ORIGINAL ARTICLE

Annals of Agricultural and Environmental Medicine 2023, Vol 30, No 4, 715–720
www.aaem.pl

Comparing results of three measurement techniques used to determine the size of oropharyngeal airway in adults

Jakub Bieliński[1,A-B,D,F], Filip Jaśkiewicz[1,A,C,E-F], Dariusz Timler[1,E-F]

[1]*Department of Emergency Medicine and Disaster Medicine, Medical University of Lodz, Poland*
A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of the article

Bieliński J, Jaśkiewicz F, Timler D. Comparing results of three measurement techniques used to determine the size of oropharyngeal airway in adults. Ann Agric Environ Med. 2023; 30(4): 715–720. doi: 10.26444/aaem/171023

Abstract

Introduction and Ojective. The oropharyngeal airway, also known as the Guedel airway, is a crucial medical device used for over a century as a basic way to maintain a patient's airway open and secure. Although it is easy to use, this can be misleading as incorrect sizing can lead to injuries, bleeding, laryngospasm, and potentially fatal complications. This study aims to compare three techniques for selecting the appropriate oropharyngeal airway size using craniofacial anatomical landmarks.
Materials and method. Three facial distances were measured, each one according to the techniques described in the scientific sources. For greater reliability of the test, measurements were made sequentially with two different methods.
Results. The study included over 500 participants. Depending on the measurement technique used, different results of average lengths and thus approximate sizes of oropharyngeal airway were obtained. This indicated that depending on which technique is used for measuring purposes, differences in the size of the oropharyngeal airway can be up to 2–3 cm, with a high degree of statistical significance.
Conclusions. Using different craniofacial anatomical landmarks to select the size of the oropharyngeal airway can yield significantly varied results for the same adult patient, thus posing a potentially fatal threat. To ensure effective and safe airway management, proper ventilation and oxygenation, it is recommended to follow the ISA (Initial Size Approximation) approach when choosing the oropharyngeal airway size in medical education, training, and clinical settings. Further research is needed to explore this matter, also in different populations

Key words
airway management, ventilation, airway obstruction, respiratory therapy, emergency medicine, oropharyngeal, airway, medical device

INTRODUCTION AND OBJECTIVE

The oropharyngeal airway (OPA) made its debut in 1908 when Sir Frederic W. Hewitt, Anaesthetist to His Majesty King Edward VII, designed it as a simple solution to a condition described at that time as 'auto-asphyxia', in which a patient undergoing general anaesthesia began to show signs of laboured and noisy breathing. The problem can be encountered by many anaesthetists, and frequently mistaken as a chloroform overdosage or a surgical shock, and became correctly recognized as an upper airway obstruction caused by a relaxed tongue covering the glottis [1, 2]. The OPA, shaped as we know it, was firstly described in 1933 by another famous anaesthetist, Dr Arthur E. Guedel, an American anaetheologist, who supposedly tested his inventions on a family dog which was sedated and dunked underwater for an hour and then revived [3, 4]. Much has changed since then, and the effectiveness of the airway repeatedly tested in human experiments using endoscopy and radiography [5, 6]. The thorough knowledge acquired through all those years suggest the high effectiveness of the OPA, which nowadays is considered as a simple solution to a complex problem used by many medical workers, such as paramedics, nurses and physicians [7]. In Poland, it is also utilised daily by non-medical first responders, e.g. firefighters, police officers, soldiers, lifeguards and mountain rescuers [8].

It has been proven that the most crucial factor determining the effectiveness of the OPA is selecting the correct size. According to evidence-based medicine, the use of an incorrectly sized OPA can paradoxically lead to potentially fatal consequences. When the airway is too big, it can impinge on the glottis and result in an injury to the laryngeal structures and possible bleeding in the airway, tissue necrosis and potential laryngospasm [7, 9, 10, 11]. On the other hand, when it is too small its tip will be obstructed by the tongue, resulting in inadequate ventilation, or even push the tongue towards the pharynx, and increase the degree of obstruction [7, 9, 12]. While the process of inserting the OPA is simple and commonly known, there is a significant diversity in the educational content of courses and university classes regarding the proper technique of size measuring [13 – 16]. Many techniques have been developed to find the correct size. By measuring the distances between two craniofacial anatomical landmarks, the rescuer can select the correct size of airway.

This study discusses three techniques known to work correctly with the majority of patients [7, 13 – 18]. Data describe them exactly explain OPA's efficiency in airway

✉ Address for correspondence: Dariusz Timler, Medical University, Pomorska 251, 92-213 Łódź, Poland
E-mail: dariusz.timler@umed.lodz.pl

Received: 14.06.2023; accepted: 14.08.2023; first published: 18.10.2023

management and ventilation. However, the comparative knowledge of these techniques, their repeatability and effectiveness is insufficient. This aroused the curiosity of the authors of the presented article about this important and underestimated topic, and prompted a comparative evaluation of the most common techniques of selecting the size of the OPA.

The main aim of the study was to compare the results of measurement of three techniques used for selecting the size of OPA recognized in the academic literature [7, 17, 18] and specialist textbooks [13 – 16].

The specific objectives of the study were as follows:

1) comparison of results between various measurement of:
   - distance between the corner of the mouth and earlobe (T1) vs. length between the gap separating the upper central incisors and angle of the mandible (T2);
   - distance between the corner of the mouth and earlobe (T1) vs. length between the level of the upper central incisors and of the mandible (T3);
   - distance between the gap separating the upper central incisors and of the mandible (T2) vs. length between the level of the upper central incisors and angle of the mandible (T3).
2) Comparison of the consistency of the results of selecting the size of the OPA by the practical method (PrM) used in everyday clinical work with the control method (CoM) using a vernier caliper.

MATERIALS AND METHOD

Study design and setting. The study was performed between June 2022 – February 2023. The study received the positive opinion of the Bioethics Committee at the Medical University of Lodz (Approval No. RNN/233/22/KE). The measurements were carried out at the Clinical and Didactic Centre of the Medical University of Łódź in central Poland.

Participants. Applications to participate in the study were carried out remotely, using an online application questionnaire posted on social media platform *Facebook* (Meta Platforms, Inc., Menlo Park, CA, USA). Participation was voluntary. Inclusion criteria: minimum age of 18 years and Caucasian race, for cohesion of the study group. Exclusion criteria: craniofacial anomalies indicating a non-physiologically formed airway, any past surgeries of the facial skeleton or the outer ear, restricted mobility of the head resulting in inability to place it in a neutral position while lying on the back on a flat surface, lack of incisors, lack of earlobe, or a history of trauma to the outer ear.

Data sources / measurement. Three facial distances were measured using two different methods sequentially:

- PrM – using a set of commercially available OPAs (Ningbo Hi-Tech Unicmed Imp. & Exp. Co. Ltd., Ningbo, China).
- CoM – using a commercially available vernier caliper 0 – 150 mm MF790015 (Mastiff GmbH, **–? –** Germany).

Measurements were made with participants laying on their back on a flat surface with the head in a neutral position. The PrM was measured by applying the OPA's flange and its pharyngeal tip to the measurement landmarks. Airway with a size closest to this distance was marked as adequate. In the CoM, the ends of the vernier caliper's jaws were applied to the measurement landmarks and the results e recorded in millimetres.

Each measurement was made according to the techniques described in scientific sources and given as the distance between:

- T1 – corner of the mouth and the other one at the earlobe (Fig. 1).

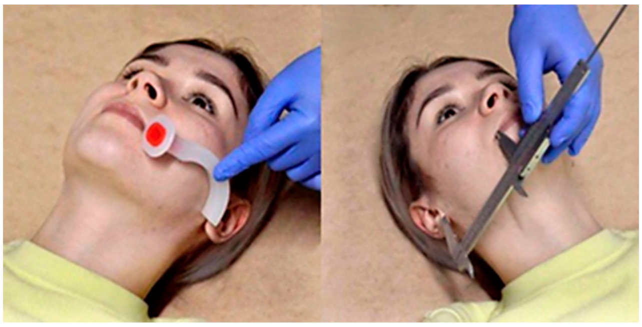

Figure 1. T1 – corner of the mouth and the other one at the earlobe

- T2 – gap separating the upper central incisors and angle of the mandible (Fig. 2).

Figure 2. T2 – gap separating the upper central incisors and angle of the mandible

- T3 – evaluated with the assistance of a tongue depressor, by placing it at the level of the upper central incisors and connecting it to one jaw of the vernier caliper, with the other placed at the angle of the mandible (Fig. 3).

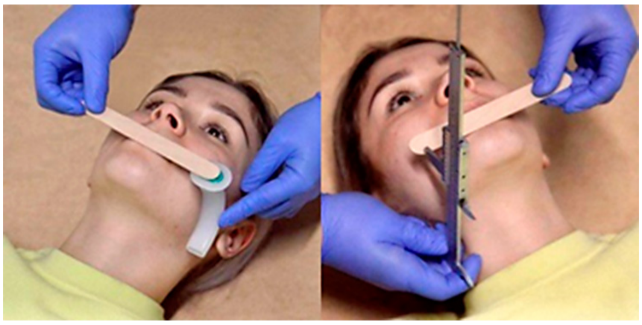

Figure 3. T3 – evaluated with the additional assistence of tongue depressor, by placing it at the level of the upper central incisors and connecting it to one jaw of the vernier caliper, while the other was placed at the angle of the mandible

Statistical analysis. Statistical analyses were performed using the PQStat statistical package, version 1.8.4.152. Elements of descriptive statistics were used to determine the mean (x), minimum (Min.), maximum (Max) and standard deviation (SD). The results between the three measurements were compared by repeated measured analysis of variance and *post hoc* Tukey's test. Between the three measurement techniques, intraclass correlation coefficient (ICC) was estimated. The test probability at the level of $p < 0.05$ was considered significant, and the test probability at the level of $p < 0.01$ was considered highly significant. Sample size was calculated by G*Power 3.1 using a two-tailed t-test. At least 484 cases were needed to reach Cohen's d = 0.14, alpha error = 0.05 and power = 0.95. To provide a safety margin in case of missing data or non-participation, the minimum size of the study group was increased to 521.

RESULTS

The study included 521 individuals with data collected from 235 females and 286 males (45.11% and 54.89%, respectively). Average age – 34.9 ± 15.1 (Min. 18, max. 82-years-old); average height – 173.8 (min. 145, max. 210 centimetres). 52% of the study population came from rural areas.

Depending on the measurement technique used (T1/T2/T3), different results of average lengths and thus approximate sizes of OPA were obtained.

Table 1. General results of the OPA size measurements with three techniques obtained by practical and control methods

N = 521	PrM x ± SD	CoM x ± SD
T1	103 ± 9.1 mm	101 ± 7.1 mm
T2	108 ± 8.8 mm	105 ± 7.6 mm
T3	88 ± 8.7 mm	91 ± 8.1 mm

OPA – oropharyngeal airway; N – population size; x – mean; SD – standard deviation; PrM – practical method; CoM – control method; T1 – technique 1; T2 – technique 2; T3 – technique 3

CoM's results are consistent with the above-mentioned variance, which indicates acceptable accuracy and measurement repeatability of PrM's results. The biggest differences with respect to the nearest size of the OPA are seen between the T2 and T3; however, based on comparative analysis, highly significant ($p < 0.01$) differences were found between all three measurement techniques, carried out by both PrM and CoM (Fig. 4, Fig. 5).

A similar tendency for the occurrence of different measurement results depending on the techniques can be seen in the analysis of arithmetic means of measurements in subgroups depending on gender.

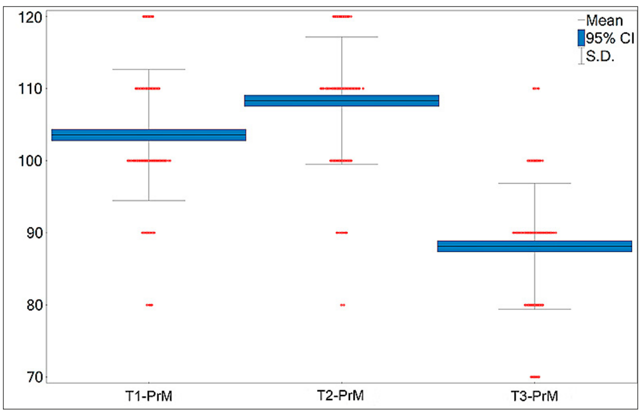

Figure 4. Comparison of measurement results using three OPA sizing techniques – a practical method.
OPA – oropharyngeal airway; T1 – technique 1; T2 – technique 2; T3 – technique 3; PrM – practical method; 95% CI – 95% confidence interval; S.D. – standard deviation

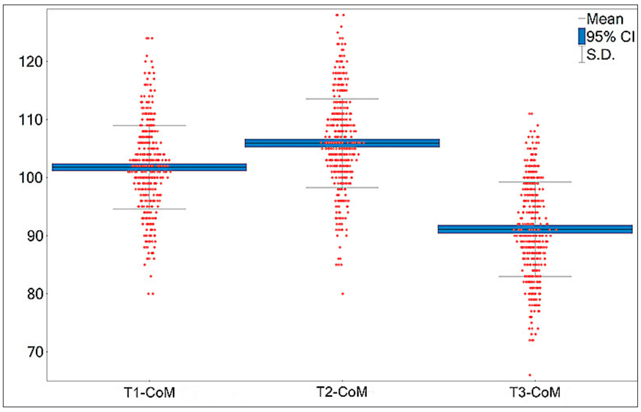

Figure 5. Comparison of measurement results using three OPA sizing techniques – control method.
OPA – oropharyngeal airway; T1 – technique 1; T2 – technique 2; T3 – technique 3; CoM – control method; 95% CI – 95% confidence interval; S.D. – standard deviation

Table 2. Comparison of measurement results using three OPA sizing techniques

	x ± SD					
	T1-PrM	T1-CoM	T2-PrM	T2-CoM	T3-PrM	T3-CoM
Men N = 286	106 ± 8.9	105 ± 6.7	110 ± 8.0	111 ± 8.1	92 ± 12.5	97 ± 14.1
Women N = 235	100 ± 7.6	98 ± 6.4	106 ± 8.9	102 ± 10.4	86 ± 8.4	88 ± 6.8

OPA – oropharyngeal airway; N – population size; x – mean; SD – standard deviation; PrM – practical method; CoM – control method; T1 – technique 1; T2 – technique 2; T3 – technique 3

In order to obtain a full and reliable view of the issue from the perspective of a single patient, the frequency of potential differences in measurements with individual technique and the number of OPA's sizes were analyzed. Differences in the obtained measurement results in relation to the size of OPA occur in most cases and are not dependent on gender. Differences of more than 2 or ≥ 3 sizes between the T2 vs. T3 and with a slightly lower incidence of T1 vs. T3.

Table 3. Differences in the number of sizes depending on the measuring technique - practical method

	OPA's size difference PrM	1 size difference	2 sizes difference	≥ 3 sizes difference
All study group; N = 521				
T1 vs. T2	321 (61.6%)	240 (46.0%)	74 (14.2%)	7 (1.3%)
T2 vs. T3	489 (93.8%)	123 (23.6%)	202 (38.7%)	164 (31.4%)
T1 vs. T3	464 (89.0%)	213 (40.8%)	158 (30.3%)	93 (17.8%)
Men; N = 286				
T1 vs. T2	178 (62.2%)	139 (48.6%)	37 (12.9%)	2 (0.7%)
T2 vs. T3	269 (94.0%)	58 (20.2%)	120 (41.9%)	91 (31.8%)
T1 vs. T3	257 (89.8%)	102 (35.6%)	90 (31.4%)	65 (22.7%)
Women; N = 235				
T1 vs. T2	143 (60.8%)	101 (42.9%)	37 (15.7%)	5 (2.1%)
T2 vs. T3	220 (93.6%)	65 (27.6%)	82 (34.8%)	73 (31.0%)
T1 vs. T3	207 (88.0%)	111 (47.2%)	68 (28.9%)	28 (11.9%)

OPA - oropharyngeal airway; N - population size; PrM - practical method; T1 - technique 1; T2 - technique 2; T3 - technique 3.

Against the background of the entire study group and the subgroup of men, the difference in the measurement result between the T1 vs. T3 equal to or exceeding 3 sizes, is less common in women.

For a more in-depth analysis, intraclass correlation coefficients (ICC) were calculated. The lack of consistency between the methods is revealed. The ICC analysis indicates that the differences in the results are not due to an easily identifiable bias but are of a more complex nature.

Table 4. Intraclass correlation coefficients for OPA sizing techniques

		ICC	95% CI	p-value
CoM	absolute agreement	0.283	0.0098 - 0.517	< 0.0001
	consistency	0.563	0.5148 - 0.6098	< 0.0001
PrM	absolute agreement	0.137	-0.0097 - 0.2944	< 0.0001
	consistency	0.332	0.275 - 0.3886	< 0.0001

OPA - oropharyngeal airway; ICC - intraclass correlation coefficient; 95% CI - 95% confidence interval; p-value - probability value; CoM - control method; PrM - practical method

DISCUSSION

Since the selection of proper OPA's size impacts on the effectiveness of airway management and ventilation, the technique of sizing should be an important subject in the medical literature. Surprisingly there are only few papers discussing more than one technique. Others focus on searching for the single most common size of the OPA [5, 6, 17]. Research by Kim-Kim et al. using a fibre-optic bronchoscope, measured and compared two external facial measurements for the selection of an appropriately-sized airway in adults [17]. The data collected indicated that OPA sized with the distance from the maxillary incisors to the angle of the mandible is more beneficial than if based upon the distance from the corner of the mouth to the angle of the mandible. In the current study, the first technique is labelled as 'T2', although the second technique analysed in the Kim-Kim et al. study is no longer widely supported in evidence-based medicine. Nemeth-Ernst used magnetic resonance imaging to validate the accuracy of using distances between two craniofacial anatomical landmarks in size estimation of OPA in children [19]. They considered T2 as the least inaccurate sizing technique, warning that it cannot reliably predict the size of an OPA, and its efficacy should be evaluated clinically.

The purpose of the current study was not to try to find a single size that would apply to the entire population or to one gender, but to answer the question: 'does simple mean repeatable and effective?' Compared to blind insertion airway devices (BIAD), such as laryngeal tubes, laryngeal masks or even to endotracheal intubation, OPA is considered a very simple tool [20]. Such thinking, however, can easily lead to the belief that its use is also simple, and different sizing techniques can be used interchangeably and are not a topic worth focusing on. The results of the current study show that such a schematization is purposeless, because even the three most recognized techniques produce different results. It is crucial not to adhere blindly to the measurement technique or the most used OPA in each population, but always to think clinically and repeatedly evaluate the effectiveness of a rescuer's actions.

More attention should be paid during training programmes to the selection of the correct OPA. It should be clearly emphasized that using one of the well-known techniques does not necessarily mean that the airway patency is effective, and should be used only as an initial approximation of size.

Repeatable assessment of the effectiveness of airway patency and ventilation with simple equipment like the OPA and bag valve mask (BVM) should also be of prime importance in the training curriculum. This method of initial ventilation is an inexpensive solution and therefore available in medical units in most countries. However, it should be borne in mind that it is applied at the beginning of the pre-hospital or early hospital stage, and usually performed by first responders or medical personnel who may not have dealt on a daily basis with cardiac arrest or respiratory failure. In the case of sudden cardiac arrest or respiratory failure, although it may seem obvious, the first minutes of the emergency and the quality of the airway and ventilation until the arrival of more experienced medical personnel will be decisive for the survival of the patient and neurological outcome [15, 16, 21 – 26]. From this perspective, the method of training, determination of the relationship between OPA selection techniques, effective ventilation and continuous assessment of the effectiveness of these actions, is crucial.

Records in four of the most conventional textbooks on trauma and cardiac arrest management were compared. The comparison showed that the greatest attention to the assessment of the effectiveness of an OPA is best described in the *Advanced Cardiac Life Support Manual* (ACLS) [13]. Unfortunately, the *Advanced Life Support* (ALS), *International Trauma Life Support* (ITLS) and *Prehospital Trauma Life Support* (PHTLS) manuals treat the problem of sizing the OPA laconically [14 – 16]. In the European Resuscitation Council, the problem of the ALS guidelines [21] is not addressed at all. While the ALS and ITLS manuals promote T1, the ACLS and PHTLS promote T2, without further clarifying whether the rigid body of the OPA should lay perpendicular or flat on the patient's skin, as seen in T3. Additionally, inaccuracies can be found in the above-mentioned sources, such as contradictions between the description of the technique and the figure photography illustrating its implementation, modifications made to the sizing techniques without any proof of their effectiveness, and suggesting interchangeability of techniques, indicating that each one will produce the same result, i.e., clearing and securing the airway.

In the present study, for greater reliability of the test and to minimize the risk of measurement error by using only PrM, it was performed with a much more accurate method using a measuring tool, such as a vernier caliper. The results of both methods were consistent in the study group. Because the OPAs have full sizes every 10 mm, it is considered that the differences in arithmetic means presented in Tables 3 and 4 are so negligible that it only indicates the reliability of the measurements performed. It is very important to remember that in the present study, CoM was used only for research purposes, to check the correctness of the measurements using the PrM, which is the target method for the patient. In emergencies, such as sudden cardiac arrest (SCA), first responders or medical staff perform with the OPA alone, without the use of additional equipment, because it would be very time-consuming [20–29]. Anyway, it is important that highly significant ($p < 0.01$) differences were found between all three measurement techniques, carried out by both PrM and CoM. It is also noteworthy that in the cases of comparing techniques T2 vs. T3, differences of more than 2 or ≥ 3 sizes occurred in 38.7% and 31.4% of study participants, respectively. Slightly lower, but from the perspective of the patients themselves a significantly high percentage of more than 2 or ≥ 3 sizes difference, was observed in comparison of T1 vs. T3, 30.3% and 17.8%, respectively. The frequency of such large differences in the results of measurements with different techniques was even more visible in the group of men. This occurred especially when comparing T2 vs. T3, where the incidence of difference of 2 or ≥ 3 sizes appeared in 41.9% and 31.8%, respectively, of the male part of study group.

In order to better understand the nature of the differences between the three measurement techniques, intraclass correlation coefficients (ICC) were estimated. The absolute consistency of the measurement made by CoM is 0.2826, which is low, but the consistency of the results is almost twice as high and amounts to 0.5632, which means that the results of the measurements by individual techniques give practically divergent results. However, to some extent these differences are a systematic error. Thus, it is confirmed that T2 generally produces the highest results, T1 shows lower results, T3 the lowest. These differences, however, are not systematic; therefore it often happens that a patient's T1 will give a higher result than T2, or T3 will be higher than T1 and T2. It is also worth noticing that in the case of PrM measurements, both the absolute agreement and consistency are lower than CoM, which is due to the obvious fact that PrM measurements are less accurate and their reliability is much lower. The lack of consistency between the methods indicates that the differences in the results are not due to an easily identifiable bias, but are of a more complex nature, or simply dependent on the anatomy of the patient.

The results of the present study clearly indicate that a simple method does not always mean it is repeatable and effective. There is a need for a more thorough analysis of the research problem in more advanced studies. Differences in the selection of OPA's size, reaching 2–3 cm in such a large group of subjects, should lead to rethinking the laconic treatment of the issue of interchangeability of OPA selection techniques in first responders, medical training and emergency clinical practice. Although emergency medicine, due to its wide scope, needs algorithms and simplifications, in this case emphasis on the anatomy of individual patients, as well as needs of the patient, seem crucial. The results of this study strongly suggest a departure from the standard approach and emphasize the fact that no matter which OPA selection technique is chosen, it is only an initial size approximation (ISA approach). The actual size of the OPA should be selected only on the basis of the reassessment of ventilation effectiveness.

Limitations of the study. Data were gathered only on one specific population living in one area and cannot be regarded as fully representative for the general population. The study also did not assess the effect of opening an airway, or the lack of this effect with individual techniques, but only compared the obtained sizes of OPA, adequate to three techniques and their anatomical measuring landmarks. Moreover, the study was carried out on able-bodied adults, which may limit the validity of the results, and may not be equivalent to those collected in an all-children group, or a population with any kind of disability.

CONCLUSIONS

Choosing the size of the OPA, based on different anatomical craniofacial landmarks, can produce significantly different results for the same adult patient. Therefore, there is the possibility of a potential threat to the patient if the use of popular OPA size selection techniques are treated as being interchangeable and fully reliable.

When choosing the size of an OPA during medical education, training, and in the clinical environment, it is recommended that rescuers should follow the ISA (Initial Size Approximation) approach, and always evaluate their actions to provide effective, safe, airway patency, proper ventilation and oxygenation. Further clinical research should be conducted in this respect.

REFERENCES

1. Hewitt FW. An artificial "air-way" for use during anaesthetisation. The Lancet. 1908;171(4407):490–491. https://doi.org/10.1016/S0140-6736(00)66510-8
2. Haridas RP. The Hewitt airway – the first known artificial oral 'air-way' 101 years since its description. Anaesthesia. 2009;64(4):435–438. https://doi.org/10.1111/j.1365-2044.2008.05755.x
3. Guedel AE. A nontraumatic pharyngeal airway. JAMA. 1933;100(23):1862–1862. https://doi.org/10.1001/jama.1933.27420230001009
4. Baskett TF. Arthur Guedel and the oropharyngeal airway. Resuscitation. 2004;63(1):3–5. https://doi.org/10.1016/j.resuscitation.2004.07.004
5. Kim HJ, Kim SH, Min JY, Park WK. Determination of the appropriate oropharyngeal airway size in adults: Assessment using ventilation and an endoscopic view. Am J Emerg Med. 2017;35(10):1430–1434. https://doi.org/10.1016/j.ajem.2017.04.029
6. González RR, García JT, Lomas A. Importance of size of the Guedel in the patency of the airway during MRI in children. Science Postprint. 2013;1(1):6–6. https://doi.org/10.14340/spp.2013.12C0001
7. Castro D, Freeman LA. Oropharyngeal Airway. In: StatPearls. Treasure Island (FL) StatPearls Publishing; 2022.
8. Regulation of the Minister of Health of 19 March 2007 on the qualified first aid course. Journal of Laws of 2007; No. 60, item 408 as amended.
9. Marsh AM, Nunn JF, Taylor SJ, et al. Airway obstruction associated with the use of the Guedel airway. Br J Anaesth. 1991;67(5):517–523. https://doi.org/ https://doi.org/10.1093/bja/67.5.517
10. Kumar N, Gupta BK, Dubey PK, et al. Palatal pressure necrosis due to inappropriate size of Guedel's airway?. Indian J Anaesth. 2016;60(2):150–150. https://doi.org/10.4103/0019-5049.176284
11. Bhardwaj A, Bhagat H. Necrosis of lower lip due to Guedel's airway in a case of head injury. JNACC. 2014;1(3):219–220. https://doi.org/10.4103/2348-0548.139121
12. Gusti V, Vaghadia H. Hybrid nasopharyngeal and oropharyngeal airway for improving upper airway and capnography in sedated patients. Can J Emerg Med. 2021;23(3):416–417. https://doi.org/10.1007/s43678-021-00090-2
13. Elmer JE, Walls RM, Page RL. ACLS: Advanced Cardiac Life Support Provider Manual. 2020 ed. American Heart Association; 2020.
14. Lott C, Carmona F. ALS: Advanced Life Support Course Manual, European Resuscitation Council Guidelines. 2021 ed. Resuscitation Council; 2021.
15. Alson RL, Han K, Campell JE. ITLS: International Trauma Life Support for Emergency Care Providers. 9th ed. Pearson North America; 2019.
16. National Association of Emergency Medical Technicians. PHTLS: Prehospital Trauma Life Support. 9th ed. Jones & Bartlett Learning; 2018.
17. Kim HJ, Kim SH, Min NH, et al. Determination of the appropriate sizes of oropharyngeal airways in adults: correlation with external facial measurements: A randomised crossover study. Eur J Anaesthesiol. 2016;33(12):936–942. https://doi.org/10.1097/EJA.0000000000000439
18. Ho AK. Should Oropharyngeal Airways Be Included With Public Automated External Defibrillators?. Circulation. 2018;138(16):1620–1622. https://doi.org/10.1161/CIRCULATIONAHA.118.035554
19. Nemeth M, Ernst M, Asendorf T, et al. Guedel oropharyngeal airway: The validation of facial landmark-distances to estimate sizing in children – Visualisation by magnetic resonance imaging (GUEDEL-I):

A prospective observational study. Resuscitation. 2023;184:109702. https://doi.org/10.1016/j.resuscitation.2023.109702
20. Jain S, Nazir N, Khan RM, et al. A prospective randomized control study comparing classic laryngeal mask airway with Guedel's airway for tracheal tube exchange and smooth extubation. Anesth Essays Res. 2016;10(3):552–556. https://doi.org/10.4103/0259-1162.186611
21. Soar J, Böttiger BW, Carli P, et al. European Resuscitation Council Guidelines 2021: Adult advanced life support [published correction appears in Resuscitation. 2021;167:105–106]. Resuscitation. 2021;161(1):115–151. https://doi.org/10.1016/j.resuscitation.2021.02.010
22. Panchal AR, Bartos JA, Cabañas JG, et al. Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_suppl_2):366–468. https://doi.org/10.1161/CIR.0000000000000916
23. Greif R, Lockey A, Breckwoldt J. et al. European Resuscitation Council Guidelines 2021: Education for resuscitation. Resuscitation. 2021;161(1):388–407. https://doi.org/10.1016/j.resuscitation.2021.02.016.
24. Greif R, Bhanji F, Bigham BL, et al. Education, Implementation, and Teams: 2020 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations. Resuscitation. 2020;156(1):188–239. https://doi.org/10.1016/j.resuscitation.2020.09.014
25. Eberhard KE, Linderoth G, Gregers MCT, et al. Impact of dispatcher-assisted cardiopulmonary resuscitation on neurologically intact survival in out-of-hospital cardiac arrest: a systematic review. Scand J Trauma Resusc Emerg Med. 2021;29(1):70–70. https://doi.org/10.1186/s13049-021-00875-5
26. Gräsner JT, Herlitz J, Tjelmeland IBM, et al. European Resuscitation Council Guidelines 2021: Epidemiology of cardiac arrest in Europe. Resuscitation. 2021;161(1):61–79. https://doi.org/10.1016/j.resuscitation.2021.02.007
27. González-Salvado V, Rodríguez-Ruiz E, Abelairas-Gómez C, et al. Training adult laypeople in basic life support. A systematic review. Rev Esp Cardiol. 2020;73(1):53–68. https://doi.org/10.1016/j.rec.2018.11.013
28. Shibahashi K, Sugiyama K, Kuwahara Y, et al. Private residence as a location of cardiac arrest may have a deleterious effect on the outcomes of out-of-hospital cardiac arrest in patients with an initial non-shockable cardiac rhythm: A multicentre retrospective cohort study. Resuscitation. 2020;150:80–89. https://doi.org/10.1016/j.resuscitation.2020.01.041
29. Bylow H, Rawshani A, Claesson A, et al. Characteristics and outcome after out-of-hospital cardiac arrest with the emphasis on workplaces: an observational study from the Swedish Registry of Cardiopulmonary Resuscitation. Resusc Plus. 2021;5:100090. https://doi.org/10.1016/j.resplu.2021.100090