, and intubation procedures in COVID-19 patients. Our study aims to compare the difference in intubation performance between doctors who have ever done tracheal intubation in COVID-19 patients versus those who have never done tracheal intubation in COVID-19 patients.

This study was supported by the Airway Management Group of the Chinese Society of Anesthesiology (CSA) and approved by the institutional review board of Beijing Hospital (No. 2020BJYEC-048-01). Written informed consent was waived by the institutional review board of Beijing Hospital. Two versions of the questionnaires were designed: questionnaire A was meant to be filled in by doctors who performed tracheal intubation in COVID-19 patients, and questionnaire B was for doctors without experiences in tracheal intubation in COVID-19 patients. The following information was collected in both questionnaire A and questionnaire B: personal information including basic hospital characteristics, age, gender, and work experience; the number of assistants; methods for airway assessment, preoxygenation, induction, and intubation. Unlike other questions in the questionnaire (both questionnaire A and questionnaire B), the question about the sedative drug has multiple answers, which means more than one kind of sedatives could be selected by doctors during induction. In questionnaire A, numbers of COVID-19 patients intubated were investigated. For doctors who had performed tracheal intubation in COVID-19 patients, they were asked to fill in the questionnaire A according to the situation during tracheal intubation in COVID-19 patients. For those doctors who had never performed tracheal intubation in COVID-19 patients, they were asked to fill in the questionnaire B about what they would do if tracheal intubation was needed in COVID-19 patients.

Doctors who filled in questionnaire A were classified as the intubation group and doctors who filled in questionnaire B were classified as the non-intubation group. The questionnaires were uploaded to the Wenjuanxing platform (https://www.wjx.cn) on March 18, 2020, where they remained through March 31, 2020; the links were officially sent to anesthetists in China by the CSA. The questionnaires were designed to ensure that each doctor could submit his or her questionnaire only once. All returned questionnaires were evaluated for validity. For those doctors who have done more than two cases of intubations or who came from a hospital not designated for the treatment of COVID-19 but still have filled in questionnaire A, we do confirm the answers with their department chiefs. If we could not reach the department chief or the number of patients was higher than the number reported by their department chief, the questionnaire would be eliminated from further analysis.

At the end of this cross-sectional survey, 3916 responses including 172 responses of questionnaire A and 3744 responses of questionnaire B were received by March 31, 2020. Five responses to questionnaire A from doctors who did not have tracheal intubation cases were excluded. Fourteen responses to questionnaire A were excluded after validation. The proportion of valid responses of questionnaire A and questionnaire B was 89% (153/172) and

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100% (3744/3744) respectively. In the 153 copies of questionnaire A included, 633 cases of intubation were completed by 153 doctors.

The data analysis was based on questionnaires validated. Categorical data collected were presented as numbers (%) and compared by the χ^2 test or Fisher exact test between groups. This study was designed to investigate techniques used by Chinese anesthesiologists when intubating patients with COVID-19. Therefore, no formal hypotheses were implemented to drive the sample size calculation. Statistical analysis was performed with SPSS 24.0 (IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

Our results showed that 41 of the 153 doctors in the intubation group completed tracheal intubation with no assistant, while 447 of the 3744 doctors in the non-

Table 1: Questionnaire survey results of clinical practice on preparation, preoxygenation, induction, and intubation in COVID-19 patients.

Items	Total ($n = 3897$)	Intubation ($n = 153$)	Non-intubation ($n = 3744$)	χ^2	*P* values
Preparation					
Working experiences				1.861	0.394
<5 years	752 (19)	23 (15)	729 (19)		
5–10 years	915 (23)	38 (25)	877 (23)		
>10 years	2230 (57)	92 (60)	2138 (57)		
Modified-Mallampati test	3048 (78)	71 (46)	2977 (80)	94.562	<0.001
Anti-fog measures	3216 (83)	125 (82)	3091 (83)	0.075	0.784
Preoxygenation					
Time				7.256	0.027
<3 min	611 (16)	35 (23)	576 (15)		
≥3 min and <5 min	1436 (37)	46 (30)	1390 (37)		
≥5 min	1850 (48)	72 (47)	1778 (48)		
Methods				–	<0.001
Bag-mask ventilation	2489 (64)	46 (30)	2443 (65)		
Nasal cannula	47 (1)	3 (2)	44 (1)		
HFNC	392 (10)	15 (10)	377 (10)		
NIV	969 (25)	89 (58)	880 (24)		
Induction					
Sedative					
Etomidate	1542 (40)	47 (31)	1495 (40)	5.216	0.022
Propofol	2868 (74)	116 (76)	2752 (74)	0.405	0.525
Midazolam	1817 (47)	51 (33)	1766 (47)	11.306	<0.001
Ketamine	90 (2)	1 (1)	89 (2)	–	0.265
None	34 (1)	4 (3)	30 (1)	–	0.042
Neuromuscular blockade				–	0.190
Succinylcholine	784 (20)	22 (14)	762 (20)		
<1 mg/kg	112 (3)	3 (2)	109 (3)		
≥1 mg/kg	672 (17)	19 (12)	653 (17)		
Rocuronium	2129 (55)	96 (63)	2033 (54)		
≤0.6 mg/kg	1122 (29)	31 (20)	1091 (29)		
≥0.9 mg/kg	1007 (26)	65 (42)	942 (25)		
Vecuronium/cis-atracurium	892 (23)	32 (21)	860 (23)		
None	92 (2)	3 (2)	89 (2)		
Analgesics				25.592	<0.001
Remifentanil	958 (25)	20 (13)	938 (25)		
Fentanyl	586 (15)	24 (16)	562 (15)		
Sufentanil	1931 (50)	76 (50)	1855 (50)		
None	422 (11)	33 (22)	389 (10)		
Oxygenation during induction				–	<0.001
Bag-mask ventilation	2348 (60)	63 (41)	2285 (61)		
HFNC	298 (8)	8 (5)	290 (8)		
NIV	1249 (32)	80 (52)	1169 (31)		
None	2 (0)	2 (1)	0 (0)		
Intubation					
Video laryngoscope with disposable blades	3307 (85)	128 (84)	3179 (85)	0.178	0.673
Auscultation for ETT position confirmation	822 (21)	14 (9)	808 (22)	13.647	<0.001

Data were presented as *n* (%). COVID-19: Coronavirus disease 2019; ETT: Endotracheal tube; HFNC: High flow nasal cannula; NIV: Noninvasive mechanical ventilation; –: Not applicable.

intubation group planned to complete tracheal intubation with no assistant. Modified Mallampati test, which was widely used for airway assessment by anesthetists, was chosen by fewer doctors in the intubation group than in the non-intubation group (46% [71/153] *vs.* 80% [2977/3744], $\chi^2 = 94.562$, $P < 0.001$). As for anti-fog measures and time used for preoxygenation, no significant difference was found between the intubation group and the non-intubation group ($P > 0.05$). Noninvasive mechanical ventilation (NIV) was used for preoxygenation by more doctors in the intubation group than in the non-intubation group (58% [89/153] *vs.* 24% [880/3744], $P < 0.001$). In comparison with the intubation group, midazolam (47% [1766/3744] *vs.* 33% [51/153], $\chi^2 = 11.306$, $P < 0.001$) and etomidate (40% [1495/3744] *vs.* 31% [47/153], $\chi^2 = 5.216$, $P = 0.022$) were used by more doctors in the non-intubation group. During the induction procedure, rocuronium at over 0.9 mg/kg was chosen by more doctors in the intubation group than the non-intubation group (42% [65/153] *vs.* 25% [942/3744], $\chi^2 = 23.020$, $P < 0.001$), but there was no significant difference in the dosage of succinylcholine chosen by doctors in the two groups ($P > 0.05$). The instrument used for intubation was similar between the two groups ($P > 0.05$). In addition, fewer doctors in the intubation group tended to confirm the position of endotracheal tube by auscultation than in the non-intubation group (9% [14/153] *vs.* 22% [808/3744], $\chi^2 = 13.647$, $P < 0.001$) [Table 1].

Our study presented characters of clinical practice on airway management in COVID-19 patients and demonstrated a significant difference between doctors with and without intubation experiences. For tracheal intubation in COVID-19 patients, a consensus guideline suggested experienced assistant should be present to help the intubation.[2] Shortage of doctors and personal protective equipment at the early stages of the COVID-19 outbreak may underlie the difference between the number of assistants recommended by the guideline and that of clinical practice. As a potential aerosol-generating procedure, a modified Mallampati test was suggested to be avoided in the airway assessment in the expert recommendation.[3] Differences between guidelines and clinical practice suggested insufficient understanding of aerosol-generating procedures was not uncommon in doctors, especially for those in the non-intubation group. Hypoxemia worsened after induction in COVID-19 patients with severe lung injury.[3] Therefore, preoxygenation for at least 3 minutes was recommended in COVID-19 patients. COVID-19 patients usually received NIV or high flow nasal cannula (HFNC) oxygen before tracheal intubation. Our results indicated that doctors in the non-intubation group might be unfamiliar with the treatment for COVID-19. In terms of induction, propofol, rocuronium, and sufentanil were the most widely used anesthetics. Attention should be paid to hypotension induced by propofol. Midazolam and etomidate were recommended for hemodynamically unstable patients.[3] Remifentanil or fentanyl was recommended to relieve cardiovascular response. Due to its long onset time, sufentanil was not recommended.[3] Rocuronium at 1.2 mg/kg was recommended during induction by Cook *et al*.[2] Ethnic differences might underlie the difference between the recommended dose in rocuronium and that used by Chinese doctors. Although ventilation during induction was not suggested in some recommendations based on the potential risk of viral spread, convincing evidence was lacking.[2,4] Tracheal intubation in COVID-19 patients should be done by the best-skilled airway manager. In China, anesthetists performed intubations in most hospitals.[5] There might be some differences between respiratory physicians or doctors from other departments and anesthetists in performing tracheal intubation. Further studies still need to be done to find out these differences.

In summary, modified rapid sequence induction and intubation using a video laryngoscope with disposable blades after preoxygenation were recommended for the intubation in COVID-19 patients. Doctors without experience in tracheal intubation in COVID-19 patients were lack of understanding of aerosol generating procedures and the impact of the protective gown on tracheal intubation operations. Thus, doctors should be trained to perform tracheal intubation under a protective gown and to avoid aerosol-generating procedures prior to entering the isolation ward.

Conflicts of interest

None.

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