

Following On-site Instructions for Operating Laryngeal Mask Supreme™ and Laryngeal Tube™ as an Alternative to Mouth-to-Mouth Ventilation in Layperson CPR: A Randomized Trial in the Manikin

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Abstract

Background: “Chest compressions only” resuscitation (CCOR) has been suggested one method of increasing laypersons attendance providing bystander resuscitation, avoiding mouth-to-mouth (MTM) ventilation and improving patients’ outcome. In prolonged CCOR without rescue breaths and a non-cardiac origin, neurological outcome is very much dependent on oxygenation. As an alternative to MTM we investigated laypersons ability to operate supraglottic airway devices (SAD) in the manikin, following illustrated on-site instruction.

Methods: Laypersons were handed a bag containing either an LMAS or an LT, a bag-mask-valve device (BMV), a syringe prefilled with air, and an instruction manual consisting of four annotated diagrams displaying the correct use of either the Laryngeal Mask Supreme™ (LMAS) or the Laryngeal Tube™ (LT). They were then asked to perform and ventilate a manikin as displayed. The process was evaluated in quantity and quality.

Results: A total of 299 laypersons were enrolled. 145 applicants in the LMAS (96.7%) and 143 in the LT (96%) group inserted the SAD in the right direction. Previous BLS education was not associated with a higher rate of success (LMAS (P=0.85) vs. LT (P=0.63)). The most common error identified was the depth of insertion (LT 40.9% (n=61) vs. LMAS 32.7% (n=49); P=0.18). No significant difference was found with regard to positioning the devices twisted or reversed (LT 4.7% (n=7) vs. LMAS 6% (n=9); P=0.79).

Conclusion: In simulated setting laypersons can achieve appropriate skills and understanding for both SADs using a simple instruction manual. Application of SADs may be improved by a better labeling, the quality of the instruction sheet and a reduction in steps required.

Keywords: Laryngeal mask; Laryngeal tube; Mouth-to-Mouth ventilation

Introduction

Immediate initiation of bystander cardio pulmonary resuscitation (CPR) improves survival and outcome [1,2]. Cardio-cerebral resuscitation (CCR=CCOR) might be equivalent or superior to CPR in patients with out of hospital cardiac arrest (OHCA) in both survival rate and neurologic benefits. However, in non-cardiac origin cardiac arrest, survival rate was better with CPR [3]. For prolonged OHCA (>15 min) of cardiac origin, conventional CPR with rescue breathing provided incremental benefit compared with either no CPR or CCOR [3,4]. Despite basic life support (BLS) education laypersons are often hesitant to provide this adequately in case of emergency [5]. Reasons given are various and include fear of potential infection and distaste for blood and bodily fluids. In addition, a low self-confidence with skills learned, plus the fear of doing harm and the associated legal aspects are frequently expressed. Moreover, mouth-to-mouth ventilation (MTM) is associated with an increased incidence of regurgitation during CPR. The willingness to provide MTM is influenced by the victim’s age, attributes and how well they are known to the rescuer [6]. In unknown adults it is lower than 50%, even among professional healthcare providers, whereas the willingness to provide chest compressions (CCOR) alone is >90% [7,8]. Laypersons experienced in CPR have a greater tendency to perform bystander CPR than people without [9,10].

In 2008 the American Heart Association (AHA) simplified the CPR guidelines and focused on providing adequate and early chest compressions and defibrillation [11,12]. The AHA and International Liaison Committee on Resuscitation (ILCOR) point out that the steps taken by rescuers-whether layperson or healthcare professional-are determined by their level of training and by local circumstances, and specifically state that a trained (lay) CPR provider should provide

breaths in a 30:2 ratio [13,14]. Bag-valve-mask ventilation (BMV) has been shown to be difficult in layperson’s hands, whereas the insertion of SAD during CPR is associated not only with higher quality ventilation, but also higher quality chest compressions and a lower incidence of aspiration and associated pulmonary complications [15-18]. Two recently published studies stated that laypersons can operate LMAS in the manikin, after either on-site instruction using a four-diagram manual, or after completing a one-hour theoretical lecture including a practical demonstration [19,20]. We hypothesize that these findings may be extended to include the Laryngeal Mask Supreme™ (LMAS) and the Laryngeal Tube™ (LT) devices in emergency resuscitation by laypersons. If so, this would further support the case for supplying SADs along with other standard BLS equipment (such as AED’s in public) as a means of reducing individuals’ threshold to initiate early and effective therapy. In the present study we compare aspects of individual performance and technical problems between the two devices, and discuss potential limitations and improvements to their use.

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Methods

We conducted a randomized simulation study enrolling untrained laypersons and comparing two SAD (LMAS, seize #4, LMA Deutschland GmbH, Bonn, Germany & LT, seize #4, VBM Medizintechnik GmbH, Sulz a.N., Germany) after on-site instruction by four annotated diagrams. The institutional review board waived the requirement for written informed consent. No personal data except age, academic background and first aid training were collected, and no influence on any participant's health was expected. All subjects agreed to being evaluated anonymously for scientific and educational purposes. Prerequisites for inclusion were the lack of any previous medical education (i.e. physician, nurse, EMT, paramedic) other than a BLS course, and an age of 18 or older. Applicants were recruited at the Rheinisch-Westfälische-Technische-Hochschule (RWTH) Aachen University campus (Audimax & Kármán Auditorium). Experimental data were recorded "on-site". A resuscitation scenario with an Ambu® M MegaCode W manikin was prepared in an enclosed area. Participants were isolated from any inadvertent exposure to the scenario and to other participants' post-trial. We designed for each device an instruction manual illustrating with four annotated photographs (plus "close-ups"), step-by-step instructions for use, with important technical aspects (e.g. connection of the syringe to the cuff-inflation port) highlighted (Figure 1).

Two separate boxed sets of airway management tools "LMAS" and "LT" were prepared for use. For easier and more intuitive use the connectors between the airway devices and the BMV were both color-coded red. Further labels on each device indicated the approximate correct depth of insertion. The cuff inflation syringes were pre-filled with the appropriate volume of air (20 ml for LMAS or 35 ml for

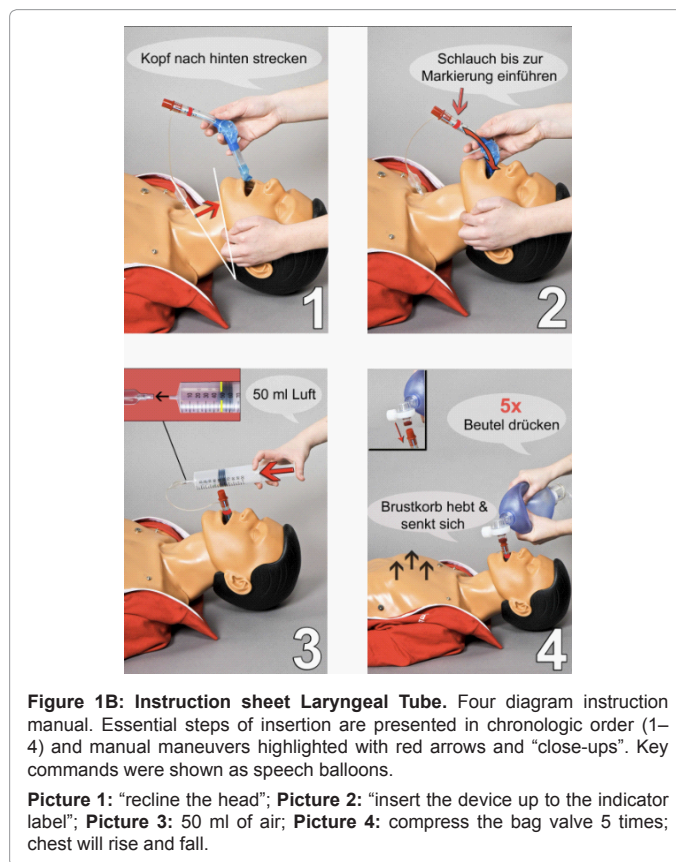


Figure 1B: Instruction sheet Laryngeal Tube. Four diagram instruction manual. Essential steps of insertion are presented in chronologic order (1–4) and manual maneuvers highlighted with red arrows and "close-ups". Key commands were shown as speech balloons.

Picture 1: "recline the head"; **Picture 2:** "insert the device up to the indicator label"; **Picture 3:** 50 ml of air; **Picture 4:** compress the bag valve 5 times; chest will rise and fall.

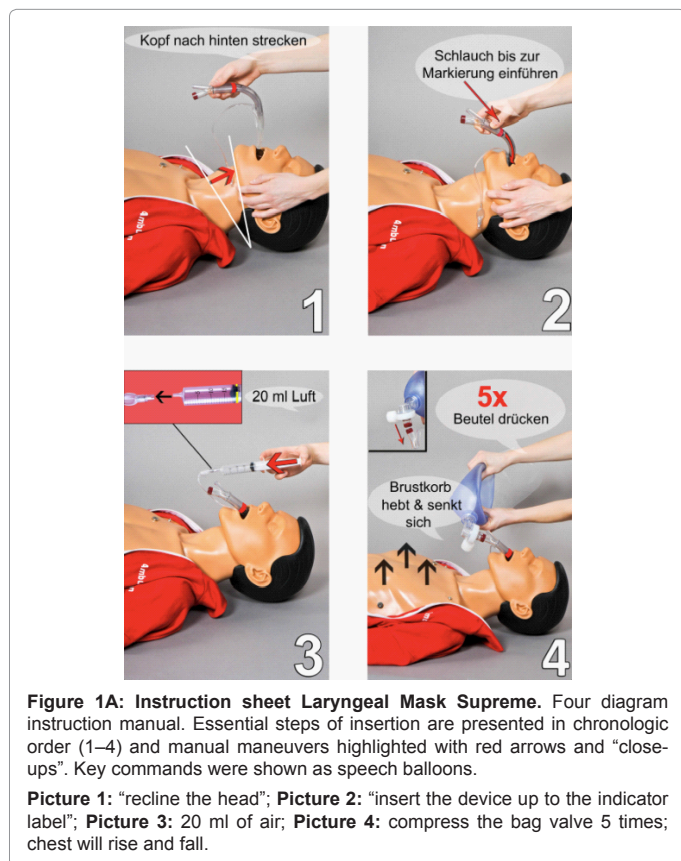


Figure 1A: Instruction sheet Laryngeal Mask Supreme. Four diagram instruction manual. Essential steps of insertion are presented in chronologic order (1–4) and manual maneuvers highlighted with red arrows and "close-ups". Key commands were shown as speech balloons.

Picture 1: "recline the head"; **Picture 2:** "insert the device up to the indicator label"; **Picture 3:** 20 ml of air; **Picture 4:** compress the bag valve 5 times; chest will rise and fall.

LT). An additional label on the syringe indicated the correct volume of air required. Squeezing the BMV was displayed using two hands. Both devices were established to fit to the manikin's anatomy and to provide an adequate seal once the cuff had been correctly inflated. The instruction manuals were supplied packaged with the individual devices. Participants were approached and asked to take part in a scientific trial investigating a new alternative to "mouth-to-mouth" ventilation in a dummy. In order to avoid potential learning bias participants performed a single trial with one device only. They were randomized to one of the SADs and were given standardized instructions before entering the experimental area: "Behind the wall you will find an unconscious person that has stopped breathing. On the scene a first-responder has already started with chest compression. You are responsible for their ventilation. To do this you should use the boxed devices next to the head. Do not perform "mouth-to-mouth" ventilation. Open the bag and proceed as displayed on the instruction sheet".

Participants then entered the experimental scene and proceeded. A study-team member initiated continuous chest compression in the meantime and continued during the individual trial. Each time starting ventilation (BMV squeeze) chest compression was interrupted for adequate quantification. Time was recorded starting when the bag was opened and stopped either after ventilation was correctly initiated or the trial was ended by the applicant or—after 2 min—by the investigators. The manikin's surfaces and the SADs were lubricated. During the entire trial both devices were re-used. In each group one device drop-out was observed, both related to a cuff-leak after more than 50 trials. The correct insertion of the LMAS or LT, cuff inflation, connection and compression of the BMV and individual corrective efforts (if any) were judged. Multiple compressions of the BMV were allowed as displayed

in the manual. In addition, we recorded the number of insertions completed within 2 minutes. Ventilation with a tidal volume of >500 ml was judged as “sufficient” in accordance with ILCOR guidelines. Tidal volumes of between 150 ml and 500 ml were judged as “ILCOR insufficient” and ventilation with tidal volumes <150 ml (equivalent to estimated dead space) were judged as “insufficient”. After the trial applicants were interviewed and asked their opinion of the materials, instructions, and their understanding of BMV ventilation. Finally, they were asked whether they would feel competent to operate an SAD in a real-life resuscitation scenario by following the instruction manual. Primary endpoint was the insertion of the devices in the right direction. Secondary endpoint was a quantitative combined endpoint of insertion, tidal volume > 150ml and ventilation achieved within 120s.

Statistics

Statistical analysis was performed using SAS (Statistical Analyses System), (SAS Institute GmbH, Heidelberg, Germany). A success rate of 95% was expected [19,21]. The power was calculated with a significance level, $\alpha=0.05$. A power of 80% requires a sample size of 120 in each group. In total 150 (LMAS) and 149 (LT) applicants were included to compensate for possible dropouts. The power calculation was performed using nQuery Advisor® Version 7.0 (Statistical Solutions, Saugus, MA, USA). A Chi-squared test was used to calculate statistical differences in success rates with respect to gender, previous BLS training, and studying in the field of engineering. A T-test was used to calculate statistical differences in time of insertion with respect to age and sex. Correlation was calculated by regression analysis. Data are presented as means \pm standard deviations unless stated otherwise. A $P < 0.05$ indicated statistical significance.

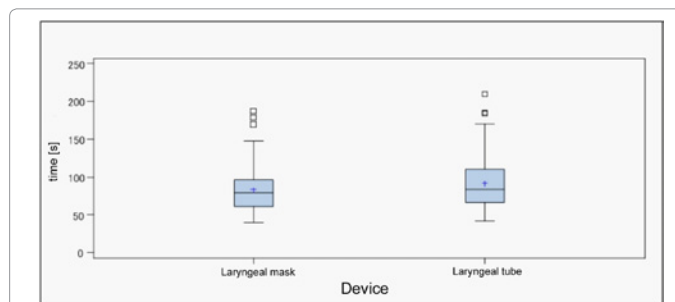
Results

Data from a total of 299 laypersons (LT n=149 and LMAS n=150) were analyzed. Mean age was 22.3 (22.3 \pm 3.5) years in the LT group and 22.9 (22.9 \pm 2.8) years in the LMAS group (n.s.). 76.3% of the participants were male (n=228) and 23.7% female (n=71) (Table 1). Overall 96.7% (n=145) of the applicants in the LMAS and 96% (n=143) in the LT group inserted the SAD in the correct orientation. No significant difference between devices was found with regard to incorrect insertion, e.g. rotated or inverted (LT 4.7%, n=7 vs. LMAS 6%, n=9; P=0.79). Applicants identified and corrected 6 out of 7 faulty insertions in the LT and 5 out of 9 in the LMAS group (P=0.3). Quantitative procedural analysis (insertion, tidal volume >150 ml and ventilation in <120 s) revealed a total of 94 (63%) applicants in the LT and 119 (79.3%) in the LMAS group successfully initiating ventilation (P=0.0022). Time needed for insertion and successful first ventilation was 80.6 \pm 26.2s (LT) and 75.1 \pm 23.9s (LMAS) respectively (P=0.17) (Figure 2). A quantitative comparison of the two devices using the more strict criteria of an error-free performance and a tidal volume

	Male	female	Total
Laryngeal mask	121 (80.7%)	29 (19.3%)	150 (50.2%)
Laryngeal tube	107 (71.8%)	42 (28.2%)	149 (49.8%)
Total	228 (76.3%)	71 (23.7%)	299

Demographic data, RWTH Aachen was founded as a technical university. Therefore the difference in number of applicants in relation to gender represents current diversity in non-medical and non-social faculties. Data are total numbers and percentage.

Table 1: Demographic data.



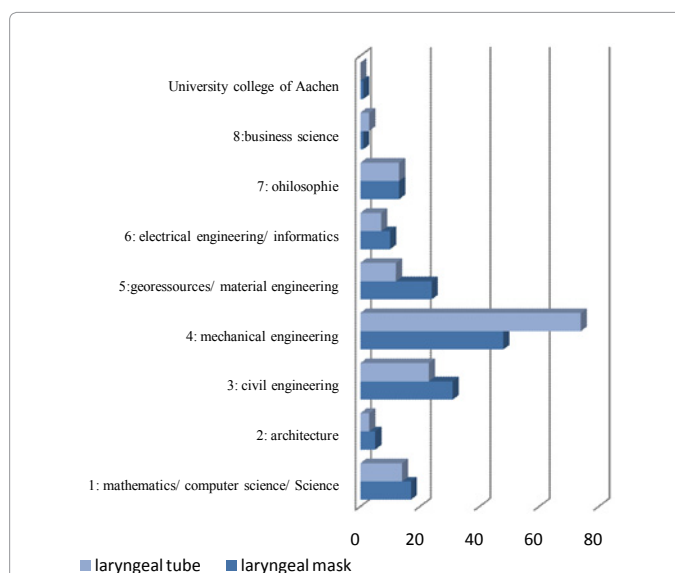
Related to the technical and engineering orientation of the RWTH Aachen University most participants were recruited from these faculties. With regard to the attribute “engineering” no significant difference in performance between engineers—assuming a more “technical” understanding - and other faculty students operating the devices could be demonstrated (LMAS P=0.07 vs. LT P=0.9). Data are numbers.

Figure 2: Time to successful insertion and ventilation (tidal volume >150 ml).

Step of induction	LT	LMAS	P value
1. Withdrawal of material from bag	0 (0%)	0 (0%)	
2. Head tilt	28 (18.8%)	30 (20%)	0.79
no correction	21 (75%)	27 (90%)	0.18
3. Wrong direction of device	7 (4.7%)	9 (6%)	0.79
no correction	6 (85.7%)	5 (55.6%)	0.14
4. No insertion up to marker	61 (40.9%)	49 (32.7%)	0.15
no correction	58 (95.1%)	42 (85.7%)	0.06
5. Cuff inflation	22 (14.8%)	9 (6%)	0.001
6. No connection to BVM	11 (7.4%)	1 (0.7%)	0.003
7. Forgotten squeeze of BVM	3 (2%)	1 (0.7%)	0.3
8. Cuff valve identification	12 (8%)	33 (22%)	0.03

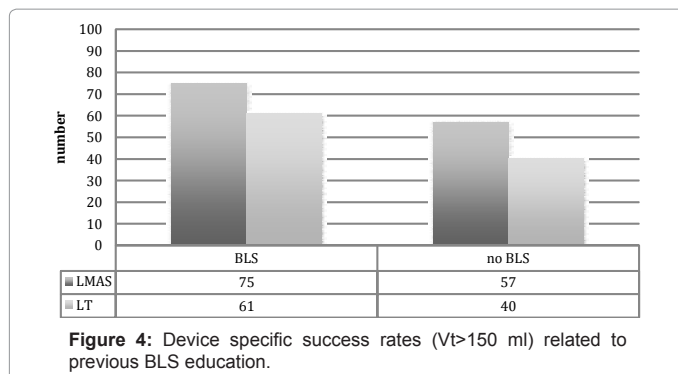
Analysis of procedural mistakes regarding LT and LMAS insertion No significant difference could be observed regarding withdrawal of the materials, inserting devices up to the correct depth, correction of a tilt head and the right direction of the device. Data are numbers and percentage.

Table 2: Procedural mistakes identified using LT or LMAS.



Success rates for both devices were independent from previous BLS education (LMAS: P=0.85 and LT: P=0.63). Data are presented as percentage. No significant difference between the devices regarding time to ventilation applying a tidal volume >150ml could be detected. Time needed for insertion and a successful first ventilation was 80.6 \pm 26.2s (LT) and 75.1 \pm 23.9s (LMAS) respectively (p=0.17).

Figure 3: Classification of participants regarding school and faculty.



>500 ml did not reveal a significant difference between both SAD (LT 46.6%, $n=76$ vs. LMAS 53.4%, $n=87$; $p=0.23$).

Significantly, more persons in LT group failed to connect the BMV to the device within a 120s interval (LT 7.4% ($n=11$) vs. LMAS 0.7% ($n=1$); $P=0.003$). 3 participants in the LT and one participant in the LMAS group forgot to squeeze the BMV ($P=0.3$) (Table 2). In both groups participants were most commonly mechanical engineering students followed by civil engineering. For both devices the attribute “engineering” however, did not come along with a higher rate of success (LMAS $P=0.07$ vs. LT $P=0.9$) (Figure 3). 21 of the applicants (7%) had no previous BLS training (LT 6.1%, $n=9$; vs. LMAS 8%, $n=12$; $P=0.65$). In both groups previous BLS education was not associated with a higher rate of success (LMAS: $P=0.85$ and LT: $P=0.63$) (Figure 4). The most common error identified in both groups was the depth of insertion (LT 40.9%, $n=61$ vs. LMAS 32.7%, $n=49$; $P=0.18$) followed by an incorrect or omitted head-tilt on the dummy (LT 18.8%, $n=21$ vs. LMAS 20%, $n=27$; $P=0.53$). As stated by the applicants in both groups however, understanding and operating the devices themselves was subjectively the most serious problem (LT 22.8% ($n=34$) vs. LMAS 24% ($n=36$); $P=0.89$) and was not dependent on a specific SAD. Furthermore, the content of the instruction manual and the quality of the diagrams was judged “improvable” for both (LT 16.8%, $n=25$ vs. LMA 23.3%, $n=35$; $P=0.15$). Significantly more people in the LMAS group reported the cuff inflation valve hard to identify (LMAS 22%, $n=33$ vs. LT 8%, $n=12$; $P=0.03$). Inflating the cuff was reported as significantly more difficult in the LT group (LT 14.8%, $n=22$ vs. LMAS 6%, $n=9$; $P=0.001$). After their trial 175 laypersons (58%) (LT 54%, $n=80$ vs. LMA 63.3%, $n=95$; $P=0.77$) stated they would feel confident to operate an SAD in a “real” emergency situation without further training. A further 37.5% ($n=112$) of the applicants (LT 42.3%, $n=63$ vs. LMAS 32.7%, $n=49$; $P=0.76$) stated they would prefer further training, and only 4% ($n=12$) (LT 4% vs. LMA 4%) confirmed they would decline to use the devices at all. After the individual trial all participants were given verbal feedback and subsequently all unsuccessful applicants succeeded.

Discussion

Discounting technical or procedural errors most applicants in the LMAS and in the LT group inserted the SAD in the correct orientation within two minutes, indicating basic understanding and uptake of the central skill involved. Following ILCOR criteria (tidal volume above 500 ml), no significant difference between the two devices was found. In accordance to recent publications, confirming that verbal guidance is likely to further improve performance, all applicants succeed after final explanations [21,22].

Operating SAD

Participants were not pre-trained or pre-instructed, and had

to acquire all relevant information and skills during the trial itself. According the secondary endpoint time to ventilation in the present study appears rather long (80.6 ± 26.2 s (LT) and 75.1 ± 23.9 s (LMAS)). In contrast to our scenario individual trials were performed after previous instructions by, brief demonstration, video, telephone, written instructions or classic teaching [21-24]. In first year medical students without any prior manual training and instruction time to insert SADs were found at 55s (Laryngeal Mask) and 38s (Laryngeal Mask Fastrach) and could significantly be reduced after minimal instruction [25]. Onsite reading and understanding instructions takes its time. This is likely to account for the comparatively longer times to ventilation found here. In case of a single bystander initiated CCOR, an interruption of cardio-compression for inserting an SAD in approximately 1.5 min, will discredit efforts in CCOR campaigns focusing “cerebral resuscitation”. For gasping occurs frequent early after OHCR of cardiac origin, initiating immediate CCOR in a “more than one” bystander scenario, and a secured airway within 1.5 minutes, neurologic outcome may favorably be influenced. Regular CPR was of an incremental benefit in OHCR of non-cardiac origin [26].

Identifying the correct depth of insertion was the most common problem found in this trial, despite the use of indicator labels. This might be one explanation for the differences in quantity revealed between the two secondary endpoints “ILCOR conformity” and “combined”. Interestingly, no other study investigating laypersons’ or novices’ performance with SAD has described this previously. There may be several reasons: the atmosphere we attempted to create was low-pressure and more explorative, with the possible result that participants tended to avoid applying too much force when inserting the SAD and had no way of gauging how much manual force might be required for correct placement. Surprisingly, only a few applicants noticed and corrected an incorrect depth of insertion, despite this being clearly displayed on the instruction sheet and indicated by a red label on the SAD.

Cuff inflation

Once the cuff was inflated, on noting that the tidal volume applied was insufficient or a leak was present, most laypersons tried to improve the positioning of the device. In this case all applicants first attempted to do so with the cuff still inflated. In this configuration, repositioning the LMAS was easier to achieve than in the LT. The technique of deflating the cuff before repositioning was not used indicating a clear gap in the understanding of the use of cuffed devices. Therefore, if the process of inflating the cuff itself caused mal-positioning or a leak, this proved difficult to correct.

Identifying the cuff inflation valve as the appropriate place to connect the syringe was reported as more difficult in the LMAS ($P=0.03$). The LT body is transparent white while its cuff and inflation line are colored, making them easier to identify than in the LMAS. In addition, following correct identification of the valve, connecting the syringe and inflating the correct volume of air proved to be another pitfall. Interestingly, these problems (i.e. a leak between syringe and valve, an incorrect volume of air, and failing to remove the syringe from the valve) were found more frequently in the LT group ($P=0.001$). In the case of users not familiar with connecting a syringe to a small valve this process is always a weak link. Inflations made without a tight connection frequently led to an incomplete inflation of the balloon and resulted in major leakage. Alternatively, where a tight seal was achieved and the syringe left connected to the valve, air might flow back into the syringe, also resulting in an inadequate seal. Finally, whatever the cause

of insufficient inflation, laypersons must understand the need to refill the syringe with air before reconnecting it to the device and further inflation.

BMV connection

Difficulties connecting the BMV to the device were described significantly more often in the LT group (LMAS 9 vs. LT 22; $P=0.014$). In LMAS the presence of the channel for a gastric decompression led to errors in connection, despite having a different diameter to the BMV connector and the absence of the red color code. In both groups a total of 4 participants simply forgot to squeeze the BMV within the two minutes despite this being displayed in the instruction manual ($P=0.3$). In the hands of laypersons and in the more stressful context of a real resuscitation scenario, the use of a device without the need for cuff inflation (i.e. the I-gel® laryngeal mask) may simplify the procedure and improve performance. [21,27-29].

BLS training and education

Individual success rates operating the LMAS or the LT were shown to be independent of previous BLS training. Similar findings have recently been published concerning the ability of laypersons to operate SADs after instructions by telephone or brief demonstration only [22,24]. We did not find that engineering students (with their assumed higher level of technical aptitude) outperformed students from other faculties with either device [19,24].

SADs

SADs are easier to insert than a tracheal tube and, unlike endotracheal intubation, can generally be placed without interrupting chest compressions [20,30,31]. They are in widespread use, following their incorporation in difficult airway algorithms worldwide as per the ILCOR guidelines [32]. Following brief instructions laypersons have been shown to operate the LMA Fastrach® faster than the LT in the manikin [24]. In both the experienced and the novice, the LMAS has been found to be superior to both the ProSeal® and the LMA Classic® in terms of speed and ease of insertion, effectiveness of ventilation and quality of seal [33-35]. The LT has an excellent alternative to tracheal intubation during daily anesthesia practice in managing the difficult airway, whether expected or unexpected. Both devices have been proven valuable in the out-of-hospital airway management, and have shown to reduce “no-flow time” during professional CPR, even in the hands of the inexperienced [18,19,35,36]. In patients, success rates for novices placing SADs were found to be over 80% and were found even higher (>90%) in the manikin [20,26,37].

Rescue breathing

Whether the practice of teaching rescue breathing to laypersons should be stopped in favor of CCOR, also known as cardio-cerebral resuscitation (CCR) is a debate still ongoing. A part of the case for doing so is that it will increase the chances of a bystander providing CPR—and any CPR is better than none [38-40]. There is increasing evidence that in witnessed collapse associated with cardiac arrest (the most common cause in adults) and fast paramedic response times (<10 min), CCOR is associated with better or at least equivalent survival rates [38-40]. Of note, all studies were completed before the introduction of the current 30:2 CPR guidelines. During unconsciousness, the human airway is rather flaccid and will tend to occlude without active maneuvers to keep it patent (e.g. chin lift, ETI, SAD etc.) [41,42]. Performing CPR without ventilation leads to a steady decrease in blood oxygenation and, after

approximately 6 minutes, the advantages of continuous CCOR are offset by hypoxemia. Even a single rescue breath delivered every 100 compressions, has been shown to favorably influence outcome [43]. Gasping or abnormal breathing is common after cardiac arrest but decreases within minutes. Patients gasping at initialization of CPR are associated with a favorable outcome [44].

Limitations

Some limitations should be discussed. The RWTH Aachen University was founded as a technical university, and is still dominated by a majority of male students. Correspondingly we make no attempt to analyze gender related differences. Results presented are obtained in a manikin model and cannot be directly transferred into (pre) clinical practice. Operating and inserting an SAD in the manikin may differ significantly from inserting the same device in patients [27,45]. Moreover, different manikins do not perform equally, and no one manikin performs best for SAD insertion. Therefore, care is required when studying and comparing the performances of different SADs [27]. Nevertheless, there is currently no substitute for the safe, standardized and robust environment provided by the manikin, and which is essential for a feasibility study such as ours. The correct insertion of an SAD and achievement of a good seal is more difficult in patients than in manikins, with lower success rates and more time required [29,45]. Correspondingly, we simply cite our secondary combined endpoint “time to insertion and successful ventilation” and refrain from further discussion in favor of presenting our procedural findings. In this context we use “correct direction of insertion” of the devices as an indicator of a rudimentary understanding and uptake of how an SAD is used.

Choosing university students, though non-medical still confers a bias with respect to educational level compared to the general population. However, it remains speculative as to whether this variable would influence performance. In a recent trial we showed that after a brief demonstration a non-academic population is enabled to operate SAD in the manikin with a high rate of success [24].

With respect to ILCOR and ASA guidelines emphasizing the clear benefit in survival after early defibrillation, airway management and installation of an AED might “compete” and conflict in sequence and, of course, might overburden lay responders without basic AED or SAD training. It remains speculative if laypersons would prefer either AED or SAD when both are available onsite and, instructions are provided by an illustrated diagram only.

It is clear that the establishment of SAD-assisted ventilation is faster when subjects receive instruction in advance, regardless of the training modality [21-24]. The implementation of SADs and their “troubleshooting” in BLS courses is likely to lead to higher rates of success in their use, as well as wider acceptance of the importance of achieving ventilation in the course of delayed initiation or prolonged CPR and OHCA of non-cardiac origin [14,26,46]. However, instructions given by an illustrated operation manual may be considered an adjunct to any SAD, enabling laypersons to operate SAD in case of emergency, either without previous skills training or as a tool recapitulation and summing up lessons learned in future BLS classes.

Conclusion

In a matter of minutes and a high degree of success, using four

illustrated diagrams, and without any prior training, laypersons can acquire the basic understanding and skills to operate two different SADs in the manikin. We envisage that CCOR would be initiated, then within a certain period of time a second person would establish ventilation using an SAD, with instructions supplied on-site, and without interruption to chest compressions. This approach may also bring about an improvement in laypersons compliance with the demand for bystander resuscitation and reduce individuals' threshold providing MTM ventilation.

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