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Evaluation of Perioperative Ventilation Strategies: National Survey Study

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Abstract

Objective: Lung injury can develop in the perioperative period due to ventilation management techniques. Thus, the attitude of anaesthetists on protective ventilation (PV) practice comes into question. In our study, we aimed to evaluate the perioperative ventilation practice of anaesthetists and trainees on anaesthesiology by a survey study.

Methods: Survey form was sent to all doctors registered to TARD via electronic mail. The participants were asked questions involving PV parameters such as low tidal volume (TV) according to ideal body weight (BW), positive end-expiratory pressure (PEEP), FiO2 use and recruitment manoeuvre (RM) application. In total, 411 doctors who answered the survey were included to the study. Application rates of PV parameters and causes were compared within the answers obtained. P<0.05 was accepted statistically significant.

Results: PV was practised by 19.4% of the participants. Those who preferred low TV used ideal BW more frequently (p<0.001). PEEP of 4-6 cm H2O was commonly used (p<0.001). The participants mostly preferred FiO2 of 1.0 (60.4%), and application rate of RM was found to be 17.2%. The use of all PV parameters was detected to be higher among instructors than among other groups.

Conclusion: In our study, application ratio of PV with all its parameters was found to be lower. Among the parameters, while low TV according to ideal BW and PEEP were applied at higher ratios, the use of RM and low oxygen percentage were applied less frequently. While PV was found to be useful in terms of perioperative ventilation strategies, low practice rates may result from habits besides lack of knowledge and experience; comprehensive and quality education studies are needed to overcome this.

Keywords: Perioperative ventilation, protective ventilation, survey study

Introduction

The effects of anaesthesia application on the respiratory system are versatile. The type of anaesthesia, anaesthetic drugs and mechanical ventilation causes changes in the physiology of the pulmonary system (1). Nowadays, perioperative ventilation strategies are being discussed extensively because of the changes that may lead to or increase lung damage.

In studies conducted in recent years, it has been suggested that, especially in major surgeries, pulmonary problems in the perioperative period could lead to increase in morbidity (2). Pulmonary morbidity also increases the duration of hospital stay, duration of intensive care follow-up and health expenditures (3).

Studies on protective ventilation strategies such as the ones on the ventilation parameters tidal volume (TV), positive end-expiratory pressure (PEEP), fraction of inspired oxygen (FiO_2) and recruitment manoeuvre (RM) have shown that some applications are beneficial (4). Especially when using the ideal body weight for the calculation of TV, recovering atelectatic alveoli via RM, maintenance of alveolar clearance with appropriate PEEP applications and need-based use of the FiO_2 level perioperatively are considered as the most important points in protective ventilation (PV) applications. Examining the knowledge and attitude of anaesthesiologists on ventilation practices is important in understanding

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to what extent evidence-based scientific data can be applied. Although there are numerous publications on the ventilation strategies in the literature, we have not been able to encounter a study on the attitudes and practices of anaesthetists in adopting and using scientific data in our country.

In our study, through questionnaires, we aimed to evaluate the perioperative ventilation applications of anaesthetists and physicians who are currently undergoing their anaesthesiology residency training in Turkey.

Methods

The ethics committee approval was obtained from the Mersin University Clinical Research Ethics Committee, dated 8 October 2015, and with the Board Decision number 2015/310 for our questionnaire titled "Evaluation of Perioperative Ventilation Practices".

In the preparation of the questionnaire, multiple choice questions were prepared within a certain system. The principle of neutrality in the choice of questions was followed, and in accordance with the principle, we avoided manipulating participants` responses through questions. Participants were not asked to provide their personal information, such as their name, surname or the name of the institution they worked for. The Turkish Anaesthesiology and Reanimation Society (TARD) was contacted, the questionnaire was sent to the TARD Scientific Supreme Board and necessary adjustments were made. The information on the purpose and nature of the survey was given to participants in the introductory part of the questionnaire.

In our questionnaire, there were a total of 29 questions, 16 of which were open-ended, 8 were closed-ended and 5 were related to the demographic data. The other questions were related to the four main parameters to examine the perioperative ventilation practices of the participants. These parameters were respectively the TV, PEEP, FiO_2 and RM applications. For questions that require clarity such as demographic data and ventilation parameters, closed-ended question techniques were used. In a closed-ended question, question-and-answer question techniques were used for information that needed clarity. Marking more than one answer was allowed in some questions where the cause-and-effect relationship was examined. There was no time limit set for the questionnaire.

We tried to reach all the specialist physicians and residents in the field of anaesthesiology and reanimation in Turkey through this Internet-based survey. In this sense, support from the TARD was received to inform the physicians and send them the questionnaires to their e-mail addresses. Regardless of their title and institution, the questionnaires were sent to a total of 2035 physicians who were official members of TARD with their available e-mail addresses. A total of 411 physicians who answered the questionnaire were included in the study. The content of the web-based questionnaire sent to the participants is presented at the end of the study (Appendix 1).

Statistical analysis

For statistical evaluation, data were analysed using the STATA MP 11 for Windows package programme (Texas, USA). Descriptive statistics were used for categorical variables, and frequency calculations were expressed in percentages. The chi-square test was performed for the cross-comparison tables, and $p<0.05$ was considered as statistically significant.

Results

I. Main findings

a. The ratio of those who apply all the parameters of lung PV together was determined as 19.4% (n=80).
b. Participants use perioperative low TV and PEEP practices at a higher rate compared to low FiO_2 and RM.
c. All the parameters of the lung PV strategies are applied at the highest level by the faculty member group who are over 40 years of age.

II. Demographic data: A total of 411 doctors participated in our survey. Demographic data of the participants are presented in Table 1.

III. Findings about TV: The TV application was evaluated by two parameters. The first one was the measurement of

Table 1. Demographic data

Gender	**Number (n)**
Female	211
Male	200
Age group (year)	**Number (n)**
25–30	101
31–40	174
41–50	97
>50	39
Type of medical institution	**Number (n)**
Teaching hospital	217
Training and research hospital	80
State hospital	71
Private hospital	43
Title	**Number (n)**
Faculty member	107
Specialist physician	161
Clinical fellow	143

body weight (BW) based on TV, and the other one was the value of TV application. For the comparison of the TV value and the preferred BW value, those who use the ideal BW value apply the low tidal volume (≤8 mL kg^{-1}) at a higher rate ($p<0.001$) (Table 2).

Among the reasons for high TV (≥9 mL kg^{-1}) application, 27.6% (n=108) of the participants chose the option of "providing adequate lung expansion", 24.5% (n=96) of the participants selected "obstructing atelectasis", and 12.7% (n=50) selected "the practice of the clinic is in this direction" option (Figure 1).

Table 2. Comparison of TV values according to the selected body weight

BW of the patient that is used	Applied TV Values (mL kg^{-1}) Low TV ≤8 (n=289)	High TV ≥9 (n=122)	p
Ideal VA (according to height) (n=205)	188 (91.7%)	17 (8.2%)	<0.001
Actual VA (measured) (n=206)	101 (49.0%)	105 (50.9%)	-

BW: body weight; TV: tidal volume; VA: alveolar volume

Among the causes of a low TV practice, the most marked options were "prevention of volutrauma" with 34.1% (n=237), "prevention of barotrauma" with 29.0% (n=202), and "decreasing postoperative pulmonary complications" with 25.0% (n=174) (Figure 2). When the title groups of the participants are examined, it is observed that the faculty members and the doctor group over 40 years of age are applying the low TV application according to the ideal BW at the highest rate.

IV. Findings about PEEP: The perioperative PEEP application rate was 71.7% (n=295). The faculty member group has been applying PEEP at the highest rate with 82.2% (n=88). When the participants were asked about their preference of the PEEP value, it was found that the most used value in all title groups was 4–6 cm H_2O (Table 3).

The most marked reasons stated by the participants of not choosing PEEP application were "the practice of the clinic is in this direction" option with 34.7% (n=80) and "it might cause haemodynamic instability" with 23.4% (n=52)

Regarding "how they determine the PEEP value" question, 23.8% (n=209) of participants selected "according to the haemodynamic stability" option, according to the decreasing frequency 17.5% (n=154) of the participants selected "accord-

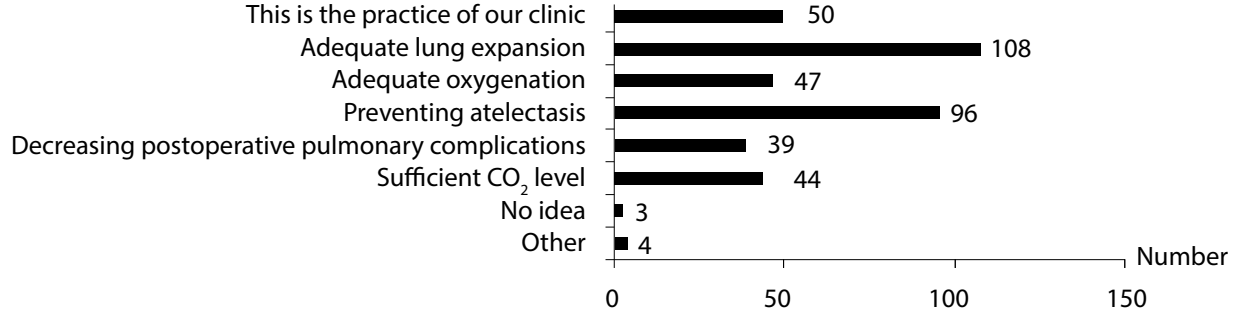

Figure 1. Participants` reasons for high tidal volume administration

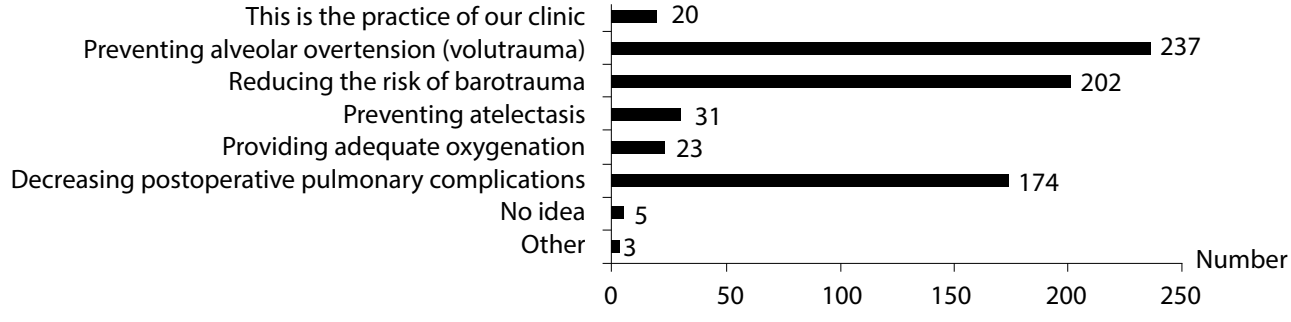

Figure 2. Participants' reasons for low tidal volume administration

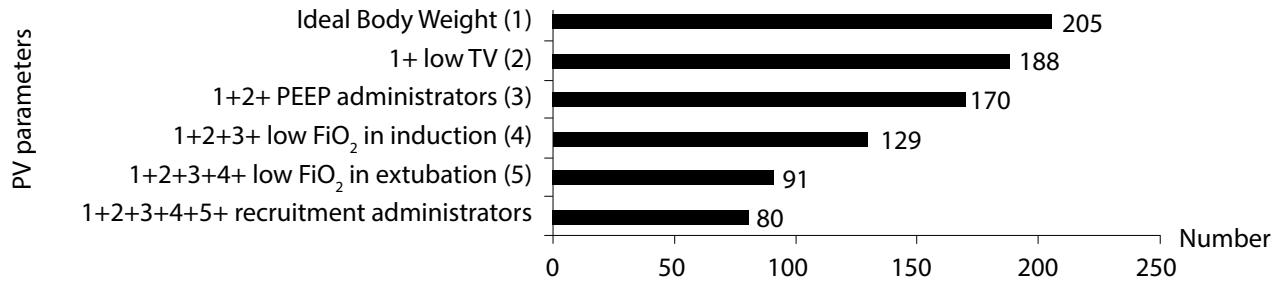

Figure 3. Number of applications of protective ventilation parameters
PV: protective ventilation

Table 3. Preoperative PEEP value preferences of the subject groups

	PEEP Value Preference (cmH_2O)			
	3 (n=53)	**4–6 (n=235)**	**7–10 (n=12)**	**No idea (n=5)**
Faculty member (n=91)	15 (16.4%)	66 (72.5%)	8 (8.7%)	2 (2.1%)
Specialist physician (n=125)	24 (19.2%)	95 (76.0%)	4 (3.2%)	2 (1.6%)
Clinical fellow (n=89)	14 (15.7%)	74 (83.1%)	0 (0.0%)	1 (1.1%)

PEEP: positive end-expiratory pressure

ing to oxygenation", while 16.9% (n=149) of the participants chose "I am using a constant PEEP value" option.

V. Findings regarding FiO_2 applications: In the induction of general anaesthesia, oxygen application rate above 80% was found to be 43.0% (n=177) among the participants.

During the extubation phase, oxygen over 80% was used at a higher rate compared to the induction (n=308 versus n=177). It was determined that physicians prefer FiO_2 ≥0.8 significantly more than the faculty member group ($p<0.001$).

Among the most frequently marked options regarding the reasons of routine use of 100% O_2 during the extubation were "to prevent hypoxaemia" with 33.3% (n=202) and "provide the necessary oxygen reserve" with 32.1% (n=195). These were followed by "the practice of the clinic is in this direction" answer with a percentage of 21.6% (n=131).

When the participants who do not use 100% O_2 during the extubation phase were asked about the reason of their choice, 40.1% (n=126) of these marked the option of "to avoid the harmful effects of hyperoxia". This response was followed by "to reduce postoperative pulmonary complications" by 32.4% (n=102) of these participants. The rate of participants who responded as "to prevent postoperative atelectasis" was 21.3% (n=67).

VI. Findings regarding RM: The routine application rate of RM was found to be 17.2% (n=71). It was observed that this manoeuvre is applied by 36.4% (n=39) of the faculty members, 14.2% (n=23) of the specialist physician group and 6.2% of the clinical fellow group (n=9).

With regard to the question about the situation in which the RM application is preferred, the "intraoperative hypoxia" option was marked by 41.1%. In terms of frequency, this option was followed by "single-lung ventilation" with a rate of 31.8%. The rate of those who marked the option "when the patient leaves the ventilator for any reason" was 13.4%, and the rate of participants who marked "I apply it intermittently in each patient" was 10.1%.

VII. Findings regarding PV: Participants were asked "which ventilation strategy they think is more useful". 65.4% of the faculty members, 59.6% of the specialist physician group and 37.7% of the clinical fellow group have indicated that PV was more beneficial.

To determine the rate of PV application, all of the parameters were studied. 19.4% (n=80) of the participants stated that they applied all the PV parameters (Figure 3).

The percentage of participants who apply PV (n=80) was determined as 36.4 %(n=39) of the faculty member group, 18% (n=29) of the specialist physician group and 8.3% (n=12) of the clinical fellow group.

Discussion

In this study that evaluates the perioperative ventilation applications performed by anaesthetists in Turkey, it has been shown that the current PV parameters are applied by approx-

imately 20% of the participants, and this application is preferred at a higher rate by faculty members compared to the clinical fellow and specialist physician groups. Furthermore, among the PV parameters, according to the ideal BW, low TV and PEEP are more frequently used compared to RM and low FiO_2.

In calculating the applied TV value, selection of the BW value is important. The actual BW measured in underweight, obese and morbidly obese patients according to the body mass index may not be compatible with lung capacities. The TV that is required by these patient groups may cause a low TV in underweight patients and high TV applications in obese and morbidly obese patients (5). For this reason, to perform low TV, it is important to determine the BW measurement that is compatible with the actual lung capacity. In our study, it was determined that the low TV application rate is less than 50% according to the ideal BW, and at least half of the anaesthetists today in Turkey, use the high-volume ventilation that has been proven harmful based on evidence. In a 5-year, multicentre observational study in which anaesthesiologists' practices were evaluated, low TV and PEEP use has increased over the years, but high TV and zero PEEP use are still performed by approximately 18% (6).

Participants who responded to the questionnaire stated their reasons for high TV practice as "to provide lung expansions" and "to prevent atelectasis". Many experimental and clinical studies have shown that high TV practice results in volutrauma, alveolar damage due to overextension, and is related to postoperative atelectasis (7, 8). In the studies performed, it was stated that although there was no significant difference between 6 and 10 mL kg^{-1} as a TV value in the perioperative mechanical ventilation in terms of postoperative atelectasis development, the ideal BW should be selected for low TV practice, the physicians who use actual BW use higher TV, and female gender and obese patients have been more frequently exposed to non-PV practices (10).

Approximately 2 out of 3 doctors who participated in our study stated that they performed perioperative PEEP and that their most preferred value was 4–6 cm H_2O. Although there was no difference between the groups in terms of participants' titles, it was determined that the highest rate of practice belonged to the faculty member group. In one study, it was shown that the use of perioperative zero PEEP has decreased from 27% to 18% over a period of 5 years (6). In another study performed by Jaber et al. (10), the rate of perioperative zero PEEP use was found to be 81%. In a multicentre, randomised controlled IMPROVE trial, the middle range of PEEP levels was compared with zero PEEP, and major pulmonary complications and postoperative mechanical ventilation were found be to be higher in the zero PEEP group (11). There are also studies showing that anaesthesiologists working in intensive care units use PEEP applications more frequently in the perioperative period due to their habitual reasons (6).

In an observational study, anaesthesiologists performed an average of 4.5 cm H_2O PEEP (6). Schultz et al. (12) have shown that the risk of developing atelectasis in healthy lungs is not different from that of damaged lungs and that 5 cm H_2O PEEP administration might be safe. It is known that a high airway pressure causes lung damage. Although the benefits of PEEP at an inappropriately high level are controversial, it should be kept in mind that zero PEEP administration is associated with atelectasis, pulmonary infection and lung damage. As the main reason for not applying PEEP, participants responded with "the practice of the clinic is in this direction". Development of learning and attitudes that are based on the practice habits of the clinic is an effective factor, especially for research assistants. It should be kept in mind that specifically the determination of the PEEP value is patient specific, and what is important here might be how to decide on the appropriate PEEP level. For a more efficient PEEP practice, patient-specific conditions such as determining the perioperative fluid status, cardiac conditions, haemodynamic stability, lung compliance, working pressure and lower inflexion (volume-pressure curve break) might be helpful for decision making (7). As a matter of fact, the results of PROVHILO study showed that when 0–2 cm H_2O PEEP and 12 cm H_2O PEEP were compared using the same TV values, postoperative complication rates were similar, whereas intraoperative hypotension development and vasoactive drug use were higher in the high PEEP group (13). The standardised high PEEP value that was applied in this study has been the cause of criticism. Standardised high PEEP value administration may be controversial and possibly harmful without an individual evaluation of each patient.

In general anaesthesia induction and extubation, high FiO_2 is usually applied in critically ill patients with preoperative low oxygen saturation, prognosis of difficult airways, and in special cases such as obese patients and pregnancies. However, apart from these special cases, the use of high FiO_2 brings certain risks. Approximately 1 out of 3 participants in our study preferred to use 100% O_2 for the induction of general anaesthesia. Hyperoxia is responsible for the formation of free oxygen radicals and absorption atelectasis mechanisms resulting in cytokine activation (14).

Especially the extubation phase is one of the most critical parts of the perioperative period. In our study, it was observed that three out of every four participants apply a high O_2 concentration in the extubation phase. This preference in the extubation phase was found to be higher compared to the

rate in the induction administration. With hyperoxic ventilation practices, participants aimed to prevent hypoxia and provide the necessary oxygen reserve during the recovery period. However, studies have shown that hyperoxia may cause atelectasis and may be associated with a low postoperative PaO_2 (15). It has been reported that the duration of an operation that is longer than 2 hours and the surgical site may also be an effective factor for these effects to occur. On the contrary, there are fewer studies suggesting that 100% O_2 administration is not associated with postoperative hypoxia and lung damage or even has an effect that decreases the surgical site infections (16). Our study shows that the anaesthesiologists in Turkey do not avoid hyperoxia, and they adopt the practice as much as PEEP and low TV practices.

RM is one of the manoeuvres that is capable of reversing the formation of atelectasis with the reduction of functional residual capacity caused by induction of general anaesthesia, and it is an important ventilation application that can prevent arterial oxygenation by preventing shunt (17, 18). In the IMPROVE trial, RM in the PV group was performed every 30 min. and compared to the conventional ventilation group, the NIMV requirement, re-intubation rates and acute lung injury development were found to be lower in the first postoperative 7 days (11). In our study, the rate of routine RM application was found to be less than 20%, and the lowest rate of application was determined in the group of research assistants. In a multicentre study performed by Jaber et al. (10), it was reported that among anaesthetists by the percentage of 81%, PEEP was not applied and that RM was preferred by only 7%. When the participants were asked about the reason, they stated that they used RM mostly for hypoxia developed intraoperatively and for single-lung ventilation. The options "routinely and intermittently in each patient" and "when disconnecting the patient from the ventilation cycle" were selected with a low incidence. This suggests that the RM administration is not routinely performed except mainly for intraoperative acute hypoxic conditions.

Whereas participants preferred low TV and PEEP applications more frequently, RM and low FiO_2 parameters were not very popular. This shows that anaesthetists are adopting some applications more among PV applications. PV applications have been tried to be described by the "open the lung and keep it open" principle and the "low energy ventilation" model, and the effectiveness of the PV depends on the co-application of all parameters (17). Low TV practice alone can result in atelectasis, shunt development, and hypoxemia. It is usually not possible to open closed alveoli with only PEEP application, but it can also cause excessive tension in the open alveoli. It is recommended that atelectasis alveoli be treated with PEEP after RM. Especially the extubation phase is susceptible to diffuse atelectasis, and high FiO_2 applications may cause this. Therefore, PV should be considered as a whole, and its optimization should be evaluated individually on a patient basis.

In terms of perioperative pulmonary complications, although more than half of the participants think that PV is useful, the PV application rate was lower. When evaluated according to the participants` titles, faculty members stated that PV was useful as twice as much as clinical fellows. It has been reported that the application of low-frequency PV might be due to the habits that do not easily change and insufficient knowledge on the subject (19, 20).

Conclusion

Anaesthesiologists are often aware of serious and life-threatening pulmonary complications that develop postoperatively. Postoperative fever, cough, and oxygen requirement are not usually seen as serious problems. For this reason, it is obvious that pulmonary morbidity is much higher than predicted. It is important to avoid ventilation practices that might affect patients' medical conditions negatively both in the short and long term. Related to PV, to make rational and evidence-based applications widespread, qualified studies and comprehensive training programmes seem to be required.

You can reach the questionnaire of this article at https://doi.org/10.5152/TJAR.2018.32392

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Mersin University (Date: 08.10.2015, No: 2015/310).

Informed Consent: Because the study design was a questionnaire, no written informed consent was required from the participants.

Peer-review: Externally peer-reviewed.

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Conflict of Interest: Authors have no conflicts of interest to declare.

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Appendix 1. Questionnaire Sent to Participants

Appendix 1. Questionnaire Sent to Participants Questionnaire for the Assessment of Perioperative Ventilation Practice

My esteemed colleagues,

I am a research assistant in the Department of Anaesthesiology and Reanimation, Mersin University

The "Perioperative Ventilation Practices Assessment Questionnaire" is prepared for scientific purposes and is aimed to be sent to all physicians working in the field of anaesthesiology and reanimation in Turkey. The data obtained from the questionnaire aim to gather information about perioperative ventilation practices. These data will be used by me in my dissertation.

The questionnaire does not contain any personal information such as your name, surname, or the name of institution you are working at. The questionnaire is not a test. The survey consists of a total of 29 questions, and the estimated response time is 5 minutes.

Thank you for your cooperation and help.

Dr. Levent ÖZDEMİR

* Required

What is your age? *

.....

Your gender? *

.....

Which city do you work in? *

.....

Which medical institution do you work at? *

.....

What is your title of specialty in anaesthesiology and reanimation? *

.....

Is there a surgical department that you are particularly interested in or a consultant of? *

☐ I work with all the departments alternately
☐ Cardiovascular surgery
☐ Neurosurgery
☐ Otolaryngology—head and neck surgery
☐ Paediatric surgery
☐ Orthopaedics and traumatology
☐ General surgery
☐ Plastic surgery
☐ Thoracic surgery
☐ Urology
☐ Eye surgery
☐ Other:.....
☐ Gynaecology and obstetrics

Which body weight measurement do you use when determining the perioperative tidal volume? *

☐ Actual (measured) ☐ Ideal (determined by height)

In perioperative mechanical ventilation, what is the tidal volume value that you frequently use as ml/kg? *

☐ <6 ☐ >10

☐ 6-8 ☐ Other:.....

☐ 9-10

In your opinion, the tidal volume (TV) you use is classified as *

☐ Low TV

☐ High TV

☐ No idea

What is the reason for using a high tidal volume (TV), if you prefer high TV?

If you do not use a high TV, you can continue with the next question. You can choose more than one option.

☐ This is the practice of our clinic ☐ Decreasing postoperative pulmonary complications

☐ Sufficient lung expansion ☐ Adequate CO_2 level

☐ Adequate oxygenation ☐ No idea

☐ Preventing atelectasis ☐ Other:.....

In your opinion, above which ml/kg value is not considered a low tidal volume?

☐ 4-6 ☐ >10

☐ 7-8 ☐ No idea

☐ 9-10 ☐ Other:.....

What is the reason for using a low tidal volume (TV), if you prefer low TV?

If you do not use a low TV, you can continue with the next question. You can choose more than one option.

☐ This is the practice of our clinic. ☐ Providing adequate oxygenation

☐ Preventing alveolar overextension (volutrauma) ☐ Decreasing postoperative pulmonary complications

☐ Decreasing barotrauma risk ☐ No idea

☐ Preventing atelectasis ☐ Other:.....

Do you use postoperative end-expiratory pressure? *

☐ No ☐ Yes

If you apply postoperative end-expiratory pressure (PEEP), what is the H_2O level in cm that you frequently use?

If you do not use PEEP, you can continue with the next question.

☐ 3 ☐ >10

☐ 4 - 6 ☐ No idea

☐ 7 - 10

What is the reason of not applying postoperative end-expiratory pressure (PEEP)?

If you apply PEEP, you can skip to the next question. You can choose more than one option.

☐ This is the practice of our clinic ☐ I do not think it is useful perioperatively.

☐ It may cause haemodynamic instability ☐ No idea

☐ It may cause alveolar overextension and barotrauma ☐ Other:.....

Do you use a perioperative positive end-expiratory pressure 7 cmH_2O and above? *

☐ No

☐ Yes

☐ Sometimes

If you use perioperative a positive end-expiratory pressure (PEEP) 7 cmH_2O and above, what is the reason?

If you do not use a perioperative PEEP 7 cmH_2O and above, you can continue with the next question. You can choose more than one option.

☐ This is the practice of our clinic ☐ Because I apply a low FiO_2

☐ I prefer low tidal volume ☐ No idea

☐ I think it prevents atelectasis ☐ Other:.....

☐ In order to improve oxygenation

If you apply positive end-expiratory pressure (PEEP), what determines the PEEP value?

If you do not use PEEP, you can continue with the next question. You can choose more than one option.

☐ I use a fixed PEEP value ☐ Lower inflexion point

☐ Haemodynamic stability ☐ Oxygenation

☐ Inspiratory peak pressure ☐ CO_2 level

☐ Inspiratory plateau pressure ☐ Other:.....

☐ Auto-PEEP level

During general anaesthesia induction, what is the amount of "frequently inspired oxygen fraction" that you frequently use? *

☐ 1.0 ☐ 0.5 – 0.7

☐ 0.8 – 0.9 ☐ 0.3 – 0.4

During extubation, what is the amount of frequently inspired oxygen fraction that you frequently use? *

☐ 1.0 ☐ 0.5 – 0.7

☐ 0.8 – 0.9 ☐ 0.3 – 0.4

During extubation, which gases do you frequently use? *

☐ 100%O_2 ☐ Just air

☐ O_2+air ☐ Other:.....

If you routinely use 100% oxygen during extubation, what is the reason?

If you do not use 100% oxygen during extubation, you can continue with the next question. You can choose more than one option.

☐ This is the practice of our clinic ☐ Decreasing postoperative pulmonary complications

☐ Preventing hypoxemia ☐ No idea

☐ Preventing postoperative atelectasis formation ☐ Other:.....

☐ Providing required oxygen reserve

If you do not routinely use 100% oxygen during extubation, what is the reason?

If you use 100% O_2, you can continue with the next question. You can choose more than one option.

☐ This is the practice of our clinic
☐ Decreasing postoperative pulmonary complications
☐ Preventing postoperative atelectasis formation
☐ No idea
☐ To avoid the harmful effects of hyperoxia
☐ Other:.....

Do you practice perioperative recruitment manoeuvre? *

☐ No
☐ Yes
☐ Sometimes

If you do use the recruitment manoeuvre (RM), in which conditions do you prefer using it?

If you do not use the RM, you can continue with the next question. You can choose more than one option.

☐ I apply it intermittently in every patient
☐ Single-lung ventilation
☐ When the patient is removed from the ventilator circuit for any reason
☐ No idea
☐ Intraoperative hypoxia
☐ Other:.....

How do you apply the recruitment manoeuvre (RM)?

If you do not use the RM, you can continue with the next question. You can choose more than one option.

☐ Plateau 20–30 cm H_2O, the duration of inspiration will be 6–10 seconds
☐ During the operation, at intervals of 30 minutes
☐ Plateau 30–40 cm H_2O, the duration of inspiration will be 2–5 seconds
☐ No idea
☐ 1–3 repetitions of the RM
☐ Other:.....
☐ 4–6 repetitions of the RM

For what type of disease or condition you do not apply protective ventilation (PV)?

If you do not use PV, you can continue with the next question. You can choose more than one option.

☐ I apply in all conditions
☐ Paediatric surgery
☐ Heart diseases
☐ Emergency surgical operations
☐ Lung diseases
☐ No idea
☐ Obesity
☐ Other:.....
☐ Elderly patients

If you apply protective ventilation (PV), which parameters do you frequently use?

If you do not use PV, you can continue with the next question. You can choose more than one option.

☐ Low tidal volume
☐ Recruitment manoeuvre
☐ PEEP
☐ Other:.....
☐ Low FiO_2

Which ventilation type do you think is more beneficial in terms of postoperative pulmonary complications? *

☐ Conventional (classic) ventilation
☐ Both
☐ Protective ventilation
☐ No idea