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Analysis of the Learning Curve with the C-MAC Video Laryngoscope: A Manikin Study

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Abstract

Purpose: Video laryngoscopes improve the view of the larynx and may improve the speed and success rate of intubation. These benefits can only be realised when the operator has developed the ability to competently use the video laryngoscope. Establishing the learning curve of such devices is therefore important. In this study we investigated the learning curve of thirty experienced anaesthetists with the C-MAC video laryngoscope.

Methods: Five sequential manikin intubations were timed and compared to one with a standard Macintosh laryngoscope. Further manikin intubations with both laryngoscopes were timed, at two and twelve weeks.

Results: A short learning curve was observed during the five sequential intubations with the C-MAC laryngoscope with the intubation time remaining unchanged after the third attempt. When the study was repeated at two and twelve weeks, the intubation time had not changed.

Conclusion: The skill of intubating with the C-MAC video laryngoscope was retained for up to twelve weeks after an initial familiarisation by performing five intubations.

Keywords: Laryngoscope: videolaryngscope; C-MAC videolaryngoscope; Intubation: Tracheal Intubation; Intubation time; Skill: Learning curve

Introduction

Several video laryngoscopes have come onto the market. Although performance data is limited [1], recent studies suggest that video laryngoscopes not only improve the view of the larynx but also increase the intubation success rate and reduce the time taken to intubation when compared with other devices [2,3].

The C-MAC (Karl Storz Endoscopy Inc., Tuttlingen, Germany) is a video laryngoscope which uses a modified Macintosh blade. An anaesthetist can use this device in the same way as a Macintosh and intubate the trachea by direct vision. When it is used in this way by experienced anaesthetists, there should be no learning curve. When the C-MAC is used as a video laryngoscope, the technique of intubating the larynx has to be adapted, as is the case with all video laryngoscopes, because the procedure is guided by an image on the monitor [4]. Knowledge of how the learning curve with the C-MAC impacts upon performance is also important in the interpretation of comparative studies. New devices for intubating the larynx are frequently compared with the standard Macintosh [5-7]. In studies which use experienced anaesthetists, the user's familiarity with the new device may have a substantial impact upon their performance and therefore upon how the new device compares. Currently, there is little data on learning curves with the C-MAC laryngoscope. Therefore the aim of this study was to establish the learning curve of tracheal intubation using the C-MAC and also evaluated the skill retention at two and twelve weeks.

Methods

Approval was obtained from our local Research Ethics Committee. Anaesthetists at University Hospital in Coventry, with at least three months experience in anaesthesia, were invited to take part in the study. Anaesthetists who were experienced in the use of the C-MAC were excluded from the study. This was defined as having performed more than two intubations with the C-MAC, on either a manikin or a patient, over any period of time. All participants were provided with written and verbal information about the study, their task and what data was being collected. Participation was voluntary and each anaesthetist gave written consent prior to taking part.

Airsim manikin (Trucorp, Ireland) was used for the study. All participants were given one practice attempt to intubate the manikin with a Macintosh laryngoscope (size 4). This attempt was not timed. The purpose of this was to remove the impact of unfamiliarity with the anatomy of the manikin. As all participants were familiar with the use of a standard Macintosh laryngoscope, it was accepted that once the participant had familiarised themselves with the manikin, there should be no learning curve in using Macintosh laryngoscope for intubation. Hence the subsequent attempt using Macintosh laryngoscope was considered as standard for the purpose of comparison with C-MAC videolaryngscope. The use of C-MAC videolaryngoscope was demonstrated, on the same manikin only once by the investigator to the participant.

The participant was then timed intubating the manikin with the Macintosh laryngoscope. Timing commenced from when the participant picked up the laryngoscope and terminated with the first inflation breath. The participant received no assistance during the procedure.

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The participant was then asked to repeat the task with the C-MAC (size 4 blade), intubating the larynx under indirect vision. No practice attempt was given as it was accepted that the participant had already familiarised themselves with the manikin. The participant was timed using the same start and end points. The participant was asked to repeat the C-MAC intubation a further four times. They were allowed to start each attempt at their own pace, with usually less than one minute between attempts, and the intubation was timed on each occasion.

Each participant was asked to perform further intubations on the manikin at two weeks and twelve weeks. The following procedure was followed on each of these occasions. The participant was allowed to familiarise themselves with the manikin with a single practice intubation, using the Macintosh. They were then timed, performing a single intubation with the Macintosh laryngoscope and again with the C-MAC. It was ensured that participants did not have an opportunity to use C-MAC videolaryngscope between these two time intervals. However Macintosh laryngscope was regularly used in clinical practice during the study period.

After the data was collected from all the participants at the twelve week stage, it was entered onto an Excel spread sheet. The participants' identification was not included in the spread sheet.

The recorded times were converted to a logarithmic scale to achieve a normal distribution of values. Paired t-tests were used for all comparisons. The back transformed mean time for intubating with Macintosh was compared against the five sequential attempts with the C-MAC. Comparisons were also made between the intubation times with the two laryngoscopes after two and twelve weeks.

Results

A total of thirty anaesthetists were enrolled into the study. Participants had between one and thirty-one years' experience working as an anaesthetist. All participants were experienced in tracheal intubation using Macintosh laryngoscope (about 50% of them had more than 10 years of clinical experience in using Macintosh laryngoscope). None of the participants had any experience of using C-MAC either on manikins or patients. Two participants did not take part in the study at the two week follow-up and three participants did not take part at the twelve week follow-up. The data analysis was based on 28 participants at two weeks and 27 participants at twelve weeks (Figure1).

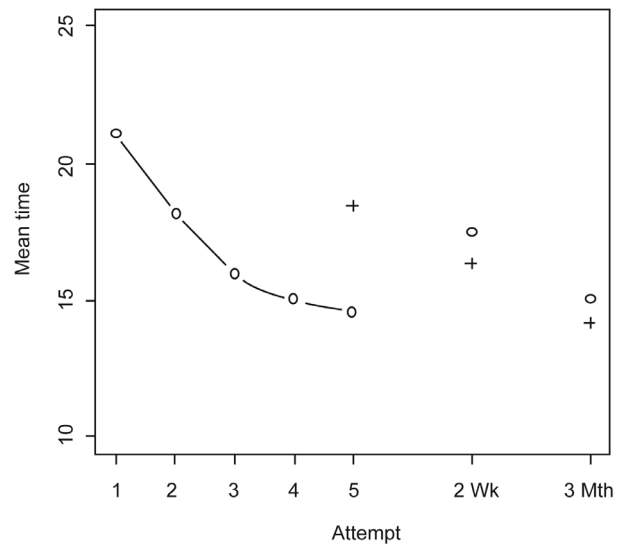

Figure 1: Mean intubation time for C-mac (0) and Mac (+).

Mean intubation times for C-MAC and Macintosh (C-MAC represented by 0 and Macintosh represented by +).

Comparison of the intubation times for the standard Macintosh with each of the attempts with the C-MAC (table 1), showed that the intubation time for the C-MAC was significantly less than with the Macintosh on the third, fourth and fifth attempts (p = 0.015, 0.0015 and 0.0021 respectively). No statistically significant differences were found between intubation times for the standard Macintosh and the first and second C-MAC attempts (p = 0.0506 and 0.8335 respectively) (Table 1).

After two and twelve weeks (Table 2), the mean intubation times with the C-MAC remained significantly shorter than that of the baseline C-MAC times (p=0.04189 and p<0.0001 respectively) (Table 2).

Discussion

We demonstrated a short learning curve with the use of the C-MAC as a video laryngoscope and that this device enabled anaesthetists to intubate faster than with a Macintosh laryngoscope. After two successive intubations with the C-MAC laryngoscope, over 70 % of our participants intubated faster with the C-MAC than Macintosh. These findings suggest that an experienced anaesthetist can familiarise with the C-MAC videolaryngoscope quickly and learn its use within the first few intubations.

McElwain et al. described the C-MAC video laryngoscope as comprising a Macintosh blade connected to a video unit [8]. This device offers the anaesthetist the flexibility to use it as a direct or indirect laryngoscope. One of the advantages of using this device is that it offers a familiar technique to those already trained in direct laryngoscopy with a Macintosh laryngoscope. In this study the participants were only allowed to use it as an indirect laryngoscope (video laryngoscope). All our participants had at least one years experience in anaesthesia and were highly experienced with direct laryngoscopy using Macintosh and McCoy laryngoscope. Although all our participants were not familiar with the C-MAC laryngoscope, they were not necessarily unfamiliar

Intubation attempt		Mean time (SD)	p value
C-MAC	1	22 (8)	0.050
C-MAC	2	19 (7)	0.833
C-MAC	3	17 (6)	0.015
C-MAC	4	16 (6)	0.001
C-MAC	5	16 (6)	0.002
Macintosh		19 (6)	
C-MAC (2 weeks)		19 (9)	0.195
Macintosh (2 weeks)		17 (4)	
C-MAC (12 weeks)		16 (4)	0.054
Macintosh (12 weeks)		15 (4)	

Table 1: Intubation attempt, mean intubation time in seconds and (SD). Initial five attempts with C-MAC, each one compared with one attempt at Macintosh. At 2 weeks and 12 weeks, C-MAC attempt is compared with respective attempts at Macintosh.

Intubation attempt	Mean time (SD)	p value
C-MAC 1st attempt	22 (8)	
C-MAC (2 weeks)	19 (9)	0.0421 (1st attempt vs 2 wk
C-MAC (12 weeks)	16 (4)	<0.0001 (1st attempt vs 12 wk)

Table 2: Mean intubation time in seconds (SD) for C-MAC attempts. At 2 and 12 weeks C-MAC attempt is compared with the first C-MAC attempt.

with indirect laryngoscopic techniques such as video-assisted fibreoptic laryngoscopy.

Several studies have shown that video laryngoscopy enhances the laryngeal view in patients with apparently normal and anticipated difficult airways [9]. One can therefore assume that if an experienced anaesthetist uses the C-MAC for intubation, they will have the unique combined benefit of a very familiar device that also offers the advantage of video laryngoscopy. Although, there was a small difference in intubation time at first attempt, one third of our participants intubated faster with the C-MAC than the Macintosh. The number of participants who intubated in a shorter time with the C-MAC than the Macintosh continued to increase with each attempt and all except five participants were faster with the C-MAC by the fifth attempt. This was the maximum number of intubations we had set to determine if there was a learning curve.

Skill acquisition appeared to be retained at twelve weeks. In our study, the superiority of the C-MAC over the Macintosh laryngoscope could not be statistically proven after two and twelve weeks, although interestingly about 60% the participants were still faster with the C-MAC as compared with Macintosh.

The C-MAC video laryngoscope was observed by Byhahn to effectively enhance the laryngeal view in patients with limited inter-incisor distance [10]. It has also been reported that use of the C-MAC can improve the view of the larynx and facilitate intubation in an unanticipated difficult airway [11,12]. The steep learning curve revealed in our study may further support these reported advantages of the C-MAC videolaryngoscope.

Ritter and Schooler described the learning curve as a plot displaying time to complete a task as a function of practice. They concluded that most tasks get faster with practice and that this holds across task size and task type [13]. Our findings concur with this model. C- MAC videolaryngscope assisted trainng has been to shown to improve the success rate and to reduce the intubation time when used by medical students [13]. Videolarynogscope allows the instructor to give more consructive feedabck on the intubation technique therfore allowing more structured learning.

The main limitation of our study is that it was performed on manikins. Patients clearly have inter-person variability which could not be replicated in a manikin study. The learning curve is unlikely to be identical in a variable population which consists of both easy and difficult airways. The results of our study cannot be used to predict that after five intubations an anaesthetist's learning will have plateaued in patients. Nonetheless, we have demonstrated a remarkably rapid learning curve with this device. This is highly suggestive that the learning curve of the C-MAC when used in patients would also be short and this would have important clinical advantages. We studied only the time for intubation on a manikin. In clinical practice along with time taken intubation other factors such as ease of intubation, success rate, laryngoscopic view and the incidence of airway trauma will contribute to the limitation in using a new laryngoscope. These parameters could not be replicated in manikins. We studied the skill retention at 2 weeks and 12 weeks. Hence we are not able to recommend a minimum frequency at which the device should be used in clinical practice.

With the stated limitations of a manikin model, we can draw some conclusions regarding intubation with the C-MAC laryngoscope. Firstly, the learning curve associated with C-MAC laryngoscope is short and the device's similarity to the Macintosh offers a great advantage even for those using it for the first time. Secondly, this laryngoscope is easy to use and after the third attempt i.e. when familiarity has been established, there is little further learning. Finally, once a user is familiar with using the C-MAC laryngoscope, the benefit gained from using the device can be retained for up to twelve weeks.

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References

1. Frerk CM, Lee G (2009) Laryngoscopy: time to change our view. Anaesthesia 64: 351-354.
2. Komiya K, Inagawa G, Nakamura K, Kikuchi T, Fujimoto J, et al. (2009) A simple fibre optic assisted laryngoscope for paediatric difficult intubation: a manikin study. Anaesthesia 64: 425-459.
3. Jungbauer A, Schumann M, Brunkhorst V, Borgers A, Groeben H (2009) Expected difficult tracheal intubation: a prospective comparison of direct laryngoscopy and video laryngoscopy in 200 patients. Br J Anaesth 102: 546-550.
4. Pott LM, Murray WB (2008) Review of video laryngoscopy and rigid fiberoptic laryngoscopy. Curr Opin Anesthesiol 21: 750-758.
5. Maharaj CH, Costello JF, Higgins BD, Harte BH, Laffey JG (2006) Learning and performance of tracheal intubation by novice personnel: a comparison of the Airtraq and Macintosh laryngoscope. Anaesthesia 61: 671-677.
6. Maharaj CH, Chonghaile MN, Higgins BD, Harte BH, Laffey JG (2006) Tracheal intubation by inexperienced medical residents using the Airtraq and Macintosh laryngoscopes – a manikin study. Am J Emerg Med 24: 769-774.
7. Maharaj CH, Higgins DB, Harte BH, Laffey JG (2006) Evaluation of intubation using the Airtraq or Macintosh laryngoscope by anaesthetists in easy and simulated difficult laryngoscopy – a manikin study. Anaesthesia 61: 469-477.
8. McElwain J, Malik MA, Harte BH, Flynn NH, Laffey JG (2010) Comparison of the C-MAC video laryngoscope with the Macintosh, Glidescope and Airtraq laryngoscopes in easy and difficult laryngoscopy scenarios in manikins. Anaesthesia 65: 483-489.
9. Meininger D, Strouhal U, Weber CF, Fogl D, Holzer L, et al. (2010) Direct laryngoscopy or C-MAC video laryngoscopy? Routine tracheal intubation in patients undergoing ENT surgery. Anaesthetist 59: 806-811.
10. Byhahn C, Iber T, Zacharowski K, Weber CF, Ruesseler M, et al. (2010) Tracheal intubation using the mobile C-MAC video laryngoscope or direct laryngoscopy for patients with a simulated difficult airway. Minerva Anestesiol 76: 577-583.
11. Cavus E, Kiechaefer J, Doerges V, Moeller T, Thee C, et al. (2010) The C-MAC video laryngoscope: first experiences with a new device for video laryngoscopy-guided intubation. Anesth Analg 110: 473-477.
12. Saxena S (2009) The ASA difficult airway algorithm: is it time to include video laryngoscopy and discourage blind and multiple intubation attempts in the non-emergency pathway? Anesth Analg 108: 1052.
13. Ritter FE, Schooler LJ (2002) The learning curve. International encyclopedia of the social and behavioural sciences 8602-8605.
14. Herbstreit F, Fassebender P, Haberl H, Kehren C, Peters J (2011) Learning endotracheal intubation using a novel videlaryngoscope improves intubation skills. Anesthesia Analgesia 113: 586-590.