Needs assessment for simulation training in neuroendoscopy: a Canadian national survey

Clinical article

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Object. In recent years, dramatic changes in surgical education have increased interest in simulation-based training for complex surgical skills. This is particularly true for endoscopic third ventriculostomy (ETV), given the potential for serious intraoperative errors arising from surgical inexperience. However, prior to simulator development, a thorough assessment of training needs is essential to ensure development of educationally relevant platforms. The purpose of this study was to conduct a national needs assessment addressing specific goals of instruction, to guide development of simulation platforms, training curricula, and assessment metrics for ETV.

Methods. Canadian neurosurgeons performing ETV were invited to participate in a structured online questionnaire regarding the procedural steps for ETV, the frequency and significance of intraoperative errors committed while learning the technique, and simulation training modules of greatest potential educational benefit. Descriptive data analysis was completed for both quantitative and qualitative responses.

Results. Thirty-two (55.2%) of 58 surgeons completed the survey. All believed that virtual reality simulation training for ETV would be a valuable addition to clinical training. Selection of ventriculostomy site, navigation within the ventricles, and performance of the ventriculostomy ranked as the most important steps to simulate. Technically inadequate ventriculostomy and inappropriate fenestration site selection were ranked as the most frequent/significant errors. A standard ETV module was thought to be most beneficial for resident training.

Conclusions. To inform the development of a simulation-based training program for ETV, the authors have conducted a national needs assessment. The results provide valuable insight to inform key design elements necessary to construct an educationally relevant device and educational program.

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Key Words • simulation-based medical education • needs assessment • endoscopic third ventriculostomy
ety of American Gastrointestinal Endoscopic Surgeons, simulation-based assessment has become the de facto standard for training and evaluation of technical skills in laparoscopy.5 Simulators, free from concerns over patient safety and limited clinical resources, provide an ideal no-risk environment in which surgical skills can be developed through harmless repetition.25 Given the increasing number of studies demonstrating the utility of SBME in the acquisition, retention, and transfer of surgical skills to the live operative setting that are emerging in the literature,5,16,27,36 the evidence for efficacy of SBME is undeniable. Furthermore, with recent advances in computational technology, the role of VR in surgical training has been appreciated: residents receiving VR training are faster, more efficient in their psychomotor performance, and make fewer intraoperative errors when compared with residents without such training, even on transfer to the OR.1,17,39,41 Thus, VR simulation may prove exceptionally relevant to neurosurgery, where even minor errors can have dire consequences.25

A particularly germane example is ETV. With technological advances in the last decade, ETV has emerged as the standard of care in the management of obstructive hydrocephalus.5,9,31,32,37 As our experience with the technique grows, so too does the list of indications under which ETV is performed.5,11,19 Like many minimally invasive procedures, ETV introduces novel challenges for surgical trainees: losing tactile feedback, having to adapt from a 3D to a 2D visual environment, and using the endoscope to both visualize and manipulate instruments with very limited freedom of movement in narrow, high-risk spaces.2,18 Thus, it is not surprising that existing reports of complications arising from ETV cite lack of experience with the technique as a primary etiological factor.5,13,30,37 The fact that complication rates as high as 10%–15% have been reported in some series6,10 underscores the need for intensive training in low-risk environments, such as those provided by VR simulation, to minimize the steep learning curve associated with this technique.30,37

Although the adoption of SBME has been slower in neurosurgery when compared with other surgical specialties, a substantial increase in published reports has been noted in recent years.32 Unfortunately, there has been an almost exclusive focus on technological advances in neurosurgical simulation, with relatively little attention paid to subsequent educational utility. Simulation—and learning using simulators—involves much more than just designing the device.7 In fact, research has shown that the quality of any SBME training program is largely dependent on the quality of its pedagogy, rather than on the simulation technology used.2,24 As our experience with SBME grows, we must clearly define the critical knowledge, skills, and attitudes that must be learned, and ensure that these elements are built into our simulations.8 Only through such critical reflection will we be able to ensure that the focus does not become the technology itself, but rather how it can be used to facilitate learning.

Therefore, SBME should be based on thorough needs assessment of key stakeholders, addressing specific goals of instruction.9 Such an assessment is essential to identify the elements of instructional design necessary to construct educationally relevant simulators, training curricula, and assessment metrics upon which trainees’ performance is judged.14 A review of the literature reveals a limited number of studies of this nature;5,4,12,38 existing reports pertain broadly to spinal or neurosurgical training, and none addresses neuroendoscopy in particular.

To address this gap in the literature, we have conducted a national survey of Canadian neuroendoscopists regarding the training needs for ETV and the capacity for SBME to fulfill this need. To advance the patient-safety agenda that has been the impetus for our current efforts, the survey has been designed with specific reference to both the technical steps of the procedure and intraoperative errors committed by trainees while learning the technique. The data generated will inform the design of future VR simulation training platforms, curricula, and assessment metrics for ETV, potentially reducing adverse events for patients undergoing this procedure.

Methods

Study Design

This cross-sectional study used mixed-methods survey methodology. A self-administered, structured online questionnaire consisting of 10 questions requested responses that were scored using a combination of dichotomous-response items (yes/no), 5-point Likert scales, and open-ended free-text responses. All scales were anchored with both numerical and verbal descriptions for each response interval to ensure comparability between participants while facilitating parametric statistical analysis. The content of the questionnaire pertained to 5 broad areas: 1) demographic information (including respondents’ experience with performing and teaching ETV in both clinical and simulated settings); 2) familiarity with and the utility of VR simulation for neuroendoscopic instruction; 3) essential procedural steps in performing ETV; 4) the frequency and significance of intraoperative errors committed while learning the technique; and 5) identification of simulation training modules to correct these errors. Item content was devised from a search of the existing literature on technical considerations and reported intraoperative errors associated with ETV9,13,30,37 as well as from the clinical experience of the principal and senior authors (F.H. and S.d.R.). The questionnaire was designed to be comprehensive yet streamlined to maximize compliance and potential information from respondents.23

Participants and Data Collection

We identified attending neurosurgeons at Canadian neurosurgical centers who perform ETV as a part of their clinical practice and who are involved in teaching the technique to neurosurgical trainees. After obtaining ethics protocol approval from the University of Western Ontario Health Sciences Research Ethics Board, surgeons meeting the above criteria for whom current electronic contact information could be obtained (n = 58) were invited to participate in the survey. All participants received a letter of information along with a link to the online survey; informed consent was assumed from par-
participants who completed the questionnaire. To encourage responses, reminder messages were sent biweekly for the duration of the data collection phase (August 22, 2011, to October 3, 2011). All data were confidentially stored in an anonymous manner.

**Data Analysis**

Data were analyzed in descriptive format for both quantitative and qualitative items. The mean responses and confidence intervals for each question-item assessed by 5-point Likert scales were calculated using STATA version 12.0 statistical software (StataCorp). Ranking lists regarding the importance of each procedural step, frequency and significance of intraoperative errors, and perceived utility of simulation modules were developed based on the calculated means. Additional qualitative data provided from free-text responses were recorded with each question and analyzed in accordance with qualitative content analysis techniques to generate a descriptive summary of participants’ responses.

**Results**

**Participant Demographics and Opinions on ETV Simulation Training**

Of the 58 neurosurgeons invited to participate in the study, 32 responses were received (overall response rate 55.2%). Demographic information and respondents’ experiences with ETV are summarized in Table 1. All participants confirmed that they both perform ETV in their clinical practice and are involved in teaching the procedure to residents and fellows. Whereas more than half of respondents had been exposed to ETV simulations previously, less than one-quarter had used simulation either to learn the procedure themselves or to teach the technique. The majority of these simulators were bench-top models designed by device companies or for surgical courses. Accordingly, all respondents thought that the development of a VR simulator for ETV would be a valuable addition to traditional clinical training (Fig. 1), with no statistically significant differences in responses among surgeons with and without prior exposure to ETV simulation (Mann-Whitney test, p = 0.24).

**Procedural Steps**

Participating surgeons were asked to rate the need to simulate the various procedural steps in ETV on a 5-point Likert scale as well as to comment on any additional procedural steps that were not included in our list (Table 2). Identification of ventriculostomy site, navigation within the ventricular system, and performance of the ventriculostomy were cited as the most important steps to simulate by more than half of respondents, whereas simulation of skin incision and closure, bur hole placement, and durotomy were thought to be unnecessary.

**Intraoperative Errors**

In the second phase of the questionnaire, surgeons were asked to rate the frequency and significance of various intraoperative errors associated with ETV. A composite score of the sum of mean responses for each item was calculated to delineate those errors of greatest frequency and significance. A ranked list of these errors is provided in Table 3. The highest-ranking errors from this analysis relate to technical skills required to perform the ventriculostomy (for example, making a ventriculostomy of insufficient size), cognitive skills and knowledge base associated with selecting an appropriate fenestration site and identifying when completion of the procedure is unsafe, and familiarity with the setup and use of the endoscope and endoscopic tools.

**Simulation Training Modules**

Respondents’ opinions regarding the utility of various simulation modules in mitigating the aforementioned errors are summarized in Table 4. Participants rated the standard ETV module with normal anatomy and simple perforation of the third ventricular floor as the most relevant training exercise. In addition, training modules facilitating learning when to abort the procedure for technical or patient safety reasons, correcting errors such as crossover into the contralateral ventricle, managing endoscopic bleeding, correcting inappropriate instrument setup, and fenestrating a thickened floor were thought to be of greatest educational value.

**Qualitative Data**

Analysis of responses from open-ended free-text questions revealed a number of important patterns. The difficulty of the procedure, given the infrequent use of endoscopic techniques in neurosurgery, along with the
needs assessment for simulation training in neuroendoscopy

TABLE 2: Procedural steps of ETV requiring simulation

<table>
<thead>
<tr>
<th>Rank</th>
<th>Procedural Step</th>
<th>Mean Score (CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>selection of ventriculostomy site</td>
<td>4.84 (4.68–5.00)</td>
</tr>
<tr>
<td>2</td>
<td>navigation w/in ventricles</td>
<td>4.66 (4.44–4.87)</td>
</tr>
<tr>
<td>3</td>
<td>performance of fenestration</td>
<td>4.56 (4.29–4.84)</td>
</tr>
<tr>
<td>4</td>
<td>confirmation of adequacy of fenestration</td>
<td>4.28 (4.03–4.53)</td>
</tr>
<tr>
<td>5</td>
<td>selection of cortical entry/trajecory</td>
<td>4.25 (4.01–4.49)</td>
</tr>
<tr>
<td>6</td>
<td>instrument setup (camera, tools, support arm, irrigation)</td>
<td>4.09 (3.81–4.37)</td>
</tr>
<tr>
<td>7</td>
<td>removal of endoscope &amp; inspection of fornix</td>
<td>3.94 (3.66–4.21)</td>
</tr>
<tr>
<td>8</td>
<td>insertion of trocar/sheath into ventricle</td>
<td>3.75 (3.46–4.04)</td>
</tr>
<tr>
<td>9</td>
<td>exposure (skin incision, bur hole, duretomy)</td>
<td>2.75 (2.37–3.13)</td>
</tr>
<tr>
<td>10</td>
<td>closure</td>
<td>2.56 (2.17–2.95)</td>
</tr>
</tbody>
</table>

* Items were scored on a 5-point Likert scale: 1, not at all important; 2, slightly important; 3, somewhat important; 4, very important; 5, extremely important.

TABLE 3: Frequency and significance of intraoperative errors during ETV

<table>
<thead>
<tr>
<th>Rank</th>
<th>Intraop Error*</th>
<th>Mean Frequency Score (CI)†</th>
<th>Mean Significance Score (CI)‡</th>
<th>Composite Score§</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>technically inadequate ventriculostomy (fenestration failure or inadequate size)</td>
<td>2.57 (2.31–2.82)</td>
<td>4.07 (3.79–4.34)</td>
<td>6.64</td>
</tr>
<tr>
<td>2</td>
<td>failure to identify unsafe ETV</td>
<td>1.93 (1.56–2.30)</td>
<td>4.5 (4.19–4.81)</td>
<td>6.43</td>
</tr>
<tr>
<td>3</td>
<td>failure to identify 3rd ventricle anatomy, improper ventriculostomy site selection</td>
<td>1.97 (1.63–2.30)</td>
<td>4.4 (4.17–4.63)</td>
<td>6.37</td>
</tr>
<tr>
<td>4</td>
<td>improper camera/endoscopic instrument setup (resulting in rotated/unfocused image)</td>
<td>2.67 (2.28–3.05)</td>
<td>3.63 (3.22–4.04)</td>
<td>6.3</td>
</tr>
<tr>
<td>5</td>
<td>neural injury (fornix, thalamus)</td>
<td>2.53 (2.23–2.84)</td>
<td>3.73 (3.38–4.09)</td>
<td>6.26</td>
</tr>
<tr>
<td>6</td>
<td>injury to basilar artery/brainstem</td>
<td>1.3 (0.99–1.61)</td>
<td>4.9 (4.75–5.00)</td>
<td>6.2</td>
</tr>
<tr>
<td>7</td>
<td>failure to fenestrate Liliequist membrane</td>
<td>2.53 (2.28–2.79)</td>
<td>3.6 (3.25–3.95)</td>
<td>6.13</td>
</tr>
<tr>
<td>8</td>
<td>improper site of cortical entry</td>
<td>2.23 (1.88–2.58)</td>
<td>3.8 (3.52–4.08)</td>
<td>6.03</td>
</tr>
<tr>
<td>9</td>
<td>improper trocar/sheath insertion trajectory</td>
<td>2.17 (1.86–2.48)</td>
<td>3.77 (3.45–4.09)</td>
<td>5.94</td>
</tr>
<tr>
<td>10</td>
<td>excessive force handling endoscope/tools</td>
<td>2.4 (2.07–2.73)</td>
<td>3.5 (3.10–3.90)</td>
<td>5.9</td>
</tr>
<tr>
<td>11</td>
<td>poor depth perception resulting in inappropriate endoscope/tool manipulation</td>
<td>2.0 (1.67–2.33)</td>
<td>3.63 (3.22–4.04)</td>
<td>5.63</td>
</tr>
<tr>
<td>12</td>
<td>improper irrigation setup (blurry image)</td>
<td>2.33 (1.96–2.70)</td>
<td>3.37 (3.02–3.71)</td>
<td>5.7</td>
</tr>
<tr>
<td>13</td>
<td>failure to manage bleeding from choroid/ependyma</td>
<td>2.4 (2.0–2.8)</td>
<td>3.07 (2.63–3.50)</td>
<td>5.47</td>
</tr>
<tr>
<td>14</td>
<td>poor skin closure leading to CSF leak</td>
<td>1.43 (1.13–1.74)</td>
<td>2.93 (2.57–3.30)</td>
<td>4.36</td>
</tr>
</tbody>
</table>

* Additional errors: release of excess CSF on trocar insertion, advancement of the trocar too deeply after insertion.
† Items scored on a 5-point Likert scale: 1, not often at all; 2, occasionally; 3, sometimes; 4, frequently; 5, always.
‡ Items scored on a 5-point Likert scale: 1, not significant at all; 2, slightly significant; 3, somewhat significant; 4, very significant; 5, extremely significant.
§ Composite score consists of the sum of the mean frequency and significance scores.
ment of the trocar too deep on insertion were noted as significant errors. Similarly, in addition to the modules described in Table 4, participants also advocated for the development of training modules modeling small ventricles, distorted anatomy (for example, via cyst or tumor), and choroid plexus coagulation.

Discussion

Interpretation of Findings

With the Accreditation Council for Graduate Medical Education’s recognition of the need for SBME and the recent Presidential Address to the Society of Neurological Surgeons calling for a national SBME agenda, it is clear that simulation will be a major part of the postgraduate neurosurgical training armamentarium in the future. The impetus for this movement is evident from a patient safety perspective: surgical error accounts for a substantial proportion of adverse events in current reviews of medical error. The utility of simulation training in mitigating these errors and associated near misses has been repeatedly demonstrated in other surgical disciplines. However, the paucity of published reports in the neurosurgical literature evaluating the impact of simulation in reducing intraoperative errors demonstrates that this issue has not yet become a priority in our specialty.

In fact, with recent reviews revealing the focus of existing studies almost entirely on technological developments in neurosurgical simulation, the more fundamental question of whether neurosurgical performance can be enhanced through SBME has not been addressed. Before this issue can be considered, however, the matter of exactly what needs to be learned must be clarified. Only by understanding the training needs for particular procedures will we be able to judge the appropriateness of simulation platforms adequately, especially in light of the considerable costs associated with high-fidelity devices. In the current climate, this needs assessment should not only include the technical and cognitive elements trainees must learn to complete a given procedure, but also an evaluation of errors committed during this process and how simulation can be effectively used to mitigate them.

The results of this study offer a number of insights in this regard. First, the fact that the majority of respondents thought that the development of a dedicated VR simulator for ETV would be “very” or “extremely” valuable suggests that sufficient realism can be achieved through simulation to meet the needs of trainees learning ETV. However, despite the fact that more than half of participants had been exposed to simulation for this technique previously, the majority continued to support the development of a new device. Therefore, it would appear that there is a gap between current simulators for ETV and their ongoing use in neurosurgical training. This gap may exist for a number of reasons: the devices referred to by respondents may not be commercially available, their cost may be prohibitive, or current platforms may not be optimized to meet educational needs. The last of these possibilities seems most plausible, given that at present many simulation platforms do not function within a structured training curriculum. This underscores the need for a paradigm shift in the focus of neurosurgical simulation from the design of individual devices to the coordinated development of simulation platforms, training curricula, and assessments of performance.

Participants’ ratings of the procedural steps of the ETV task provide clear guidance on the relative importance of these subtasks in training. The perceived importance of endoscope navigation within the ventricle, selection of the fenestration site, performance of the ventriculostomy, and confirmation of adequacy underscores the importance of faithfully representing the visual anatomical cues and appropriate responsiveness of the simulated environment to trainees’ manipulation. From a simulator design perspective, authentic graphical representation of the third ventricular floor and use of real endoscopic instruments would be essential to the development of an educationally relevant device. Furthermore, it may not be sufficient simply to have the trainee select the site of ventriculostomy—the technical performance of the fenestration and enlargement of the ventriculostomy, including appropriate tactile (haptic) feedback and authentic defor-

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**TABLE 4: Simulation modules for ETV**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Simulation Module/Characteristic</th>
<th>Mean Score (CI)*</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>standard ETV (normal anatomy, simple perforation)</td>
<td>4.31 (4.09–4.54)</td>
</tr>
<tr>
<td>2</td>
<td>technically unsafe ETV</td>
<td>4.10 (3.79–4.41)</td>
</tr>
<tr>
<td>3</td>
<td>improper trajectory (crossover into contralat ventricle)</td>
<td>4.07 (3.87–4.27)</td>
</tr>
<tr>
<td>4</td>
<td>excess endoscopic bleeding</td>
<td>4.03 (3.71–4.36)</td>
</tr>
<tr>
<td>5</td>
<td>inappropriate setup (unfocused/rotated image, irrigation failure, no support arm)</td>
<td>4.00 (3.77–4.23)</td>
</tr>
<tr>
<td>6</td>
<td>thickened 3rd ventricle floor</td>
<td>3.93 (3.61–4.25)</td>
</tr>
<tr>
<td>7</td>
<td>force feedback exercise (feedback when excess force has caused neural injury)</td>
<td>3.79 (3.50–4.09)</td>
</tr>
<tr>
<td>8</td>
<td>depth exercise (identify anatomical landmarks to determine endoscope/tool depth)</td>
<td>3.79 (3.45–4.14)</td>
</tr>
<tr>
<td>9</td>
<td>Liliequist membrane fenestration</td>
<td>3.76 (3.46–4.06)</td>
</tr>
<tr>
<td>10</td>
<td>identification of traction injury to fornix</td>
<td>3.31 (2.96–3.66)</td>
</tr>
</tbody>
</table>

* Items scored on a 5-point Likert scale: 1, not at all useful; 2, slightly useful; 3, somewhat useful; 4, very useful; 5, extremely useful.
mation of the floor during manipulation, may also be important to simulate.

Because composite scores demonstrate that the majority of intraoperative errors are associated with either cognitive or technical aspects of performing the actual ventriculostomy, it is imperative that simulation modules be designed to address these skills adequately. To our surprise, errors associated with inappropriate setup of the endoscope/endoscopic instruments and injury to the basilar artery and/or brainstem were also rated highly. Published reports suggest the basilar artery rupture rate during ETV is only 0.21%.

Although it is infrequent, these reports also suggest that this complication usually occurs in the hands of less experienced surgeons. In these cases technical errors such as posterior slipping of the balloon catheter during perforation have been noted as a contributing factor. Analogously, herniation syndromes due to inadvertent blocked egress of irrigation fluid have been reported; thus, educating trainees in the appropriate setup and use of endoscopic instruments prior to any clinical encounter is equally important. In addition, we suspect that participants were also taking near misses into consideration when selecting their rankings of errors. In these cases complications may have occurred if trainees were left unsupervised, but were avoided when senior surgeons intervened to correct trainees’ errors in time. For obvious reasons such incidents would not be captured in the published literature, but would be well known to seasoned instructors, again stressing the importance of conducting needs analyses such as the current study.

The error rankings are also useful for the development of metrics to assess trainee performance. A number of reports have demonstrated that the efficacy of SBME can be gauged by evaluating the reduction in errors trainees make before and after training, or compared with clinically trained peers. Such assessments may also be beneficial in ongoing assessment of competence, as a quality assurance measure. Although many additional elements including demonstration of validity and reliability of rating scales, development and validation of appropriate simulation scenarios, and evidence that these assessments reflect performance in practice will be required prior to their clinical use, these data provide an important initial step toward this goal.

The ranking of simulation modules was included in the study largely to provide a road map for those engaging in SBME curriculum development. In keeping with respondents’ perspectives that simulation has its greatest utility in preparing trainees for the OR by providing them with a basic psychomotor skill set, it is not surprising that a standard, uncomplicated ETV module would be perceived as having the greatest benefit. Interestingly, the top-ranking modules (simple ETV and technically unsafe ETV) align with the top-ranking procedural steps to simulate (selection of the ventriculostomy site and navigation within the ventricle and performing the fenestration) and intraoperative errors (technically inadequate ventriculostomy, failure to identify unsafe ETV, and inappropriate ventriculostomy site selection), suggesting internal consistency of the results and providing additional credibility to the findings. In addition to the items delineated from the quantitative analysis provided in the tables, however, the appropriate design of simulation training curricula should also incorporate the use of neuronavigation, real endoscopic instruments and, ideally, authentic data from hydrocephalic patients, as described in the qualitative analysis above. The simulation of anatomical variations and additional pathological entities (for example small ventricles, distorted foramen of Monro, and colloid cysts/tumors) may be of additional benefit.

Weaknesses and Limitations

There are some inherent limitations to this study, largely resulting from the survey-based design. First, given the retrospective and subjective nature of the data, the results may be influenced by recall bias of respondents. Furthermore, the nature of the questions themselves may have generated interest in the topic or prompted a specific answer. However, when responses among surgeons with and without prior exposure to simulation were compared, no overt differences were observed, suggesting that interest in the topic generated by the survey did not unduly influence the results. Second, although Likert scales were anchored with both numeric and verbal descriptors, participants may have misinterpreted the ranking intervals, thus diminishing the accuracy of the results. Third, although a response rate of 55% for an online survey is good, the study results may still be subject to nonresponse bias, if the perspectives of the 45% who did not participate differ significantly from respondents. Last, because our survey has not previously been evaluated for reliability and validity, we cannot substantiate the results found. However, as described above, the concordance between rankings from the different questions suggests that the results are internally consistent.

An additional limitation to our study is that the learner’s perspective was not directly taken into consideration. It is conceivable that the rankings of important steps to simulate and simulation modules of greatest value may differ for learners at different stages of training. This is especially relevant to simulations that seek to target a particular learner cohort (for example junior and senior residents, clinical fellows, practicing surgeons, and so forth), because specific modules and/or scenarios may need to be developed, evaluated, and funded to meet the needs of each cohort. Given that the purpose of our study was to delineate the procedural steps and intraoperative errors associated with ETV for the purpose of SBME training program development, we chose to survey a population that had experience both performing and teaching the ETV procedure, so that they could reflect not only on what was important from a technical and patient safety perspective, but also on what may be beneficial for learning. Therefore, an assessment of trainees’ perspectives was beyond the scope of this study. It is essential to note, however, that prior to the implementation of any training program, an assessment of the perspectives of all stakeholders, including trainees, program administrators, and faculty must be considered. It is only through such contextual analysis that SBME programs can be appropriately integrated into existing training curricula, and without engagement of key stakeholders these programs are ultimately doomed to fail.
Conclusions

Although still in its infancy, SBME, especially VR platforms, are gaining traction in neurosurgical training. As our experience with simulation grows, it is essential that this technology be developed in coordination with appropriate training curricula and assessment metrics, in accordance with current educational theory. As a first step in coordinating a simulation-based training program for neuroendoscopy, we have conducted a national survey of attending surgeons regarding the training needs for ETV. The results provide valuable insight to guide the development of future training programs and a standard by which to gauge the appropriateness of various simulation platforms.

Disclosure

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Author contributions to the study and manuscript preparation include the following. Conception and design: Haji, Dubrowski, de Ribaupierre. Acquisition of data: Haji. Analysis and interpretation of data: all authors. Drafting the article: all authors. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Haji. Statistical analysis: Haji, de Ribaupierre. Administrative/technical/material support: all authors. Study supervision: all authors.

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