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Teaching with a Video System Improves the Training Period but Not Subsequent Success of Tracheal Intubation with the Bullard Laryngoscope

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Background: **The Bullard laryngoscope is useful for the management of a variety of airway management scenarios. Without the aid of a video system, teaching laryngoscopy skills occurs with indirect feedback to the instructor. The purpose of this study was to determine if use of a video system would quicken the process of learning the Bullard laryngoscope or improve the performance (speed or success) of its use.**

Methods: **Thirty-six anesthesia providers with no previous Bullard laryngoscope experience were randomly divided into two groups: initial training (first 15 intubations) with looking directly through the eyepiece (n = 20), or with the display of the scope on a video monitor (n = 16). The subjects each then performed 15 Bullard intubations by looking directly through the eyepiece.**

Results: **There was not an overall significant difference in laryngoscopy or intubation times between the groups. When only the first 15 intubations were considered, the laryngoscopy time was shorter in the video group (26 ± 24) than in the nonvideo group (32 ± 34; $P < 0.04$). In the first 15 patients, there were fewer single attempts at intubation (67.9% *vs.* 80.3%; $P < 0.002$) and more failed intubations (17.2% *vs.* 6.0%; $P < 0.0001$) in the nonvideo group.**

Conclusions: **In conclusion, the authors have shown that use of a video camera decreases time for laryngoscopic view and improves success rate when the Bullard laryngoscope is first being taught to experienced clinicians. However, these benefits are not evident as more experience with the Bullard laryngoscope is achieved, such that no difference in skill with the Bullard laryngoscope is discernible after 15 intubations whether a video system was used to teach this technique.**

SKILL acquisition in the field of medicine continues in the medieval guild tradition of direct tutelage with an experienced instructor. During the majority of the procedures performed in medicine, the instructor is able to see what the trainee sees and does. This allows the instructor to give advice to the trainee while performing the procedure. However, there are skills in which the trainee is the only eyewitness, and the instructor is forced to advise based on inference from what is externally seen and what the trainee is able to verbalize as to how the activity is progressing.

In anesthesia, laryngoscopy falls into the category of indirect feedback to the instructor. If the student encounters difficulty, the instructor will give advice according to external cues and the limited feedback from the student. If verbal guidance is insufficient, the instructor is often forced to take over the laryngoscopy, which limits the learning experience for the student and could prolong the training period. Advanced laryngoscopic techniques such as flexible fiberoptic bronchoscope (FFB) and the Bullard laryngoscope (BL; Circon ACMI, Stamford, CT) have the advantage over direct laryngoscopy in that the view from the scope can be easily displayed on a video monitor, permitting the instructor and the student a view of the laryngoscopy. It has been our experience that teaching use of the BL is facilitated with the use of a camera–television system attached to the laryngoscope. The purpose of this study was to determine if BL trainees taught with a video system had better results during the early learning experience (*i.e.*, lower frequency of failed intubation and shorter intubation times) that could be translated into greater later success (*i.e.*, lower frequency of failed intubations and shorter intubation times).

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Methods

After Institutional Review Board approval, the study was begun. The entire department of anesthesia at the Marshfield Clinic central campus was canvassed regarding previous BL exposure. Those who had performed fewer than 3 BL in the past 5 yr were enrolled. Written informed consent was obtained from these laryngoscopists. All of the eligible anesthesia providers participated in this study. Before participating in this study, the laryngoscopists viewed a video (of the view through the BL) of what the normal anatomy looked like and how the BL usually proceeds. They also were present for a minimum of three BL intubations before participation in this study. This group of anesthesia providers (certified registered nurse anesthetists [CRNAs] and anesthesiologists) were then randomly divided by a computer-generated list into two groups: one group had initial training with the display of the BL viewable on a video monitor (video group); the other group performed laryngoscopies in the traditional method of directly looking through the eyepiece (nonvideo group). Patient demographics (age, sex, and weight) were also documented. The patients in whom the intubations were performed were scheduled for elective surgical procedures requiring general anesthesia and tracheal intubation (scheduled to be given anesthesia by the anesthesia provider). Patients were excluded if they had risk factors for aspiration or if an awake intubation was planned. The patients' airways were classified using the modified Mallampati classification system[1] by one of the two instructors. The anesthetic medication was not standardized, but it included use of a nondepolarizing neuromuscular blocking agent to facilitate intubation. Antisialagogue medications were not administered. Laryngoscopy was not attempted until neuromuscular blockade was confirmed with a nerve stimulator.

Each trainee performed 15 intubations according to their randomization (video or nonvideo group). After the initial 15 intubations, both groups performed an additional 15 intubations using the scope in the traditional fashion of directly looking through the eyepiece. The BL was prepared by having the endotracheal tube (TT) loaded on the standard stylet after removal of the TT circuit adapter, which was inserted in its attachment port on the BL before laryngoscopy. The setup was kept warm by wrapping it in a warmed blanket. Endpoints examined included success of intubation, time required to intubate, laryngeal view at intubation, and the number of passes of the TT. The time to intubate was defined as the time from the last mask ventilation to the reestablishment of ventilation *via* the TT. This was confirmed by the presence of end-tidal carbon dioxide. The time from intubation initiation to successful laryngoscopic view and successful intubation was determined for each attempt. One of the two instructors supervised every intubation and gave advice to the intubator regarding his or her technique. If the intubator was unable to get a view of the larynx with four significant manipulations of the BL despite advice and assistance from the instructor, the instructor attempted the laryngoscopy and intubation. If the instructor was unable to get a laryngoscopic view, the BL was removed and the extension piece was added. The student was then allowed to again attempt laryngoscopy with the BL using the attached extension piece. In these cases, the time for laryngoscopic view and intubation for the attempt was measured with the extension piece in place. If the instructor got a view of the larynx without the extension piece, the student again attempted the laryngoscopy without the extension piece. In these cases, the time for laryngoscopic view and intubation included all attempts except for the time in which the instructor was using the scope and the time spent mask ventilating the patient between the attempts. The patients' vital signs were continuously monitored throughout the intubation process; the laryngoscopy was stopped and mask ventilation was performed if the oxygen saturation decreased to 94%. A failure at intubation was defined as four tube advancements without successfully passing the tube into the trachea.

Table 1. Airway Classification of Patients in Video and Nonvideo Groups

Group	Class I	Class II	Class III	Class IV
Video (n = 459)	197	187	70	5
Nonvideo (n = 579)*	276	229	68	4

Data shows number of patients each class. There were no significant differences between the groups. Class I view revealed uvula, tonsillar pillars, and palate. Class II revealed uvula and palate. Class III revealed both hard and soft palate. Class IV revealed hard palate only.

*There were two patients in the nonvideo group in whom the airway classification was not documented.

Patient demographic data were analyzed by analysis of variance (ANOVA). Nonparametric testing was used to determine if there was a difference among the groups with respect to laryngoscopy and intubation times. Chi-square test was used to compare airway classification and number of intubation attempts. A P value of less than 0.05 was considered statistically significant.

Results

The patients in the video group weighed 83 ± 20 kg, and the patients in the nonvideo group weighed 84 ± 21 kg. There were 207 male and 252 female patients in the video group and 238 male and 341 female patients in the nonvideo group. There were no significant differences in the demographics of the patients assigned to each teaching technique group. There were no significant differences between the groups with respect to airway classification (table 1). There were 20 trainees in the nonvideo group and 16 trainees in the video group. Six trainees left the department before completion of all 30 intubations (2 in the video group [459 intubations instead of 480] and 4 in the nonvideo group [579 intubations instead of 600]); the partial data remain and account for the fact there are uneven and unequal intubation attempts in each group. The video group had an overall intubation success rate of 92%. The nonvideo group had an intubation success rate of 85%. Neither group showed an advantage with respect to overall success or speed of intubation. There was a large variability in the time for each intubation. Individual practitioners varied in their individual mean times for intubation from as low as 45 s to as high as 128 s.

When all 30 patients were considered, the time to laryngoscopy view was longer ($P < 0.05$) and the intubation times were longer ($P < 0.002$) in the first 15 patients compared with the second 15 patients. When all 30 patients were considered, there was not a significant difference in laryngoscopy time or intubation time

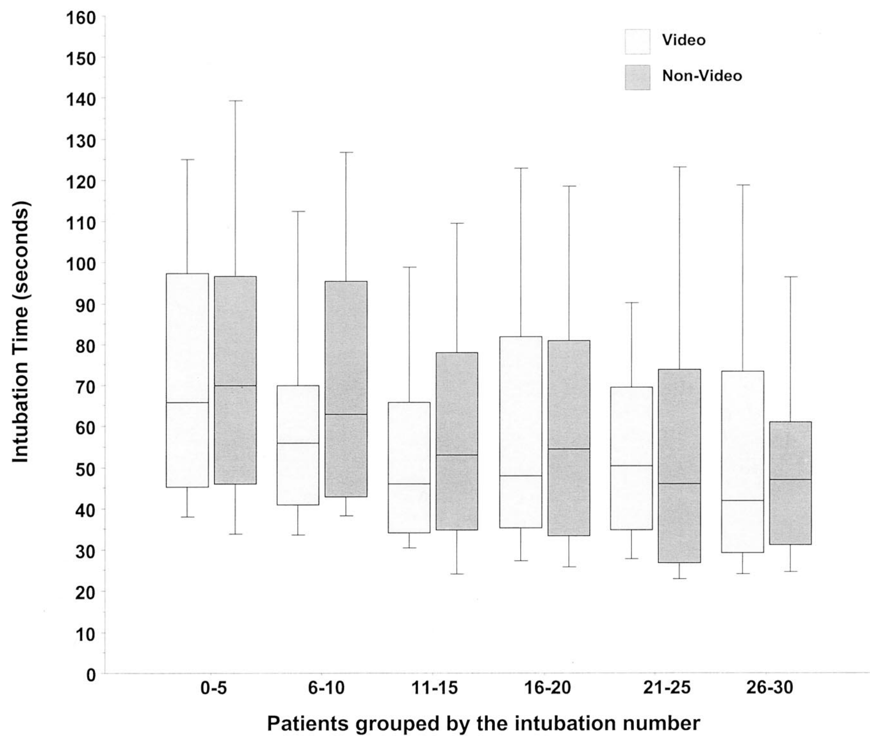

Fig. 1. The intubation times for the video (light) and nonvideo (dark) groups. The intubations are grouped in order by each subsequent five patients. The box represents the twenty-fifth to seventy-fifth percentiles. The dark line is the median. The extended bars represent the tenth to ninetieth percentiles.

between the two groups (fig. 1 and table 2). When only the first 15 patients were considered, the laryngoscopy time ($P < 0.04$) was significantly shorter in the video group than in the nonvideo group; there was no difference with respect to intubation time. The mean times for both groups appear to be similar by the fifteenth intubation (fig. 2). There were more intubation failures in the nonvideo group in the first 15 patients than in the video group (table 3; $P < 0.0001$). In the first 15 patients, there were more successful single-attempt intubations in the video group (table 3; $P < 0.002$). In the first 15 patients, there was not a significant difference between the two groups with respect to the number of multiple attempts at successful intubations. None of these times or intubation attempts were significant when only the second 15 intubation attempts were considered.

Of 128 intubation failures (laryngoscopy trainee unable to pass the TT), 8 were unable to be intubated by the instructors. Of these eight, the major reason for failure was blood and secretions (four patients) obscuring the BL view. All eight patients were successfully intubated with a conventional laryngoscope.

Discussion

Acquiring a new skill requires instruction, training, and experience. It seems that humans learn in a stepwise fashion. Initially, the simplest aspects of the skill are daunting, but with practice these steps can become automatic. In doing so, one is able to increase the complexity of the skill being learned until true mastery of a technique is accomplished. Some skills are so challenging that they overwhelm the novice to such a degree that it prevents him or her from accomplishing even the simplest aspects of the task. However, if one breaks the skill down into smaller steps, each task can be learned, and eventually the complex skill will be mastered. Typically learning in this fashion also speeds up skill acquisition because success comes more quickly in these small stages than when attempting to learn the skill all at once.

Table 2. Laryngoscopy and Intubation Times

	L Time, s			I Time, s		
Group	All 30 Patients	*First 15 Patients	Second 15 Patients	All 30 Patients	First 15 Patients	Second 15 Patients
Video	26 ± 25	26 ± 24	25 ± 26	63 ± 37	65 ± 35	60 ± 39
Nonvideo	29 ± 31	32 ± 34	26 ± 29	65 ± 40	70 ± 41	59 ± 38

The laryngoscopy and intubation times for the two groups for all the patients, the first 15 intubation attempts, and second 15 intubation attempts (mean ± SD).
*The L time was shorter in the video group when only the first 15 patients are considered ($P < 0.04$).
I, intubation; L, laryngoscopy.

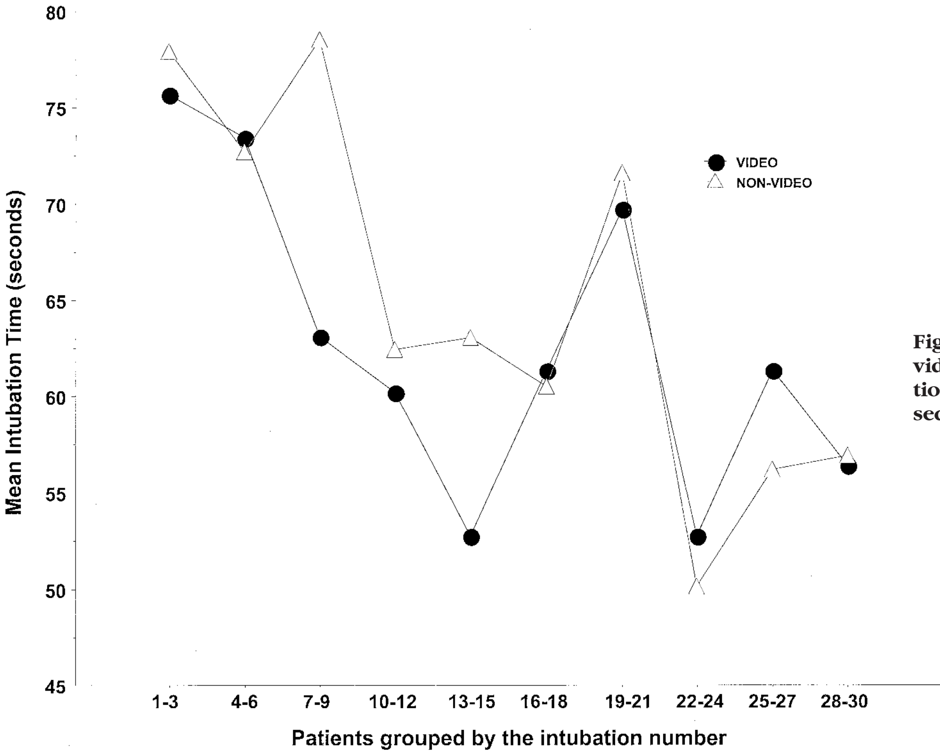

Fig. 2. The mean intubation times for the video and nonvideo groups. The intubations are grouped in order by each subsequent three patients.

There is little information in the literature examining different teaching techniques and skill acquisition of anesthetic airway management. Ovassapian *et al.*,[2] in a small study, showed that a graduated teaching program instructing students in the use of the FFB as an intubating tool improved the success rate. The authors believed that the graduated program allowed students to develop the psychomotor coordination more quickly because this skill development was not overwhelmed by the complexity of the activity occurring during intubation attempts in the clinical setting. Having the students break down the procedure into smaller steps allowed them to learn what the anatomy looked like; thus, they were readily able to identify structures in the later steps. They were able to describe to the instructor what they saw and take instruction more readily because the instructor's information had a frame of reference in which to be interpreted.[2]

A training program including use of simulator and performing fiberoptic nasal endoscopy on live patients resulted in a greater success rate than for trainees who did not have such training.[3] However, there was a significant time contribution to achieve this early success: 1 h of instructor time and 3 h of simulator time.[3] Practice on models can train one in the manipulation skill necessary for clinical success.[4] Clinical acquisition was shown to be equally improved with either model practice or virtual reality simulation.[5] Simulation technology has been reported to have the benefit of immediate feedback without the need to have an experienced teacher available throughout the instruction.[6] Two facets shown to be important when learning on a model are practice and

Table 3. Number and Success of Intubation Attempts

	Unsuccessful, n (%)	One Attempt, n (%)	Multiple Attempts, n (%)
All Thirty Patients	—	—	—
Video (n = 459)	38 (8.3%)	352 (76.7%)	69 (15.0%)
Nonvideo (n = 579)	90 (15.5%)	414 (71.5%)	75 (13.0%)
First fifteen	—	—	—
Video (n = 234)	14 (6.0%)	188 (80.3%)	32 (13.7%)
Nonvideo (n = 296)	51 (17.2%)	201 (67.9%)	44 (14.9%)
Second fifteen	—	—	—
Video (n = 225)	24 (10.7%)	164 (72.9%)	37 (16.4%)
Nonvideo (n = 283)	39 (13.8%)	213 (75.3%)	31 (10.9%)

The number (n) and the percent of patients in whom intubation with the Bullard was unsuccessful, were intubated with one attempt, or were intubated following multiple attempts. The patients were considered in the following groups: all 30 patients as a whole group, the first 15 patients, and the second 15 patients, respectively. The video group had more successful single-attempt intubations in the first 15 patients ($P < 0.002$). There were more intubation failures in the nonvideo group in the first 15 patients ($P < 0.0001$). There were no significant differences between the groups in the second 15 patient grouping.

individualized personal feedback.[7] We believe the video camera system allows for this individualized feedback when teaching the use of the BL.

It has been shown that good success rates and relatively short intubation times can be achieved when pediatric fiberoptic intubation is taught without the use of a video system.[8] However, these trainees had experience in adult fiberoptic intubation; thus, familiarity with the fiberoptic scope and knowledge of airway anatomy had already been achieved.[8] The ability to view what is being visualized by the student intubating has been described as benefitting the instructor in monitoring the student's progress.[9,10] We agree with this belief; we are much more comfortable teaching advanced airway techniques when using a camera system. After performance of approximately 10 intubations, a significant decrease in intubating time and increase in success rate was shown in 4 residents taught fiberoptic intubation using bronchoscope with a teaching adaptor (an auxiliary eyepiece).[11] Likewise, Schaefer[12] showed that the time for successful fiberoptic intubation decreases over the first 10 uses. It appears the BL laryngoscopy time decreases by the tenth to fifteenth use (fig. 2).

It has been shown that novice fiberoptic intubations take longer when the anesthetized patient is spontaneously breathing (144 s) compared with when the patient is muscle relaxed (64 s).[13] Whether the presence of muscle relaxation significantly decreases the time required for BL remains unclear. Most anesthesiologists administer an intravenous muscle relaxant when planning direct laryngoscopy; thus, we did the same in the current investigation.

The mean intubation time for BL intubation has been reported to be 25–46 s in adults[14–17] and 29–38 s[18,19] in pediatric patients. Our definition of "time for intubation" was the time from last mask ventilation to the reestablishment of ventilation *via* the TT tube as confirmed by the presence of end-tidal carbon dioxide. The endpoint criteria were not clearly defined in all of the adult studies, making direct comparisons difficult. The times in the current report may be slightly longer than what has been previously reported for intubations done by practitioners with significant ($>$ 50 intubations) BL experience[18,19]; as with any skill, we would expect that these times will decrease for this study's trainees as they gain further experience with the BL.

It has been shown that a videotape demonstration of clinical activities improves clinical skills compared with personal teaching.[20] Watching a videotape of direct laryngoscopies improved the intubation success rates of novice paramedics.[21] Whether incorporating a more comprehensive BL videotape session (than given in the current study) before clinical use would improve success with the BL is an area for future investigation. It is certainly easy to videotape the view through the BL with the camera system we currently use to produce such a video.

A video display of the TT view (video-intuboscopy) has been shown to aid difficult tracheal intubations.[22] Viewing the intubation from the tube improves teaching and clinical success of tracheal intubation in pediatric patients.[23] Furthermore, use of a video laryngoscope (a laryngoscope modified with an integrated fiberoptic scope hooked up to a monitoring system) has facilitated teaching of direct laryngoscopy of pediatric patients.[24] This video laryngoscope was found to be particularly beneficial for explaining direct laryngoscopies to multiple viewers.[24] The teachers were able to recognize and correct problems encountered during direct laryngoscopy and were able to give precise assistance to the trainees.[24] We believe the same advantages exist when initially teaching use of the BL; namely, we are able to give immediate direction to the trainees and are able to facilitate the intubation process. We are more comfortable teaching with the video system because we are able to instruct the trainees "real time."

In conclusion, we believe that use of a video camera facilitates teaching, and we have shown that a video system decreases time for laryngoscopic view and improves success rate when the BL is first taught to experienced clinicians. However, these benefits dissipate as more experience with the BL is achieved, such that no difference in skill with the BL is discernible after 15 intubations whether a video system was used to teach this technique.

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