

# Managing the Difficult Airway: A Survey of Doctors With Different Seniority in China

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## Research article

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# Abstract

**Background:** Although equipment and human resources are vital elements of difficult airway management (DAM), But the approach and practice of DAM are more important. So, We conducted the present survey to address anesthesiologists who of different working years in this knowledge gaps.

**Methods:** This nationwide cross-sectional study was conducted from October 27, 2016 to November 27,2016. The survey was completed online in New Youth Anesthesia Forum including: DAM assesment, anticipated and unanticipated DAM, difficult airway algorithm, used of front of neck access (FONA) technique and training, DAM outside the OR and difficult extubation management.

**Results:** We received 1935 replies (44%). Mouth opening and Mallampati classification were the most commonly methods to evaluate difficult airways. When suffer to unanticipated DA 63% less than 10 years anesthesiologists(LA) and 65% more than 10 years anesthesiologists (MA) would ask for help after trying 1-2 times ( $P=0.000$ ). More than 70% of LA and MA respondents reported preferring cannula cricothyrotomy to deal with emergency airway, 507 (41.6%) MA respondents reported that they used FONA techniques to save patients' lives ( $P=0.000$ ). Nearly 70% respondents worried full stomach when intubated outside OR and more than 80% respondents selected auscultation to identify the placement. More than 80% respondents had not used Bougie to assist extubation. 73.2% respondents know ABS algorithm and 96.4% know Chinese airway expert consensus among MA respondents, this was significant to LA respondents( $P=0.000$ ).

**Conclusions:** The respondents in the LA and MA have a training-gap in their evaluation of difficult airway, trained and used of FONA emergency skills, facilitated of the airway guidelines at home and abroad. Also, We should provide more airway theory and skill training to our young doctors to advanced airway skills.

## Implication Statement

The approach and practice of difficult airway management address to anesthesiologists who of different working years in China .

## 1 Background

Airway management out/in the operation room (OR) is one of the most vital initial steps resuscitation and is also a critical skill requiring mastery by an anesthesiologist. The rate of difficult endotracheal intubation (ETI ) in elective surgery is 0.5–8.5% <sup>[1-2]</sup>, outside OR ranges from 6.1 to 23.5%<sup>[3-4]</sup>. Maybe because of the more critical patient population, the lesser controlled setting, and the inadequate opportunity for a complete evaluation of the patient <sup>[5]</sup>. Failure to obtain and maintain an adequate airway oxygenation and ventilation will result in pathological damage that is not reversed, such as hypoxia, aspiration, and cardiac arrest. In order to avoid many uncommon, yet critical failures, many tools for airway management have been developed,such as the Laryngeal Mask Airway and video tube,which

have been demonstrated efficacious and easily mastered by anesthesia in many settings<sup>[6-7]</sup>. But, When we encounter the life-threatening 'can't ventilate can't oxygenate'(CVCO) scenario, the approach and practice of doctors of DAM are more important. As we know that this will take some time to train,that may be differences between doctors with different years of work.

Instruction in airway management during anesthesiology residency was surveyed by Hagberg et al<sup>[8]</sup> in 2003. In 2011, United States and Canada<sup>[9]</sup> re-surveyed assumed that there has been a convert in the education of anesthesia residents in airway management regarding choices of airway devices and modes of training. However, the approach and practice of DAM between anesthesiologists who of different working years in China is unknown. We also believe that if a doctor works for 10 years, his thinking mode of difficult airway algorithm has been basically settled. So, this survey takes the length of working time (10 years) as a boundary address to knowledge the gaps.

## 2 Methods

A survey was designed by the authors and discussed with our local Airway Management Society, who confirmed that formal approval by an Ethics Committee was not required.

### 2.1 Study design

The survey was completed online from October 27, 2016 to November 27, 2016 at the New Youth Anesthesia Forum, with more than 78,000 registered anesthesia experts. A survey was sent to all anesthesiologist members by WeChat. Each IP address is allowed to complete the survey once.The respondents can choose computer or mobile device to complete the survey.

### 2.2 Survey items

A questionnaire, which was based on clinical Experience of Doctor Ma. It also referred to some relevant studies conducted in other countries which have similarly assessed EDs<sup>[10-11]</sup>, ICUs<sup>[12-13]</sup>, ORs<sup>[14-15]</sup>, and pre-hospital settings<sup>[16-17]</sup>. We then distributed the drafts to the survey team members. It was completed in August 2016.The DAM included specifically in the survey were as follows:

Survey items covered nine areas:

1. Airway assessment
2. Anticipated difficult airway management
3. Anticipated difficult airway tools selection
4. Unanticipated difficult airway management
5. Difficult airway management outside the operating room
6. Recognition of difficult airway management algorithm
7. Front of neck access technique
8. Difficult airway extubation

## 9. Difficult airway training

The survey questions included basic demographic information about the anesthesiologist's hospital level (grade I, II, or III). To minimize the bias for several open issues, question formats were used: "Yes" or "No" boxes, choose of the best possible answer from 2 to 5 alternatives options. No monetary compensation was provided for any form of participation in this survey .

## 3 Statistical Analysis

All survey items were evaluated using descriptive statistics. The associations between the results were analyzed using a Fisher's exact test which included only the complete data sets. Non-parametric Tests were used for continuous variables. All statistical analyses were performed using IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, NY). All tests were 2 tailed with a type I error rate of 0.05.

## 4 Results

The survey was conducted from October 27, 2016 to November 27, 2016. The server can record how many members open and read the invitation. The study included only those members who read the survey invitation.

A total of 4437 members read invitations. In total 2478 forms were returned, the remaining (at least partially completed) 1935 questionnaires were analysed and the overall response rate was 44%. Responses were received from hospitals in 31 provinces of China. The distribution of working years was: >10 years 63% (1222/1935), < 10 years 37% (713/1935).

### 4.1 Evaluation of difficult airway

Table 1 shows responses by working years (of respondent) to the questions concerning evaluation of difficult airway. All groups of respondents believed that Mouth Opening and Mallampati Classification are the most commonly used methods. The number of Thyromental Distance and Atlanto-Occipital Joint Extension selected medium. Approximately 839/1221 of the respondents(> 10 years) think there are other ways to evaluate, but LA only 51/713 ( $P= 0.000$ ).

### 4.2 Anticipated -difficult airway and tools

Table 2 indicates how to deal with anticipated difficult airway between LA and MA. Of 59.7% respondents who described elective Awake VFIS Intubation combined Topical Anesthesia(TA) and sedation to deal with anticipated difficult airway among LA, but 72.7% respondents among MA. Fewer than one-third reported elective use Rapid Sequence Anesthesia Induction(RSAI), The number of VFIS intubation combined sedation and VFIS intubation combined both TA performed by the respondents was small but greater than zero.

Figure 1 shows how to select the airway tool in each respondent. 310 of 713 possible LA respondents reported videolaryngoscope of selection. 220 of a possible 713 LA respondents who described selective use of VFIS intubation. 12.9% reported regular use Macintosh Laryngoscope, and less than 15% reported to chose Optical Stylets, Lightwand or Intubating Laryngeal Mask.

The trend is the same among MA respondents, and there were no statistics difference between groups ( $p = 0.263$ ). They tend to chose visualization and easy to performed tools.

### **4.3 Unanticipated difficult airway**

Not all difficult airways can be evaluated in advance. When we are in the life threatening difficult intubation or even CVCI scenario, what should we do first. 63% LA and 65% MA would ask for help after trying 1–2 times. 23% LA may choice try 2–3 times before seeking help, while 23% MA selected change intubation tools after trying 2–3 times (Fig. 2) ( $P = 0.000$ ).

### **4.4 Front Of Neck Access emergency technique**

Table 3 and Fig. 3 indicates when we suffered the life-threatening CICO scenario, FONA emergency technique like cannula cricothyrotomy, surgical cricothyrotomy and tracheotomy's performed and attitudes to it between LA and MA respondents, and this was significant( $P = 0.000$ ) .

More than 70% of LA respondents reported preferring cannula cricothyrotomy to deal with CICO, but only 47(6.9%) used it by themselves. The number of surgical cricothyrotomy and tracheotomy performed by LA respondents was small but greater than zero. Among LA, less than one third respondents reported used FONA emergency technique. While among MA, 507 respondents (41.6%) reported that they used FONA emergency techniques to save patients' lives. Nearly 931 respondents (76.4%) preferred cannula cricothyrotomy like LA respondents. The number of surgical cricothyrotomy, tracheotomy and other FONA emergency technique performed by MA respondents was small but greater than zero. 229 MA respondents (18.8%) responded that they had used cannula cricothyrotomy technique by themselves. Whereas a fraction of programs had operated surgical cricothyrotomy (6.0%) and tracheotomy (4.2%) .

### **4.5 Difficult airway management outside the operating room**

Table 4 details the responses of worried when intubated outside operating room: including full stomach, difficult airway, environmental impact or others. 484 of 713 possible LA respondents preferred worried full stomach. Among MA respondents even high to 71%. The number of difficult airway and environmental performed by MA and LA respondents was small but greater than zero.

How to identify the ETT placement outside of OR is very important. More than 80% respondents selected auscultation. Despite the high availability of capnometry, its routine use for ETI was reported by 6.5% of the LA and 5.5% of the MA outside of OR. Other minority of respondents selected chest rise. The number of VFIS and other methods, such as tube fogging, direct visualization performed by MA and LA respondents was small but greater than zero.

## 4.6 Difficult airway extubation

Figure 4 indicates removal of the endotracheal tube in a patient with difficulty airway. 512 of 713 LA respondents who experienced or assisted difficult airway re-intubation. Among them, 12.8% of the patients failed re-intubation and faced with the use of FONA emergency technical to rescue the patients. Nearly 86% of the LA and 80.1% of the MA had not used Bougie to assist in extubation of difficult airway. So, even among MA, 84.5% respondents who experienced or assisted difficult airway re-intubation, and 20.2% failed it.

## 4.7 Airway management training

To clarify the current situation and to provide a reference point, this requested information on the airway management training programs available in each doctor, including difficult airway treatment algorithms at home and abroad, airway management training, such as surgical cricothyrotomy, tracheotomy, retrograde intubation and transtracheal jet ventilation .

41.1% LA respondents had already attended a airway training course, while 158 (22.2%) intended cannula cricothyrotomy and transtracheal jet ventilation, only 97(13.6%) respondents intended surgical cricothyrotomy and 95 (13.2%) to the retrograde intubation training. With the increase of working years, 692 of a possible 1221 MA respondents had already attended a airway training course, 422(34.6%)intended cannula cricothyrotomy and transtracheal jet ventilation, 304(24.9%) respondents intended surgical cricothyrotomy and 231(18.9%) to the retrograde intubation training(Fig. 5).

Figure 6 shows the understanding of difficult airway algorithm at home and America. Respondents who never read ASA algorithm occupied the largest proportion. While only a minority of respondents did not know Chinese airway expert consensus and difficult airway management ABS algorithm. Among MA, even 73.2% respondents know ABS algorithm and 96.4% know Chinese airway expert consensus .

## 5 Discussion

The New Youth Anesthesia Forum has more than 78,000 registered anesthesiologists. New Youth Anesthesia WeChat public number can calculate the number of people who read the survey invitation and record their locations. Therefore, we can calculate the response rate. Jane Candlish suggested that the minimum number of survey answers required for a survey to be effective should be equal to the number of questions times 10 <sup>[18]</sup>. In this study, we received the 1935 reply. The location of the respondents indicated that the participants came from every province in China.

This survey provides the differences of LA and MA's evaluation, chosed the tools, training, management of difficult airway in the China. Airway management has always been a cornerstone of anaesthetic practice <sup>[19]</sup>. This study confirms the central role of anesthetists in DAM in/out OR. Given that airway management in the anesthetists is so vital to patient survival, LA and MA must have sufficient

opportunities to train their airway knowledge and skills. The guidance of anesthetists in airway management comes not only from teaching exposures, but also from empirical approaches, including patient care in/out the OR. Although large training centers may have many resources available, many anesthetists practice in settings where these resources are limited or non-existent. But the approach and practice of doctors of DAM are more important. In many settings the anesthetists is the sole member of the airway team throughout the hospital in China. So, We conducted the present survey to address anesthetists who of different working years in this knowledge gaps in China.

Our study demonstrates that most LA and MA chose mouth opening as the first index in the evaluation of difficult airway, therefore second choice among MA was experiential methodologies, and LA may choose less, they tend to Mallampati classification which was classical method in book (Table 1). Although the assessment of DAM are different, they are basically consistent in the treatment of anticipated difficult airways (Table 2). 426 (60%) LA and 888(73%) MA put TA + sedation + VFIS as the first choice to manage anticipated DAM. Cricothyrotomy can provide airway anaesthesia for an awake VFIS, it can also provides a valuable experience in the life threatening CICO scenario. The American Society of Anaesthesiologists (ASA) guidelines <sup>[20]</sup> recommend the first choice of awake fiberoptic intubation in difficult airway management.

Hyuk Kim and colleagues <sup>[21]</sup> suggested that there was no failed attempt when the resident had performed more than 30 times training endoscopies. Rana K <sup>[22]</sup> recommends 10 fiberoptic intubations on asleep patients and 15–20 on awake patients for acceptable expertise. So adequate training in difficult airway management can enhance our confidence.

As mentioned above, the anesthetists is the sole member of the airway team throughout the hospital in China. Out of OR, What respondents are most worried about is the patients with full stomach (68% LA and 71% MA) (Table 4). Maybe they are also worried about some other situations, such as bleeding, drinking and so on. They care about environmental impact less. After intubation, more than 80% respondents selected auscultation which is considered to be Third-class evidence to verify the placement of ETT (Table 4) outside of the OR. Less than 15% of the respondents routinely used capnography (Second-class evidence) and chest rise (Third-class evidence) for ETT placement verification. They rarely trust the intubation graphics (First-class evidence) of the video laryngoscope including VFIS (gold evidence) alone. The results showed that the increased use of experience to verify ETT placement, maybe because of lacked theoretical knowledge. We can provide more training on this in the future. If there is no video tools for ETT placement, previous studies <sup>[23]</sup> showed that the increased use of CO2 monitors was the single change which has the greatest potential to prevent death from airway complications outside the OR.

When we encounter difficult airways, we should choose the tools we are most familiar with. Approximately half of the LA and MA put videolaryngoscope as the first choice and VFIS intubations as the second choice (Fig. 1). There are numerous benefits of videolaryngoscopy, and these include improved laryngeal view, high rates of successful rescue after failure of direct laryngoscopy [17], improved training

of novices<sup>[24]</sup>, T. M. Cook<sup>[25]</sup> suggested that Videolaryngoscopy was used in 91% of operating theatres, 50% of intensive care units (ICUs) and obstetric theatres. Not all difficult airways can be evaluated in advance. When we are in the life threatening difficult intubation or even CICO scenario, what should we do first. 63% LA and 65% MA would ask for help after trying 1–2 times. 23% LA may choose to try 2–3 times before seeking help, while 23% MA selected change intubation tools after trying 2–3 times (Fig. 2). But what I want to remind is to put 'ask for help' in the first place and try to maintain oxygenation, so as to reduce the risk of patients.

The incidence of CVCI is rare, but when we are threatened by it, 506(71.0%) LA and 931(76.2%) MA selected cannula cricothyrotomy (Table 3), 90(12.6%) LA and 107(8.7%) chose tracheotomy. Only very small numbers of anaesthetists chose surgical cricothyrotomy. In a study conducted the next year<sup>[28]</sup> only 10% had previous experience of surgical cricothyrotomy in patients, while Hung<sup>[27]</sup> reported that 86% of Canadian training teach surgical cricothyrotomy. Years ago, guidelines<sup>[26]</sup> highlight the role of surgical cricothyrotomy in an emergency, is a difficult airway skill where a training-gap may exist. While cannula cricothyrotomy kits can be quickly mastered.

Though it is important to master the intubation skills, it rather have correct treatment approach. There are difficult airway treatment guidelines at home and abroad. The author of Professor Ma also has his own set of ABS algorithm. Such as guideline in USA, less than 30% respondents read one time, most of them even do not know about it. Approximately more than one third respondents read Chinese DAM guidelines, nearly 67% read 2–3 times even more than 3 times in MA and 54% in LA (Fig. 6). Among respondents more than 60% LA and MA read the ABS algorithm, that may be because of its simplicity, safety and easy to remember (Fig. 7). Everyone of us may be familiar with these algorithm, as the algorithm is like a light that allows us to make the right selection in the emergency of airway treatment.

As surveyed in our paper, very few people can use the FONA emergency technique, however, cricothyroid puncture used most (Fig. 3). Among MA, they received more airway training than LA, especially DAM (57%), cricothyroid puncture and tracheal jet ventilation (34%). Wong and colleagues<sup>[28]</sup> suggested five cannula cricothyrotomy on models as the minimum training requirement, but how this infer to clinical practice is unclear. Surgical cricothyrotomy was trained least. Skills can be taught on commercial mannequins or self-contained models<sup>[29]</sup>, although they do not really represent clinical practice. LA should participate in more airway related training especially airway workshops.

Finally, this study surveyed difficult extubation. Every difficult airway patient is a difficult extubation object. 72% LA and 85% MA experienced difficult extubation, and 13% LA and 20% MA even experienced re-intubation or failed re-intubation. So we may master extubation skills to deal with it. Bougie is a good tool for handling difficult extubation. A survey of British anaesthetic departments published in 2009 showed that the bougie was available on more than 90% of difficult airway trolleys<sup>[30]</sup>. While in our survey less than 20% respondents used it (Fig. 4). That maybe the direction of training.

## 6 Conclusion

The respondents in the LA and MA have a training-gap in their evaluation of difficult airway, trained and used of FONA emergency skills, facilitated of the airway guidelines at home and abroad. However, they are basically the same when they deal with CICV and chose tools for DAM. Because of more work experience among MA respondents, they like to rely on themselves to complete the difficult airway instead of asking for help as soon as possible. This is also the core idea of Professor Ma's ABS difficult airway algorithm<sup>[31]</sup>. Any time we may put 'Ask For Help' first and try to ensure the patient's 'oxygenation'. Also, We should provide more airway theory and skills training to our young doctors to advanced airway skills in the model, animal and homemade tools.

## 7 Limitations

This survey has a number of limitations. First, because it is a survey, the data are self reported, so the reporters may wish to reflect more of what the reporters want than the actual situation. Second, We can shorten the interval between respondents. Finally, We can make the choices a little bit more detailed for respondents.

### Additional file

Additional file 1: 2016 National Difficult Airway Management Status Survey. Includes the 63-question survey used for the needs-assessment study. (DOCX 41 kb)

## Abbreviations

DAM=difficult airway management ;FONA=used of front of neck access ;LA=less than 10 years anesthesiologists;DA=difficult airway;MA=more than 10 years anesthesiologists;OR=operation room;ABS:A=ask for help,B=breathing,S=S1 spontaneous breathing,S2 stab,S3 surgical airway; ETI=endotracheal intubation;CICO='can't ventilate can't oxygenate';VFIS=Video Flexible Intubation Scope;RSAl=Rapid Sequence Anesthesia Induction;CVCI='can't ventilate can't intubation';ETT=endotracheal tube

## Declarations

### Ethics approval and consent to participate

Following approval from the Institutional Review Board of the First Affiliated Hospital of Guangzhou University of Chinese Medicine (Guangzhou, China)(NO:ZYYEC-ERK[2019]141),Every anesthesiologists member in the New Youth Anesthesia Forum participate the survey invitation anonymously by WeChat.Before the investigation, they would first choose whether to agree with the contents of the investigation. The data we collect were all part of the agreement.

### Consent for publication

Not applicable.

### **Availability of data and materials**

Not applicable.

### **Competing interests**

All authors declare that they have no competing interests.

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### **Authors' contributions**

All authors contributed to the construction of the questionnaire. HG and ZJ supervised conductance of the survey and data collection. HL managed the data, constructed the database and drafted the initial manuscript. WY MZ and YL participated in survey design. HL and WM contributed substantially to its revision. All authors read and approved the final version of the manuscript.

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### **Authors' information**

Hui-Hui Liu, Yong Wang, Ming Zhong, Yu-Hui Li, Huan Gao, Jian-Feng Zhang, Wu-Hua Ma are co-authors.

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## Tables

**Table 1:** The index of LA and MA to evaluate the difficult airway (multiple selection)

	<10 years N=713	>10 years N=1221	<i>P</i>
Mouth opening	637	1044	0.016
Thyromental distance	518	242	0.000
Atlanto-occipital joint extension	338	507	0.012
Mallampati classification	544	527	0.000
Cormack-Lehane classification	79	474	0.000
Other	51	839	0.000

**Table 2:** The approach to deal with anticipated difficult airway. TA=Topical Anesthesia, VFIS=Video Flexible Intubation Scope, RSI=Rapid Sequence Anesthesia Induction.

	<10 years N=713	>10 years N=1221	<i>P</i>
TA+Awake VFIS	63(8.8%)	112(9.2%)	0.000
TA+Sedation+Awake VFIS	426(59.7%)	888(72.7%)	
Sedation+Analgesia+VFIS	63(8.8%)	56(4.6%)	
RSI	161(22.6%)	165(13.5%)	

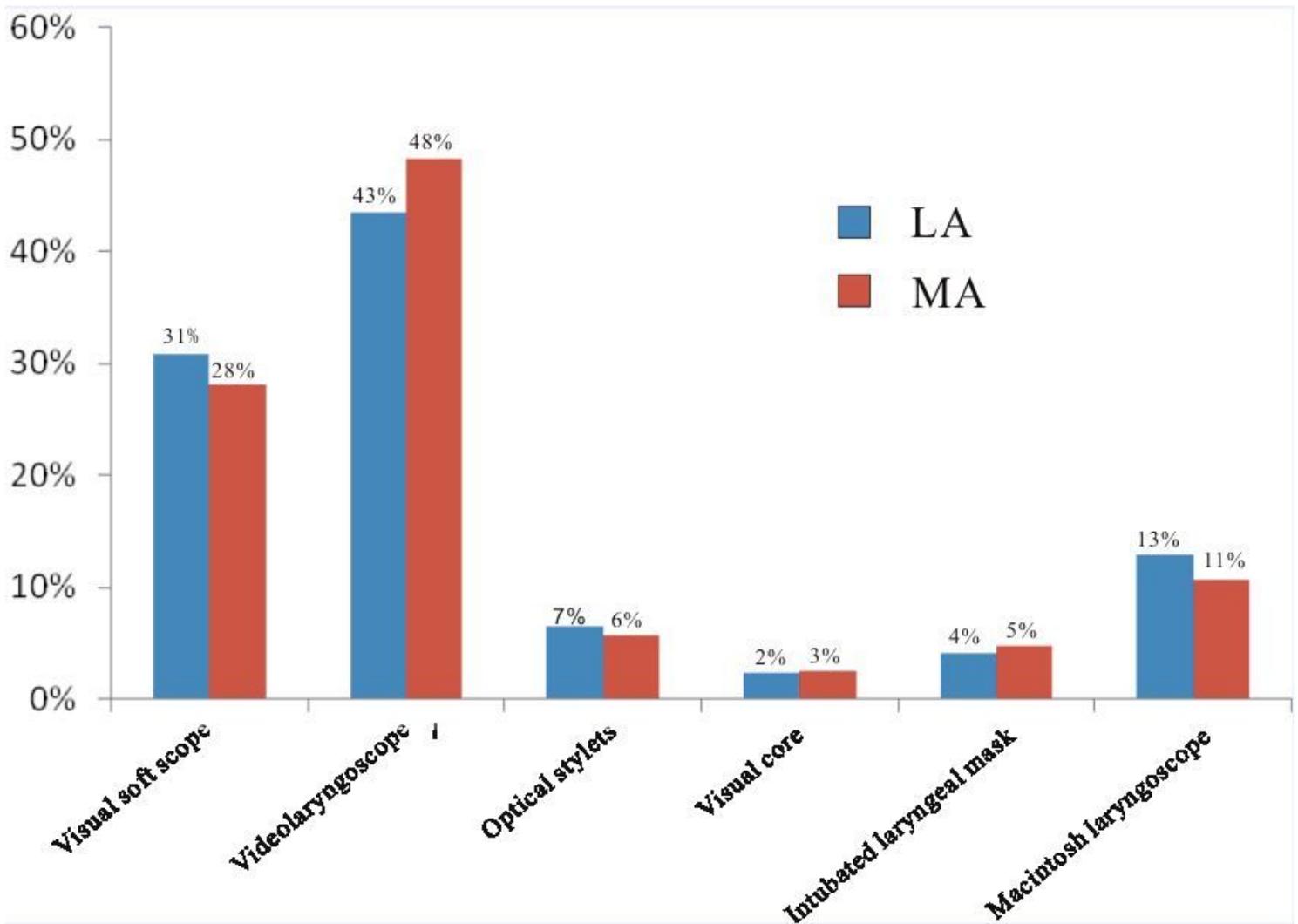
**Table 3:** First choice of FONA emergency technique when suffered CICO scenario. FONA=front of neck access, CICO=can't ventilate can't oxygenate, First choice of FONA emergency technique significantly different between LA and MA responders P= 0.000

	<10 years N=713	>10 years N=1221
Cannula Cricothyrotomy	506(71.0%)	931(76.2%)
Surgical Cricothyrotomy	56(7.9%)	71(5.8%)
Tracheotomy	90(12.6%)	107(8.7%)
Others	61(7.6%)	109(8.9%)

**Table 4:** The most worried condition when we intubated out of the OR and identified the placement of the ETT. OR=operation room, ETT=endotracheal tube, The most worried when intubated outside OR significantly no different P=0.451, The methode respondents selected to identify trachea significantly different P=0.006.

	<10 years N=713	>10 years N=1221
<b>The most worried</b>		
Full stomach	484(67.9%)	867(71.0%)
Difficult airway	61(8.6%)	66(7.0%)
Environmental impact(Family members)	1(0.1%)	4(0.3%)
Others	167(23.4%)	264(21.6%)
<b>How to identify the placement of the ETT</b>		
Auscultation	581(81.5%)	1003(82.1%)
Chest rise	40(5.6%)	105(8.6%)
Capnography	46(6.5%)	67(5.5%)
Graphics of VIFS	35(4.9%)	31(2.5%)
Others	11(1.5%)	13(1.1%)

## Figures



**Figure 1**

Proportion of LA and MA preferred intubation tools for patients with anticipated difficult airway. LA =less than 10 years anesthesiologists, MA=more than 10 years anesthesiologists

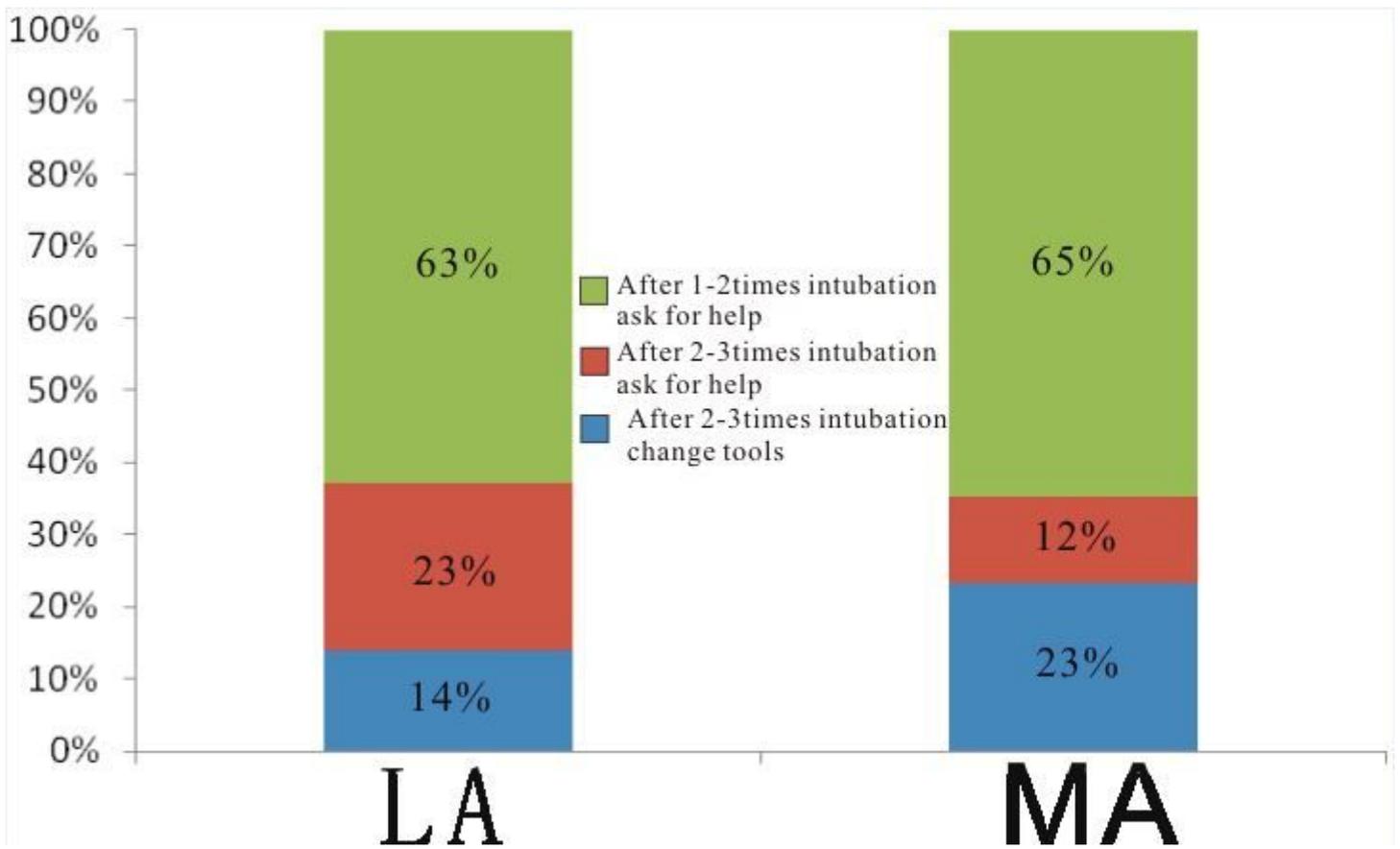
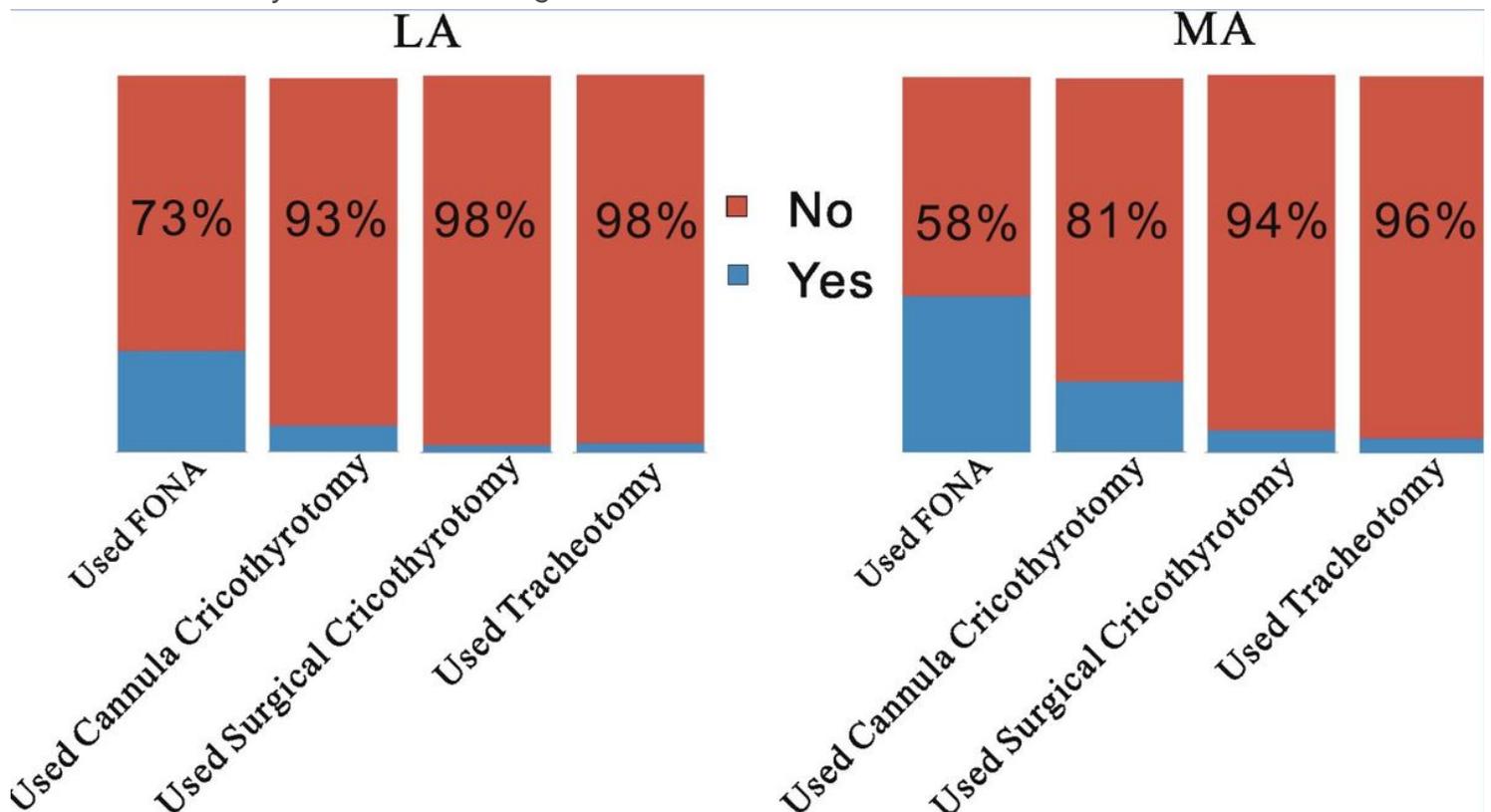


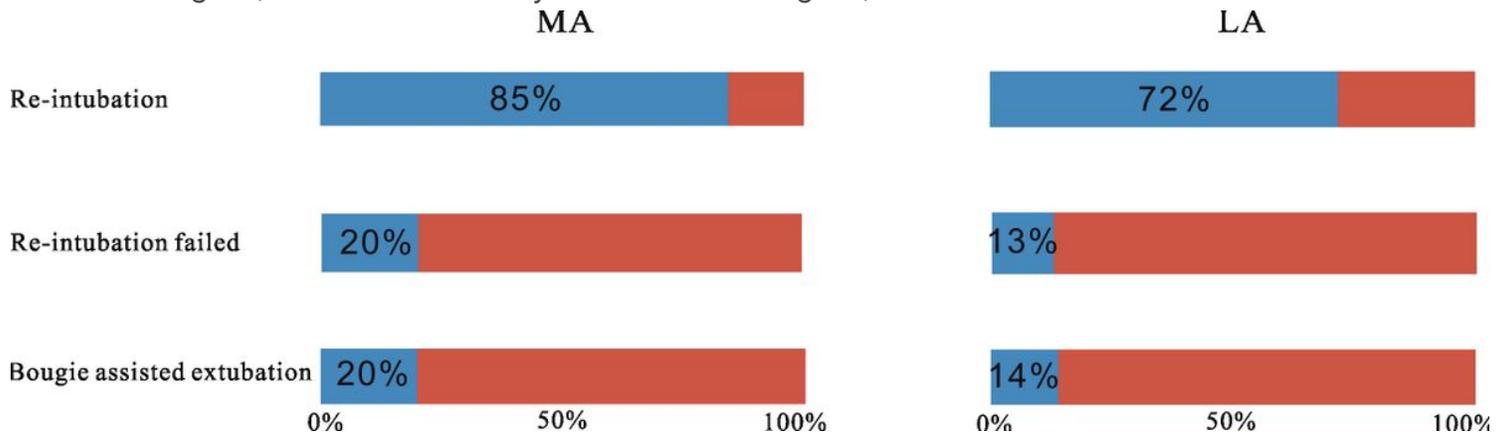
Figure 2

Proportion of LA and MA practice unanticipated difficult airway. LA=less than 10 years anesthesiologists, MA=more than 10 years anesthesiologists.



**Figure 3**

The proportion of anesthesiologists used of front of neck access emergency technique. LA=less than 10 years anesthesiologists, MA=more than 10 years anesthesiologists, FONA=Front Of Neck Access.



**Figure 4**

The proportion of LA and MA deal with difficult airway extubation. LA=less than 10 years anesthesiologists, MA=more than 10 years anesthesiologists.

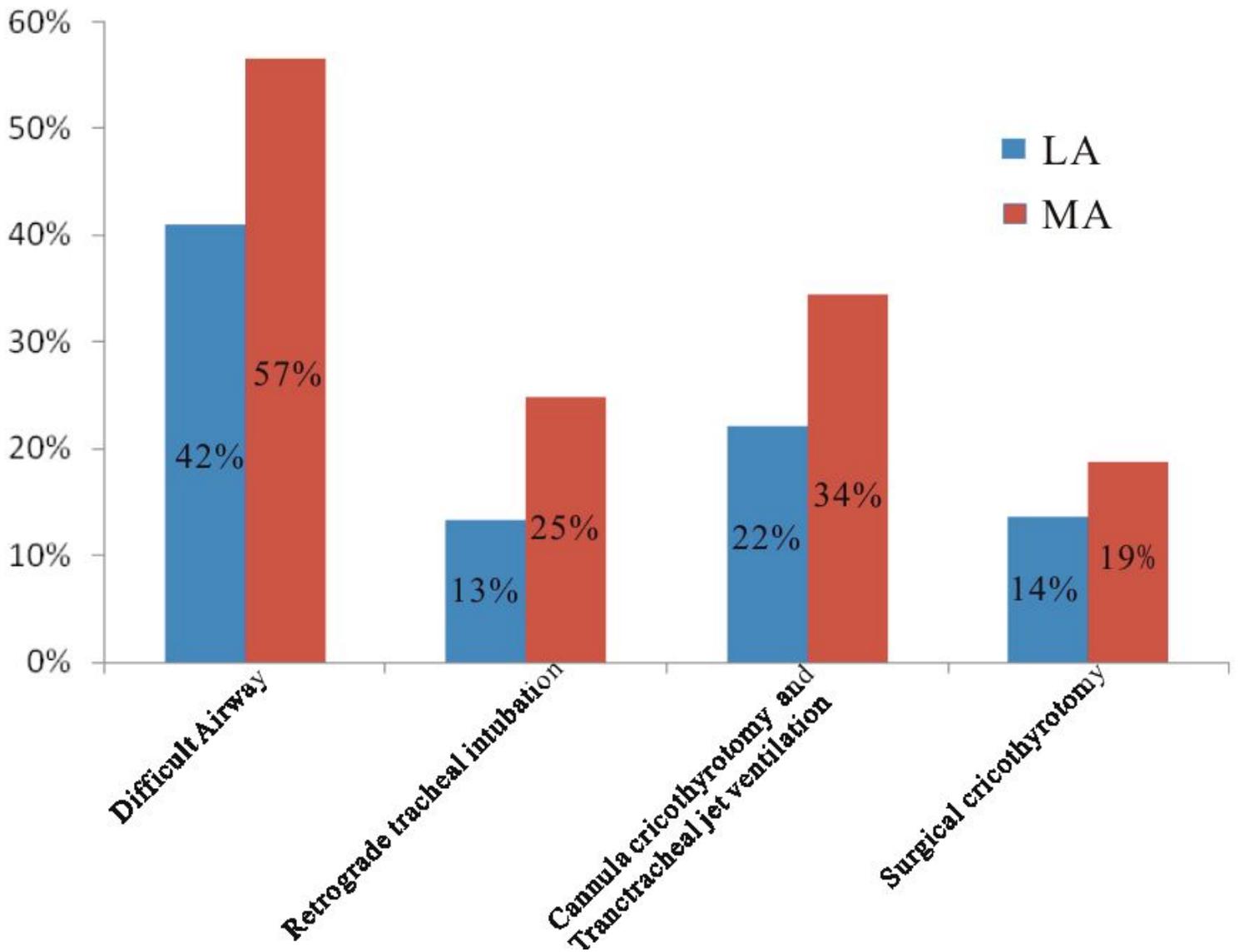


Figure 5

Proportion of LA and MA received airway management training. LA=less than 10 years anesthesiologists, MA=more than 10 years anesthesiologists.

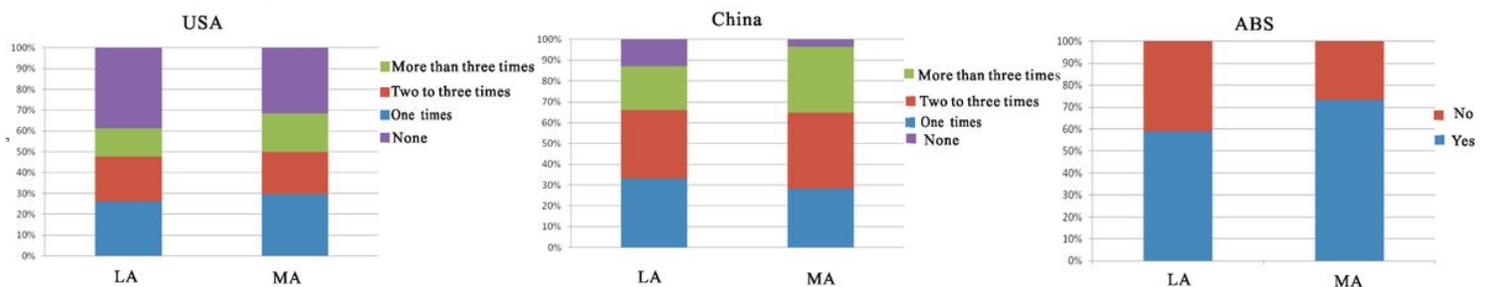


Figure 6

Proportion of LA and MA who understood of airway management algorithm at home and America. LA=less than 10 years anesthesiologists, MA=more than 10 years anesthesiologists, ABS:A=ask for help,

B=breathing, S=S1 spontaneous breathing, S2 stab, S3 surgical airway(See Appendix).

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [NationalDifficultAirwayManagementStatusSurvey.docx](#)
- [renamedab5ec.tif](#)