A prospective observational study to evaluate a simple airway management algorithm in the austere environment using the McCoy laryngoscope

Daniel Perin
CTVA Centro de Treinamento em Vias Aereas
Gustavo Inoue (gu.inoue4@gmail.com)
CTVA Centro de Treinamento em Vias Aereas https://orcid.org/0000-0003-2414-1732
Camila S. Campana
Universidade de Sao Paulo Hospital das Clinicas
Maria J. C. Carmona
Universidade de Sao Paulo Hospital das Clinicas

Research article

Keywords: Algorithm, Airway Management, Airway devices.

Posted Date: July 14th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-41227/v1

Abstract

Background Problems related to inadequate oxygen or ventilation remain an important issue regarding anesthesia care, representing more than 30% of primary airway complications in both North America and United Kingdom. Several guidelines have been proposed since the early 1990's. Although they have had important effects on patient's outcome and survival, it is difficult to identify the optimal guideline. This project prospectively evaluated the success rate of a simple intubation management algorithm with costless and low learning curve equipment.

Methods this study included all adult patients (18 years or older) who underwent induction of elective general anesthesia performed by the researchers. A total of 293 patients were included. Their ASA physical status ranged from 1 to 4. After induction of general anesthesia and confirmation of adequate ventilation the algorithm was followed. If ventilation with face mask was impossible or oxygen saturation reached below 90%, the protocol was interrupted. The algorithm was centered on the use of McCoy laryngoscope, "*backward, upward and right upward and rightward pressure" BURP maneuver and bougie.* All patients were evaluated before the induction of anesthesia. The following characteristics were noted: age, sex, dental status (good, regular and poor, defined by the patients themselves), Mallampati index, personal history of apnea or snoring, mouth opening (mm), body mass index (m^2/kg), cervical circumference (cm), previous history of difficult airway, thyromental distance and previous treatment with cervical radiation.

Results all patients were successfully intubated following the algorithm.

Conclusions this algorithm, centered on the use of McCoy laryngoscope, BURP maneuver and bougie, was able to be used successfully in patients of daily practice with a high success rate.

1. Background

Most problems in airway management can be solved by proper adherence to predefined algorithms [1]. Several national anesthesiology societies and experts have proposed strategies using different techniques for “cannot intubate, cannot oxygenate” (CICO) events [2, 3, 4]. Although these protocols contributed to decrease the occurrence of respiratory adverse events mainly in the induction of anesthesia [5], claim reports demonstrate that airway management difficulties are still associated with brain damage or death, representing a considerable fraction of anesthesia cases on litigation-based studies [6, 7]. Considering that, additional educational support and management strategies seems relevant to improve patient's safety.

In these circumstances, most algorithms for airway management incorporate devices conceived to facilitate tracheal intubation or to create a patent airway, but they are most based on expert opinion and lack prospectively validations [1, 2]. Besides, the applicability of strategies may be more or less suitable depending on the location and on the familiarity to the equipment described [1]. Low income countries can benefit with simple and costless algorithms.

Our aim was to evaluate prospectively the success rate of a simple intubation management algorithm with costless and low learning curve equipment [3, 8]. The devices used in the study were: McCoy articulated blade, gum elastic bougie (GEB) and LMA Fastrach™ and the protocol was followed by two anesthesiology residents in the operating room (OR).

2. Methods

2.1 Ethics

The study was approved by the Ethics Committee (*Plataforma Brasil*) at University of Sao Paulo Clinics Hospital (HCFMUSP) (*license number: 68742617.3.0000.0068*). All patients were submitted to and signed written informed consent.

2.2 Study Design and Setting

This was a prospective observational study conducted by two second year and third year anesthesia residents from August 2017 to January 2019. They were given a theoretical-practical training with the devices on standard intubation mannequins before the beginning of the research.

All patients were evaluated by the trainees before the induction of anesthesia and the following characteristics of the patient's physical and historical examination were noted: age, sex, dental status (good, regular and poor, defined by the patients themselves), Mallampati index, personal history of apnea or snoring, mouth opening (mm), body mass index (m^2/kg), cervical circumference (cm), previous history of difficult airway, thyromental distance and previous treatment with cervical radiation.

HCFMUSP is a tertiary teaching hospital that includes a central surgical unit made of 30 ORs. Since there are no anesthetist nurses in our institution and in our country, all ORs must have an anesthesiologist or a senior anesthesia resident taking care for the patients. On a daily basis, each OR has two to three surgeries including all surgical specialties. In cases where an anesthesia resident is present, four-hands induction of anesthesia is systematically performed and the trainee usually initiate standard airway management.

2.3 Patients

The study included all adult patients (18 years or older) who underwent induction of elective general anesthesia performed by the researchers. Subjects who underwent orotracheal intubation with topical anesthesia and/or conscious sedation, obstetric patients and patients submitted to general anesthesia in emergency situations were excluded.

2.4 Algorithm Description

All patients were put in sniffing position and pre-oxygenation was performed for 3 minutes with 100% oxygen flow on a face mask and general anesthesia with neuromuscular block was performed. The anesthesia provider assessed the ease of face mask ventilation and graded it using the HAN scale [9].

The first tracheal intubation attempt was with the McCoy laryngoscope without articulating the lever, like a conventional laryngoscope. At that time, the modified Cormack-Lehane classification (CLm) was observed. In case of failure and/or CLm of 3A or higher, the articulated blade was used in conjunction with "*backward, upward and rightward pressure*" (BURP) maneuver. In case of a new failure, the bougie would be used for CLm 3A or lower. And if intubation was not achieved, the Fastrach™ was used and one blind attempt of tracheal intubation was done through the device (Fig. 1). Tracheal intubation was confirmed after observation of 3 capnography curves and adequate capnometry.

If face mask ventilation was impossible or if arterial oxygen saturation (SpO2) decreased to less than 93%, Fastrach™ would be used to rescue oxygenation and the study would be interrupted. From this moment, the attending physician responsible for the case would be able to use other methods to oxygenate the patient or to discontinue intubation attempts and allow the patient to recover.

2.5 Outcome variables

The primary outcome was the success rate for tracheal intubation using the algorithm. The secondary outcome was the evaluation of clinical characteristics correlated to difficult direct laryngoscopy intubation.

2.6 Statistical Analyses

Descriptive statistics, including frequency counts, proportion, mean, and standard deviation (SD) calculation, were computed using Chi-squared, ANOVA and likelihood ratio tests with IBM-SPSS software, version 20.0 (Chicago, IL).

3. Results

Two residents performed tracheal intubations during 18 months of the research. A total of 293 patients were included in the study and all patients were successfully intubated following the algorithm. Intubation through laryngeal mask Fastrach™ was not necessary because all cases ended on the third step of the algorithm (articulated McCoy blade + BURP + Bougie). Two subjects were excluded from the study because their surgeries were previously canceled. No patients presented impossible ventilation by face mask and there was no hypoxemia during intubation attempts in the study cases.

Patients characteristics are given in table 1. Airway management of all patients are shown in the flowchart of figure 2. The algorithm was effective in solving all unanticipated airway problems.

Table 1. Patients demographics

Variables	Description	Variables	Description
	(N = 293)		(N = 293)
Gender, n (%)		**Cervical mobility, n (%)**	
Female	147 (50,2)	Normal	286 (97,6)
Male	146 (49,8)	Reduced	7 (2,4)
Age (yr)		**Dental status**	
mean ± SD [a]	52,3 ± 15	No teeth	18 (6,1)
median (min.; max.)	54 (18; 89)	Good	106 (36,2)
BMI [b] (Kg/m^2)		Regular	78 (26,6)
mean ± SD	27,1 ± 5,3	"Poor"	91 (31,1)
median (min.; max.)	26,6 (16,4; 48,6)	**Snoring or Sleep Apnea, n (%)**	
Cervical circumference (mm)		No	128 (43,7)
mean ± SD	365,3 ± 59,6	Yes	165 (56,3)
median (min.; max.)	380 (320; 480)	**Mouth opening**	
Modified Cormack-Lehane, n (%)		mean ± SD	41,6 ± 5,2
1	194 (66,2)	median (min.; max.)	41 (28; 60)
2A	59 (20,1)	**Thyromental distance (mm)**	
2B	30 (10,2)	mean ± SD	75,7 ± 13,1
3A	10 (3,4)	median (min.; max.)	74 (50; 170)
HAN scale, n (%)		**Cervical Radiotherapy, n (%)**	
No ventilation	3 (1)	No	290 (99)
Grade 1	150 (52,1)	Yes	3 (1)
Grade 2	99 (34,4)	**Intubation Success, n (%)**	
Grade 3	36 (12,5)	Unarticulated McCoy	250 (85,3)
Mallampati, n (%)		Articulated McCoy + BURP	29 (9,9)
1	97 (33,1)	Articulated McCoy + BURP + BOUGIE	14 (4,8)
2	105 (35,8)		
3	80 (27,3)		
4	11 (3,8)		

a. Standard deviation; b. Body mass index

All 29 patients who were intubated on the algorithm's second step presented an improvement on their CLm after articulating the lever on McCoy blade associated to BURP maneuver (7 patients changed from 2A to 1; 2 patients from 2B to 1; 19 patients from 2B to 2A; and one patient from 3A to 1).

On the other hand, improvement with lever activation and BURP seems less effective in worse CLm visualizations in the first attempt. Only five cases submitted to the algorithm third step presented a significant improvement on their CLm after articulating the McCoy blade (all of them from 3A to 2B) (Table 2).

Table 2. Patients at 1st laryngoscopy and after algorithms manipulations.

	Algorithm step	Unarticulated blade	Articulated blade + BURP		Articulated blade + Bougie + BURP	
	Patients, n (%)	250 (85.3)	29 (10)		14 (4.7)	
	Intervention	1st laryngoscopy	1st laryngoscopy	Articulated blade + BURP	1st laryngoscopy	Articulated blade + BURP
Visualization	CLm [a] 1, n (%)	194 (77.6)	-	10 (34.5)	-	-
	CLm 2A, n (%)	51 (20.4)	7 (24.1)	19 (65.5)	-	-
	CLm 2B, n (%)	5 (2)	21 (72.4)	-	1 (7.1)	6 (42.8)
	CLm 3A, n (%)	-	1 (3.5)	-	13 (92.9)	8 (57.2)
			Articulated blade + BURP		Articulated blade + Bougie + BURP	
			Improvement of CLm scale	Number of patients	Improvement of CLm scale	Number of patients
	Change in CLm scale after interventions	-	2A to 1	7	3A to 2B	5
		-	2B to 2A	19	-	-
		-	2B to 1	2	-	-
		-	3A to 1	1	-	-

a. Modified Cormack-Lehane classification

As secondary outcomes, we noticed that HAN scale, Mallampati grades and BMI statistically influenced for difficulty in intubations (table 3).

Table 3. Secondary outcome analysis.

Variables	Intubation: Unarticulated McCoy N = 250	Articulated McCoy + BURP N = 29	Articulated McCoy + BURP + BOUGIE N = 14	Total N = 293	p
Gender, N (%)					0,56
Female	124 (84,4)	17 (11,6)	6 (4,1)	147	
Male	126 (86,3)	12 (8,2)	8 (5,5)	146	
Age (years)					0,764
Mean ± SD	52,2 ± 15,4	52,1 ± 12,3	55,2 ± 14	52,3 ± 15	
Median (min.; max.)	52 (18; 89)	54 (26; 75)	56,5 (34; 80)	54 (18; 89)	
BMI (kg/m²)					0,045
Mean ± SD	26,8 ± 5,2	28,1 ± 6,4	30 ± 3,5	27,1 ± 5,3	
Median (min.; max.)	26,3 (16,4; 48,6)	25,6 (17,5; 45)	29,4 (22,3; 37)	26,6 (16,4; 48,6)	
Cervical circumference (mm)					0,722
Mean ± SD	364,1 ± 51,4	373 ± 94,3	369,7 ± 99,2	365,3 ± 59,6	
Median (min.; max.)	370 (320; 480)	400 (320; 450)	390 (370; 450)	380 (360; 480)	
HAN scale, n (%)					0,001
No ventilation	3 (100)	0 (0)	0 (0)	3	
Grade 1	140 (93,3)	6 (4)	4 (2,7)	150	
Grade 2	77 (77,8)	17 (17,2)	5 (5,1)	99	
Grade 3	25 (69,4)	6 (16,7)	5 (13,9)	36	
Mallampati, n (%)					<0,001
Grade 1	92 (94,8)	4 (4,1)	1 (1)	97	
Grade 2	100 (95,2)	2 (1,9)	3 (2,9)	105	
Grade 3	52 (65)	21 (26,3)	7 (8,8)	80	
Grade 4	6 (54,5)	2 (18,2)	3 (27,3)	11	
Cervical mobility, n (%)					0,086
Normal	246 (86)	28 (9,8)	12 (4,2)	286	
Reduced	4 (57,1)	1 (14,3)	2 (28,6)	7	
Snoring or sleep apnea, n (%)					0,078
No	116 (90,6)	8 (6,3)	4 (3,1)	128	
Yes	134 (81,2)	21 (12,7)	10 (6,1)	165	
Dental status, n (%)					0,059
No teeth	18 (100)	0 (0)	0 (0)	18	
Good	93 (87,7)	6 (5,7)	7 (6,6)	106	
Regular	65 (83,3)	11 (14,1)	2 (2,6)	78	
"Poor"	74 (81,3)	12 (13,2)	5 (5,5)	91	
Thyromental distance (mm)					0,598
Mean ± SD	76,1 ± 13,6	73,8 ± 11,2	74,1 ± 4,7	75,7 ± 13,1	
Median (min.; max.)	74 (50; 170)	73 (60; 100)	74 (65; 80)	74 (50; 170)	
Cervical radiotherapy, n (%)					0,620
No	247 (85,2)	29 (10)	14 (4,8)	290	
Yes	3 (100)	0 (0)	0 (0)	3	

$P < 0.05$

4. Discussion

The use of the algorithm was effective in managing the airways in this protocol. This research showed that most airways in elective surgeries scenarios can be managed with a simple algorithm limited to a small number and low-cost airway devices. It was also demonstrated that this sequence can be applied in a major teaching hospital where physicians under training perform intubations. Although guidelines and recommendations for the management of unexpected difficult airway already exist [2, 4, 10, 11], they are not wholly applicable in particular places or conditions. This algorithm was followed aiming to adopt few mandatory devices which can be easily introduced into an OR daily routine.

The McCoy blade associated with external laryngeal pressure improved the laryngoscopic view in all patients with CLm grade 2A and 2B. Our finds are compatible with previous literature. Studies have been consistent in their findings that improvement in Cormack-Lehane grade 3 views to grade 2 or better is significant occurring in 44 to 91% of cases [10, 11, 12, 13]. Literature also demonstrated that the McCoy blade is less useful in easy laryngoscopies. In practice, however, we observed that it is not a problem, since a good view of the larynx can be achieved with the levering in neutral position [10, 13]. External laryngeal pressure, used as BURP maneuver in our study seemed to be effective because it moved the glottic opening into the laryngoscopic line of vision. Thus, articulated McCoy blade and BURP maneuver had an additive effect in most of our patients.

There were no modifications in only 8 patients with CLm grade 3A. Previous studies also had similar problems when they analyzed the applicability of McCoy blade. The poor efficacy of McCoy blade was associated to patients' diseases [14] and in some cases it was not enough to lift the base of the tongue and vallecula [14, 15]. In this research, three of these patients were submitted to total thyroidectomy and five presented Mallampati grade 3 or 4. It is possible that the underlying pathology and the soft tissue oropharyngeal disproportion may contribute to decrease visualization or mobility of the epiglottis in these cases.

The bougie was used the third step because of its efficacy, simplicity of use and low cost. Reports have demonstrated a high success rate of tracheal intubation associated with the use of bougie in case of unpredicted difficult laryngoscopy [1, 3, 16]. In this study, bougie was used to aid intubation in patients with CLm grade 2B and 3A, being effective in all cases.

In comparison with other studies, it was found a similar proportion of grade 3 views (4.8%) at laryngoscopy with the blade in neutral position. The incidence of grades 3 or 4 laryngeal views varies between 0.3% and 13.3% in unselected populations [17, 18]. This led us believe that the McCoy blade in neutral position functions similarly to the Macintosh blade for glottic view.

This study has some limitations. Reports of CICO cases varies from 1 in 5000 [19] to 1 in 32000 [20]. The patient population is small and can miss the most difficult cases. During elective general anesthesia, situations such as CICO or CLm 3B and 4 are rare events. Incidence of Cormack-Lehane grade 3 and 4 is around 4.9% [21] and CLm grade 3B is close to 1.8% [17]. Because of that, a higher number of subjects is important for a more accurate analysis of our algorithm. The study did not reach the final step of the algorithm using LMA Fastrach™. Another limitation is that successful use of the algorithm was based on practical experience of only two researchers who were second- and third-year residents. Besides that, during the study they may have improved their skills with the algorithm devices. Thus, their final cases could be biased by acquired experience.

5. Conclusions

In conclusion, we demonstrated that this algorithm, centered on the use of McCoy laryngoscope, BURP maneuver and bougie, was able to be used successfully in patients of daily practice with a high success rate. As the levering laryngoscope reduces the incidence of difficult laryngoscopy, we would recommend it to be added to the tools available in the operating rooms especially in hospitals where video laryngoscopes are not available.

List Of Abbreviations

BMI: Body mass index

BURP: backward, upward and right upward and rightward pressure

CICO: Cannot intubate, cannot oxygenate

CLm: modified Cormack-Lehane classification

GEB: gum elastic bougie

OR: operating room

SD: standard deviation

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee (*Plataforma Brasil*) at University of Sao Paulo Clinics Hospital (HCFMUSP) (*license number: 68742617.3.0000.0068*).

Consent for publication

All patients were submitted to and signed written informed consent.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author's contributions

DP: conceptualization, formal analysis, writing - review & editing, methodology, supervision, investigation, formal analysis, software, validation, visualization, project administration;

GNCI: writing - original draft, data curation, investigation, visualization;

CSC: data curation, investigation;

MJCC: resources.

All authors read and approved the final manuscript.

Acknowledgements

Not applicable.

References

1. Combes X, Le Roux B, Suen P, Dumerat M, Motamed C, Sauvat S, Duvaldestin P, Dhonneur G. Unanticipated difficult airway in anesthetized patients: Prospective validation of a management algorithm. Anesthesiology. 2004;100:1146–50.
2. Frova G, Sorbello M. Algorithms for difficult airway management: a review. minerva Anestesiol. 2009;75:201–9.
3. Jabre P, Combes X, Leroux B, Aaron E, Auger H, Margenet A, Dhonneur G. Use of gum elastic bougie for prehospital difficult intubation. Am J Emerg Med. 2005;23:552–5.
4. Amathieu R. et. al. An algorithm for difficult airway management, modified for modern optical devices (Airtraq laryngoscope; LMA CTrach™): a 2-year prospective validation in patients for elective abdominal, gynecologic, and thyroid surgery. Anesthesiology. 2011 Jan;114(1):25–33.
5. Olivier, Langeron. Julien Amour Benoît Vivien and Frédéric Aubrun. Clinical review: Management of difficult airways. Crit Care. 2006;10:243.

6. Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW. Management of the difficult airway: a closed claims analysis. Anesthesiology. 2005;103:33–9.
7. Dr Tim Cook, Dr Nick Woodall and Dr Chris Frerk. 4th National Audit Project of The Royal College of Anaesthetists and The Difficult Airway Society. Major complications of airway management in the United Kingdom. ISBN 978-1-900936-03-3.
8. Messant I, Lenfant F, Chomel A, Rapenne T, Freysz M. Evaluation of the learning curve of a new intubation technique: Intubating laryngeal mask. Ann Fr Anesth Reanim. 2002;21:622–6.
9. Han R, et al. Grading scale for mask ventilation. Anesthesiology. 2004;101:267.
10. Tuckey JP, Cook TM, Render CA. An evaluation of the levering laryngoscope. Anaesthesia. 1996;51:71–3.
11. Harioka T, Nomura K, Mukaida K, et al. The McCoy laryngoscope, external laryngeal pressure, and their combined use. Anaesth Intensive Care. 2000;28:537–9.
12. Randell T, Maattanen M, Kytta J. The best view at laryngoscopy using the McCoy laryngoscope with and without cricoid pressure. Anaesthesia. 1998;53:536–9.
13. Levitan RM, Ochroch EA. Explaining the variable effect on laryngeal view obtained with the McCoy laryngoscope [letter]. Anaesthesia. 1999;54:599–601.
14. Chisholm DG, Calder I. Experience with the McCoy laryngoscope in difficult laryngoscopy. Anaesthesia. 1997;52:906–8.
15. Cook TM, Tuckey JP. A Comparison between the Macintosh and McCoyl aryngoscope blades. Anaesthesia. 1997;51:977–80.
16. Latto IP, Stacey M, Mecklenburgh J, Vaughan RS. Survey of the use of the gum elastic bougie in clinical practice. Anaesthesia. 2002;57:379–84.
17. T. M. Cook. A new practical classification of laryngeal view. Anaesthesia, 2000; 55, 260–287.
18. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth. 1994 May;41(5 Pt 1):372–83.
19. Cook TM, MacDougall-Davis SR. Complications and failure of airway management. Br J Anaesth. December 2012;109:68–85.
20. Tachibana N, Niiyama Y, Yamakage M. Incidence of cannot intubate-cannot ventilate (CICV): results of a 3-year retrospective multicenter clinical study in a network of university hospitals. J Anesth. 2015 Jun;29(3):326–30.
21. Heinrich S. et. al. Incidences and predictors of difficult laryngoscopy in adult patients undergoing general anesthesia: a single-center analysis of 102,305 cases. J Anesth. 2013 Dec;27(6):815–21.

Figures

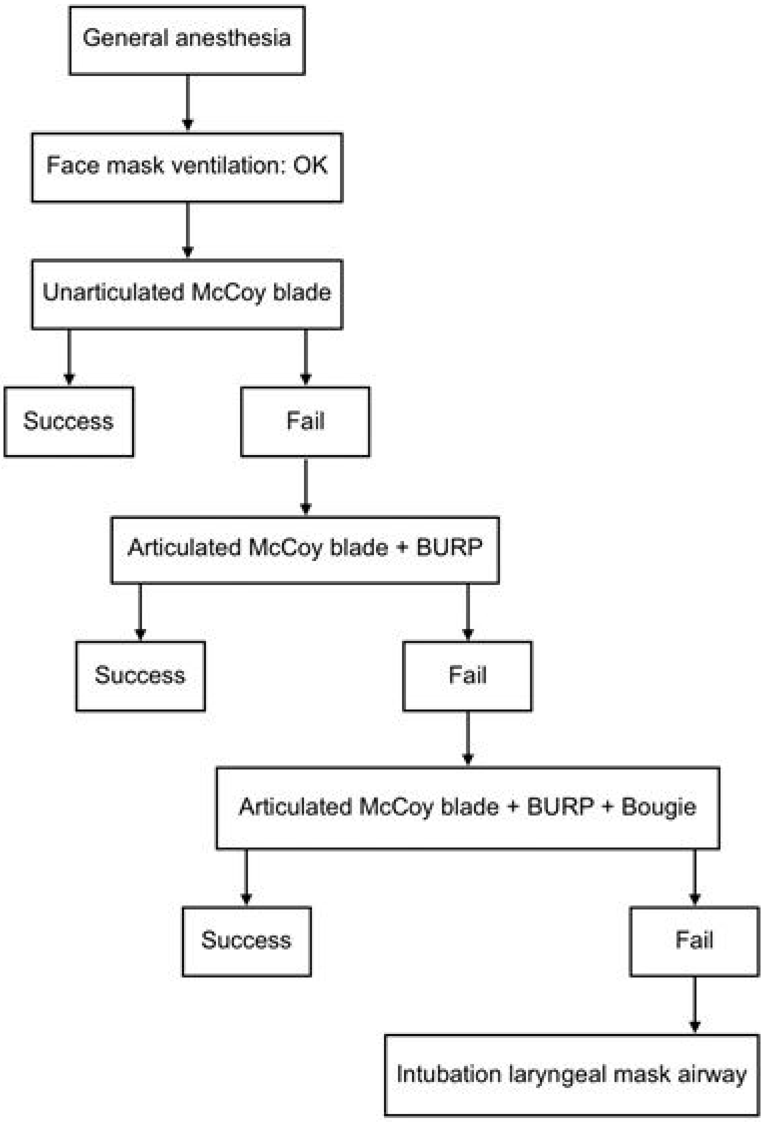

Figure 1

Intubation management algorithm.

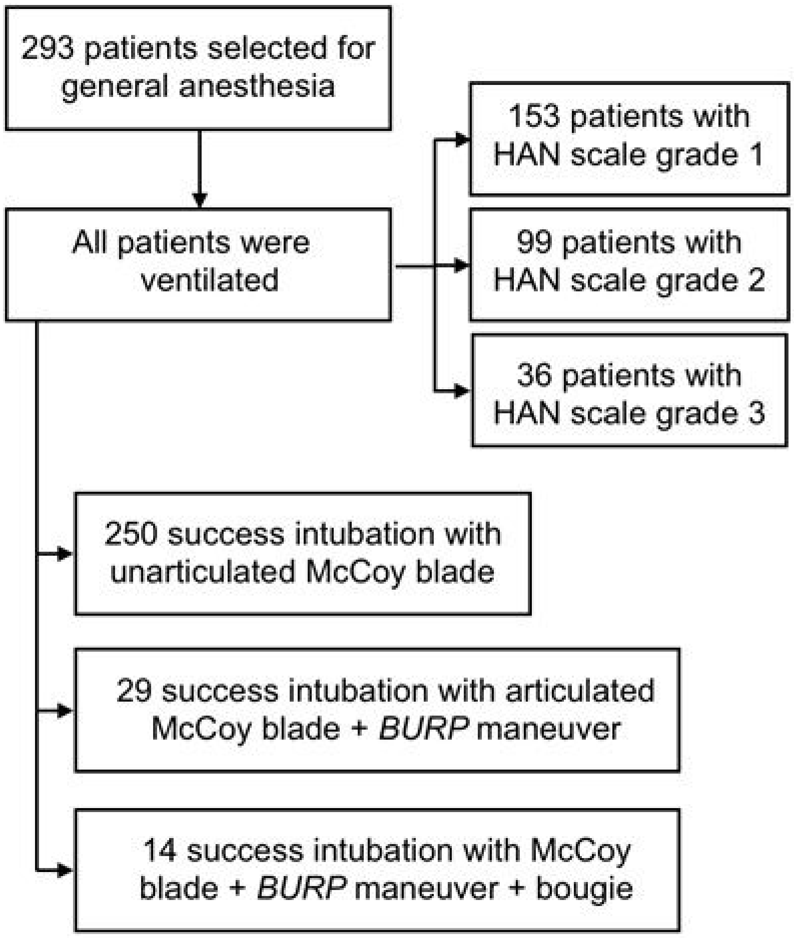

Figure 2

Number of patients in each algorithm step.