7-2023

Comparing Video Modeling to Tactile Feedback to Train Medical Skills

Kelcie Erin McCafferty

Comparing Video Modeling to Tactile Feedback to Train Medical Skills

by

Kelcie Erin McCafferty

A thesis submitted to the School of Behavior Analysis of
Florida Institute of Technology
in partial fulfillment of the requirements
for the degree of

Master of Science
in
Applied Behavior Analysis and Organizational Management

Melbourne, Florida
July, 2023

We the undersigned committee hereby approve the attached thesis,

"Comparing Video Modeling to Tactile Feedback to Train Medical Skills."

by

Kelcie Erin McCafferty

David A.Wilder, Ph.D., BCBA-D
Professor
School Behavior Analysis
Major Advisor

Radhika Krishnamurthy, Psy.D., ABAP
Professor
School of Psychology

Kaitlynn M. Gokey, Ph.D., BCBA-D
Assistant Professor
School of Behavior Analysis

Nicole Gravina, Ph.D.
Assistant Professor
Department of Psychology
University of Florida
Guest Member

Robert A. Taylor, Ph.D.
Professor and Dean
College of Psychology and Liberal Arts

Abstract

Title: Comparing Video Modeling to Tactile Feedback to Train Medical Skills

Author: Kelcie Erin McCafferty

Advisor: David A. Wilder, Ph.D., BCBA-D

Medical skills and practices have been continuously advancing, with many recent advancements in clinical practice. However, medical training has yet to develop in tandem with medical advancement. Behavior analysis has a large body of research and practice in the area of skill acquisition to offer the medical field. TAGteach® is one example of a behavior analytic method that could be beneficial to the medical field. Although traditional applications of TAGteach® have been proven to be effective, they may not be socially valid or accepted by the larger population or medical professionals. The purpose of the present study was to compare traditionally effective methods of training that include video modeling and self-evaluative video feedback to tactile TAGteach®. The results show that both interventions improved performance compared to baseline responding. However, tactile TAGteach® was the only intervention to produce 100% correct responding. In addition, responding under tactile TAGteach®, but not video modeling and feedback, maintained at mastery levels.

Keywords: tactile TAGteach®, video modeling, video feedback, medical skills, physician

Table of Contents

Chapter 1: Introduction

The practice of medicine entails an extensive knowledge and skill base to effectively treat patient ailments. Mastery of those important skills is necessary for ensuring that high-quality patient care is delivered. Across medical fields, there are basic skills that encompass the behaviors that medical providers will be asked to perform through the years of their practice. Many of these skills require fine-motor behaviors that take extensive training to master, which often occurs long after the completion of initial medical training and are developed in direct practice with real patients. However, concerns arise when medical training is not sufficient for maintenance and generalization of these skills across settings.

In 2016, there were approximately 883.7 million office-based physician visits (Ashman et al., 2019), 9,915, 100 outpatient surgeries in 2014 (Steiner et al., 2014), and 7,247,600 inpatient surgeries the same year (Steiner et al., 2014). The National Opinion Research Center (2017) evaluated the percentage of adults receiving medical services that either encountered a medical error themselves or had a close family member that experienced them. It was identified that approximately 40% of adults encountered a medical error, and 73% of medical errors resulted in permanent health impacts (National Opinion Research Center, 2017). Respondents in the survey noted that the primary concerns underlying the medical errors were related to a lack of attention to detail and ineffective medical training. Although lack of attention to detail was cited, this may be evidence of ineffective training. Lack of attention to detail is likely due to not acquiring stimulus control over the target behavior and a repertoire that has not been trained to fluency.

Current Medical Training

Medical training consists primarily of lecture-based instruction followed by practice. As an example, in medical school the first two years include lecture-based instruction followed by two years of clinical rotations to assist in skill development. Thus, clinical sites must provide the training necessary to develop and refine skills learned and build those not learned through didactics. Inconsistent and ineffective training may reduce competencies which could compromise patient safety.

Most instruction includes what has been referred to as the “see one, do one, teach one,” or Halsted method of instruction (Seifert et al., 2020). This method includes a demonstration of the skill followed by practice and then asking the learner to teach another novice the skill. The see-do training method was initially established based on the German system for training surgeons. Following its development, it was widely adopted across fields without independent evaluation of its efficacy as a training method. Sealy (1999) questioned the aforementioned method of instruction, stating the need for change in medical training. Seifert et al. (2020) subsequently noted that a growing body of research has demonstrated the deficiencies in current instructional methods. It was recommended that this method be relinquished in favor of training that better fit current surgical training needs. Research has compared the Halsted model with other methods.

Romero et al. (2018) compared Halsted’s method to Peyton’s 4-Step method of training. Peyton’s 4-Step method includes instructor demonstration of the skill, a second demonstration with enumeration of the sub steps that the skill consists of, a requirement for the student to explain each sub step, and finally student performance of the skill. Fifty-six medical students were included in the study and were randomly assigned to either receive the Peyton 4-Step training or Halsted training. Participants were trained to tie surgical knots using intracorporeal knot tying which was anecdotally considered to be difficult (Romero et al., 2018). A comparison of the performance of the skill and the amount of time it took to complete the task revealed that the Peyton 4-Step method was more effective, resulting in better acquisition in generally less time. However, no differences in knot quality or accuracy were observed.

Few have assessed the preferred training methods for long-term maintenance or generalization across settings. Munster et al. (2016) examined the efficacy and maintenance of chest compression skills. The training included being taught using Peyton’s 4-Step method, the 4-step with the exclusion of the student practice step, and with only the detailed explanation plus demonstration of the skill followed by narration and execution of the skill by the student. In other words, for two of the groups, one to two of the critical steps in Peyton's 4-Step procedure were omitted. Skills were tested after initial training, one week after, and then five to six months after training. The study found that more than half of the participants were unable to correctly perform chest compressions. It is important to note that a correct chest compression was considered if 60% of the chest compressions in the demonstration were completed correctly. Overall, this demonstrates that the present preferred methods of teaching foundational medical skills are not necessarily sufficient in mastery or maintenance.

These studies highlight the need for training that is effective beyond statistical significance. In some cases, statistically significant results may not have much practical value. Practical applications of skill acquisition require that behaviors taught be demonstrated to mastery, meaning the individual should be able to demonstrate the behavior above a pre-determined level to be considered competent in the skill. That is, mastery should be easily discriminable through visual analysis. Statistical significance only requires that a difference between data sets exists and that the likelihood that the difference is due to error is low. Evaluation of skill acquisition data in this way prevents a determination of meaningful differences; although only a small difference between data sets may exist, a result can be statistically significant without achieving significant gains in performance. However, many training studies have relied on statistical significance within the medical field. Thus, future research is needed that employs single subject designs intended to directly compare various training approaches to determine if there is a visible difference in performance.

In addition to utilizing different research designs to assess the effectiveness of training interventions, other interventions should also be considered when attempting to improve one's skills. Applied behavior analysis (ABA) is a subfield of behavior analysis that focuses on improving behaviors considered socially important (Baer et al., 1968). ABA approaches have also been applied in the area of training. One example is Behavior Skills Training or BST. BST includes the following steps: description of a target skill, demonstration of the target skill, and practice with feedback until mastery is achieved (Parsons et al., 2013). Peyton's 4-Step method utilizes behavioral skills training (BST) aspects, but other methods derived directly from behavior analytic practice may be more effective in promoting the development of medical skills.

Video Modeling and Self-Evaluative Video Feedback

Video modeling and video feedback is a common package intervention intended to promote skill acquisition. It resembles the see one, do one method in that a video of the skill being performed is recorded and then the student's performance is recorded for them to review before re-performing the skill. Performing their skill and evaluating it allows for the feedback to be self-delivered so that they can then modify their own performance later (Huskens et al., 2012). Video modeling and video feedback have been evaluated independently and found to be effective without additional interventions (Baudry et al., 2006; Kelley & Miltenberger, 2015; Stokes et al., 2010). The present study refers specifically to self-evaluative video feedback, in an effort to differentiate it from expert delivered video feedback. Video feedback is delivered by an expert reviewing an individual's performance and delivering specific feedback based on that performance. However, self-evaluative feedback entails the performer reviewing their own behavior and evaluating their performance so that they can modify future performance.

Video modeling and video feedback have been implemented in organizational settings, particularly in sports. Quinn et al. (2019) evaluated video modeling and video modeling with video feedback to improve dance performance. In a multiple baseline design, four dancers were first trained using video modeling and then with a combined approach that included video modeling and a video feedback intervention. Further, two additional conditions were included in which the participant viewed the instructor as the model and a second condition in which video modeling with the instructor was used for feedback for the student. Results indicate that the most performance increases were obtained when video feedback was included with video modeling.

The benefits of a combined approach have since been applied to the medical field. Laparoscopic surgery was effectively trained using video modeling and video feedback (Alkatout et al., 2021). It has further been shown to decrease times to place an intravenous catheter (IV) (Yu et al., 2019). With the effectiveness of the method in training medical skills, there is a precedent set for its use. However, there may be some concerns with implementing this method considering that there is some level of delay in feedback delivery. Thus, other methods may prove superior in training medical skills. However, future research is needed to examine this issue.

Critical Components of Feedback

Feedback is considered any "information about a performance that allows a person to change [their] behavior," (Daniels & Bailey, 2014). There are components of feedback that impact its effectiveness. In a literature review, Sleiman et al. (2020) reviewed articles between 1988-2018 to evaluate the qualities of feedback that influence its effects. Several qualities were identified that enhance the effectiveness of feedback. As stated in Daniels and Bailey (2014), the qualities associated with greatest performance increases included feedback delivered privately, daily or weekly, inclusion of positive information, feedback which was self-generated or delivered by supervisors, and feedback which was delivered within 60 seconds of the performance. The articles that included these qualities yielded the largest effect sizes across studies, regardless of the use of other interventions. Further, even when implemented alone feedback is a highly effective intervention.

Video modeling and video feedback includes many of these components, however, it often fails to meet criteria for immediacy of feedback. That is, the feedback delivered is often delayed. Immediacy allows for feedback precision, but is not included in many training methods.

Weighted Checklists

A method of further improving the precision of feedback is through the use of weighted checklists. Weighted checklists contain the critical behaviors that a performer will be scored on. However, point values are assigned to each of the behaviors with the most critical ones being assigned a higher point value than others (Daniels & Bailey, 2014). This aids in setting a priority for the behaviors that need to be attended to the most. In the case of medical behaviors, there are certain ones that are far more critical than others. As an example, behaviors that maintain the sterile field in an operating room would be weighted higher because they can significantly impact the safety of a patient.

TAGteach®

The primary concern with previously outlined methods of training has been the lack of immediate feedback delivered. Immediate feedback allows for precision that delayed feedback fails to provide. Teaching with acoustical guidance (TAGteach®) addresses this by the immediate provision of feedback through the sound of a click. TAGteach® is designed to break down the various steps of a task into smaller precise behaviors that are reinforced with a salient sound when performed correctly. The sound of the clicker is initially identified as feedback for correct performance at the start of training with the intent of the click becoming a conditioned reinforcer. As opposed to other forms of feedback, the auditory stimulus serves as an efficient method of feedback that does not require the additional time that delayed verbal feedback may require. With the design of TAGteach®, reinforcement is delivered specifically for form and topography-based measures of behavior; this requirement makes it ideal for skills that need precise form or topography to be performed correctly. Thus, the method has been used across fields with a majority of studies being conducted in sports.

An early study evaluating the use of TAGteach® in sports was Fogel et al. (2010) who evaluated the use of TAGteach® to teach a golf swing to a novice performer. The researchers implemented a multiple baseline design across skills. During baseline, participants received no intervention and during treatment the participants were trained using TAGteach®. Feedback was delivered contingent on correct performance of portions of a TA completed for a golf swing. The study also included a generalization condition in which a novel golf driver was used without the participant being trained with this driver. Results demonstrated that TAGteach® was effective in training correct performance of a golf swing and that the skill maintained. Consequently, other studies have implemented TAGteach® across various skills. Quinn et al. (2015) used TAGteach® to improve dance performance. Results demonstrated that the use of TAGteach® was effective in improving the proficiency of kicks, leaps, and turns.

The above studies represent two among many conducted demonstrating the efficacy of TAGteach® in sports, but TAGteach® is not exclusively used in these two sports. TAGteach® has also been implemented to improve yoga poses (Ennett et al., 2020), weightlifting (Vorbeck et al., 2020), and passing skills in rugby (Elmore et al., 2018). All studies found that the training method is effective in improving the form and topography of skills. With its efficacy in sports, TAGteach® has since been applied across other domains.

In addition to sports, the field of ABA has long been using auditory feedback to improve client skills. A particular area of emphasis has been its implementation to decrease toe-walking in children with autism. Unlike other applications of auditory feedback that serve as reinforcement, this focuses primarily on the use of it as a punisher or prompt to decrease occurrence of the behavior (Hodges et al., 2019; Persicke et al., 2014). Results of such studies have found auditory feedback to be similarly effective in decreasing behaviors as much as it is in increasing them. Although TAGteach® is being used in many contexts, applications involving the development of skills with medical practitioners are lacking.

Recent applications of TAGteach® have begun to address this gap in the literature. Canon et al. (2021) implemented modified TAGteach® to develop relationship building skills with ABA practitioners. The researchers used clicker training in addition to verbal instructions and role-play to train two ABA practitioners in relationship building skills such as asking questions, appreciating, and mindful reflecting. A multiple baseline design across skills was used to evaluate the efficacy of these methods that included maintenance and generalization probes. Results demonstrated that the method was effective in developing relationship building skills. In addition to showing the effectiveness of the method, this study also served as an example of the relevance of this method in human service settings and its potential utility in developing skills with practitioners. Thus, this opens the door for implementation in the medical field.

Levy et al. (2016) used auditory feedback in a comparison study to determine how clicker training compared to the see-do method of training. The researchers implemented both methods randomly assigned to either tying a surgical knot or drilling a low-angle hole. Participants in the study were non-orthopedic surgical residents and first- or second-year medical students. Precision and speed were assessed to determine which method was most effective in training either of these skills. Of 12 participants in the control group, only 4 were able to demonstrate correct knot tying and were less able to drill the low angle compared to the group that received the auditory feedback training. The researchers emphasized that time may not be saved in training, but that the outcomes of training include more accurate demonstration of these skills. This study served as a foundation for future studies to implement empirically demonstrated behavior analytic techniques for skill acquisition across fields. However, there are a few concerns that arise with the implementation of auditory feedback and the data analysis methods.

For example, there is a concern with the social validity of clicker training in professional settings, especially in human service settings. Although across studies social validity measures demonstrate that auditory feedback is preferred, these measures represent small samples of participants. Social validity has yet to be assessed with a wider population of professionals that are in need of developing precise form and topography with their skills. Additionally, the social validity of clicker training has yet to be assessed in a medical setting. A long history of the use of clicker training exists with non-human animals (e.g., dog training). This long history perhaps leads to the perception that it should be used primarily with animals. This may reduce the acceptance of these methods in applied settings outside of clinical research. This represents a significant issue; practitioners may be more likely to select a less effective training in favor of one that does not share these same associations. A potential solution that is subtle and likely to be more socially acceptable is the use of a tactile stimulus as opposed to an auditory one.

Tactile Stimulus Prompts and Feedback

Tactile stimuli in the form of vibrations have been primarily used in research as prompts, similar to the prompt on a cellphone indicating that a message or call has been delivered. Shabani et al. (2002) evaluated the effects of tactile prompting in the form of a vibrating pager to increase social initiations in children with autism. An ABAB reversal design was used for three participants in which the intervention was delivered and removed. All participants received training to teach social initiations. Following training, participants were given a pager that vibrated once in every 25 second observation interval. After replicating the second tactile prompt phase, a prompt fading procedure was implemented. The pager was activated a second time if no initiation occurred. All three participants increased social initiations and responses to peer-initiated social interactions following the implementation of the tactile prompt procedure. However, upon fading the intervention, it was noted that some participants' initiations did not maintain without the presence of the prompt device.

Similarly, Lopez et al. (2020) evaluated the use of a tactile vibrating prompt to increase the initiation of social interactions in children with autism. A multiple baseline design across participants was used to evaluate the use of vibrating prompts in increasing the number of social interactions initiated. Vibrating prompts were delivered via text message to an Apple Watch® to prompt the participants to interact with their peers. Results demonstrated that the prompt was effective in increasing the number of peer interactions in intervention and follow up. Further, the study also found decreased latency to initiate interactions. Similar results were found for increasing on-task behavior in children with autism (Finn et al., 2015) and in assisting in time management (Hughes et al., 2011). Overall, results of these studies demonstrate the efficacy of tactile stimuli to serve as effective prompts for a range of behaviors. However, prompts do not address the necessary feedback portion of skill acquisition, regardless of the efficacy of the tactile vibrating prompts as antecedents.

Few studies have evaluated the use of tactile prompts as feedback. Andajani et al. (2020) evaluated the technical use of a vibrating watch as a form of feedback. The researchers used vibrating watches to indicate to visually impaired athletes that they had run the correct distance. As this was delivered following a performance and gave information about the performance itself, this is considered feedback (Daniels & Bailey, 2014). The tactile vibration (as feedback) was successful in assisting runners to complete the correct distances without the abrasiveness of a loud auditory stimulus. Dubuque et al. (2021) evaluated the efficacy of tactile stimulation as feedback with a 6-year-old participant with autism spectrum disorder using a watch in a withdrawal design to increase time spent coloring. The results found that the feedback delivered in the form of a vibration was effective in increasing time spent coloring. This indicates that tactile feedback may be a potential intervention for other skills across settings. However, additional research has not been conducted on the efficacy of a vibrating watch used to deliver feedback in the form of a vibration without any additional prompts such as texts.

The lack of research in this area represents another gap in the literature where the social validity of interventions in real settings has yet to be assessed. Given the previous research demonstrating the effectiveness of TAGteach® as a skill acquisition method and the social validity of vibrating watches in settings in which an auditory stimulus may not be appropriate, combining the two may lead to an effective intervention for applied settings. Thus, the purpose of the present study was to compare the effects of two interventions: 1) Video modeling and video feedback and 2) Tactile TAGteach® on the percentage of steps in medical skills performed correctly across two different medical tasks. The tasks targeted included simple interrupted suturing with instrument tying and endotracheal intubation performed in a simulated medical setting. It was hypothesized that Tactile TAGteach® would be the superior intervention in terms of achieving the mastery criterion in fewer sessions in comparison to video modeling and video self-evaluative feedback. Secondly, it was expected that participants would generally prefer the Tactile TAGteach® intervention.

Chapter 2: Method

Participants

Four participants were included in the study. Participants were either college students currently enrolled in courses or administrative staff within the department. Compensation in the form of $25.00 per participant was delivered to participants not receiving course or degree credit for participation. Participants received $5.00 at the end of each condition completed (e.g., baseline, intervention, and maintenance) and $10.00 at the completion of the final best alone condition.

Physical requirements for the participants included adequate fine motor skills such as the ability to grasp and manipulate objects with both hands. Participants must have been able to safely touch and handle needles without concern. Any participants without good motor skills, or a history of trypanophobia (e.g., fear of needles) or hemophobia (e.g., fear of blood) would have been excluded; however, this was not a concern for any participants interested in the study. The participants did not have any history with medical instruction that would have reasonably included suturing or basic first aid to ensure learning history does not impact the results. Participants that scored above 30% on any of the skills in baseline would have been excluded to ensure no ceiling effects occur; no participants were excluded from participation.

Informed consent consisted of a form detailing information including the purpose of the study, the procedures, risks of participation, compensation and benefits, assurance of confidentiality, and right of withdrawal. Opportunities for questions about the study were given at the time of participation or at any point via email. Signature lines for the participant and primary investigator were provided. Deception was not used in this study.

In addition to the informed consent, participants were required to sign a form stating that training in this study was not an official course for any of the medical skills taught and that at the conclusion of the study they will not in any way be certified or able to use the skills learned outside of this setting. Participants were given an opportunity to ask questions about the form. Signature lines for the participant and primary investigator were provided.

Setting and Materials

Sessions were held in a conference room or in a private office at a university in the southeastern United States. Sessions were completed at a conference table or desk of approximately the same height to ensure that enough space for materials was provided with room for instruments to be placed out of reach to prevent accidental injury. No injuries occurred for the duration of this study.

Materials used in the study included instruments and practice models relevant to each skill. For simple interrupted suture with instrument tying, participants were provided with suture training pads that replicate the texture and skin layers of natural skin, a tension device for replicating tension on the human body, 3-0 Nylon suture with a 19mm 3/8 reverse cutting needle, Adsons with Teeth, Forceps for pinching and holding a skin model, suture scissors, Needle Drivers, and protective cutting gloves to prevent injury. The endotracheal intubation task included a model laryngoscope, intubation model, rigid stylet, bag valve mask (BVM), and syringe.

Additional materials included a sharps container for disposal of needles used in the study to ensure safety. At the conclusion of the study, sharps were disposed of at an approved disposal location in the state of Florida. For the purposes of data collection and interobserver agreement (IOA) an iPad®, a tripod, laptop computer with video-editing software, pencils and pens, a modified watch for vibration delivery, and two task analyses (see Appendix A and B) were used. Participants were required to wear long-sleeve clothing, close-toed shoes, and pants that cover the entirety of their legs to participate. Protective gloves and eye-goggles were also provided to participants during the sessions.

Dependent Variables and Measurement

The present study assessed the percent correct steps of two skill-sets relevant to the medical field. Each skill set is discussed in detail below. Each skill is independent of the other; learning one skill should have no bearing on the acquisition of the other skill. In addition to being functionally independent, the two skills assess basic areas that are trained across medical professions, including medical doctors and nurses, that are necessary for use in most practices. The primary investigator received training in both skills evaluated in the study as a part of previous education. However, task analyses and video models were independently evaluated by a Paramedic, Surgical Technician, and Emergency Medical Physician.

Task analyses were created for both skills (see Appendices A and B). The behaviors were then scored by the primary researcher and an independent expert to identify the most critical steps in the task analyses. All steps were initially assigned one point and additional points were added to steps that were considered to be critical by both the expert and primary researcher. Critical steps were defined as a step in the task analyses that, if not completed correctly, would prevent the completion of the subsequent steps. Task analyses were scored out of a total of 100 points. The point values were not available to participants to view and were only used by the researcher to evaluate performance across conditions. Participants were scored out of the 100-point total. A point system was selected for evaluating participant performance for ease of scoring and assurance in equality of skill difficulty.

Correct Endotracheal Intubation

The first targeted skill set was the correct completion of an endotracheal intubation. Endotracheal intubation includes the placement of a tube into the windpipe generally through the mouth to assist in breathing when a person is unable to breathe independently. Endotracheal intubation was selected because of its necessity as a basic medical skill that is often trained across professions and because it is functionally independent from the other skill. Completion of this skill correctly takes approximately 3 minutes for fluent performers. This skill requires self-tracking of steps and evaluation of correct placement in the windpipe. Anecdotally, this skill has been considered a difficult skill for novice learners to initially master.

Performance was measured based on the percentage of steps correctly completed as outlined in Appendix A. The task analysis includes 40 identified steps that are necessary in ensuring the tube is placed correctly and safely in the windpipe of the model. Participants were trained and scored on all 40 steps. An example of a correct completion includes step 25, the pressing of the end of the laryngoscope against the epiglottis that results in the opening of the throat such that the vocal cords are visible to the participant. Incorrect completion of the step could result in placement of the endotracheal tube inside the throat as opposed to the vocal cords. This would mean that the intubation would fail and the participant would be unable to inflate the lungs of the model patient.

Correct Simple Interrupted Suture with Instrument Tying

Simple interrupted suture with instrument tying is a basic method of suturing open wounds on the human body. An interrupted suture is considered when the sutures placed are not connected in any way and are tied separately from one another, resulting in independent sets of sutures. Instrument tying refers to the use of medical instruments (i.e., Adsons Forceps and Needle Drivers) to create knots with the suture to close the wound. Simple interrupted suture includes the insertion of a suture needle using Needle drivers on one side of the incision, pulling it across and re-inserting directly across from the initial insertion point on the other side, and tying two sets of knots one after the other in alternating direction such that the skin re-approximates. Re-approximation is defined as both sides of the incision touching at the point of the suture. Simple interrupted suture with instrument tying is a common suture used across multiple settings that is a basic skill taught in medical professions. This skill was selected because of its difficulty for novice learners, similarity in difficulty to wound wrapping, and functional independence from the other skill. Completion of a single suture for a fluent learner takes approximately 2 minutes.

Performance was measured based on the percentage of correct completion of the steps in Appendix B. A total of 49 steps were selected that were required for the simple interrupted suture with instrument tying. To be considered correct completion, step 46 of skin re-approximation must be completed. Skin approximation means that the skin edges have been placed together to facilitate proper healing of a wound; without re-approximation, the other steps are considered unsuccessful because the wound would not be able to heal properly. Thus, this step is required for prior steps to have been considered completed correctly. An example of the correct completion of a step is step 22. To be considered correct, the Adsons forceps must be rotated away from the suture holding hand and the subcutaneous layers of the skin were facing out and visible. Incorrect completion of this step would be any other rotation that results in the subcutaneous layer facing inward and not visible to the participant or primary investigator. Estimated time to train the skill is 15 minutes and estimated time to perform the skill is 2 minutes.

Interobserver Agreement

Data on interobserver agreement (IOA) were collected for a minimum of 33% of all sessions. Secondary observers, who collected IOA, received training consisting of a video presentation of each step of the task analysis for all skills as demonstrated by a model. Videos included descriptions of the qualities that make the step correct and included examples of incorrect completion of each step. Following the completion of training, observers independently scored two videos per skill that demonstrate correct and incorrect steps. Observers were required to obtain a minimum of 90% agreement before moving on to collect IOA. After completing the practice videos, observers met with the primary investigator to review any disagreements and receive additional training if IOA during training was below 90%. If IOA during the study fell below the 80% minimum, secondary observers received task clarification and re-completed the training outlined above to review areas of disagreements. Secondary observers did not continue to collect IOA unless the 90% agreement was met.

Videos were randomly selected by assigning numbers to each video and inputting the numbers into a random generator. Trial-by-trial agreement was used for IOA. Task analyses for each skill were scored as correct or incorrect by the primary investigator and a secondary observer(s). Agreements were defined as any step in the task analysis that both observers scored the same. For example, if both observers recorded a step as correct and awarded the assigned percentage points for the step, this was considered an agreement. A disagreement was considered when two observers recorded a step differently. For example, if observer A recorded the step as correct and observer B recorded the step as incorrect, this was considered a disagreement. The number of agreements between the primary investigator and secondary observer(s) for each task analysis were added together and divided by the total number of agreements and disagreements before being multiplied by 100 to obtain the IOA percentage. IOA data were collected weekly and all sessions were recorded for IOA purposes.

IOA data were collected for 33% of the total sessions across participants. For Frances, IOA data were collected for 33% of sessions. The IOA mean was 96% (range, 94% to 98%) in baseline and 95% (range, 95% to 96%) across intervention, maintenance, and best alone conditions. For Linton, IOA data were collected for 33% of sessions. Linton's mean IOA was 88% (range, 88% to 95%) in baseline and 97% (range, 88% to 100 %) across intervention, maintenance, and best alone. For Catherine, IOA data were collected for 33% of sessions. IOA means for Catherine were 89.5% (range, 80% to 98%) in baseline and 90.5% (range, 84% to 98%) across intervention, maintenance, and best alone. Finally, for Isabella, IOA data were collected for 33% of sessions. Mean IOA was 96% (range, 92% to 100%) in baseline and 91% (range, 85% to 100%) across intervention, maintenance, and best alone.

Independent Variables

Tactile TAGteach®

The following intervention included a modified version of the TAGteach® based procedure that included all steps and protocols established within the TAGteach® guidelines; the exception to this is the implementation of a tactile, vibration stimulus instead of an auditory click. TAGteach® traditionally implements the use of a clicker to serve as a form of auditory feedback for TAG points that are steps of a larger, complex skill. Tactile TAGteach® was implemented in the same manner as that of auditory TAGteach®, except for the use of a modified vibrating watch that was used in place of an auditory click. All task analyses implemented for tactile TAGteach® were constructed with the same conventions as that of auditory TAGteach®.

Participants were instructed on the purpose of the watch and TAGteach® intervention. During the intervention, a short demonstration of each step in the TA was delivered, and participants were given one opportunity to practice the behavior. If the behavior was demonstrated correctly, the researcher delivered a vibration to the wrist of the participant via a modified watch. If the step was not completed correctly then the researcher asked the participant to perform the last mastered step before re-completing the unmastered step. Participants did not perform all steps of the skill up to the new TAGpoint due to the nature of the skills, which may be too difficult to re-perform the skills repeatedly. That is, participants only had to complete the step the researcher indicated and was not required to complete any other pre-requisite steps.

Video Modeling and Self-Evaluative Video Feedback

Video modeling and video feedback is an intervention in which participants recorded their own performance of a skill and self-delivered feedback after re-watching their performance based on the task analyses provided. Task analyses were the same as those constructed for the purposes of TAGteach® that include one step per behavior and steps that are five words or less.

Participants were instructed on the purpose of the video recording and were given a single opportunity to perform the skill following the initial lecture-based training in baseline. Participants recorded themselves completing the skill and were given two opportunities to watch their performance of the skill, then scored the task analysis delivered based on their video.

Research Design

An adapted alternating treatment design with an embedded non-concurrent multiple baseline was used to compare the two procedures. Video modeling and tactile TAGteach® that was applied to the two dependent variables evaluated previously. The procedures were rapidly alternated, and orders were randomly assigned across participants. Baseline phases were staggered such that while one participant was receiving the intervention, a second participant did not receive the intervention for a minimum of three collected data points. Four phases that included baseline, intervention, maintenance, and best alone were used. The best alone condition included training the skill that did not achieve mastery levels or levels similar to the other two skills with the most successful procedure implemented during the intervention condition.

All skills were counterbalanced and randomly assigned. Half of the participants were trained using tactile TAGteach® for endotracheal intubation and half of the participants were trained using tactile TAGteach® for simple interrupted instrument tying. Participants assigned to receive TAGteach® for endotracheal intubation received video self-evaluation to teach simple interrupted instrument tying. Participants assigned to receive TAGteach® for simple interrupted instrument tying received video self-evaluation for endotracheal intubation.

Chapter 3: Procedures

Safety Procedures

Participants were required to wear personal protective equipment (PPE) during participation while handling sharp items. PPE included eye protection (goggles), protective gloves on non-dominant hands, and exam gloves. Gloves on only the non-dominant hand were needed as the dominant hand was holding the instrument to pick up needles; thus, there was minimal risk of participant injury on the dominant hand. Prior to beginning instruction, the researcher used a checklist to ensure all PPE was worn by participants before starting. During participation, participants were unable to remove any of the PPE until all sharp items had been returned to the sharp boxes by the researcher. A first aid kit was available and near the researcher at all times. No injuries occurred during the duration of the study.

The lecture delivered to all participants in baseline included safe sharp handling according to national standards. Participants were informed that unsafe sharp handling could lead to dismissal from the study. No participants were dismissed due to unsafe sharp handling.

Baseline

The instructor provided a lecture format instruction for each skill prior to the first baseline trial. Lectures included PowerPoint slides reviewing safety procedures and the instruments that should be used when completing each skill. If participants scored above 30% for any of the target skills in baseline, they were dismissed from the study. No participants scored above 30% in baseline.

Independent Variable Comparison

Performance of all skill sets was evaluated using the weighted task analyses developed by the primary researcher and an independent expert. Each step was scored as an “all or nothing”. If the step was performed correctly, then the primary researcher scored the participant as receiving all points available for that step. If the step was performed incorrectly, then the participant received no points associated with that step. This method was adopted because of the nature of the skills being assessed in that failure to complete one of the steps could result in failure to complete future steps. All participants were then randomly assigned to their respective interventions and skill sets.

Tactile TAGteach® Training

After the completion of baseline, participants were introduced to the clicker that was implemented for the tactile TAGteach® procedure. Prior to beginning instruction, participants were given the opportunity to fit different Velcro watch bands lengths to ensure that they were comfortable during training. Each participant received their own watch band that was not worn or shared by any other participant in the study. The watch was worn for the duration of the tactile TAGteach® procedure. Participants were informed that vibration of the modified watch indicated that they completed the step correctly. At this point, an example vibration was delivered for the participant and the instructor asked if the participant could feel the vibration and if any discomfort was experienced. If no vibration was felt, the instructor removed the watch to identify the problem before testing it with the participant again. The instructor described what each tag point was and demonstrated the tag for the participant prior to them demonstrating the step. When indicating that the participant would demonstrate the skill, the instructor stated, "the tag point is," then stated the specific step on the task analysis. Participants were given a single opportunity to demonstrate the step in the task analysis and if completed correctly, a single vibration was delivered. Due to the nature of the skills, participants were only given a single opportunity to complete the step unless it was completed incorrectly.

Tactile TAGteach® Data Collection

The instructor described what each tag point was and demonstrated the tag for the participant prior to them demonstrating the step. When indicating that the participant would demonstrate the skill, the instructor stated "the tag point is," then stated the specific step on the task analysis. Participants were given a single opportunity to demonstrate the step in the task analysis and if completed correctly, a single vibration was delivered. Due to the nature of the skills, participants were only given a single opportunity to complete the step.

At the start of each session, participants were told what behaviors were targeted and were reminded of the TAGteach® procedure. The researcher provided verbal instructions on how to complete each step and a model if needed. Participants did not receive verbal or written feedback about their performance. The skills were performed step-by-step. As stated previously during training, the researcher stated, “the tag point is,” and the name of the step to be completed by the participant. The participants were then given one opportunity to demonstrate the skill. If completed correctly, the researcher delivered the click and moved on to the next step in the assigned task analysis. If completed incorrectly, the researcher did not deliver a vibration and adjusted the materials such that it was in the state of the previous step before asking the participant to complete the step again if necessary.

Once the tactile TAGteach® instruction was completed, participants were given the opportunity to practice the skill twice before being scored on the skill. Practices were not recorded, but participants were informed that the third time they would be recorded and scored on performance. No feedback was delivered following the practice or the scored performance. The video was used to score the participants’ performance and used for IOA purposes. Following the collection of at least two data points, the intervention was alternated with the other intervention.

Video Modeling and Video Self-Evaluation Training

Following baseline, participants were given a video model of either endotracheal intubation or simple interrupted suturing with instrument tying. After viewing the video, participants were instructed that they were recording their own performance and then scoring their performance based on the task analysis. Two opportunities to practice the skill were given before recording began. After recording, participants scored themselves as “yes” or “no” to a correct versus incorrect category. Participants were instructed to score themselves as “yes” if they completed the step correctly and “no” if they completed the step incorrectly. Feedback was not delivered on correct scoring of the task analysis to better represent the natural conditions of medical training in which this is not likely to be formally provided to students.

Video Modeling and Video Self-Evaluative Feedback Data Collection

Participants were asked to perform the step while being video recorded at the beginning of the first session. Following their performance, they were asked to score their performance using the task analysis given to them during training. Participants were given the opportunity to practice twice before being scored on the skill. Participants were informed that on the third performance they would be recorded and scored.

Before scoring themselves each time, participants were instructed to mark "yes" if they believe they completed a step correctly and "no" if they completed a step incorrectly. Participants were marking their performance on a laptop computer with a checklist provided by the primary researcher. As in training, feedback on correct scoring was not provided to simulate natural training conditions.

Maintenance

Following the completion of the training, participants were asked to perform both medical skills. These maintenance data points were collected after three weeks for the first three participants and after one week for the last participant. Practice time was not provided to participants. Participants were scored as they were during instruction for all targeted behaviors. Interventions were not in place during this phase, however, participants were instructed on safety behaviors prior to the performance of each skill.

Best Intervention Alone

After the independent variable comparison phase was completed, the primary researcher reviewed the data and determined by visual analysis which intervention was most effective. The intervention that demonstrated the greatest gains in performance was selected to train the skill that did not achieve mastery.

Procedural Integrity

Procedural integrity data were collected similarly to that of IOA. Procedural integrity was completed on correct statement of each step according to the guidelines provided by TAGteach® international for tactile TAGteach® (Appendices C and D) or the correct statement of the script for video self-evaluative feedback. The procedural integrity goal was a minimum of 90% agreement. Secondary observers were provided scripts and task analyses outlining the TAG points for each skill. Observers received training in the same format of IOA with two video exemplars per skill of the procedure being implemented for observers to score prior to collecting procedural integrity. Observers must have obtained the minimum of 90% agreement before scoring procedural integrity. Procedural integrity data were collected weekly. Data collectors met with the primary investigator following collection of procedural integrity to review disagreements for each participant. If procedural integrity fell below 90%, participants were retrained using the same method as original training and did not continue collecting data until the minimum 90% agreement was met.

Procedural integrity was collected for 33% of the total intervention and best alone sessions for each participant. For Frances, mean procedural integrity across sessions was 100%. Procedural integrity across sessions for Linton was 100%. For Catherine, procedural integrity was 100% across sessions. Finally, for Isabella, the mean procedural integrity across sessions was 100%.

Social Validity

Following the completion of the study, participants were asked to complete a social validity survey (See Appendix E). The social validity survey was sent via email to the participants that asked them to rate their preference for each of the interventions. Participants were asked to identify which of the training methods they believed was likely to be the most useful in a natural setting and which they would recommend to future medical students.

Chapter 4: Results

Overall Results

In baseline, participants overall performed lower for suture (*M*=17.9%) and intubation (*M*=18.8%). Upon introduction of the interventions, all skills improved compared to baseline performance. Tactile TAGteach® improved skills to a greater extent compared to baseline across participants (*M*=85.3%); whereas, video self-evaluative feedback improved performance, but did not reach mastery criteria for most participants (*M*=69.1%). In maintenance, Tactile TAGteach® produced greater performance maintenance 1-3 weeks after training concluded (*M*=92.5%). Compared to video self-evaluative feedback, performance did not maintain at mastery levels across all participants (*M*=65.8%, *R*=63-70%).

Times to implement the interventions varied across participants. Overall, tactile TAGteach® session lengths were higher (*M*= 27:56 mins) and were more varied (*R*= 15:00 to 49:00 mins). Video modeling and video self-evaluative feedback sessions were shorter (*M*= 18:40 mins), and less varied in length (*R*=13:00 to 28:00 mins). Individual session lengths (i.e., time to complete the skill), were idiosyncratic across participants and are discussed individually below.

Frances

During baseline, Frances performed an average of 16.8% steps correct, with a range of 16-22% steps correct, intubation. Suture overall was scored lower at 11% average steps correct, with a range of 5-15% steps correct. In baseline, time to complete the suture skill was an average of 3.5 minutes, and a range of 3:06 to 4:11 minutes. The intubation skill in baseline was completed in an average of 1 minute, with a range of 52 seconds to 1.5 minutes. Upon introduction of the interventions, Frances was pseudo-randomly assigned to receive Tactile TAGteach® for intubation and video self-evaluative feedback for suturing. Video modeling and video self-evaluative feedback required an average of 18 minutes, with a range of 15 to 26 minutes. Tactile TAGteach® took an average of 28 minutes to implement, with a range of 18 to 41 minutes. Tactile TAGteach® for intubation increased to an average 69.7% correct, with a range of 49%-91% steps correct. Time to complete the intubation skill in intervention was an average of 2.5 minutes, with a range of 1:41 to 4:02 minutes. Video self-evaluative feedback for suturing increased to an average of 58.7% steps correct, with a range of 19-96% steps correct. Time to complete the suture skill was an average of 3 minutes, with a range of 2:08 to 4:48 minutes. Frances the met mastery criterion after 6 intervention sessions. The second intervention, video self-evaluative feedback, improved the skill to mastery criteria first. This intervention was initially selected as the superior intervention. However, during maintenance, the skill trained with Tactile TAGteach® (intubation) maintained at 83% steps correct, whereas the skill trained with video self-evaluative feedback maintained at 67% steps correct. Given the significant difference in maintenance, and the relative close performance of the training methods, Tactile TAGteach® was selected as the superior intervention. Thus, Tactile TAGteach® was implemented in the best alone condition for suturing and the skill improved to an average of 92.5% steps correct, with a range of 85-100% steps correct.

Linton

In baseline, Linton performed an average of 22% steps correct, with a range of 16-30% steps correct, in the intubation skill. Time to complete the intubation skill in baseline was an average of 46 seconds, with a range of 35 seconds to 3 minutes. Suture was demonstrated at an average of 18.4% with a range of 9-26% steps correct during baseline. Time to complete the suture skill in baseline was an average of 5 minutes, with a range of 3:06 to 5:45 minutes. Linton was assigned to receive Tactile TAGteach® for suturing and video self-evaluative feedback for intubation. Video modeling and video self-evaluative feedback required an average of 18:45 minutes to implement, with a range of 17 to 20 minutes. Tactile TAGteach® required an average of 30 minutes to implement, with a range of 18 to 49 minutes. Tactile TAGteach® for suturing increased to an average of 96.8% correct, with a range of 87-100% steps correct. Time to complete suture in intervention was an average of 2.5 minutes, with a range of 2:22 to 2:48 minutes. Linton achieved the mastery criterion in two sessions; however, data collection continued to ensure there were enough data points to identify a trend. Video self-evaluative feedback for intubation increased to an average of 84.5% steps correct, with a range of 66-98% steps correct. Time to complete intubation in intervention was an average of 1:49 minutes, and a range of 1:09 to 2:30 minutes. The skill trained with Tactile TAGteach® (suturing) maintained above mastery criteria (92%) 3-weeks post intervention. The skill trained with video self-evaluative feedback (intubation) did not maintain at mastery (63%). Tactile TAGteach® was identified to be the superior intervention as it produced the greatest initial performance increases, was the first to achieve mastery with the paired skill and maintained above mastery criteria during maintenance. Thus, Tactile TAGteach® was implemented in the best alone condition for intubation and the skill improved to an average of 97.7% steps correct, with a range of 96-100% steps correct.

Catherine

In baseline, Catherine performed suture at an average of 18.2% steps correct, with a range of 16-24%. Time to complete suture in baseline was an average of 4.5 minutes, with a range of 2:53 to 5:06 minutes. Intubation was scored at an average of 27%, with a range of 23-30% steps correct in baseline. Time to complete intubation in baseline was an average of 1 minute, with a range of 41 seconds to 2.5 minutes. Catherine received Tactile TAGteach® for intubation and video self-evaluative feedback for suturing. Video modeling and video self-evaluative feedback required an average of 15:15 minutes to implement, with a range of 13 to 18 minutes. Tactile TAGteach® required an average of 20 minutes to implement, with a range of 15 to 23 minutes. Tactile TAGteach® for intubation increased performance to an average of 97.2% correct, with a range of 93-100% steps correct. Time to complete intubation in intervention was an average of 2 minutes, with a range of 1:51 to 2:46 minutes. It took Catherine 3 sessions to achieve the mastery criterion. Similar to Linton, Catherine achieved mastery in the second session for intubation, the skill trained with Tactile TAGteach®, and sessions continued to ensure a trend. Video self-evaluative feedback for suturing increased to an average of 72.8% steps correct, with a range of 56-85% steps correct. Time to complete suture in intervention was an average of 2 minutes, with a range of 1:57 to 2:05 minutes. The skill trained with Tactile TAGteach® (intubation) maintained above mastery criteria (99%) 3-weeks post intervention. The skill trained with video self-evaluative feedback (suturing) did not maintain at mastery (63%). Considering Tactile TAGteach® was the only training method to achieve mastery criteria with the paired skill, and it maintained above mastery in maintenance, this was selected as the superior intervention for Catherine. Tactile TAGteach® was implemented in the best alone condition for suturing and the skill improved to an average of 96% steps correct. Both performances were scored at 96% steps correct during the best alone condition.

Isabella

Isabella performed suture at an average of 19.5% steps correct, with a range of 13-23% in baseline. Time to complete suture in baseline was an average of 10 minutes, with a range of 4:47 to 15:26 minutes. Intubation was performed at an average of 11.3% steps correct and a range of 6-18% in baseline. Time to complete intubation in baseline was an average of 3 minutes, with a range of 1:17 to 11:52 minutes. Isabella received Tactile TAGteach® for suture and video self-evaluative feedback for intubation. Video modeling and video self-evaluative feedback required an average of 19:45 minutes to implement, with a range of 13 to28 minutes. Tactile TAGteach® required an average of 30:15 minutes to implement, with a range of 28 to 34 minutes. Upon introduction of the interventions, Tactile TAGteach® increased performance to an average of 85.3% correct, with a range of 69-96% steps correct for suturing. Time to complete suturing in intervention was an average of 7 minutes, with a range of 5:14 to 9:33 minutes. Video self-evaluative feedback increased performance for intubation to an average of 65.5% steps correct, with a range of 49-85% steps correct. Time to complete intubation in intervention was an average of 2:49 minutes, with a range of 1:11 to 2:50 minutes. Isabella achieved the mastery criterion after 4 sessions. 1-week post intervention, maintenance was recorded for both skills. The skill trained with Tactile TAGteach® (suturing) maintained at 96% steps correct, and the skill trained with video self-evaluative feedback (intubation) maintained at 70% steps correct. Tactile TAGteach® was selected as the superior intervention and implemented in the best alone condition for intubation. Performance in intubation following the introduction of the Tactile TAGteach® intervention improved to an average of 97% steps correct with a range of 96-98% steps correct.

Social Validity

Responses to the social validity questionnaire (Table 1) were somewhat idiosyncratic. Overall, all participants rated that both Tactile TAGteach® and video-self evaluative feedback were helpful for understanding when they completed a step correctly. Catherine and Isabella rated video self-evaluative feedback lower compared to Tactile TAGteach®, stating that video feedback was somewhat and slightly helpful, respectively. Linton and Catherine preferred Tactile TAGteach® to video-self-evaluative feedback. Whereas Frances and Isabella preferred video-self-evaluative feedback. Two participants (Linton and Catherine) indicated that Tactile TAGteach® would be recommended for training medical students. Isabella recommended both and Frances recommended video self-evaluative feedback.

Chapter 5: Discussion

The present study was conducted to evaluate the comparative effects of Tactile TAGteach® and video self-evaluative feedback. Further, it was intended to identify whether a tactile or haptic stimulus could be effectively substituted for auditory feedback. These trainings were also evaluated with two medical skills used in common practice, which were identified to be simple interrupted suture and endotracheal intubation. The skills were selected by the author who had previously received training in the skills as a part of early education and were validated by a surgical technician with experience as a paramedic and an emergency medical physician. Participants that were included in the study had no prior experience in medical training and had no additional certifications outside of basic life support or cardiopulmonary resuscitation (CPR) certification. None of the participants had previously taken anatomy or physiology courses. Thus, all participants in the study were novice learners.

With the exception of Frances, the skills trained with Tactile TAGteach® improved to mastery in fewer sessions and to a greater degree compared to video self-evaluative feedback. Across all participants, Tactile TAGteach® was the only intervention to produce maintenance above or near the mastery criteria 1-3 weeks post intervention. Tactile TAGteach® was likely more successful for similar reasons that traditional TAGteach® has been demonstrated to be (e.g., immediacy of feedback, accuracy of feedback, frequency of feedback, etc.).

For Frances, video modeling and self-evaluation was the initially superior intervention as it was scored as having achieved the mastery criteria first. However, the skill pairings may have played a significant factor in the differences between the interventions. The skill paired with video modeling and self-evaluation was suturing which did not require any preparation of the instruments on the part of the participant. As a part of the intubation skill, checking steps were embedded in the checklist as a part of the practice (e.g., ensuring that cuff inflates). Frances scored lower in intubation due to skipping these early steps. Towards the end during a practice session, Frances noted that although she received tags for completing the steps, she thought they had already been done and there was no need to repeat them. Further, Frances frequently only repeated the insertion of the ET tube to ensure that the lungs would inflate as opposed to practicing the entirety of the skill. Intubation requires seeing internal anatomy that the suture skill did not. Although rated as relatively similar in difficulty, the inability to see the structures within the medical model easily may have led to increased difficulty for those sections of the checklist. Across both skills, Frances required more sessions to mastery than all other participants.

Regardless of video modeling and self-evaluation being initially the more effective intervention, it did not maintain at the same levels compared to TAGteach®. Generalization across time is a significant factor for medical skills considering physicians may go months without opportunities to practice a skill but will still be required to complete it to the same level of fluency. For this reason, Tactile TAGteach® was selected as the superior intervention. It should be noted that both skills were performed above baseline levels. However, Tactile TAGteach® was the only intervention that resulted in the successful completion of the skill; intubation was successfully completed in that, although some steps were missed, the model's lungs did inflate. In comparison to suturing, the skin edges did not reapproximate, meaning the suture was not successfully completed.

The TAGteach® procedure allows for extended rehearsal directly after verbal instructions and modeling of a skill. Meaning, the delay between the instructions, practice, and feedback is extremely small. When compared to video modeling and self-evaluative feedback, the latency between each component is extended and the feedback delivered is not always accurate. These factors may have contributed to the overall effectiveness of the TAGteach® procedure.

Linton was the only participant in the study that (a) did not have experience with sewing, and (b) noted to have watched themselves receive stitches after a previous accident. During baseline, Linton commented to have attempted to replicate the procedure they had seen. Overall, this participant scored highest in baseline compared to others. In intervention, Tactile TAGteach® paired with suturing improved performance to mastery and 100% steps correct by the second session. It was noted that the suture was snapped multiple times during baseline and intervention. This meant that the tension the participant was placing on the suture was too great, which resulted in breaking. Endotracheal intubation reached mastery criteria after suture. Thus, video modeling and video self-evaluative feedback was similarly effective in improving performance. However, as with Frances, the skill trained with video modeling and video self-evaluation did not maintain at mastery, whereas the skill trained with Tactile TAGteach® did. For these reasons, Tactile TAGteach® was the superior intervention for Linton.

Across sessions, Linton noted feeling frustrated when they did not receive a tag and requested feedback from the instructor during self-evaluative feedback. In responding to the social validity survey, Linton stated that Tactile TAGteach® felt overwhelming due to the length of the checklist and the number of repetitions required. They felt that this method was more effective and preferred it to video modeling and video self-evaluative feedback.

Catherine responded similarly to Frances and Isabella in baseline. She had expressed having extensive experience in sewing, but no medical experience. Participants that had experience in sewing, including Catherine, frequently attempted to sew the medical model's wound closed. The suture was threaded repeatedly from the top to the bottom, and the suture was not knotted nor separated; meaning, it did not meet any of the criteria for being a simple interrupted suture. In intervention, Catherine exhibited greater differentiation in performance between Tactile TAGteach® and video modeling and self-evaluative feedback. Tactile TAGteach® resulted in mastery by the second session at 93% or greater. Like Linton, Catherine also reached 100% correct for the skill trained with Tactile TAGteach®. However, unlike Frances, this participant did not exhibit similar concerns with endotracheal intubation. Across all four intervention sessions, Catherine was able to successfully complete the intubation (e.g., the medical model's lungs inflated). Performance for endotracheal intubation maintained at 99% correct, with the only step completed incorrectly being removing the hand from the cheek too early in the checklist (a non-critical step that was rated with only 1 point accordingly). Of note, Catherine completed the intubation in 1 minute and 51 seconds. This meant that not only was she correct, but she was rapidly able to intubate with no prior medical experience. Suturing was not completed comparably, and critical steps were missed in maintenance (e.g., relatching the needle correctly in the needle drivers). Tactile TAGteach® was also selected as the superior intervention and implemented in the best alone condition.

Isabella scored similarly low in baseline for both skills. Similar to Frances and Catherine, she also expressed having experience with sewing. Thus, in baseline, she too attempted to sew the wound closed using the entire suture from the top to bottom without cutting the suture. During baseline, Isabella was the only participant to disassemble the instruments for endotracheal intubation. She frequently did not attempt to intubate during this phase, but instead spent a majority of the session manipulating the instruments before setting them down and stating she had finished. Upon introduction of the intervention, video modeling and video self-evaluative feedback resulted in significantly more variability for endotracheal intubation compared to suture, which was trained with Tactile TAGteach®. For Isabella, mastery was achieved in the third session, and she was successfully able to complete the suture. With endotracheal intubation, Isabella consistently struggled with the order and correct completion of steps related to inserting the ET tube. Unlike the other participants, Isabella's maintenance period was only 1 week. The difference in maintenance was due to Isabella's pending relocation out of the city. Thus, maintenance was completed earlier compared to other participants. Regardless of the shorter maintenance period, a similar trend was noted for performance across skills. The skill trained with video modeling and video self-evaluative feedback not only did not reach mastery but maintained at only 70% correct. In comparison to the skill trained with Tactile TAGteach®, the skill maintained at 96% after 1 week. Given this, Tactile TAGteach® was selected as the superior intervention and implemented in the best alone condition.

Across participants, Tactile TAGteach® was noted to be the superior intervention. As stated previously, this is likely due to the immediacy and frequency of feedback during practice. Compared to video modeling and video self-evaluative feedback, the delays may be a significant factor in differing performance. Further, skills trained with Tactile TAGteach® were the only ones to reach 100% steps correct during intervention and maintain at 85% or greater. For medical professionals, this is likely to be one of the most compelling findings. It is expected that skills maintain across time and generalize across settings, even without continued practice opportunities. Even 1 week post intervention, the performance in a skill taught with video modeling and self-evaluative feedback was significantly lower than that of the skill trained with Tactile TAGteach®.

In reference to the tactile or haptic stimulus, all participants frequently noted forgetting they were wearing the modified watch. The watch used for this study was not necessarily intended for human use and was large compared to normal watches. However, the sensation of the vibration was subtle and familiar (i.e., similar to a cell phone vibration) to participants. Frances noted that the vibration was pleasing, and many participants enjoyed wearing it. Previous studies such as Levy et al. (2016), implemented the auditory click stimulus, which is part of the TAGteach® model. The use of this stimulus has produced significant amounts of criticism for its similarity to animal training. A haptic stimulus is less likely to be associated with animal training, and is extensively used by humans currently (e.g., smart watches, cellphones, pagers, etc.). The results of this study indicate that it may be the method of instruction as opposed to a specific type of stimulus that leads to improved skill acquisition and maintenance.

Participants rated both interventions highly overall. Two participants preferred video modeling and self-evaluative feedback (Frances and Isabella), and two preferred Tactile TAGteach® (Linton and Catherine). This indicates that preferences for interventions are idiosyncratic. The most common concern for video modeling and self-evaluative feedback was that it did not include enough expert feedback. Participants frequently requested additional corrective feedback during practice after watching the video model, and some noted this in their social validity survey responses. For Tactile TAGteach®, participants commented that the checklists felt longer when broken down in this way. Isabella reported that although this intervention was better, she disliked feeling heavily monitored. Most participants rated that they would recommend both interventions to others, but preferences aligned with recommendations for which intervention to use.

Similar to social validity, the accuracy of self-ratings tended to be idiosyncratic across participants. Although not included as a primary dependent measure, during self-evaluative video feedback participant ratings of their own performance frequently did not align with the ratings of the primary investigator or IOA data collectors. It is speculated that participants had not yet developed a sufficient discrimination repertoire to identify a correct vs. incorrect response.

The social validity responses provide a significant amount of information for practice. Overall, all participants enjoyed the feedback that is embedded in the TAGteach® model. However, the common theme was the overwhelming length of the checklist; this was not a concern with the video modeling and video self-evaluative feedback. Medical skills are often complex, which was true for the skills selected in the present study. This means that a new model of instruction may need to be evaluated that combines the effective TAGteach® model with feedback from participants.

Limitations and Future Directions

Although the results of the study are promising, no study is without limitations. The present study implemented a multiple baseline design with an embedded adapted alternating treatments design. As called for with most single subject designs, and given the time constraints of the study, fewer participants were required. When evaluating interventions for critical skills in a critical field of practices, more studies with larger participant samples is necessary. This study did use counterbalancing to increase confidence that the effects were due to the intervention, and not necessarily the skill. However, more studies are needed using randomization of participants to groups. Future research should also use the target population that would likely receive these interventions. A group design may be fitting for evaluating a similar instructional comparison, as was done in previous studies (Munster et al., 2016; Romero et al., 2018).

The participants in the study had no prior knowledge of anatomy/physiology or medical training. This meant that they lacked the prerequisites that most medical professionals would have prior to beginning training in these skills. Thus, participants frequently struggled with identifying critical structures on both medical models, placing them at a disadvantage. Replicating a similar model with medical professionals may yield better results for both interventions and allow for opportunities to assess generalization across settings and models. It would have been unsafe and unethical to allow these participants to perform these skills in a live setting.

A modified watch was substituted for the auditory stimulus in the TAGteach® model. The watch was not developed for human use; this resulted in it being far larger than a smart watch or similar device that would be used daily. Many watches currently on the market are not designed to be used for feedback. That is, a smaller device would need to be specifically developed for this purpose and lack many of the features a smart watch would have (e.g., a light-up screen that displays notifications). Further, the vibration was set on its lowest setting for all participants. Nevertheless, there was still some audible noise as a result of the vibration that could not be eliminated. Thus, it is possible that the tactile and auditory stimulus overlapped to make the stimulus more salient for the participant. These factors were not separated as a part of this study.

Mastery criterion for this study was set at 85% performance for two consecutive sessions. This was selected due to the participants' inexperience with the skills and as a conservative measure given that the intervention modifications were novel. In practice, mastery criteria should be set higher (e.g., 90% or 100% correct steps for three or more consecutive performances) to ensure participants truly master the skill.

The present study evaluated two interventions that were designed for individual implementation, not group implementation. Many medical programs and residencies see hundreds of students that require training. It may simply not be feasible for most instructors to implement this model in practice. Future studies should evaluate similarly effective models and modify them for group instruction to ease the burden on instructors.

There were notable differences in the session lengths between the interventions. Typically, Tactile TAGteach® took longer to implement compared to video modeling and video self-evaluative feedback. Thus, more time for practice was given to Tactile TAGteach®. However, this did not include the preparation time for video modeling and video self-evaluative feedback. An intervention with a video model requires not only evaluation of the checklists used, but also the video models themselves. Although the sessions for TAGteach® are greater in length, more effort is needed to develop the materials necessary for implementing video modeling and video self-evaluative feedback.

Weighted checklists were developed in the current study to account for the differences in step importance and to limit ceiling effects. The checklists were scored out of 100 points total to ensure ease of scoring for both the researcher and IOA data collectors. This meant that every step was allotted 1 point and remaining points were allocated based on relative importance of the step. The checklists were scored independently, and differences were averaged or discussed. However, this method lacked randomization. Future studies should consider random point assignment to all steps in the checklist to ensure ratings are entirely representative of step difficulty. This will be especially important for checklists in which participants are able to see their overall score, which may play a role in the effectiveness of self-evaluative feedback. However, participants were not aware of the weights and were only made aware of the number of steps completed correctly. Further, the task analyses created were based on a single method of performing each of the skills. Often, it is found that there are differences between methods achieving the same goal (e.g., suturing), meaning these task analyses are not wholly representative of how each provider may approach these skills. The differences in the task analysis length may also assist in improving the ease of self-evaluation, meaning for some skills it may be slightly easier than others.

This study did not evaluate time for intubation. An intubation is completed under two conditions (a) surgery, (b) emergency intubation. In an emergency, it is required that practitioners complete the skill rapidly. Speed was not targeted by either of the interventions, even though data time to complete each skill were collected. Most participants successfully intubated the medical model after receiving Tactile TAGteach®, but they may not have completed the skill at sufficient speed to ensure a patient would be revived without significant function loss. Future studies should include targeting speed as a measure that participants receive specific feedback on, especially when these trainings are implemented with participants within the medical profession.

Lastly, the inferior intervention was not carried out to mastery during the intervention phase. That is, sessions only continued until one of the skills achieved mastery criteria, not both. Given this, the number of sessions to achieve the mastery criteria between the two interventions cannot be compared. Future studies should include continued sessions until mastery across skills evaluated to provide data on the differences in number of sessions required.

Conclusion

The purpose of the present study was to compare effects of tactile TAGteach® and self-evaluative video feedback in improving basic medical skills with novice learners. It was found that both interventions were effective in improving overall performance across skills. However, tactile TAGteach® was the only intervention that resulted in maintenance at or above mastery criteria and improved skills to 100% correct. Present methods implemented in the medical field vary greatly and are often demonstrated to achieve moderate effects at best, which presents significant concerns for medical providers that are not being supported fully in their training and for patients who place their trust in a system that fails to train their providers to mastery. The present study aimed to offer an effective alternative to instruction that can be implemented with the end goal of improving medical skills and patient safety.

Present studies in medical research have set a precedence for 60% mastery to be not only acceptable, but commendable. Medical providers are often given the highest form of trust to make decisions about the health of patients and provide services that can be life-altering if performed poorly. Yet, the medical training system has continued to perpetuate an outdated method of instruction that has repeatedly failed to translate to skill mastery and behavior analysis has yet to be applied in this way, in this setting. Broad change is needed in the medical field to improve working conditions for medical providers and support them in their early stages of training. This study is only the beginning in what will need to be a long line of future research to evaluate what medical practitioners need. The hope is that this serves as a mending bridge between behavior analysis and medical practice, and that this may prompt future researchers to listen before we lecture.

References

Alkatout, I., Dhanawat, J., Ackermann, J., Freytag, D., Peters, G., Maass, N., Mettler, L., & Pape, J.M. (2021). Video feedback and video modeling in teaching laparoscopic surgery: A visionary concept from Kiel. *Journal of Clinical Medicine*, *10*, 163-178. https://doi.org/10.3390/jcm10010163

Andajani, S.J., Wirawan, O., & Pamuju, P. (2020). Development of detector watch model for 100-meter dash race for visually impaired athletes. *International Journal of Online and Biomedical Engineering*, *16*(10), 68-81. https://doi.org/10.3991/ijoe.v16i10.15617

Ashman, J.J., Rui, P., & Okeyode, T. (2019). Characteristics of office-based physician visits. *NCHS Data Brief*. https://www.cdc.gov/nchs/data/databriefs/db331-h.pdf

Baer, D.M., Wolf, M.M., & Risley, T.R. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis*, *1*(1), 91-97. https://doi.org/10.1901/jaba.1968.1-91

Baudry, L., Leroy, D., & Chollet, D. (2006). The effect of combined self-and expert-modeling on the performance of the double leg circle on the pommel horse. *Journal of Sports Sciences*, *24*(10), 1055-1063. https://doi.org/10.1080/02640410500432243

Canon, L.F., & Gould, E. (2021). A preliminary analysis of the effects of clicker training and verbal instructions on the acquisition of relationship-building in two applied behavior analysis practitioners. *Behavior Analysis in Practice*, *15*, 383-396. https://doi.org/10.1007/s40617-021-00555-x

Daniels, A. C., & Bailey, J. S. (2014). *Performance management: Changing behavior that drives organizational effectiveness*. Atlanta, GA: Performance Management Publications.

Dubuque, E.M., Collins, L., & Dubuque, M.L. (2021). Improving performance covertly and remotely with tactile stimulation. *Behavior Analysis in Practice*, *14*(1), 203-207. https://doi.org/10.1007/s40617-020-00493-0

Elmore, T., & Healy, O. (2018). An evaluation of teaching with acoustical guidance (TAGteach) for improving passing skills among university rugby athletes. *Journal of Sport Behavior*, *41*(4), 1-13.

Ennett, T.M., Zonneveld, K., Thomson, K.M., Vause, T., & Ditor, D. (2020). Comparison of two TAGteach error correction procedures to teach beginner yoga poses to adults. *Journal of Applied Behavior Analysis*, *53*(1), 226-236. https://doi.org/10.1002/jaba.550

Finn, L., Ramasamy, R., Dukes, C., & Scott, J. (2015). Using WatchMinder to increase the on-task behavior of students with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *45*, 1408-1418. https://doi.org/10.1007/s10803-014-2300-x

Fogel, V.A., Weil, T.M., & Burris, H. (2010). Evaluating the efficacy of TAGteach as a training strategy for teaching a golf swing. *Journal of Behavioral Health Medicine*, *1*(1), 25–41. https://doiorg.portal.lib.fit.edu/10.1037/h0100539

Hodges, A.C., Betz, A., Wilder, D.A., & Anita, K. (2019). The use of acoustical feedback to decrease toe walking in a child with Autism. *Education and Treatment of Children*, *42*(2), 151-160. https://doi.org/10.1353/etc.2019.0007

Hughes, E.M., Ryan, J.B., & Green, J.M. (2011). The use of assistive technology to improve time management skills of a young adult with an intellectual disability. *Journal of Special Education Technology*, *26*(3), 13-20. https://doi.org/10.1177/016264341102600302

Huskens, B., Reijers, H., & Didden, R. (2012). Staff training effective in increasing learning opportunities for school-aged children with Autism spectrum disorders. *Developmental Neurorehabilitation, 15*(6), 435-447. https://doi.org/10.3109/17518423.2012.705910

Kelley, H., & Miltenberger, R.G. (2015). Using video feedback to improve horseback-riding skills. *Journal of Applied Behavior Analysis*, *49*(1), 138-147. https://doi.org/10.1002/jaba.272

Levy, M., Pryor, K., & McKeon, T. (2016). Is teaching simple surgical skills using an operant learning program more effective than teaching by demonstration? *Clinical Orthopaedics and Related Research*, *474*(4), 945-955. https://doi.org/10.1007/s11999-015-4555-8

Lopez, A.R., & Wiskow, K.M. (2020). Teaching children with Autism to initiate social interactions using textual prompts delivered via apple watches. *Behavior Analysis in Practice*, *13*, 641-647. https://doi.org/10.1007/s40617-019-00385-y

Munster, T., Stosch, C., Hindrichs, N., Franklin, J., & Matthes, J. (2016). Peyton's 4-steps approach in comparison: Medium term effects on learning external chest compression. *GMS Journal for Medical Education*, *33*(4). https://doi.org/10.3205/zma001059

NORC at the University of Chicago and IHI/NPSF Lucian Leape Institute (2017). Americans' experiences with medical errors and views on patient Safety. Cambridge, MA: *Institute for Healthcare Improvement and NORC at the University of Chicago*. https://www.ihi.org/about/news/Documents/IHI_NPSF_NORC_Patient_Safety_Survey_2017_Final_Report.pdf

Parsons, M.B., & Rollyson, J.H. (2013). Teaching practitioners to conduct behavioral skills training: A pyramidal approach for training multiple human service staff. *Behavior Analysis in Practice*, *6*(2), 4-16. https://doi.org/10.1007/BF03391798

Persicke, A., Jackson, M., & Adams, A.N. (2014). Brief report: An evaluation of TAGteach components to decrease toe-walking in a 4 year old child with Autism. *Journal of Autism and Developmental Disorders*, *44*, 965-968. https://doi-org.portal.lib.fit.edu/10.1007/s10803-013-1934-4

Quinn, M.J., Miltenberger, R.G., & Fogel, V.A. (2015). Using TAGteach to improve the proficiency of dance movements. *Journal of Applied Behavior Analysis*, *48*(1), 11-24. https://doi.org/10.1002/jaba.191

Quinn, M.J., Narozanick, T., Miltenberger, R.G., Greenberg, L., & Schenk, M. (2019). Evaluating video modeling and video modeling with video feedback to enhance the performance of competitive dancers. *Behavioral Interventions*, *35*(1), 76-83. https://doi.org/10.1002/bin.1691

Romero, P., Gunther, P., Kowalewski, K.F., Friedrich, M., Schmidt, M.W., Trent, S., De La Garza, J.R., Muller-Stich, B.P., & Nickel, F. (2018). Halsted's "see one, do one, and teach one" versus Peyton's four-step approach: A randomized trial for training of laparoscopic suturing and knot tying. *Journal of Surgical Education*, *75*(2), 510-515. https://doi.org/10.1016/j.jsurg.2017.07.025

Seifert, L.B., Schnurr, B., Stefganescu, M.C., Sader, R., Ruesseler, M., & Sterz. (2020). Comparing video-based versions of Halsted's 'see one, do one' and Peyton's '4 step approach' for teaching surgical skills: A randomized controlled trial. *BMC Medical Education*, *20*, 1-11. https://doi.org/10.1186/s12909-020-02105-5

Sealy, W.C. (1999). Halsted is dead: Time for change in graduate surgical education. *Current Surgery*, *56*(1-2), 34-39. https://doi.org/10.1016/S0149-7944(99)00005-7

Shabani, D.B., Katz, R.C., Wilder, D.A., Beauchamp, K., Taylor, C.R., & Fischer, K.J. (2002). Increasing social initiations in children with autism: Effects of a tactile prompt. *Journal of Applied Behavior Analysis*, *35*(1), 79-83. https://doi-org.portal.lib.fit.edu/10.1901/jaba.2002.35-79

Sleiman, A.A., Sigurjonsdottir, S., Elnes, A., Gage, N.A., & Gravina, N.E. (2020). A quantitative review of performance feedback in organizational settings (1998-2018). *Journal of*

Organizational Behavior Management, *40*(3-4), 303-332. https://doi.org/10.1080/01608061.2020.1823300

Steiner, C.A., Karaca, Z., Moore, B.J., Imshaug, M.C., & Pickens, G. (2017). Statistical brief #223 surgeries in hospital-based ambulatory surgery and hospital inpatient settings, 2014. In: *Healthcare Cost and Utilization Project Statistical Briefs*. https://www.ncbi.nlm.nih.gov/books/NBK442035/

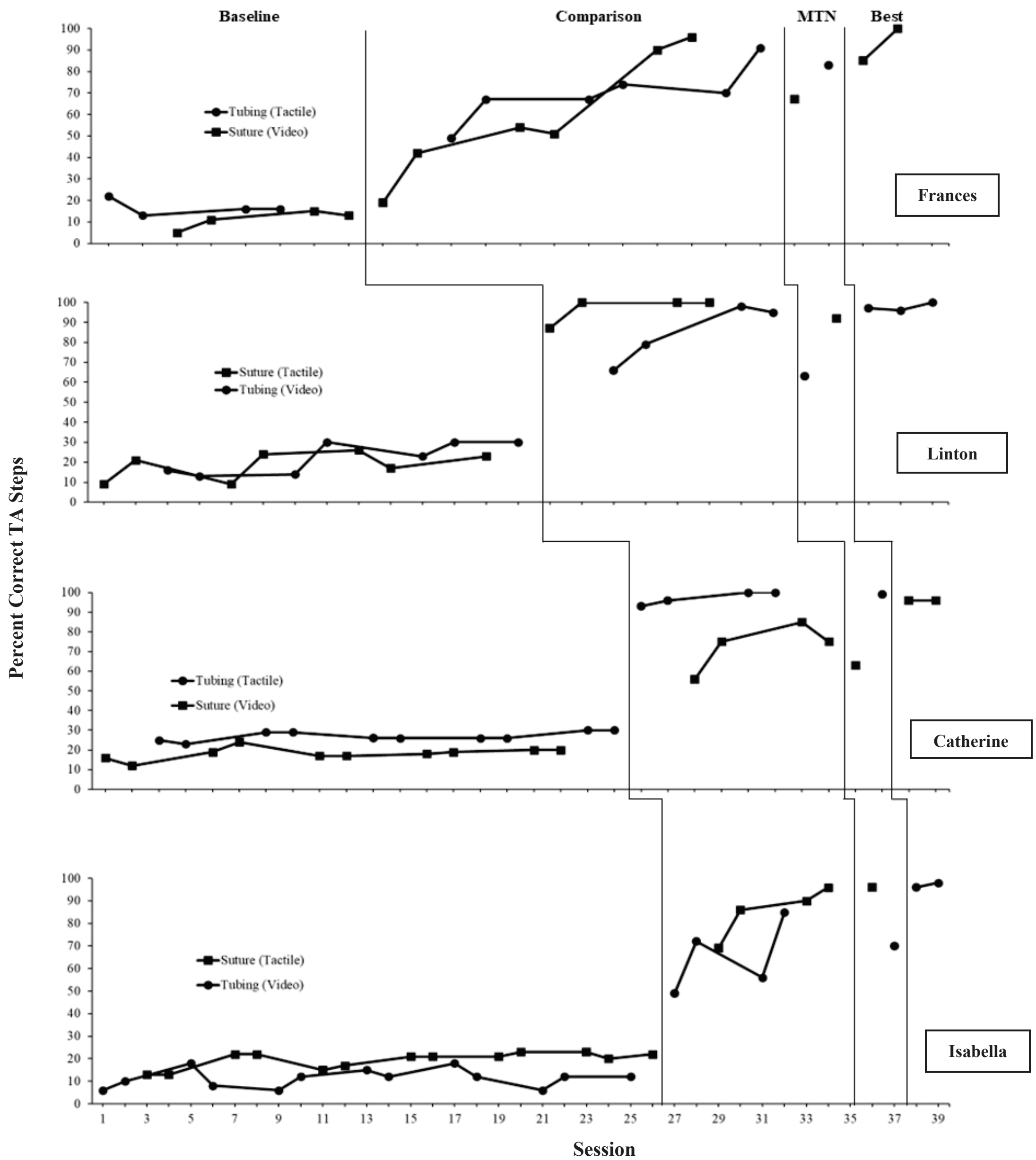
Stokes, J.V., Luiselli, J.K., Reed, D.D., & Fleming, R.K. (2010). Behavioral coaching to improve offensive line pass-blocking skills of high school football athletes. *Journal of Applied Behavior Analysis*, *43*(3), 463-472. https://doi.org/10.1901/jaba.2010.43-463

Vorbeck, B., & Bordlein, C. (2020). Using auditory feedback in body weight training. *Journal of Applied Behavior Analysis*, *53*(4), 2349-2359. https://doi.org/10.1002/jaba.723

Yu, J., Lo, C., Madampage, C., Bajwa, J., O'Brien, J., Olszynski, P., & Lucy, M. (2020). Video modeling and video feedback to reduce time to perform intravenous cannulation in medical students: A randomized controlled mixed-methods study. *Canadian Journal of Anesthesia*, *67*, 715-725. https://doi.org/10.3390/jcm10010163

Appendix

Tactile TAGteach® vs. Video Feedback Figure



Note. Figure 1 depicts the results in a multiple baseline design. Closed circles indicate that tactile TAGteach® was implemented, and closed squares indicate video self-evaluative feedback was implemented. "MTN" indicates the maintenance condition and "best" indicates the most effective intervention implemented alone.

Social Validity Survey Responses

Question	Frances	Linton	Catherine	Isabella
Helpfulness of Tactile TAGteach®	Extremely Helpful	Extremely Helpful	Very helpful	Somewhat helpful
Helpfulness of Video Feedback	Extremely Helpful	Extremely Helpful	Somewhat helpful	Slightly helpful
Likelihood of Tactile TAGteach® Recommendation	Extremely Likely	Likely	Likely	Neutral
Likelihood of Video Feedback Recommendation	Extremely Likely	Likely	Unlikely	Neutral
Training Preference	Video Feedback	Tactile TAGteach®	Tactile TAGteach®	Video Feedback
Recommended for Medical Students	Video Feedback	Tactile TAGteach®	Tactile TAGteach®	Both

Note. Table 1 depicts the social validity survey responses for all participants.

Task Analysis for Endotracheal Intubation

Step Label	**Description**	**Point Value**	**Correct (Y/N)**
1	**Orient to patient head.**	3	☐
2	**Pick up ET tube.**	2	☐
3	**Rigid stylet removed.**	1	☐
4	**Rigid stylet replaced.**	1	☐
5	**Rigid stylet curved 35 degrees.**	4	☐
6	**Secure syringe to ET Tube.**	3	☐
7	**Fill tube with air.**	3	☐
8	**ET tube checked.**	3	☐
9	**Pull air out of ET tube.**	3	☐
10	**Syringe removed.**	1	☐
11	**Syringe put away.**	1	☐

12	**Place hand on model chin.**	3	☐
13	**Flex chin up.**	3	☐
14	**L.Scope collected by handle** (hand oriented so that thumb is on underside and hand grasping top)	3	☐
15	**Pointer finger on inside of cheek.**	1	☐
16	**Cheek pulled out.** Away from face of model (inside of mouth should be visible)	1	☐
17	**L. Scope placed beneath finger.**	1	☐
18	**L.Scope pushed down in mouth.** (stopping at throat opening.)	3	☐

19	**L. Scope inserted into throat.** (until base of blade rests near teeth of model).	3	☐
20	**Remove hand from cheek.**	1	☐
21	**L.Scope moved to center.**	3	☐
22	**L.Scope pulled upwards.** (L. Scope should not be removed from mouth or rested against teeth).	3	☐
23	**Arm at 90 degrees.**	1	☐
24	**Check epiglottis visual.**	2	☐
25	**L.Scope pressed against epiglottis** (until vocal cords are visible).	3	☐

26	**ET tube collected with dominant.**	4	☐
27	**Insert ET tube into vocal cords.** (3-4 cm).	4	☐
28	**Remove L.Scope.**	3	☐
29	**Press ET tube against mouth.**	1	☐
30	**Remove stylet.**	3	☐
31	**Attach syringe.**	3	☐
32	**Inflate cuff.**	3	☐
33	**Connect BVM to ET Tube.**	3	☐
34	**Press bag to inflate ET tube.** (“lungs” should inflate to indicate correct placement).	4	☐
35	**Request BVM hold.**	1	☐

36	**Tape collected.**	3	☐
37	**Right edge of tape on right cheek.** (adhesive side down)	3	☐
38	**Tape pulled to center of ET Tube.** (adhesive side down)	3	☐
39	**Tape looped clockwise on ET tube.** (adhesive side down)	3	☐
40	**Secure ET tube with tape.**	3	☐
	Total Points:	100	/100

Task Analysis for Simple Interrupted Suture with Instrument Tying

Step Label	Steps	Point Value	Correct (Y/N)
1	**Needle holders picked up dominant.**	1	☐
2	**Needle holders unlatched.**	3	☐
3	**Needle holders latched around needle.**	1	☐
4	**Non-tipped edge of needle pinched** (between index finger and thumb of gloved hand).	1	☐
5	**Needle holders unlatched**.	1	☐
6	**2/3 Relatch between jaws.** (2/3 to ¾ away from needle point).	2	☐

7	**Needle drivers relatched.**	1	☐
8	**Pick up suture.**	2	☐
9	**Forceps collected with non-dominant**.	1	☐
10	**Forceps in "pencil" hold.**	1	☐
11	**Forceps on dermal layer sides.**	3	☐
12	**Dermal layer pinched.**	2	☐
13	**Forceps hand rotated in.** (towards needle hand)	3	☐
14	**Needle insertion with needle holders** (2-3 mm away from incision).	3	☐
15	**Needle pushed through interior.**	2	☐

16	**Needle holders unlatched.**	2	☐
17	**Needle holders relatched on tip.**	1	☐
18	**Suture pulled through incision.** (2-3 inches of suture pulled through incision)	3	☐
19	**Re-orient needle.**	2	☐
20	**Adsons pinched on opposite** (opposite incision side from initial suture entrance point).	3	☐
21	**Adsons on sides of dermal layer.**	3	☐
22	**Adsons hand rotated outwards.** (Away from needle holder hand,	3	☐

	subcutaneous layer should be visible).		
23	**Needle inserted through interior** (Inserted through interior portion of incision directly opposite of initial suture entrance).	3	☐
24	**Needle pushed through.** (tip now visible outside of skin 2-3 mm from incision).	2	☐
25	**Needle holders unlatched.**	2	☐
26	**Needle holders relatched around tip.**	1	☐
27	**Suture pulled through.**	2	☐

	(3-4 inches of free suture near initial entrance point).		
28	**Needle placed away.** (away from workspace by unlatching needle holders and releasing needle.)	1	☐
29	**Relatch needle holders.**	1	☐
30	**Grasp working end with glove.**	3	☐
31	**Needle holders perpendicular over incision.**	2	☐
32	**Clockwise suture wrap loose 3.**	3	☐
33	**Needle holders unlatched.**	1	☐
34	**Grasp free end of suture.**	2	☐

	(Grasped by relatching needle holders over suture.)		
35	**Pull working end of suture away.**	2	☐
36	**Pull free end towards** (directly opposite of working end. Tail end of suture should be completely through loops once complete)	2	☐
37	**Form x-shape with hands.**	3	☐
38	**Pull working and free end opposite.** (Skin edges should re-approximate)	2	☐
39	**Needle holders unlatched.** (Free end no longer held)	2	☐

40	**Relatch needle holders.**	1	☐
41	**Counterclockwise suture wrap 2.**	3	☐
42	**Grasp free end of suture** (with needle holders).	2	☐
43	**Pull working end away.**	2	☐
44	**Pull tail end towards.**	2	☐
45	**Form x-shape with hands.**	1	☐
46	**Pull working and free end opposite.** (Skin edges should reapproximate)	4	☐
47	**Needle holders unlatched.**	2	☐
48	**Instruments placed down.**	2	☐

49	**Extra suture cut with scissors.** (1 cm of suture forming 2 tails over knot)	3	☐
	Total Points:	100	/100

Procedural Integrity Endotracheal Intubation TAGteach®

Step Label	Description	Instruction	"TAG Point is…"	Stated Step	Step Tagged
1	**Orient to patient head.**	☐	☐	☐	☐
2	**Pick up ET tube.**	☐	☐	☐	☐
3	**Rigid stylet removed.**	☐	☐	☐	☐
4	**Rigid stylet replaced.**	☐	☐	☐	☐
5	**Rigid stylet curved 35 degrees.**	☐	☐	☐	☐
6	**Secure syringe to ET Tube.**	☐	☐	☐	☐
7	**Fill tube with air.**	☐	☐	☐	☐
8	**ET tube checked.**	☐	☐	☐	☐

9	**Pull air out of ET tube.**	☐	☐	☐	☐
10	**Syringe removed.**	☐	☐	☐	☐
11	**Syringe put away.**	☐	☐	☐	☐
12	**Place hand on model chin.**	☐	☐	☐	☐
13	**Flex chin up.**	☐	☐	☐	☐
14	**L.Scope collected by handle** (hand oriented so that thumb is on underside and hand grasping top)	☐	☐	☐	☐
15	**Pointer finger on inside of cheek.**	☐	☐	☐	☐
16	**Cheek pulled out.**	☐	☐	☐	☐

	Away from face of model (inside of mouth should be visible)				
17	**L. Scope placed beneath finger.**	☐	☐	☐	☐
18	**L.Scope pushed down in mouth.** (stopping at throat opening.)	☐	☐	☐	☐
19	**L. Scope inserted into throat.** (until base of blade rests near teeth of model).	☐	☐	☐	☐
20	**Remove hand from cheek.**	☐	☐	☐	☐

21	**L.Scope moved to center.**	☐	☐	☐	☐
22	**L.Scope pulled upwards.** (L. Scope should not be removed from mouth or rested against teeth).	☐	☐	☐	☐
23	**Arm at 90 degrees.**	☐	☐	☐	☐
24	**Check epiglottis visual.**	☐	☐	☐	☐
25	**L.Scope pressed against epiglottis** (until vocal cords are visible).	☐	☐	☐	☐

26	**ET tube collected with dominant.**	☐	☐	☐	
27	**Insert ET tube into vocal cords.** (3-4 cm).	☐	☐	☐	☐
28	**Remove L.Scope.**	☐	☐	☐	☐
29	**Press ET tube against mouth.**	☐	☐	☐	☐
30	**Remove stylet.**	☐	☐	☐	☐
31	**Attach syringe.**	☐	☐	☐	☐
32	**Inflate cuff.**	☐	☐	☐	☐
33	**Connect BVM to ET Tube.**	☐	☐	☐	☐

34	**Press bag to inflate ET tube.** ("lungs" should inflate to indicate correct placement).	☐	☐	☐	☐
35	**Request BVM hold.**	☐	☐	☐	☐
36	**Tape collected.**	☐	☐	☐	☐
37	**Right edge of tape on right cheek.** (adhesive side down)	☐	☐	☐	☐
38	**Tape pulled to center of ET Tube.** (adhesive side down)	☐	☐	☐	☐

39	**Tape looped clockwise on ET tube.** (adhesive side down)	☐	☐	☐	☐
40	**Secure ET tube with tape.**	☐	☐	☐	☐
	Total Points:	/40	/40	/40	/40

Procedural Integrity Simple Interrupted Suture with Instruments TAGteach®

Step Label	Steps	Instruction	"TAG Point is…"	Stated Step	Step Tagged
1	**Needle holders picked up dominant.**	☐	☐	☐	☐
2	**Needle holders unlatched.**	☐	☐	☐	☐
3	**Needle holders latched around needle.**	☐	☐	☐	☐
4	**Non-tipped edge of needle pinched** (between index finger and thumb of gloved hand).	☐	☐	☐	☐
5	**Needle holders unlatched**.	☐	☐	☐	☐

6	**2/3 Relatch between jaws.** (2/3 to ¾ away from needle point).	☐	☐	☐	☐
7	**Needle drivers relatched.**	☐	☐	☐	☐
8	**Pick up suture.**	☐	☐	☐	☐
9	**Forceps collected with non-dominant**.	☐	☐	☐	☐
10	**Forceps in "pencil" hold.**	☐	☐	☐	☐
11	**Forceps on dermal layer sides.**	☐	☐	☐	☐
12	**Dermal layer pinched.**	☐	☐	☐	☐
13	**Forceps hand rotated in.**	☐	☐	☐	☐

	(towards needle hand)				
14	**Needle insertion with needle holders** (2-3 mm away from incision).	☐	☐	☐	☐
15	**Needle pushed through interior.**	☐	☐	☐	☐
16	**Needle holders unlatched.**	☐	☐	☐	☐
17	**Needle holders relatched on tip.**	☐	☐	☐	☐
18	**Suture pulled through incision.** (2-3 inches of suture pulled through incision)	☐	☐	☐	☐

19	**Re-orient needle.**	☐	☐	☐	☐
20	**Adsons pinched on opposite** (opposite incision side from initial suture entrance point).	☐	☐	☐	☐
21	**Adsons on sides of dermal layer.**	☐	☐	☐	☐
22	**Adsons hand rotated outwards.** (Away from needle holder hand, subcutaneous layer should be visible).	☐	☐	☐	☐
23	**Needle inserted**	☐	☐	☐	☐

	through interior (Inserted through interior portion of incision directly opposite of initial suture entrance).				
24	**Needle pushed through.** (tip now visible outside of skin 2-3 mm from incision).	☐	☐	☐	☐
25	**Needle holders unlatched.**	☐	☐	☐	☐
26	**Needle holders relatched around tip.**	☐	☐	☐	☐
27	**Suture pulled through.**	☐	☐	☐	☐

	(3-4 inches of free suture near initial entrance point).				
28	**Needle placed away.** (away from workspace by unlatching needle holders and releasing needle.)	☐	☐	☐	☐
29	**Relatch needle holders.**	☐	☐	☐	☐
30	**Grasp working end with glove.**	☐	☐	☐	☐
31	**Needle holders perpendicular over incision.**	☐	☐	☐	☐
32	**Clockwise suture wrap loose 3.**	☐	☐	☐	☐

33	**Needle holders unlatched.**	☐	☐	☐	☐
34	**Grasp free end of suture.** (Grasped by relatching needle holders over suture.)	☐	☐	☐	☐
35	**Pull working end of suture away.**	☐	☐	☐	☐
36	**Pull free end towards** (directly opposite of working end. Tail end of suture should be completely through loops once complete)	☐	☐	☐	☐
37	**Form x-shape with hands.**	☐	☐	☐	☐

38	**Pull working and free end opposite.** (Skin edges should re-approximate)	☐	☐	☐	☐
39	**Needle holders unlatched.** (Free end no longer held)	☐	☐	☐	☐
40	**Relatch needle holders.**	☐	☐	☐	☐
41	**Counterclock wise suture wrap 2.**	☐	☐	☐	☐
42	**Grasp free end of suture** (with needle holders).	☐	☐	☐	☐
43	**Pull working end away.**	☐	☐	☐	☐
44	**Pull tail end towards.**	☐	☐	☐	☐

45	**Form x-shape with hands.**	☐	☐	☐	☐
46	**Pull working and free end opposite.** (Skin edges should reapproximate)	☐	☐	☐	☐
47	**Needle holders unlatched.**	☐	☐	☐	☐
48	**Instruments placed down.**	☐	☐	☐	☐
49	**Extra suture cut with scissors.** (1 cm of suture forming 2 tails over knot)	☐	☐	☐	☐
	Total Points:	/49	/49	/49	/49

Social Validity Survey

Please rate the following statements and highlight the letter to indicate your level of agreement.

1. The vibrating watch was helpful for me to know when I did a step correctly.
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree
2. The checklist for me to evaluate myself was helpful for me to know when I did a step correctly.
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree
3. I would recommend TAGteach® with the watch for teaching similar skills to future students.
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree
4. I would recommend video self-evaluation for teaching similar skills to future students.
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

5. Please select the training you liked the most:
    a. TAGteach® with a watch
    b. Video Self-Evaluation
6. Please select the training you would recommend for medical students learning these skills:
    a. TAGteach® with a watch
    b. Video Self-Evaluation
7. Please select the training you think would be best suited for use in a real training setting (ex., a hospital):
    a. TAGteach® with a watch
    b. Video Self-Evaluation
8. Please use the space below to provide your overall thoughts on the interventions (ex., what you like or didn't like about the vibrating watch).

Comments:

Video Self-Evaluation Procedural Integrity Checklist

Instructions: You are being instructed to review video of the researcher reading aloud the script for the video self-evaluative feedback intervention. Please listen and check off if the researcher vocally stated the following phrases. The complete script is shown below. All bolded and underlined items indicate the important phrases in the script that you will score.

Video Self-Evaluation Script: "You will now be **<u>shown</u>** a **<u>video</u>** of [**<u>insert skill name</u>**]. You will be allowed to review this video up to **<u>two times</u>**. After you have viewed the video, you will be given **<u>two opportunities</u>** to **<u>practice</u>** the skill using the medical model. On the third opportunity, your performance will be recorded. Once your performance has been recorded, you will be unable to re-record. I will then give you a checklist for you to **<u>score your performance</u>**. If you completed the step in the checklist **<u>correctly, score yourself as "yes,"</u>**. If you completed the step in the checklist **<u>incorrectly, score yourself "no,"</u>**. You can review your video **<u>twice</u>** once you have begun scoring. Do you have any questions?"

<u>Script Checklist</u>

Word or phrase	**Used by researcher?**
"shown"	
"video"	
For [insert skill name] researcher stated either "endotracheal intubation" **OR** "simple interrupted suture"	
"two times"	
"two opportunities"	
"practice"	
"score your performance"	
"correctly, score yourself as yes"	
"incorrectly, score yourself as no"	
"twice"	

TOTAL	/10

Notes:

Procedure Checklist

Did the researcher give the participant the checklist?

□ Yes □ No

Did the researcher give the participant two opportunities to practice?

□ Yes □ No

Did the researcher give the participant two opportunities to view their video?

□ Yes □ No