Methods to Improve Success With the GlideScope Video Laryngoscope

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Occasionally intubation of patients is difficult using a video laryngoscope (GlideScope, Verathon Medical) because of an inability to guide the endotracheal tube to the glottis or pass the tube into the trachea despite an adequate view of the glottis. We examined methods to improve success when this difficulty occurs.

A literature search revealed 253 potential sources, with 25 meeting search criteria: 7 randomized controlled trials, 4 descriptive studies, 8 case series, and 6 case reports. Findings from the randomized controlled trials suggested that using a flexible-tipped endotracheal tube with a rigid stylet (GlideRite, Verathon Medical) improved intubation success, whereas other methods did not, such as using a forceps-guided endotracheal tube exchanger. If a malleable stylet was used, a 90° bend above the endotracheal tube cuff was preferable to a 60° bend. Evidence from lower-level sources suggested that several interventions were helpful, including using a controllable stylet, a fiberoptic bronchoscope in conjunction with the GlideScope, or an intubation guide, and twisting the endotracheal tube to facilitate passage into the trachea. Providers must consider the risks and benefits of any technique, particularly if the device manufacturer does not recommend the technique. Further rigorous investigations should be conducted examining methods to increase success.

Keywords: Airway, anesthesia, complications, GlideScope, video laryngoscope, video laryngoscopy.

The video laryngoscope is used to facilitate endotracheal intubation in cases of a suspected or unanticipated difficult airway.\(^1\) The GlideScope video laryngoscope (GSV; Verathon Medical) was introduced in 2001 and provides direct visualization of the larynx in patients with a potentially difficult airway. The GlideRite stylet (GRS; Verathon Medical) is placed into the endotracheal (ET) tube to help direct the ET tube through the glottic opening.\(^2,3\) Despite the success of the GSV as an intubation device,\(^4,5,8\) there have been reports of problems, including failure to successfully intubate patients.\(^5\)

A high-grade Cormack and Lehane\(^9\) view due to excessive GSV advancement resulting in the camera being close to the vocal cords can impede directing the ET tube through the glottic opening. Problems due to excessive GSV advancement include little room for the GSV and the ET tube, decreased field of view, and distortion of the anatomy, such as creating a sharp laryngeal angle in relation to the trachea.\(^10\) Even when the GSV is not advanced excessively, there can be problems in passing the ET tube into the trachea.\(^5\) We examined methods of facilitating the passage of the ET tube into the trachea under these conditions.

Materials and Methods

• The Clinical Question. The PICO (population, intervention, comparison, outcome) question\(^11\) guiding the search for evidence was as follows: In patients undergoing video laryngoscopy with the GSV where there is adequate visualization of the glottic opening, what additional maneuvers help improve intubation success?
• Search Strategy. A search was conducted using the following search engines (2001 to 2014): PubMed, the Cochrane Library, SUMSearch, the GSV operator and service manual from Verathon Medical, and professional and governmental websites. The authors examined the reference lists of obtained sources for other potential sources of evidence.

The following keywords and keyword strings were used alone or in combination: difficult intubation, failed intubation, GlideScope video laryngoscope, intubation failures with the GlideScope video laryngoscope, difficult intubation techniques using the GlideScope, Parker Flex-Tip endotracheal tube, GlideScope-assisted fiberoptic intubation, and trauma associated with the use of the GlideScope.

The following were the inclusion criteria: systematic reviews, randomized controlled trials (RCTs), observational studies, cases series, and case reports involving human subjects published in the English language, in peer-reviewed journals in full-text form or on a professional specialty website addressing the PICO question. Lower-level evidence such as observational studies, case series, and case reports were included because of the nature of the problem. Evidence where a video laryngoscope was used other than the GSV was considered...
because of the similarities between these devices. The evidence was appraised and classified by level according to the method proposed by Melnyk and Fineout-Overholt. The hierarchy of evidence described in this method ranges from level I (systematic review or meta-analysis of randomized controlled trials) to level VII (expert opinion).

**Results**

Two hundred fifty-two sources were found, and after a review of the sources and removal of any duplicates, 25 met the inclusion criteria (Tables 1 and 2). All the techniques described in Table 2 were reported to be successful. There were 7 RCTs with a total of 750 subjects (ranging from 58 to 196 per study) and 4 descriptive studies totaling more than 1,029 subjects (from 16 to greater than 500 subjects in each study); there also were 8 cases series (41 subjects, ranging from 4 to 13 per study with the number not specified in 3 articles and 6 case reports).

Five of the RCTs were conducted outside the United States. All investigators randomly assigned subjects to control or intervention groups, and in 2 studies the authors used a randomized block design to control for potential confounders such as operator experience. There was at least partial blinding of operators and observers in 5 of the studies, and the authors of the other RCT did not comment on blinding. The sample size in 5 of the studies was determined using a power analysis, in 1 study the sample size was described as “appeared reasonable”, and the other RCT did not comment on the method of sample size determination. The subjects in the control and intervention groups overall were comparable.

All the subjects in 5 RCTs were assessed preoperatively as not being difficult to intubate (normal airway), and most of the subjects in another study were assessed as having a normal airway. A difficult airway was simulated in the final study by placing a semiflexible cervical collar on the subject and strapping the subject’s head to the bed. Operators were described as experienced, novice, and heterogeneous but some authors did not indicate operator experience. All subjects were intubated after induction of general anesthesia and administration of a muscle relaxant.

Of the 4 descriptive studies, most described the respective interventions as being effective. None of the authors discussed blinding, and usually they did not discuss sample size determination; however, the authors of 1 study performed a power analysis to determine the required sample size. Subject airways were assessed preoperatively as being normal, normal and abnormal, or potentially difficult. Operator’s experience was most often not described. Subjects were intubated after induction of general anesthesia or the anesthetic technique was not described. All but 1 study lacked a control group.

Of the 8 cases series, 4 reports originated from outside the United States. None of the authors discussed blinding and sample size determination. Subjects’ airways were assessed preoperatively as being normal and abnormal or potentially difficult, and airway status was not indicated in 3 sources. Operator’s experience was often not described. The subjects were intubated after induction of general anesthesia or sedation and administration of topical anesthetic to the airway, in 4 reports, the anesthetic technique was not described. The authors of all the case series reported that the interventions were effective, suggesting the possibility of publication bias.

All but 1 of the 6 case reports were from the United States. Subjects’ airways were assessed preoperatively as normal or potentially difficult and were not described in 1 source. Authors of 5 of the reports stated they used the described intervention after failure using a standard laryngoscope or GSV or both, and the technique described was successful. Most subjects were intubated after induction of general anesthesia and administration of a muscle relaxant. Authors of only 1 study described the operator’s experience. Interventions described included using alternatives to the GRS such as an intubation guide, using a malleable stylet shaped to the GSV blade and rotating the ET tube after passing below the glottic opening, or GSV-assisted fiber optic bronchoscope intubation (FOBI) or GSV-assisted FOBI with the ET tube bevel facing posteriorly.

**Discussion**

- **Stronger Evidence.** The highest level of evidence was from 7 RCTs. Below is a summary of these findings.

  - **Malleable Stylet With 90° Bend Formed 8 cm From the Tip Compared With GlideRite Stylet.** Using an ET tube with an acute bend was proposed to improve intubation success by increasing the ability to advance the ET tube through the glottic opening. Authors of 2 studies compared using a malleable stylet with a 90° bend formed 8 cm from the tip with the GRS. Operators were described as expert or novice. Authors of these studies reported a difference between the styles in outcomes, including time to intubation, ease of intubation, Cormack and Lehane grade view, number of attempts, and number of laryngeal manipulations. Some authors reported that operators voiced more dissatisfaction when using the GRS.

  - **Endotracheal Tube With a Malleable Tip Compared With GlideRite Stylet.** Investigators of 1 study compared an ET tube with a malleable tip shaped into a “J” with
the GRS. Avoiding the use of the GRS was proposed to lessen the risk of airway injury. The only significant difference reported was the mean time to intubation favoring the GRS by 8 seconds. Intubation was unsuccessful in 2 subjects, who subsequently were intubated using the GRS. This study may have been underpowered.

- **Endotracheal Tube Forward or Reverse Camber Loaded on Malleable Stylet Compared With 60° or 90° Bend.** Investigators of 1 study compared an ET tube loaded (forward or reverse camber; Figures 1 and 2) on a malleable stylet with a 60° bend compared with an ET tube loaded (forward or reverse camber) on a malleable stylet with a 90° bend. The reverse camber loading was proposed to overcome the problem of the tip of ET tube hitting the anterior tracheal wall and the 90° bend to facilitate directing the ET tube through the glottic opening. The camber had no impact on time to intubation. The mean time to intubation was significantly less with use of the malleable stylet with a 90° bend (47.1 seconds vs 54.4 seconds). The use of a stylet with a 90° bend also resulted in significantly increased ease of intubation and less use of external laryngeal manipulations. Evidence found incidentally suggested using a jaw thrust, but not less use of external laryngeal manipulations. Evidence from descriptive studies13,14,22,25 is weaker evidence. Interventions examined included using the GSV in combination with a fiberoptic bronchoscope,16,24,28 the GSV22,25,26 or a similar device14 with a malleable stylet rather than the GRS, a controllable stylet,27 or the GSV with an intubation guide rather than the GRS.13,29-31 Case reports32-37 represent even weaker evidence. Authors of case reports employed alternatives to the GRS such as an intubation guide,32,37 a malleable stylet with rotation of the ET tube after passing it below the glottic opening,35 GSV-assisted FOBI,33,34 and GSV-assisted FOBI with ET tube bevel facing posteriorly.36 Below is a summary of these findings.

- **Controllable Stylet.** Authors from Japan reported using a stylet with a controllable tip to help maneuver the ET tube anteriorly to the glottic opening.27 The stylet allowed the operator to direct the ET tube posteriorly to help prevent the ET tube from impacting the anterior airway structures as it passed through the glottic opening into the trachea.

- **GlideScope-Assisted Fiberoptic Bronchoscopic Intubation.** Authors of 3 studies16,24,28 reported success using GSV-assisted FOBI. This technique was described as a teaching tool when the patient is under general anesthesia,24 for awake intubation in difficult-to-intubate situations,28 and in scenarios where the glottic view is adequate but there is difficulty in passing the ET tube into the trachea.10 Authors of 3 case reports reported similar findings.33,34,36 The controllable fiberoptic bronchoscope allows its passage through the glottic opening into the trachea. Unlike a styleted ET tube that can impact the anterior tracheal wall, the fiberoptic bronchoscope can be directed posteriorly, facilitating its placement into the trachea. The ET tube can be passed over the fiberoptic bronchoscope into the trachea. Orienting the ET tube with the bevel facing posteriorly may further facilitate passage of the ET tube.30 Figure 4 demonstrates the GSV-assisted FOBI procedure using a manikin.

- **GlideScope or Similar Device With Malleable Stylet Rather Than GlideRite.** Authors of a large retrospective descriptive study suggested a higher success rate using the GRS compared with a malleable stylet in an emergency department setting.22 Other authors reported success using a malleable stylet.14,25

A J-shaped malleable stylet was used in 12 subjects (2 with a suspected difficult airway).23 The investigators reported that this stylet is more effective compared with a stylet with a single 60° bend. The authors also recom-
<table>
<thead>
<tr>
<th>Evidence source</th>
<th>Evidence type/level of evidence</th>
<th>N</th>
<th>Intervention</th>
<th>Major findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falco-Molneneu et al, 2006</td>
<td>Descriptive study/ level VI</td>
<td>40</td>
<td>“C”-shaped intubating guide</td>
<td>TTI &lt; 60 s in 38 of 40 subjects; in remaining 2 subjects, modified guide allowed intubation in &lt; 180 s</td>
<td>Used electively; small diameter and memory allows easier passage of guide into trachea</td>
</tr>
<tr>
<td>Kramer and Osborn, 2006</td>
<td>Descriptive study/ level VI</td>
<td>&gt; 500</td>
<td>“Hockey stick”-shaped MS</td>
<td>Combination of techniques resulted in successful intubation</td>
<td>GSV used as primary intubation method and after failed intubation with DL; twisting the ETT helps navigation around laryngeal structures</td>
</tr>
<tr>
<td>Jones et al, 2007</td>
<td>RCT/level II</td>
<td>196</td>
<td>MS with 60° bend (ETT loaded forward or reverse camber) vs MS with 90° bend (ETT loaded forward or reverse camber)</td>
<td>Angle of ETT bend had impact on TTI, but camber did not</td>
<td>Less use of external laryngeal manipulations with 90° bend</td>
</tr>
<tr>
<td>Greib et al, 2007</td>
<td>Descriptive study/ level VI</td>
<td>16</td>
<td>Rigid video laryngoscope-assisted FOI with patient under general anesthesia</td>
<td>Operator rated procedure as easy in 15 of 16, fair in 1 of 16 subjects</td>
<td>Used electively; reported vital signs stable during procedure</td>
</tr>
<tr>
<td>Turkstra et al, 2007</td>
<td>RCT/level II</td>
<td>78</td>
<td>GRS vs MS with 90° bend formed 8 cm from tip</td>
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<tr>
<td>Phua et al, 2009</td>
<td>RCT/level II</td>
<td>60</td>
<td>GRS vs ETT with malleable distal tip in “J” shape</td>
<td></td>
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<tr>
<td>Dupanović et al, 2010</td>
<td>RCT/level II</td>
<td>120</td>
<td>ETT “reversed-loaded” on MS with 60° bend vs ETT “reversed-loaded” on MS with 90° bend; MS bent just above cuff to the specified angle against the natural concave ETT curve</td>
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*TTI:* time to intubation; *MS:* Miller’s stylet; *DL:* direct laryngoscopy; *GSV:* guided置入; *FOI:* flexible oropharyngeal intubation; *ETT:* endotracheal tube; *GRS:* guided reintubation system; *VAS:* visual analog scale; *CL:* clear view; *IQR:* interquartile range; *randomized block design:* attempting to control for experience between operators, some blinding of operator and observer; *unknown method:* method of sample size determination not described; *conversion:* required change to standard equipment.
<table>
<thead>
<tr>
<th>Study</th>
<th>Design/Level</th>
<th>n</th>
<th>Intubation Method</th>
<th>Outcome Measures</th>
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<tr>
<td>Jones et al, 2011</td>
<td>RCT/level II</td>
<td>60</td>
<td>GRS vs MS with 90° bend formed 8 cm from tip</td>
<td>Median TTI, s (SD) 60 (48-75) 61 (49-75), Ease of intubation 1.5 (1-2) 1.0 (1-2)</td>
</tr>
<tr>
<td>Radesic et al, 2012</td>
<td>RCT/level II</td>
<td>58</td>
<td>Conventional ETT vs flexible-tip ETT vs both with GRS</td>
<td>Mean TTI, s (SE) 14.2 (1.1) 8.2 (1.1), Mean number of redirections (SE) 1.3 (1.2) 0.6 (1.2)</td>
</tr>
<tr>
<td>Sakles and Kalin, 2012</td>
<td>Retrospective descriptive study/ level VI</td>
<td>473</td>
<td>GRS vs MS</td>
<td>No significant difference between groups for TTI (P = .005) and mean VAS ease of intubation (P = .007)</td>
</tr>
<tr>
<td>Jeon et al, 2013</td>
<td>RCT/level II</td>
<td>178</td>
<td>GRS vs tube exchange with placement assisted using vascular forceps</td>
<td>Intubation on first attempt, % 93.2 94.4, Mean TTI, s (SD) 67.8 (28.7) 66.1 (15.5)</td>
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Randomized design, operator mostly blinded and observer blinded; sample size determined using a power analysis

Randomized block design, single-blinded observer; sample size determined using a power analysis

Incidence of oxygen desaturation less with GRS

Subjects randomized to groups; no blinding; sample size determined using a power analysis; all subjects were successfully intubated using the assigned technique

**Table 1.** Randomized Controlled Trials and Descriptive Studies Examining Methods to Increase Intubation Success During Use of the GlideScope Video Laryngoscope

Abbreviations: ANCOVA, analysis of covariance; Cl, Cormack and Lehane grade; DL, direct laryngoscopy; ETT, endotracheal tube; GRS, GlideRite rigid stylet; GSV, GlideScope video laryngoscope; IQR, interquartile range; MS, malleable stylet, RCT, randomized clinical trial; TTI, time to intubation; VAS, visual analog scale.

a Evidence was appraised and classified by level using the method described by Melnyk and Fineout-Overholt.12

b Eschmann stylet was modified with a wire core, allowing it to maintain a preset shape.

c TTI not defined.

d From when GSV passed the lips to when end-tidal carbon dioxide (CO2) level was ≥ 30 mm Hg.

e DCI Video Laryngoscope (Karl Storz).

f From when GSV passed the teeth to when end-tidal CO2 level was ≥ 30 mm Hg.

g EndoFlex (Merlyn Associates).

h From insertion of GSV to appearance of trace end-tidal CO2.

i Parker Flex-Tip (Parker Medical).

j From optimal glottic view via the GSV to ETT passing through the glottis.

k Sheridan T.T.X. (Teleflex).

l Insertion of GSV to 3 continuous end-tidal CO2 curves.
mended an additional 90° bend to the proximal end of the ET tube because it may prevent the ET tube from impacting the anterior tracheal wall.

Authors of a case series reported success using a malleable stylet with a 90° bend proximal to the cuff of the ET tube. If this is not successful, they recommended using an intubation guide, passing the coudé tip of the guide into the trachea. The ET tube can then be passed over the guide into the trachea. They, too, recommended an additional 90° bend to the proximal end of the ET tube to help avoid impacting the anterior tracheal wall. The exact number of subjects was not reported.

Other authors reported using a malleable stylet shaped like a hockey stick to facilitate intubations in more than 500 awake and anesthetized subjects. They recommended twisting the ET tube to navigate around laryngeal structures and withdrawing the stylet during passage through the glottic opening.

• *GlideScope With Intubation Guide Rather Than GlideRite.* A malleable C-shaped ET tube introducer was used instead of the GRS. The time to intubation was less than 60 seconds in 38 of 40 subjects, and 2 subjects were intubated in 180 seconds after modifying curvature of the guide. A modified intubating guide was described in another case series involving 4 subjects. They also oriented the ET tube so the bevel faced posteriorly, aiding passage of the ET tube through the glottis into the trachea. In 4 other subjects, an intubation guide was used after failure using direct laryngoscopy and the GSV with the GRS. Two case reports also described successful use of this technique. The narrow gauge and malleable yet flexible nature of the intubating guides probably facilitated passage into the trachea, and the ET tube was then passed over the guide.

- Rotating Endotracheal Tube After Passing Below Glottic Opening. A subject assessed as having a normal airway was unable to be intubated with use of the GRS. A sharp posterior tracheal angulation in relation to the larynx was noted on GSV inspection. Successful intubation was accomplished by rotating the ET tube 180° clockwise after the ET tube loaded on a malleable stylet was passed through the glottic opening. This must be done with extreme caution because of the risk of tracheal injury.

**Conclusion**

Despite an adequate glottic view, passage of the ET tube into the trachea can be difficult. Reasons for this difficulty include not being able to maneuver the tip of the

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### Table 2. Case Series and Case Reports Describing Successful Intubation Methods During Use of the GlideScope Video Laryngoscope

<table>
<thead>
<tr>
<th>Evidence source</th>
<th>Intervention</th>
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<tbody>
<tr>
<td>Case series</td>
<td></td>
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<tr>
<td>Doyle, 2004 GSV-assisted FOI (8 subjects)</td>
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<tr>
<td>Bader et al, 2006 MS bent into a “J”-shape (12 subjects)</td>
<td></td>
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<tr>
<td>Dupanović et al, 2006 MS bent above cuff to 90° (unable to determine sample size)</td>
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<tr>
<td>Dupanović et al, 2006 If intervention failed, coudé-tipped endotracheal introducer was inserted through ETT into the trachea over the introducer</td>
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<tr>
<td>Hirabayashi, 2006 Controllable stylet (unable to determine sample size)</td>
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<tr>
<td>Xue et al, 2006 GSV-assisted FOI (13 subjects)</td>
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<tr>
<td>Muallem and Baraka, 2007 Curved pipe stylet and ET tube introducer (4 subjects)</td>
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<tr>
<td>Technique used electively</td>
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<tr>
<td>ETT can be rotated 90° so bevel faces posteriorly</td>
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<tr>
<td>Intubation guide with coudé tip (unable to determine sample size)</td>
<td></td>
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<tr>
<td>Intubating introducer (4 subjects)</td>
<td></td>
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<tr>
<td>Case reports</td>
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<tr>
<td>Heitz and Mastrando, 2005 Coudé-tipped, gum elastic bougie</td>
<td></td>
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<tr>
<td>Moore and Wong, 2007 GSV-assisted FOI</td>
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<td>Vitin and Erdman, 2007 GSV-assisted FOI</td>
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<tr>
<td>Walls et al, 2010 MS shaped to the GSV blade, 180° clockwise rotation of ETT after passing through glottis</td>
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<tr>
<td>Sharma et al, 2010 GSV-assisted FOI with ET tube facing posteriorly</td>
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<tr>
<td>O’Mahony and Pagano, 2013 Straight end of ET tube introducer in a “C” shape</td>
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</table>

Abbreviations: ETT, endotracheal tube; FOI, fiberoptic intubation; GSV, GlideScope video laryngoscope; MS, malleable stylet.

* Evidence was appraised and classified by level using the method described by Melnyk and Fineout-Overholt.

b StyletScope (Nihon Kohden Corp).
c Muallem ET Tube Introducer (VBM Medizintechnik).
d Frova Intubating Introducer (Cook Medical).
e Eschmann stylet modified with a wire core allowing it to maintain a preset shape.
f SunMed Endotracheal Tube Introducer (Azimuth Corp).
ET tube through the glottic opening or the ET tube tip impinging on airway structures, including the anterior aspects of the larynx or trachea. Findings from RCTs represent the highest level evidence. Findings from an RCT suggested that using a flexible-tipped ET tube with the GRS may increase intubation success. Authors of 2 studies found no benefit of using a malleable stylet with a 90° bend formed proximal to the ET tube cuff. There was also no benefit of “reverse camber” loading the ET tube onto the stylet. However, if using a malleable stylet, a 90° bend was preferable to a 60° bend regardless if the ET tube was loaded forward camber or reverse camber. A malleable stylet with a “J” bend was not found to be superior to the GRS but this study may have been underpowered. Using an ET tube exchanger with a vascular forceps did not result in an increase in first attempt intubations or a decrease in the time to intubation compared with the GRS.

Figure 1. Endotracheal tube loaded onto a malleable stylet forward camber. From top to bottom: stylet and endotracheal tube, endotracheal tube loaded onto stylet, endotracheal tube advanced off stylet. Note how tip of endotracheal tube tends to advance anteriorly.

Figure 2. Endotracheal tube loaded onto a malleable style reverse camber, or “reverse loaded.” From top to bottom: stylet and endotracheal tube, endotracheal tube loaded onto stylet, endotracheal tube advanced off stylet. Note how tip of endotracheal tube tends to advance posteriorly.

Figure 3. Parker Flex-Tip endotracheal tube.
A controllable stylet could increase intubation success. Tube after passing below the glottic opening and using has been described in a technical report. Use of the fiberoptic bronchoscope with GSV has also suggested benefit of using a malleable tipped ET tube rather than a conventional ET tube with the GRS.

The generalizability of these findings must be viewed with caution. Like any technique requiring psychomotor skill, an individual provider may be capable with a particular technique because of experience using the technique. Providers must consider the additional risks and benefits must be considered particularly if using a technique not recommended by the device manufacturer. Cost and personnel requirements must be considered such as the additional expensive equipment and personnel required for the GSV-FOBI technique.

Further rigorous investigations should be conducted examining methods to increase success of intubation using the GSV. Until then, providers should be aware of methods that may increase success when encountering problems while using the GSV. These alternatives should be practiced in a controlled setting before being employed in an emergency situation.

**REFERENCES**


15. Jones PM, Turkstra TP, Armstrong KP, et al. Effect of stylet angula-

**Figure 4. GlideScope-assisted fiberoptic bronchoscopic intubation in a simulated setting.**

A, GlideScope operator and fiberoptic bronchoscope operator. B, Fiberoptic bronchoscope passed through endotracheal tube and entering the glottic opening. C, Fiberoptic bronchoscope in the trachea, with endotracheal tube passing over the fiberoptic bronchoscope through the glottic opening and into the trachea.

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The authors have declared no financial relationships with any commercial interest related to the content of this activity. The authors did not discuss off-label use within the article.

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