

References

1. Sessler DI, Sigl JC, Kelley SD, Chamoun NG, Manberg PJ, Saager L, Kurz A, Greenwald S: Hospital stay and mortality are increased in patients having a "triple low" of low blood pressure, low bispectral index, and low minimum alveolar concentration of volatile anesthesia. *ANESTHESIOLOGY* 2012; 116:1195–203
2. Sessler DI, Sigl JC, Manberg PJ, Kelley SD, Schubert A, Chamoun NG: Broadly applicable risk stratification system for predicting duration of hospitalization and mortality. *ANESTHESIOLOGY* 2010; 113:1026–37

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Airway Anatomy of AirSim High-fidelity Simulator

To the Editor:

We read the article by Schebesta *et al.*¹ with great interest because it is the first study to compare airway simulators

with normal human anatomy using objective anatomical measurements.

Previous studies have compared the effectiveness of four airway simulators, including Airway Management Trainer (Ambu, St Ives, United Kingdom), Airway Trainer (Laerdal, Stavanger, Norway), AirSim (Trucorp, Belfast, Northern Ireland), and Bill 1 (VBM, GmbH, Sulz, Germany) for demonstrating the LMA-Classic™ (LMA North America Inc., San Diego, CA), other supraglottic airway devices, difficult airway management procedures, and other advanced airway skills.^{2–5} The results of these studies have rated AirSim as one of the better devices. Given the previous favorable ratings for the AirSim simulator, we were surprised that AirSim was not included in the study by Schebesta *et al.*¹

At our institution, we are currently using the AirSim Bronchi simulator for training residents to place supraglottic airway devices, single lumen endotracheal tubes, double lumen endobronchial tubes, and bronchial blockers.⁶

Table 1. Airway Dimensions of 20 Patients from the Study by Schebesta *et al.*¹ Compared with High-fidelity AirSim Patient Simulator (Trucorp, Belfast, Northern Ireland)

	Patient		AirSim
	Mean (SD)	95% CI	
Palate			
Cross-sectional area, cm ²	2.7 (1.0)	2.3–3.2	2.7
Curved length, cm	3.7 (0.6)	3.4–4.0	2.4*
Height, cm	2.7 (0.7)	2.4–3.1	2.6
Center–pharynx, cm	1.5 (0.2)	1.4–1.6	1.6
Palate–epiglottis, cm	4.4 (0.9)	4.0–4.9	4.6
Palate–vallecula, cm	5.7 (1.0)	5.3–6.2	5.6
Epiglottis			
Anterior length, cm	1.6 (0.4)	1.4–1.7	1.4
Posterior length, cm	2.8 (0.7)	2.5–3.2	2.9
Tip–pharynx, cm	0.9 (0.4)	0.7–1.1	0.8
Vallecula–pharynx, cm	1.7 (0.6)	1.4–2.0	1.4
Total for palate and epiglottis (10 measures)			9/10
Tongue			
Cross-sectional area, cm ²	25.6 (3.7)	23.8–27.5	15.1*
Horizontal diameter, cm	6.3 (0.7)	5.9–6.6	5.9
Coronal diameter, cm	4.4 (0.5)	4.2–4.7	3.1*
Edge–pharynx, cm	1.6 (0.7)	1.2–1.9	2.2*
Overall distances			
Teeth–pharynx, cm	8.1 (0.6)	7.9–8.4	8.6*
Lip–pharynx, cm	9.5 (0.6)	9.2–9.8	11.0*
Total for tongue and overall distances (six measures)			1/6
Volumes			
Oral airspace, cm ³	4.3 (5.3)	1.9–6.8	93.3*
Retropalatal airspace, cm ³	5.1 (2.0)	4.2–6.1	5.8
Pharyngeal airspace, cm ³	13.5 (7.7)	9.9–17.1	26.2*
Total for volumes (three measures)			1/3
Total for all measures (19 measures)			11/19

* Values above or below 95% CI (level of clinical relevance).

We have performed a computed tomography scan of the AirSim Bronchi simulator and made the same measurements as reported by Schebesta *et al.*¹ (table 1). Most of the AirSim simulator measurements (with the exception of the tongue dimensions) were similar to human subjects, with 11 of 19 measurements within the 95% CI for human subjects as reported by Schebesta *et al.* The best simulator tested by Schebesta *et al.* was similar in only 6 of 19 measurements.

Our tongue measurements may have been smaller and oral space volume larger than human subjects in part because we did not add any additional air to the AirSim tongue volume, which can be adjusted by syringe inflation or deflation.

Schebesta *et al.*¹ used the pharyngeal space volume as their primary outcome with none of the airway simulator pharyngeal volumes within the 95% CI of human subjects. The AirSim pharyngeal volume (26 cm³) was also outside the 95% CI of human subjects (17 cm³), but was closer to the upper limit than the next best simulator tested by Schebesta *et al.* (31 cm³).

We agree with the conclusions of Schebesta *et al.*¹ that airway simulators do not reflect normal human airway anatomy. However, the AirSim simulator seems to be of much higher fidelity based on the objective anatomical measurements than the other airway simulators that were tested. Obviously, there are other important properties than dimensions that determine the realism of airway simulators, especially the appearance and physical properties of the simulated tissues.

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References

1. Schebesta K, Hüpfel M, Rössler B, Ringl H, Müller MP, Kimberger O: Degrees of reality: airway anatomy of high-fidelity human patient simulators and airway trainers. *ANESTHESIOLOGY* 2012; 116:1204–9
2. Silsby J, Jordan G, Bayley G, Cook TM: Evaluation of four airway training manikins as simulators for inserting the LMA Classic*. *Anaesthesia* 2006; 61:576–9
3. Jackson KM, Cook TM: Evaluation of four airway training manikins as patient simulators for the insertion of eight types of supraglottic airway devices. *Anaesthesia* 2007; 62:388–93
4. Cook TM, Green C, McGrath J, Srivastava R: Evaluation of four airway training manikins as patient simulators for the insertion of single use laryngeal mask airways. *Anaesthesia* 2007; 62:713–8
5. Jordan GM, Silsby J, Bayley G, Cook TM, Difficult Airway Society: Evaluation of four manikins as simulators for teaching airway management procedures specified in the Difficult Airway Society guidelines, and other advanced airway skills. *Anaesthesia* 2007; 62:708–12
6. Failor EK, Barlow S, Bowdle TA: The use of high-fidelity single-lung isolation simulation in anesthesiology resident training. Presented at the Annual Meeting of the American Society of Anesthesiologists, October 15, 2011, Chicago, IL, A161

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In Reply:

We commend Dr. Jelačić *et al.* for their efforts to add further evidence to the ongoing debate of airway research based on manikins by using our radiographic technique. In particular, the evaluation of the so-called airway task trainers or low-fidelity manikins might help to develop better training options for one of the most crucial skills in anesthesia and acute care—airway management.

There is a vast multitude of airway training manikins available, including the AirSim Bronchi (Trucorp, Belfast, Northern Ireland), the Airway Management Trainer (Laerdal Medical, Stavanger, Norway), and Ambu M MegaCode Trainer W (Ambu A/S®, Ballerup, Denmark). Only some of them have been evaluated in different benchmark trials or by means of radiographic techniques because of their general availability.^{1–4} Obviously, we were also only able to test an unavoidably arbitrary selection of commonly used simulators.

We fully agree with Dr. Jelačić *et al.* although radiographic evidence indicates that none of the evaluated manikins perfectly reflect the upper airway anatomy of actual patients (some better, some worse), other factors such as tissue elasticity and compressibility are equally important when it comes to judging how realistic a manikin can simulate an actual patient. The latter factors may be an explanation for the fact, that even though, for example, the AirSim and Airway Management Trainer significantly differ in radiographic measures, they are equal performance wise when compared with human cadavers.⁵

Finally, we firmly believe that there is a significant impact of the choice of a manikin on the performance and outcome in airway management training; however, subsequent investigations are necessary to elucidate the relevance of these choices on the application and transfer of simulator training in actual patient care.

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References

1. Schebesta K, Hüpfel M, Rössler B, Ringl H, Müller MP, Kimberger O: Degrees of reality: Airway anatomy of high-fidelity human patient simulators and airway trainers. *ANESTHESIOLOGY* 2012; 116:1204–9
2. Cook TM, Green C, McGrath J, Srivastava R: Evaluation of four airway training manikins as patient simulators for the insertion of single use laryngeal mask airways. *Anaesthesia* 2007; 62:713–8
3. Jordan GM, Silsby J, Bayley G, Cook TM, Difficult Airway Society: Evaluation of four manikins as simulators for teaching airway management procedures specified in the Difficult Airway Society guidelines, and other advanced airway skills. *Anaesthesia* 2007; 62:708–12
4. Jackson KM, Cook TM: Evaluation of four airway training manikins as patient simulators for the insertion of eight types of supraglottic airway devices. *Anaesthesia* 2007; 62:388–93