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Deploying the video laryngoscope into a ground EMS system

By **Mark E.A. Escott**, MD, MPH, FACEP; **Guy R. Gleisberg**, MBA, BSEE, NREMT-B, EMS-I; **Lee S. Gillum**, MPH, BS, LP; **Jared Cosper**, BS, LP; **Kevin M. Traynor**, AAS, LP; **Lisa Aulbert**, BS, RN, LP; **Levon Vartanian**, MD; **Shane P. Jenks**, MD & **Brett J. Monroe**, MD

Emergency airway management is a high-risk, low-frequency skill in the austere environment of EMS and one of the most important procedures performed by providers in the prehospital setting. Endotracheal (ET) intubation remains the standard procedure,[1] but requires 15–20 intubations to obtain a baseline proficiency.[2,3] However, proficiency in training doesn't necessarily translate to proficiency in practice. In a study by Wang et al., it was determined that even after 30 intubations, paramedics don't achieve proficiency (at least a 90% success rate) in their prehospital intubations with direct laryngoscopy (DL).[3] The development of low-cost video laryngoscopy (VL) with its improved visualization of the airway necessitates the evaluation and implementation of VL in emergency medicine.

Overall success of ET intubations is often quite high (90–100%), but the first-pass success rate of approximately 58% in DL remains a concerning statistic.[4] First-pass intubation success rates are a well-defined and established metric that EMS services track, which ultimately becomes the mark of success. A high first-pass success rate is essential because multiple intubation attempts in the prehospital setting lead to increased complications including hypoxia, damage to the airway and mortality. Literature demonstrates patient adverse events significantly increase with each additional attempt.[5] Therefore, first-attempt success rate is a critical patient outcome that must be measured and should be emphasized in airway management education, training and quality improvement.

BACKGROUND & DISCUSSION

Effective airway management requires establishing and maintaining a patent (open) airway

and ensuring effective oxygenation and ventilation. Ventilation is the physical act of moving air into and out of the lungs, whereas oxygenation is the loading of oxygen molecules onto hemoglobin molecules in the bloodstream.[6] Failure to manage the airway is a major cause of preventable death in the prehospital setting. Rescuers must recognize the importance of early detection of airway compromise and must respond with rapid and effective interventions. The decision by the clinician to intubate should be reached long before the patient shows signs of obvious crisis. The essential criteria are:

1. Respiratory failure (of ventilation or oxygenation);
2. Failure to maintain or protect the airway; and
3. A condition is present or a therapy is required that mandates intubation.[7]

ET intubation is the gold standard of airway care in patients who can't protect their airways or need assistance with breathing, but it's not always the most appropriate choice for airway management in the prehospital setting.[8] Therefore, providers must be competent in all forms of airway management and be able to escalate quickly from basic to advanced airway procedures.

In 2012, the Baylor College of Medicine (BCM) EMS Collaborative Research Group, (CRG) in conjunction with the Montgomery County (Texas) Hospital District (MCHD) and Cypress Creek (Texas) EMS (CCEMS) received a grant from SouthEast Texas Regional Advisory Council for the purchase and deployment of 50 King Vision laryngoscopes—enough to stock half the ambulances and supervisory vehicles at both EMS services. The goal of the funding was to evaluate the role of VL in prehospital airway management compared to traditional DL via a clinical study. A VL deployment process plan was developed that included advanced airway training (both didactic and skills based), clinical study guidelines, troubleshooting, system credentialing, outcome measurement, quality review data elements and continued competency training.

GUIDELINE DEVELOPMENT

During the initial research and development phase of this study, there was no scientific evidence that supported VL was superior to DL when used in the prehospital setting. Therefore, a standardized adult advanced airway management study protocol was developed for medics to follow unless the patient's clinical course necessitated alteration. Half of both agencies' vehicle fleets were equipped with video laryngoscopes and rotated to the other half monthly. Regular larynoscopes served as a backup device when vehicles were stocked with video laryngoscopes. A training model for the VL system was then developed, which met the requirements of the study but was system-specific to allow for ease of training and deployment.

DIDACTIC TRAINING

The video laryngoscope training varied slightly between the two organizations. MCHD held regular in-house quarterly continuing education training sessions with periodic reinforcement of physical skills, whereas CCEMS conducted on-shift skills training to assist in reducing training and deployment costs. All training sessions lasted four hours and focused on current clinical quality initiatives, protocol revision, and training on new procedures and skill verification.

Classes at MCHD were limited to 24 participants and 10 classes were offered during a five-day period (one morning and one afternoon). Nearly 180 MCHD uniformed field staff were trained.

Providers must be competent in basic and advanced airway procedures to provide proper patient care. Photo courtesy Kevin Nutt

CCEMS rotated units into their training facility during the provider's normal shift rotation, which took approximately three months to complete. CCEMS also included paramedic students in the training to provide consistency for the study period; these medics would ultimately be going through clinical training during the study period. Roughly 160 CCEMS providers were trained.

The didactic orientation portion of the training program was developed from a variety of materials including basic and advanced airway anatomy, evaluation of the airway using percentage of glottic opening (POGO) and Cormack-Lehane score, King System's training videos and laboratory usage of the laryngoscope. All components were included in a PowerPoint presentation that was then provided to all EMT-intermediates and paramedics. Additionally, the presentation was uploaded to an e-learning platform so staff at both agencies could review it at as needed to maintain consistency.

In addition to the orientation training program, the medics maximized their skills through hands-on practice sessions. Two sets of Levitan Airway Training Series manikins were purchased

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Paramedics practiced on six Levitan Airway manikins to become comfortable with both direct and channeled blades on the video laryngoscope. Photo courtesy Kevin Nutt

to supplement the various other airway training manikins, including the Laerdal Airway Management Trainer, Laerdal SimMan, Laerdal AT Torso and Laerdal Heartsim 2000 manikins. Each Levitan manikins has a unique mold, which provides a different visual experience with the variety of epiglottis shapes and laryngeal appearances. The goal was to create a skills lab for the video laryngoscope that was steady in message and easily reproducible over time to allow for consistent onboarding and training of new personnel.

Prior to staff participating in the quarterly training, alpha and beta testing with clinical staff was completed to test and review the process timing and flow. When participants weren't engaged in the skills rotation, they rotated through a presentation from the clinical manager on updated treatment guidelines and participated in a general question-and-answer session.

ORIENTATION & TROUBLESHOOTING

After formal didactic training, each medic had 30 minutes to familiarize themselves with the King Vision's channeled and standard blades, rigid stylet and suction device. Personnel were divided into four instructor-led groups. Each group member practiced using the blades as the instructor reinforced troubleshooting skills. Then each medic was required to complete six separate skills, including:

1. Disconnecting/connecting the camera blade;
2. Assessing posterior cartilage impact;
3. Intubating a manikin with C-collar;
4. Intubating a manikin using rigid stylet;
5. Intubating an obese chest; and
6. Suctioning the airway.

Each paramedic was reviewed, validated and checked off on each skill before proceeding to next phase of training. Participants were allowed to practice as much as they wanted during this phase and given a one-page handout including teaching points and "pearls" regarding VL. Once all participants completed this phase, each was paired with an instructor and moved on to skills training.

SKILLS TRAINING & MEDICAL CREDENTIALING

MCHD and CCEMS believed that VL was a dissimilar skill to that of DL in acquired knowledge, perceptual abilities, skilled movements and adaptation. In 1956, Benjamin S. Bloom, MD, described the concept of Bloom's Taxonomy of learning which included the cognitive (knowledge), affective (attitude) and psychomotor (physical skills) domains.

Currently, regardless of the various psychomotor domains or learning theorists, there are three basic levels in the overall instructional process: imitation, practice and habit. Therefore, weekly field training continued during the entire study in order for paramedics to learn and capture these new psychomotor behaviors to ensure success and efficiency of VL and DL skills. MCHD and CCEMS endeavored to be consistent with this theme throughout the study period to ensure the performance of the skill became second nature with confident proficiency.

The skills training process consisted of the Levitan Airway Training manikins, a Laerdal AT Torso manikin and a Laerdal Airway Management Trainer. Participants

intubated each manikin using both the channeled and standard blades for a total of 16 intubations minimum. This provided a detailed data skill record sheet. To reduce bias and the likelihood of participants feeling that the intubations were becoming progressively easier or harder, the sequence for practicing intubation on the Levitan manikins was randomized so each participant received a unique rounding through those six models. Each student completed the entire rotation process in approximately 45 minutes, including terminal testing using the channeled and standard blade.

Several metrics were evaluated:

1. POGO for participant and instructor;
2. Cormack-Lehane score for both student and instructor;
3. Intubation attempt time from when the blade passed the lips until the tube was placed and ventilated; and
4. Visual analog scale rating for difficulty of intubation as scored by the student.

Each medic was also skill tested on ET intubation with both blades on a Laerdal AT Kelly Torso manikin with a C-collar. The National Registry of Emergency Medical Technicians Advanced Level Psychomotor Examination skill sheet (Ventilatory Management—Adult) was modified for the VL validation sign-off.

MCHD & CCEMS believed that VL was a dissimilar skill to that of DL in acquired knowledge, perceptual abilities, skilled movements & adaptation.

Although current EMS practice doesn't require individual skill credentialing of paramedics, MCHD is in the infancy stage of implementing hospital-based credentialing. Credentialing is the process of verifying education, training and skills of practitioners who provide patient care services in or for a healthcare entity (collect, verify and assess information). Some methods and areas for monitoring include periodic chart review, direct observation, clinical knowledge, interpersonal and communication skills, and professionalism.[9] Therefore, each medic was required to receive sign-offs in all phases of VL training to become officially credentialed by the EMS medical director.

QUALITY IMPROVEMENT & DATA MANAGEMENT

Appropriate collection and analysis of patient care data is critical for any EMS system and is particularly important in analysis of critical procedures or new treatment regimens. In this circumstance, the primary investigator and a team of

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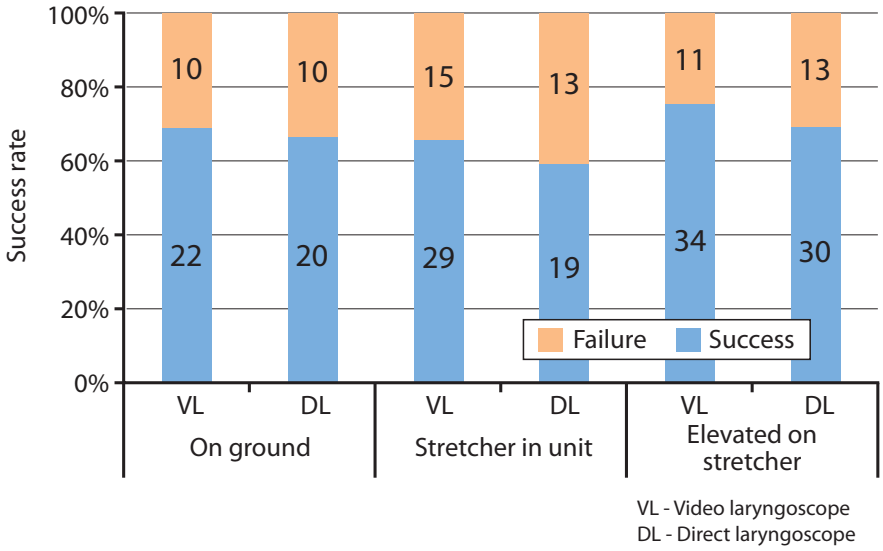
Figure 1: Intubation first attempt success rate by patient position



VL - Video laryngoscope
DL - Direct laryngoscope

emergency medical physicians/directors, airway researchers and site investigators met to discuss the study data elements and create the data dictionary/definitions for out-of-hospital airway reporting. These required steps met the primary and secondary outcome measures and would be needed for the final study data analysis. Data management for quality improvement or clinical research involves defining the data table, developing the data entry system and querying the data for monitoring and analysis.[10]

To ensure uniformity of reporting across systems,[2] MCHD and CCEMS utilized the position statement of the National Association of EMS Physicians. All EMS data was captured, stored and extracted from ZOLL RescueNet electronic patient care records.

STUDY RESULTS

Within the first 100 days of the study, the video laryngoscope utilizing the channeled blade has shown to be at least as effective as DL in relation to first-attempt success [VL 60/84 (71%) and DL 48/71 (68%)].[11] This comparison validates that our training and credentialing processes were adequate.

It's also important to understand that the mean experience with DL in this group was nine years and that most uses of VL were the first or second time the medic had used it on a live patient.[12] The four-month run-in period has shown that first-path success is superior utilizing a VL channeled blade compared to DL at 90% [VL 137/186 (74%) and DL 132/203 (65%)]. This is critical when considering the lengthy learning curve of DL. Furthermore, providers should consider prehospital intubation position in airway management strategies as we found an increase in success during DL by moving the patient from the floor to the stretcher. (See Figure 1.)

The positive trend of benefit of VL has continued beyond this initial phase-in period and the one-year multiagency prospective analysis will be presented at the American College of Emergency Physicians' Scientific Assembly in October.

CLINICAL GUIDELINE REVISION

After analyzing the data and results from the past year, it was conclusive that VL was superior to DL for our EMS systems. Therefore, an amended or post-study standardized adult advanced airway management protocol was developed for medics to follow unless the patient's clinical course necessitated alteration. Video laryngoscopes are now placed on all vehicles at both agencies as the primary device with DL as backup.

The new protocol dictates that both the first and second attempt at intubation should be made with the video laryngoscope. If a third attempt is needed, the medic can then choose to switch to a direct laryngoscope, a supraglottic airway kit, a BLS airway device or perform a surgical airway technique. All paramedics must document the justification for their choice. If three attempts at VL have been reached and the provider is unsuccessful, a backup airway device should be utilized.

CONCLUSION

EMS physician-piloted and -directed research is the pillar and strength of scientific development for new training skills,

In 2012, the Montgomery County Hospital District and Cypress Creek EMS received a grant to evaluate the role of video laryngoscopy in prehospital airway management via a clinical study. Photo courtesy Kevin Traynor

new outcome-based protocols and new contributions to the current EMS body of knowledge. VL with the King Vision channeled blade has shown to be safe and effective, even during the phase-in period where experience is limited to one or two human uses. The mean experience in our group with DL is nine years, yet the success rate remains unacceptable. It's time to consider transition from a skill that's difficult to obtain and maintain to one that appears to have a quicker learning curve and will likely result in decreased episodes of multiple attempts at intubation and associated complications. JEMS

Mark E.A. Escott, MD, MPH, FACEP, is the medical director for Montgomery County (Texas) Hospital District (MCHD) EMS and founder/director of the Baylor College of Medicine (Texas) EMS Collaborative Research Group. Escott is also an assistant professor in the Section of Emergency Medicine at the Baylor College of Medicine and a board-certified EMS physician.

Guy R. Gleisberg, MBA, BSEE, NREMT-B, EMS-I, is a research coordinator at MCHD.

Lee S. Gillum, MPH, BS, LP, is a clinical education coordinator at MCHD.

Jared Cosper, BS, LP, is the director of EMS at MCHD.

Kevin M. Traynor, AAS, LP, is the senior clinical supervisor at Cypress Creek EMS (CCEMS).

Lisa Aulbert, BS, RN, LP, is the clinical manager at CCEMS.

Levon Vartanian, MD, is the medical director of CCEMS.

Shane P. Jenks, MD, is assistant medical director and EMS fellow at CCEMS, and an assistant professor at Baylor College of Medicine, Section of Emergency Medicine.

Brett J. Monroe, MD, is assistant medical director and EMS fellow at MCHD, and an assistant professor at Baylor College of Medicine, Section of Emergency Medicine.

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