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ORIGINAL ARTICLE

Sex difference and intra-operative tidal volume

Insights from the LAS VEGAS study

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BACKGROUND One key element of lung-protective ventilation is the use of a low tidal volume (V_T). A sex difference in use of low tidal volume ventilation (LTVV) has been described in critically ill ICU patients.

OBJECTIVES The aim of this study was to determine whether a sex difference in use of LTVV also exists in operating room patients, and if present what factors drive this difference.

DESIGN, PATIENTS AND SETTING This is a posthoc analysis of LAS VEGAS, a 1-week worldwide observational study in adults requiring intra-operative ventilation during general anaesthesia for surgery in 146 hospitals in 29 countries.

MAIN OUTCOME MEASURES Women and men were compared with respect to use of LTVV, defined as V_T of 8 ml kg^{-1} or less predicted bodyweight (PBW). A V_T was deemed 'default' if the set V_T was a round number. A mediation analysis assessed which factors may explain the sex difference in use of LTVV during intra-operative ventilation.

RESULTS This analysis includes 9864 patients, of whom 5425 (55%) were women. A default V_T was often set, both in women and men; mode V_T was 500 ml. Median [IQR] V_T was higher in women than in men (8.6 [7.7 to 9.6] vs. 7.6 [6.8 to 8.4] ml kg^{-1} PBW, $P < 0.001$). Compared with men, women were twice as likely not to receive LTVV [68.8 vs. 36.0%; relative risk ratio 2.1 (95% CI 1.9 to 2.1), $P < 0.001$]. In the mediation analysis, patients' height and actual body weight (ABW) explained 81 and 18% of the sex difference in use of LTVV, respectively; it was not explained by the use of a default V_T.

CONCLUSION In this worldwide cohort of patients receiving intra-operative ventilation during general anaesthesia for surgery, women received a higher V_T than men during intra-operative ventilation. The risk for a female not to receive LTVV during surgery was double that of males. Height and ABW were the two mediators of the sex difference in use of LTVV.

TRIAL REGISTRATION The study was registered at Clinicaltrials.gov, NCT01601223

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Introduction

One key element of lung-protective ventilation is the use of a low tidal volume (V_T).[1,2] Increasing and convincing evidence for benefit of low tidal volume ventilation (LTVV) in ICU patients[3] stimulated the use of a low V_T in the operating room.[4] Recent studies confirmed that intra-operative use of lung-protective ventilation, in part consisting of use of a low V_T, protects against postoperative pulmonary complications (PPCs).[2,5–7] Despite recommendations on use of a V_T of 8 ml kg^{-1} predicted body weight (PBW) or lower,[8] LTVV remains grossly underused. Large observational studies show that more than a third of surgery patients receive ventilation with a V_T more than 8 ml kg^{-1} PBW,[9] and one in five patients with a V_T more than 10 ml kg^{-1} PBW.[10,11]

A recent secondary analysis of the 'Large observational study to Understand the Global Impact of Severe Acute respiratory FailurE' (LUNG SAFE) showed that female patients with acute respiratory distress syndrome (ARDS) received LTVV less often than males.[12] It is uncertain whether a sex difference in use of LTVV also exists in the operating room. We reassessed the database of the 'Local Assessment of VEntilatory management during General Anaesthesia for Surgery' (LAS VEGAS) study to describe and compare the use of LTVV in female versus male surgery patients. In addition, we ascertained which factors are associated with this sex difference in use of LTVV. We hypothesised that women receive intra-operative LTVV less often than men, and that this difference is driven by anthropometric factors such as height and weight, and the use of a possibly sex-specific default V_T.

Materials and methods

This is a posthoc analysis of the LAS VEGAS study,[9] carried out in accordance with the recommendations of the 'STrengthening the Reporting of OBservational studies in Epidemiology' (STROBE) statement (checklist can be found at page 3 of Online Supplement, http://links.lww.com/EJA/A517) (http://www.strobe-statement.org/). LAS VEGAS was a worldwide, international, multicentre, prospective 1-week observational study describing in detail intra-operative ventilation practices in the operating rooms of 146 centres in 29 countries.[9] Surgical patients were enrolled between 14 January and 4 March 2013. National coordinators selected the exact period during which data were collected for the study in their respective country.

The study protocol of the LAS VEGAS study was first approved on 22 August 2012 by the ethics committee of the Academic Medical Center, Amsterdam, The Netherlands (W12_190#12.17.0227, chairperson Prof. M.P.M. Burger). In all participating centres, approval was obtained from the institutional review board if needed, and depending on national or regional legislation, written informed consent was obtained from the individual patients.

The LAS VEGAS study was registered at clinicaltrial.gov (study identifier NCT01601223).

The LAS VEGAS study enrolled consecutive patients requiring invasive ventilation during general anaesthesia for surgery during a predefined calendar week. Exclusion criteria of the LAS VEGAS study were age less than 18 years, scheduled for pregnancy-related surgery and surgical procedures outside an operating room. The current posthoc analysis also excluded patients undergoing a surgical procedure involving cardiopulmonary bypass, thoracic surgery or planned use of one-lung ventilation during surgery.

Collected data included baseline characteristics and demographics, details of the surgical procedure, the 'Assess Respiratory Risk in Surgical Patients in Catalonia for postoperative pulmonary complications' (ARISCAT) score,[13] hourly collection of vital parameters and ventilation data, including V_T, positive end-expiratory pressure (PEEP) and peak pressure (Ppeak), fraction of inspired oxygen (F_{IO_2}) and respiratory rate.

V_T was normalised for actual body weight (ABW) and for PBW, as follows:

$$V_{T,ABW} = \text{absolute } V_T/\text{ABW in kg (Eq. 1)} \quad (1)$$

$$V_{T,PBW} = \text{absolute } V_T/\text{PBW in kg (Eq. 2)} \quad (2)$$

PBW for women and men was calculated as follows:

$$\text{men, PBW} = 50.0 + 0.91 * (\text{height in cm} - 152.4) \text{ (Eq.3a)} \quad (3a)$$

$$\text{women, PBW} = 45.5 + 0.91 * (\text{height in cm} - 152.4) \text{ (Eq. 3b)} \quad (3b)$$

The primary outcome was use of LTVV, defined as having received a median $V_{T,PBW}$ of 8 ml kg^{-1} or less during intra-operative ventilation. A patient was defined as possibly having received ventilation with a default V_T when the reported absolute V_T was a rounded number, for example a V_T of 200, 250, 300, 350, 400, 450, 500, 550, 600 or 650 ml.

Statistical analysis

A detailed description of the statistical analysis can be found in the eMethods in the Online Supplement, http://links.lww.com/EJA/A517. Descriptive statistics were reported for the study population stratified according to sex, and as number and relative proportions for categorical variables and median [IQR] for continuous variables. No assumptions were made for missing data. The anthropometric indices were compared between the sex groups using Wilcoxon rank sum test for continuous variables. For all analyses, the male sex was used as reference. The number and proportion of patients receiving LTVV was described and an unadjusted mixed-effect generalised linear model considering the centres as random effect was used to extract the risk difference. The proportion of patients receiving LTVV was also assessed according to quintiles of height and weight. In addition, the proportions of patients receiving a $V_{T,PBW}$ more than 9 ml kg^{-1} and $V_{T,PBW}$ more than 10 ml kg^{-1} were described using a χ^2 statistic. In all models, continuous variables were standardised to improve convergence.

Finally, to investigate whether the difference in the use of LTVV between female and male patients is due to differences in height, ABW or setting a 'default' possibly sex-dependent V_T, a mixed-effect multivariable mediation model was used. Mediators are variables that are affected by group assignment and that subsequently can affect the outcome. Therefore, mediators are on the causal pathway of the relationship between group and outcome, at least partly explaining the effects of the group on the outcome. In a first step, we assessed the individual impact of height, weight or use of a fixed V_T as potential mediators for the different use of low V_T according to sex in a multivariable model adjusted by all the covariates described above. For this model, quasi-Bayesian confidence intervals were estimated after 10 000 simulations. In a second step, height, weight and setting a default V_T were included at the same time in the same model to assess the impact and importance of each. In this second model, the confidence intervals were estimated with bootstrapping with 1000 samples. For the mediation models, the following estimates are described: the total effect (estimates the total effect of sex on ventilation), the average causal mediation effect (ACME, explains how much of the effect of sex on ventilation is explained by the mediator [height, weight or setting a default V_T]), the average direct effect (ADE, explains how much of the effect of sex on ventilation is still explained by sex after considering the effect of the mediator) and the proportion of mediation (estimates the proportion of the total effect that is explained by the mediator).

All analyses were conducted in R v.3.60 and a P value less than 0.05 was considered statistically significant.

Results

This analysis included 5425 (55%) women and 4439 (45%) men undergoing intra-operative ventilation not meeting the additional exclusion criteria. Patient characteristics and anthropometric indices are summarised in Table 1. Women were median 11 (95% CI 11 to 12) cm shorter ($P < 0.001$) and 12 (11 to 13) kg lighter than men ($P < 0.001$). Anaesthesia, surgery and intra-operative ventilation characteristics are shown in Supplementary eTables 1 and 2, http://links.lww.com/EJA/A517.

V_T in women and men are shown in Fig. 1 and Supplementary eFigs. 1, 2 and 3, http://links.lww.com/EJA/A517. Mean V_T was 500 ml, and was similar for women and men. In women, median $V_{T,ABW}$ and median $V_{T,PBW}$ were higher than men 6.9 (5.9 to 7.9) vs. 6.6 (5.7 to 7.5) ml kg^{-1} ABW; median difference was 0.3 (0.2 to 0.4) ml kg^{-1} ABW ($P < 0.001$); and 8.6 (7.7 to 9.6) vs. 7.6 (6.8 to 8.4) ml kg^{-1} PBW; median difference was 1.1 (1.0 to 1.1) ml kg^{-1} PBW ($P < 0.001$). Women were less likely to receive a default V_T than men (64.3 vs. 67.9%; $P < 0.001$). In the lower quintiles of height, $V_{T,PBW}$ was higher, an effect that was stronger in women, and for every quintile in ABW, women received a higher $V_{T,PBW}$ (Supplementary eFigs. 4 and 5, http://links.lww.com/EJA/A517). Although women received a lower absolute V_T, the $V_{T,PBW}$ was always higher than in men (Supplementary eFigs. 6 and 7, http://links.lww.com/EJA/A517). The proportion of women receiving V_T more than 9 ml kg^{-1} was three times higher than in men (39.3 vs. 13.8%; $P < 0.001$); the proportion of females receiving V_T 10 ml kg^{-1} or higher was four times higher than in men (18.8 vs. 4.3%; $P < 0.001$). Intra-operative driving pressures were higher in women than in men, albeit that the difference between sexes was small.

The proportion of women receiving intra-operative LTVV was less than half of that in males (31.1 vs. 64.0%; $P < 0.001$). Women were at a higher risk of not receiving intra-operative LTVV than men (68.8 vs. 36.0%; $P < 0.001$). After adjustment for confounders, the difference in use of LTVV persisted [−5.78 (−8.12 to −3.45), $P < 0.001$] (Supplementary eFig. 8, http://links.lww.com/EJA/A517). In the lowest quintiles of height, and in all quintiles of ABW, women received LTVV less often than men (Fig. 2).

In the mediation models, mostly height and to a lesser extent ABW were the independent drivers of the effect of sex on use of intra-operative LTVV (Table 2). Use of a default V_T during intra-operative ventilation was not a driver of the sex difference in use of LTVV.

Discussion

The main findings of the current analysis of the LAS VEGAS database are that women, compared with men, received higher median $V_{T,ABW}$ and higher median $V_{T,PBW}$ during intra-operative ventilation. Consequently, women received LTVV much less often, a finding that was more pronounced in shorter women. The sex difference in use of LTVV was mostly mediated by differences in height and ABW, and not by sex or the use of a default V_T.

This study has several strengths. It used a large and robust database of a worldwide study in patients receiving intra-

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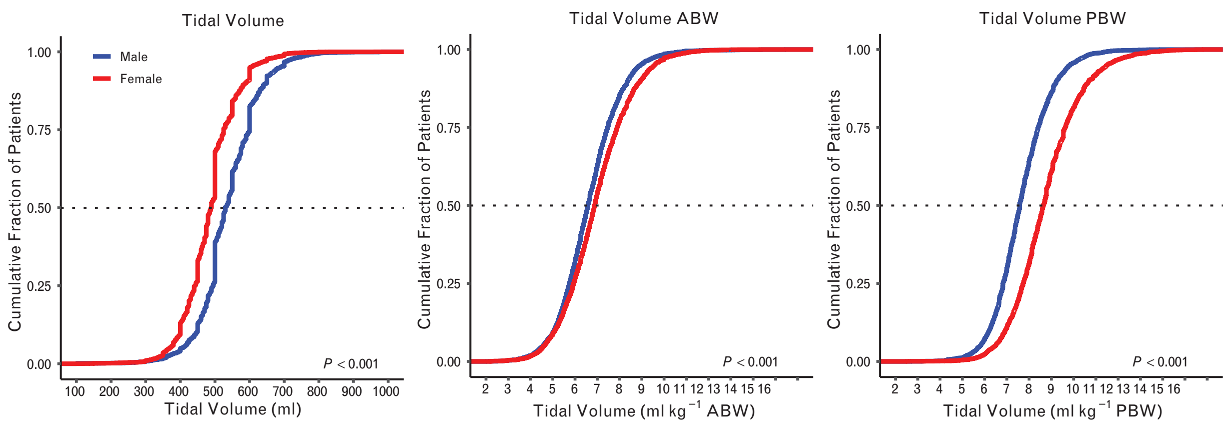
Table 1 Baseline characteristics of the patients

	Female ($n=5425$)	Male ($n=4439$)	*P*
Age (years)	52 [39 to 64]	55 [40 to 67]	<0.001
Height (cm)	164 [159 to 168]	175 [170 to 180]	<0.001
Weight (kg)	70 [60 to 81]	82 [72 to 93]	<0.001
PBW (kg)	56.1 [51.5 to 59.7]	70.6 [66.0 to 75.1]	<0.001
BMI ($kg\,m^{-2}$)	25.9 [22.7 to 30.4]	26.5 [24.1 to 29.7]	<0.001
ASA physical status			<0.001
1	1720 (31.8)	1293 (29.2)	
2	2703 (50.0)	2040 (46.0)	
3	907 (16.8)	996 (22.5)	
4	75 (1.4)	98 (2.2)	
5	4 (0.1)	4 (0.1)	
ARISCAT score	15.00 [3.00 to 26.00]	16.00 [3.00 to 27.00]	0.293
Low	3806 (73.4)	2937 (69.4)	<0.001
Moderate	1148 (22.2)	1067 (25.2)	
High	228 (4.4)	227 (5.4)	
Pre-operative anaemia (Hb $\leq$10 $g\,dl^{-1}$)	204 (4.5)	125 (3.4)	0.015
Pre-operative haemoglobin, $g\,dl^{-1}$	13.2 [12.2 to 14.0]	14.6 [13.3 to 15.5]	<0.001
Pre-operative SpO_2, %	98 [96 to 99]	97 [96 to 99]	<0.001
Respiratory infection <30 days	198 (3.6)	165 (3.7)	0.902
Blood transfusion <30 days	43 (0.8)	32 (0.7)	0.771
Pre-operative creatinine ($\mu mol\,l^{-1}$)	64.6 [56.6 to 78.0]	80.5 [70.7 to 97.3]	<0.001
Functional status			0.265
Independent	5027 (92.7)	4078 (92.0)	
Partially dependent	331 (6.1)	290 (6.5)	
Totally dependent	65 (1.2)	67 (1.5)	
Chronic comorbidities			
Smoking	1008 (18.6)	1282 (28.9)	<0.001
Chronic obstructive pulmonary disease	263 (4.8)	333 (7.5)	<0.001
Cancer	190 (3.5)	202 (4.6)	0.009
Chronic kidney disease	125 (2.3)	185 (4.2)	<0.001
Heart failure	288 (5.3)	297 (6.7)	0.004
Obstructive sleep apnoea	91 (1.7)	114 (2.6)	0.003
Planned duration of surgery			<0.001
$\leq$2 h	3899 (72.0)	2963 (66.9)	
2 to 3 h	1021 (18.9)	893 (20.1)	
>3 h	495 (9.1)	576 (13.0)	
Urgency of surgery[a]			<0.001
Elective	4888 (90.1)	3877 (87.4)	
Urgent	415 (7.7)	430 (9.7)	
Emergency	121 (2.2)	131 (3.0)	
Surgical technique[b]			
Open	933 (17.2)	840 (18.9)	0.028
Laparoscopic	1167 (21.5)	570 (12.8)	<0.001
Laparoscopic-assisted	97 (1.8)	70 (1.6)	0.465
Peripheral	964 (17.8)	863 (19.4)	0.036
Other type	2309 (42.6)	2118 (47.7)	<0.001
Surgical procedure			
Lower gastrointestinal	486 (9.0)	610 (13.7)	<0.001
Upper gastrointestinal	774 (14.3)	583 (13.1)	0.110
Vascular[c]	103 (1.9)	206 (4.6)	<0.001
Aortic	8 (0.1)	56 (1.3)	<0.001
Neurosurgery, head and neck	962 (17.7)	1044 (23.5)	<0.001
Urological and kidney	214 (3.9)	651 (14.7)	<0.001
Gynaecological	1134 (20.9)	0 (0.0)	<0.001
Endocrine	151 (2.8)	43 (1.0)	<0.001
Transplant	12 (0.2)	22 (0.5)	0.032
Plastic, cutaneous, breast	784 (14.5)	253 (5.7)	<0.001
Bone, joint, trauma spine	736 (13.6)	859 (19.4)	<0.001
Others	246 (4.5)	339 (7.6)	<0.001

Data are presented as median [IQR] or *n* (%). ARISCAT, Assess Respiratory Risk in Surgical Patients in Catalonia; ASA, American Society of Anesthesiologists; Hb, haemoglobin; PBW, predicted body weight. [a] Urgency of surgery, elective: surgery that is scheduled in advance because it does not involve a medical emergency; urgent, surgery required within < 48 h; emergency, nonelective surgery performed when the patient's life or wellbeing is in direct jeopardy. [b] Patient can have more than one. [c] Vascular surgery is carotid endarterectomy, aortic surgery and peripheral vascular taken together.

operative mechanical ventilation during general anaesthesia for various types of surgery. The study had a multicentre design, increasing the generalisability of the findings. $V_{T,ABW}$ and $V_{T,PBW}$ could be calculated in all patients, and the amount of missing data was very small. The analysis followed a strict analysis plan that used sophisticated statistical computations and the mediation analysis allowed us to explain the sex difference in use of LTVV.

Fig. 1 Cumulative distribution plots for the median values of the ventilatory parameters during the intra-operative period stratified by sex

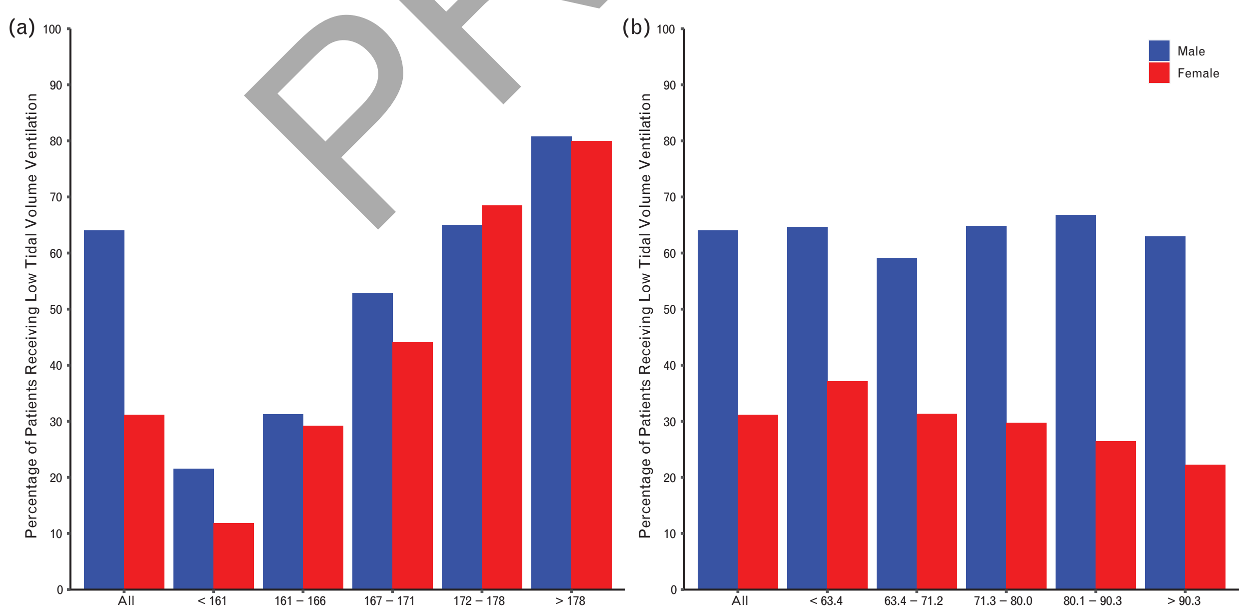


PBW calculated according to standard formula. *P* value from the unadjusted mixed-effect linear model with centres as random effect. ABW, actual body weight; PBW, predicted body weight.

This study is the largest investigation that shows differences in V_T titrations between women and men undergoing invasive ventilation during general anaesthesia for surgery. Its findings are in line with results from previous single-centre[10] and national investigations[11,14–16] that all showed women to be at risk of receiving larger $V_{T,PBW}$ compared with men. Its findings also suggest that anaesthesiologists are titrating V_T to ABW more than PBW, and foregoing the cumbersome process of measuring height and performing the PBW calculation altogether. Nevertheless, anaesthesiologists may have been interested in lung-protective ventilation, as the V_T based on ABW was less than 7 ml kg^{-1} for both women and men.

Thus far, studies performed in the operating room[10,11,14–16] as well as studies performed in the ICU[12] failed to identify the factors behind sex differences in use of LTVV. The current findings add to our knowledge by showing that the sex difference in use of LTVV is mostly driven by patients' height and ABW. The latter finding

Fig. 2 Frequency of use of low tidal volume ventilation in the overall cohort stratified by sex and according to quintiles of height and weight



A low tidal volume was defined as a tidal volume ≤8 ml kg^{-1}. PBW calculated according to standard formula. ABW, actual body weight; PBW, predicted body weight.

Table 2 Mediation analysis

	Adjusted absolute difference (95% CI)[a,b]	*P*
Low tidal volume ventilation		
Height as mediator[c]		
Total effect of sex	−32.91 (−34.99 to −31.00)	<0.001
Average causal mediation effect of height	−26.56 (−28.14 to −25.00)	<0.001
Average direct effect of female sex	−6.35 (−8.67 to −4.00)	<0.001
Proportion of mediation by height in female sex	80.70 (74.76 to 87.00)	<0.001
Actual body weight as mediator[d]		
Total effect of sex	−5.41 (−7.81 to −3.00)	<0.001
Average causal mediation effect of weight	0.95 (0.42 to 2.00)	<0.001
Average direct effect of female sex	−6.37 (−8.73 to −4.00)	<0.001
Proportion of mediation by weight in female sex	−17.65 (−39.54 to −7.00)	<0.001
Default V_T as mediator[e]		
Total effect of sex	−5.14 (−7.55 to −3.00)	<0.001
Average causal mediation effect of default V_T	−0.00 (−0.05 to 0.00)	0.730
Average direct effect of female sex	−5.13 (−7.54 to −3.00)	<0.001
Proportion of mediation by weight in female sex	0.05 (−0.60 to 1.00)	0.730
Height, weight and default V_T as mediators[f]		
Total effect of sex	−30.80 (−34.30 to −27.20)	<0.001
Average causal mediation effect of height	−31.90 (−34.10 to −29.70)	<0.001
Average causal mediation effect of weight	6.10 (5.00 to 7.20)	<0.001
Average causal mediation effect of default V_T	0.00 (−0.10 to 0.10)	0.618
Average direct effect of female sex	−5.00 (−8.80 to −1.10)	0.011

ASA, American Society of Anesthesiologists' physical status; ARISCAT, Assess Respiratory Risk in Surgical Patients in Catalonia for postoperative pulmonary complications' (ARISCAT) score; $etCO_2$, end-tidal carbon dioxide tension. [a] Multilevel mediation model with quasi–Bayesian confidence intervals, with centres as random effects and adjusted for ASA, ARISCAT, presence of obstructive sleep apnoea, urgency of surgery, total fluid intake, need of intra-operative transfusion, reversal of neuromuscular blockade, duration of anaesthesia and intra-operative $etCO_2$. [b] All estimates generated after 10 000 simulations. [c] Further adjusted by weight and default V_T. [d] Further adjusted by height and default V_T. [e] Further adjusted by height and weight. [f] Adjusted only for the variables described in 'a' (height, weight and default V_T excluded) and confidence intervals estimated with bootstrapping with 1000 samples.

suggests that the risk of using too large a V_T can also occur in men, that the risk is larger in shorter individuals and that it also affects overweight patients. This is in line with previous investigations showing that these anthropometric indices influence the risk of receiving intra-operative ventilation with an incorrectly titrated V_T.[10,11,14–16,17] The current findings reject the hypothesis that incorrect titration of V_T is a sex-specific problem.

In settings with shorter individuals, the problem of receiving ventilation with too large a V_T could even be greater, albeit that the average differences in height between women and men is nearly 10–15 cm worldwide.[18,19] The same could be true in areas where there are more overweight or obese individuals. However, the current findings should increase the awareness of using the correct information for proper V_T titrations – patient's height, maybe patient's sex but not patient's ABW – should be considered when titrating V_T.

Our finding of sex disparity in V_T titrations mirrors the practice of ventilation in critically ill patients, for example invasive ventilation in ICUs. Indeed, not only in unselected critically ill patients,[19–22] but also in specific ICU cohorts such as organ donors,[23] patients with sepsis[24] and even in patients with ARDS,[25] women continue to receive LTVV less often than males. These findings suggest that the problem is widespread, and also needs attention beyond the operating room. Furthermore, the effect of anthropometric factors on intra-operative V_T titrations, and thus, the use of LTVV may be more important in patients undergoing more extreme procedures, for example intrathoracic procedures that require one-lung ventilation. In these patients, use of lung-protective ventilation is reported to be low[26] and every effort to improve this may result in better postoperative outcomes.

One additional finding was that patients undergoing surgery frequently receive a default V_T. This was also found in one French study.[11] Using a default V_T could be more straightforward and is probably an easier approach at the bedside than collecting or measuring patients' height, and performing a rather complex calculation. Of note, the mediation analysis showed use of a default V_T did not mediate the effect of sex on use of LTVV. One possible explanation is that a default V_T may already have been adjusted for sex, that is lower default V_T may have been use in women than in men. This could be a practical alternative for use at the bedside, albeit that a default V_T could better be based on whether the patient is 'short' or 'tall', than whether the patients is female or male.[27]

The results of our study should be seen against a background of an ongoing uncertainty regarding what is the best V_T during intra-operative ventilation. Although multiple studies directly[2,5,10] or indirectly[28,29] suggest benefit from a low V_T, the results of one recent study[30] suggest otherwise. In that study, intra-operative ventilation with a V_T of 6 ml kg^{-1} PBW was compared with a V_T of 10 ml kg^{-1} and resulted in a similar proportion of patients who developed PPC. Additional studies are needed to help decide what V_T to use in intra-operative ventilation during general anaesthesia for surgery.

Several limitations need to be mentioned. First, this was a posthoc analysis. However, to prevent data-driven analysis and reporting, we developed a cautious statistical model, aiming to compensate for potential confounding factors. Second, the present findings may not apply to all patient categories, such as children, patients undergoing cardiac surgery or one-lung ventilation during surgery, and pregnant women, as these patients were excluded from the original LAS VEGAS study.[9] Third, the LAS VEGAS study was performed more than 7 years ago. It is possible that changes in clinical practice over recent years resulted in a further reduction in V_T, mitigating sex differences in use of LTVV. It should be mentioned, however, that the sex differences found in the current analysis were not different from those in an earlier study in which patients received ventilation with a much higher V_T.[10] Fourth, patients' height and ABW were collected from patients' records, assuming that these were correctly reported – this may not be true for all patients – however, it seems logical that the recorded height was used to set V_T. Fifth, additional confounders such as actual practice and personal preferences of the anaesthesiologist could not be accounted for in the mediation analysis. It is possible that these and other yet unknown factors could have influenced the findings. Sixth, we conducted a complete case analysis, considering only patients for whom data needed for calculation of the outcome were available. Finally, we assumed that every rounded V_T was a default V_T. Although we cannot conclude that use of a default V_T had no mediation effect, we can state that use of a rounded V_T did not mediate the sex difference in use of LTVV.

Conclusion

During ventilation for general anaesthesia, women are less likely to receive LTVV than men. This sex difference is mostly mediated by patients' height and ABW. These findings raise the awareness of the importance of proper titration of V_T in operating rooms.

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LAS VEGAS: 'Local Assessment of VEntilatory management during General Anaesthesia for Surgery'.full list of investigators is provided in the online Supplement.

PROVE Network: 'PROtective VEntilation Network'.

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