A Prospective Assessment of a Novel, Disposable Video Laryngoscope With Physician Assistant Trainees Using a Synthetic Cadaver Model

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ABSTRACT

Background: Airway obstruction is the second leading cause of preventable death on the battlefield. Video laryngoscopy has improved airway management in the emergency setting for several decades, and technology continues to improve. Current technology in the supply chain is cost-prohibitive to incorporate at Role 1 facilities, which is where many intubations occur by novice intubators. The i-view is a novel video laryngoscopy device that is handheld, inexpensive, and disposable. The aim of this study was to determine if the i-view is suitable based on performance assessments by physician assistant trainees and survey feedback.

Materials and Methods: We prospectively enrolled physician assistant students at the Interservice Physician Assistant Program at Joint Base San Antonio—Fort Sam Houston. We provided them structured training on how to use the device, and then, a board-certified emergency medicine physician or certified registered nurse anesthetist assessed their intubations performed on a SynDaver mannequin model. We surveyed the participants afterward.

Results: We enrolled 60 Interservice Physician Assistant Program students. Most participants were male (75%) with a median age of 32 years. Service affiliations included Army (50%), Navy (23%), Air Force (18%), and Coast Guard (8%). Most (70%) had previous deployment experience. All the participants successfully cannulated the mannequins and 98% achieved first-attempt success. Most participants (78%) reported a grade 1 view. On postprocedure survey, 91% strongly agreed with using this device in the deployed setting and 89% strongly agreed with finding it easy to use.

Conclusions: All physician assistant trainees successfully and rapidly performed endotracheal intubation using the disposable i-view video laryngoscope. Study participants rated the device as easy to use and desirable for deployment. Further research is necessary to validate this novel device in the clinical setting before recommending dissemination to the deployed military medical force sets, kits, and outfits.

INTRODUCTION

Background

Endotracheal intubation is a crucial skill for prehospital medical personnel, especially at the prehospital Role 1 (e.g., battalion aid station) and Role 2 (e.g., area support medical company) phases of care. Airway compromise is the second leading cause of preventable death in the prehospital setting.1,2 Airway management is the first priority in the hospital setting in trauma patients who are unable to protect their airway according to Advanced Trauma Life Support guidelines.3 The advent of video laryngoscopy (VL) in the early 2000s offered a new intubation modality to address this critical capability gap. Video laryngoscopy allows the operator to view the airway anatomy indirectly through a camera that projects onto a monitor.4,5 While definitive evidence is lacking, observational evidence suggests that first-attempt intubation success is higher with VL compared to direct laryngoscopy.
Moreover, it appears that this association is particularly pronounced among operators with less airway management experience. Many of the military end users share this characteristic such as combat medics and physician assistants who might potentially manage the airways of combat casualties on the battlefield.\textsuperscript{6,7} One national registry study found that VL was more frequently used than DL for emergent intubation in the civilian emergency department setting.\textsuperscript{8,9} One study demonstrated higher first-attempt intubations using VL over DL.\textsuperscript{10}

Medical personnel at Role 1 and Role 2 facilities have a broad range of training backgrounds and intubation experience and are frequently staffed by physician assistants (PAs) without physician consultation readily available. VL offers a potential benefit for improved airway management in these settings, particularly for facilities staffed by providers with limited intubation experience. Supplying all Role 1 and Role 2 facilities with VL equipment commonly used in U.S. emergency departments, such as the currently fielded GlideScope, is not logistically possible because of the cost of the device, power supply requirements, and periodic maintenance/repairs of this equipment at far forward locations. The U.S. Army currently fields the GlideScopes to the forward surgical teams and the emergency/operating rooms of Combat Support Hospitals (with conversion into the new Field Hospital model) at a cost of $12,292.67 each (National Supply Number 6515-01-572-7262). A new disposable, single-use video laryngoscope is on the market—the i-view—at a cost of approximately $100-200 per unit (Fig. 1). Given that this single-use device does not require maintenance and power sources, the i-view offers a potential opportunity to bring VL technology to Role 1 and Role 2 facilities. Furthermore, the i-view as an expendable item offers additional benefits with respect to U.S. military property accountability and reporting.

**Goals of the Investigation**

We obtained end-user performance and survey feedback on the i-view video laryngoscope as a potential solution for improving intubations in far forward staged areas.

**MATERIALS AND METHODS**

**Ethics**

The U.S. Army Institute of Surgical Research regulatory office reviewed protocol H-19-029 and determined that it was exempt from institutional review board oversight. This office approved a consent documentation waiver—we provided consent information sheets along with a briefing. We obtained approval from their academic director before recruiting.

**Subjects and Setting**

We enrolled PA trainees at the Medical Readiness Center of Excellence at Joint Base San Antonio—Fort Sam Houston. Physician assistant trainees were in their first phase of academic training, which is didactic and classroom-based; they had not completed any of their clinical phases at the time of enrollment. We enrolled them during their procedural skills training didactics.

![FIGURE 1. Example of the i-view video laryngoscope used in this study.](image-url)
Protocol
We recruited PA students as they rotated through their annual skills training stations in small groups of approximately two to six students per session. We divided the students into two groups of no more than three participants. A study team member, either an emergency medicine or anesthetist trained clinician, provided a demonstration of intubation using the i-view on the SynDaver airway trainer model (Fig. 2), along with a brief overview of troubleshooting an intubation while using the i-view. Then, we permitted the participants to practice intubation with the i-view on their own for <10 minutes with expert oversight. After this time, the participants performed a timed intubation on their own. All the participants utilized a cuffed 7.5 endotracheal tube and could use a flexible stylet, rigid stylet, or bougie based on personal preference. Time started after the participant verbally indicated they were ready, and time stopped when they verbally indicated the procedure was complete. An expert team member assessed the intubation as success or failure. We defined success as the endotracheal tube inserted into the trachea to an appropriate depth, which was defined by the balloon passing the cords and the tube in the trachea (e.g., not in the right or left main stem). The investigator assessing success also documented complications such as esophageal placement or improper tube depth as free text on the data collection forms. We considered every insertion and removal of the endotracheal tube from the oral cavity as an attempt. The participants evaluated their view of airway anatomy utilizing the Cormack–Lehane grading system. After completing the procedure, the participants filled out a demographic worksheet and survey comprised of 5-point Likert items to assess end-user appraisal of the i-view.

Data Analysis
We performed all the analyses using Microsoft Excel (version 10, Redmond, Washington) and JMP Statistical Discovery from SAS (version 13, Cary, NC). We used descriptive statistics. Continuous variables are presented as means and 95% CIs, ordinal variables as medians and interquartile ranges, and nominal variables as percentages and numbers. Data were visually assessed for normal versus skewed distribution using histogram plots. Normally distributed continuous variables were compared using a $t$-test, and nonnormally distributed continuous variables were compared using the Wilcoxon rank sum test.

RESULTS
We enrolled 60 Interservice Physician Assistant Program students. Most participants were male (75%) with a median age of 32 years. Service affiliations included Army (50%), Navy (23%), Air Force (18%), and Coast Guard (8%). Most (70%) had previous deployment experience (Table I). All the participants successfully cannulated the mannequins, and 98% achieved first-attempt success. Most participants (78%) reported a grade 1 view. On postprocedure survey, 91% strongly agreed with using this device in the deployed setting and 89% strongly agreed with finding it easy to use (Table II).

When stratifying by subgroup, we found no difference with respect to intubation success by sex (males 24.8 versus 28.9 seconds, $P = .200$) or real-world video laryngoscopy experience (yes 21.0 versus 26.4, $P = .758$). We did find difference when stratified by deployment experience (yes 22.8 versus 32.9, $P = .005$) and real-world DL experience (yes 18.3 versus 28.8, $P = .006$).

DISCUSSION
In our study assessing the performance of physician assistant trainees using the i-view, we found that all 60 participants

| TABLE I. Background on Participants | Demographics | Age | 32 (29-34) years |
|-------------------------------------|--------------|-----|-----------------|
|                                     | Male         | 75% (45) |                      |
|                                     | Army         | 50% (30) |                      |
|                                     | Navy         | 23% (14) |                      |
|                                     | Air Force    | 18% (11) |                      |
|                                     | Coast Guard  | 8% (5)   |                      |
| Service                             |              |         |                  |
| Operational experience              | Previous deployment | 70% (42) |    |
|                                     | Time in combat zone | 12 (7-18) months | |
| Experience                          | Real-world direct laryngoscopy | 28% (17) |    |
|                                     | Real-world video laryngoscopy | 10% (6) |    |

*Response counted as positive if the subject had any intubations on live patients in human clinical settings.
were able to successfully intubate the synthetic cadavers rapidly. No major complications occurred, and all participants were able to troubleshoot the device after brief training. The majority of these intubations, most of whom likely have little airway training. This includes PAs located at battalion-level medical treatment areas where they must function independently without physician consultation readily available—a factor that may contribute to worse survival outcomes for casualties intubated in prehospital phases of care. The i-view may provide a VL technology capability within these forward staged areas, enhance definitive prehospital airway management, and improve combat casualty survival.

Limited data exist with regard to outcomes after PA-performed intubations in the civilian setting as PAs infrequently perform intubation without direct or close indirect oversight. However, within the civilian setting, there are potential benefits to this one-time-use VL technology. A recent study of 879 emergency department intubations found that almost 1 in 10 developed aspiration pneumonia. While it is likely that most of these were the result of stomach content aspiration, it remains unclear how many related to cross-contamination of reusable VL devices. The single-use i-view would eliminate this risk.

Further research is necessary to validate the use of this device in the clinical setting. Of note, a multicenter, prospective study is underway, which will compare i-view to the currently used nondisposable models among emergency physicians. We believe that the data presented here along with a clinical trial will guide acquisitions by U.S. military for future conflicts.

Our study has several important limitations. First, the study took place in a well-lit, well-controlled environment using a synthetic cadaver model. While we believe the model that we chose is a very realistic option, it is not identical to a real patient. Moreover, there was no airway obstruction with blood or vomit. Second, we provided training on the device just before use. This may not reflect real-world use where the PAs may go prolonged periods of time in between procedures. Third, we are unable to mimic the anxiety-provoking environment of performing an intubation in a real, critically injured casualty without physician consultation readily available. Moreover, the airways in the mannequin do not necessarily reflect the reality of emergency airways including blood, vomit, and anatomical disruptions obscuring the view or placement. Fourth, our group size was limited based on the available participants, and because of the limited time we had with them, we were not able to build in a control arm. This may limit some applicability, and thus, our data represent pilot-level data. Last, the participants knew the purpose of the study ahead of time, so it is possible that may have skewed their feedback.

**CONCLUSIONS**

All physician assistant trainees successfully and rapidly performed endotracheal intubation using the disposable i-view video laryngoscope. Study participants rated the device as easy to use and desirable for deployment. Further research is necessary to validate this novel device in the clinical setting before recommending dissemination to the deployed military medical force sets, kits, and outfits.

**AUTHORSHIP STATEMENT**

S.G.S. is the overall principal investigator and was involved in all aspects of this study. W.T.D. and M.D.J. were involved in protocol development, data collection, data interpretation, and critical revisions of the manuscript. J.K.M. and M.D.A. were involved in the grant application, protocol development, data interpretation, and critical revisions of the manuscript. J.F.N. was involved in protocol development, data interpretation, and critical revisions of the manuscript. M.A.E., N.U., and K.A.V. were involved in data collection and critical revisions of the manuscript. All authors contributed to this study and accept responsibility for the publication.

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**TABLE II. Outcome Metrics**

| Outcome                        | Successful cannulation | First pass success | Time to intubation |
|--------------------------------|------------------------|--------------------|--------------------|
|                                | 100% (60)              | 98% (59)           | 25.8 (22.2-29.5)   |

| View                           | Grade 1    | Grade 2    | Grade 3    | Grade 4    |
|--------------------------------|------------|------------|------------|------------|
|                                | 78% (42)   | 22% (12)   | 0% (0)     | 0% (0)     |

| I would use the i-view in the deployed setting       | Strongly agree | Agree | Neutral | Disagree |
|-----------------------------------------------------|----------------|-------|---------|----------|
|                                                      | 91% (54)       | 6%    | <1%     | 0%       |

| I found the i-view easy to use                       | Strongly agree | Agree | Neutral | Disagree |
|-----------------------------------------------------|----------------|-------|---------|----------|
|                                                      | 89% (53)       | 8%    | <1%     | 0%       |
CONFLICT OF INTEREST STATEMENT

None declared.

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