

Pediatric Web-based Video Capsule Endoscopy Curriculum: A Pilot Study to Determine the Ability to Implement a Standardized Educational Curriculum

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ABSTRACT

Objectives: Video capsule endoscopy (VCE) is a noninvasive modality to broadly image the gastrointestinal tract. Previously, the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition and its endoscopy committee noted a lack of standardized pediatric VCE training. It was hypothesized that a web-based curriculum could be broadly implemented and help to enhance comfort and develop VCE skills.

Methods: A pilot web-based VCE curriculum was created using REDCap database. An email invitation asking for participation was sent to a pediatric gastroenterology Listserv. Baseline comfort and knowledge regarding VCE skills were measured. Educational links and materials were provided following which participants completed VCE cases with immediate feedback. Finally, participants completed a posttest and a survey to complete the curriculum.

Results: Fifty-two participants began the curriculum of which 37 (71%) partially completed, 12 (23%) completed, and 3 (6%) withdrew. Significant improvement was noted regarding self-reported mean comfort level in explaining indications ($P = 0.0097$), contraindications ($P = 0.0036$), managing complications ($P = 0.0048$), using VCE software ($P = 0.00035$), and interpreting VCE findings ($P = 0.00015$). Participants showed significant

What Is Known

- Video capsule endoscopy (VCE) is a less invasive method of visualizing the entire gastrointestinal tract.
- VCE training curricula for pediatric gastroenterologists are not standardized and are based on expert opinion without routine availability of validated pediatric training opportunities.
- Although VCE offers several benefits, it may be underutilized due to limited number of trained pediatric gastroenterologists in this technology.

What Is New

- There is a need and an interest for pediatric VCE education.
- A web-based curriculum could enhance usage of VCE and improve the comfort level and knowledge of VCE for pediatric gastroenterologists.
- Creation of virtual curriculum for VCE can be implemented into the education programming for pediatric gastroenterology trainees and provide maintenance of certification and continuing medical education for practicing pediatric gastroenterologists.

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improvement in knowledge ($P = 0.041$) and photo recognition posttests ($P = 0.015$). All participants who completed the curriculum found it helpful and reported that they would recommend it to their colleagues.

Conclusions: This pilot curriculum demonstrated an improvement in participant self-reported comfort and an increase in VCE knowledge. Further resources would make a web-based curriculum easier to navigate and complete. Providing Continuation of Medical Education and Maintenance of Certification credits for future curricular iterations would provide an opportunity for training with recognition for pediatric gastroenterologists.

Key Words: VCE, Pillcam, video capsule, capsule endoscopy, endoscopy, pediatric, online curriculum, continuing education, medical education, gastroenterology

INTRODUCTION

Video capsule endoscopy (VCE) was first described in 2000 as a less invasive method to visualize the small bowel that did not require the use of anesthesia unless the patient was unable to swallow the capsule (1,2). VCE involves ingestion or endoscopic placement of a video capsule that captures images, but not biopsies, as it traverses the esophagus, stomach, small bowel, and colon. VCE can be used to visualize the entire gastrointestinal (GI) tract, however, it is most commonly used to assess the small bowel mucosa. Captured images are transmitted from the capsule to a portable data recorder

worn by the patient using radio transmission signals. These images are then downloaded to a computer and interpreted by a trained physician (1,2). The US Food and Drug Administration approved VCE for use in adults in 2001, in children ages 10–18 years old in 2003, and in children above 2 years of age in 2009 (2). A meta-analysis performed by Cohen et al reviewed 740 VCEs in patients \leq 18 years of age and found that VCE is primarily used for evaluation of inflammatory bowel disease in this age group (3). Other indications include obscure GI bleeding and undiagnosed anemia, abdominal pain and diarrhea, polyposis, and other small intestinal pathology (2–4). In addition, VCE can be used as a complementary study to double balloon enteroscopy in the diagnosis of small bowel lesions (5).

Although, this modality has been available for almost two decades, objective measures to establish competence in performing and interpreting VCE are limited. In adults, validated scoring systems such as the Capsule Competency Test (CapCT), colon capsule endoscopy reading competence assessment test (CCAT), and evaluation tool for capsule endoscopy training (ET-CET) have been previously used (6). However, such assessment tools do not currently exist for evaluation of competence in pediatric VCE (2,7). Further, current training requirements can be time consuming for the learner and the mentor, are based on expert opinion, and are not validated (2,8). The North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN) and American Society for Gastrointestinal Endoscopy (ASGE) agree that capsule endoscopy should be performed by individuals trained and determined to be competent in VCE. The NASPGHAN guidelines for training in pediatric GI suggest that at least 20 VCEs should be performed to achieve competence (9). However, the exact criteria for training remain unclear (2,8). In addition, for pediatric gastroenterologists, VCE training opportunities can be limited. Although, training courses endorsed by national and international gastrointestinal societies are available for adults, pediatric VCE training opportunities are inadequate (2,10). Pediatric and adult VCE differ in several aspects including indications, prep procedure preparation, and equipment, highlighting the need for such pediatric curricula (11). We hypothesized that a structured web-based pediatric VCE curriculum could be broadly implemented and improve comfort and knowledge among pediatric gastroenterology fellows and faculty in performing and interpreting VCEs (7).

METHODS

A curriculum was created by the authors after careful review of the pediatric literature on VCE to include important and relevant reading materials and educational resources. VCE cases were chosen based on common pediatric indications and based on the clinical and teaching experience of the first and senior authors. Both authors serve as the primary video capsule endoscopists at their respective institutions and are responsible for training fellows in this technology. A website to serve as the homepage of a web-based VCE curriculum was created (<http://www.pedsigconsent.com/capsule/>). The website contained introductory instructions on the structure of the curriculum and links to teaching resources including: NASPGHAN capsule endoscopy clinical report, video capsule viewing software (Rapid Reader) from Medtronic/Covidien, deidentified pediatric video capsule cases, and pre- and posttest questions (2) (Fig. 1). Technology from Medtronic/Covidien was chosen for this curriculum for its ease of implementation, as it was the software being used at the authors' institutions. An email invitation for participation was sent to pediatric gastroenterologists nationally and internationally using the Pediatric GI Bulletin Board, <PEDGI@list.uvm.edu>. Those pediatric gastroenterology (GI) fellows and attendings interested in participating in the curriculum study were asked to respond via email to enroll. Once enrolled, they were emailed instructions with a link to the homepage website. Online technical support via email and telephone was

available for any participant with questions or issues with navigating the curriculum.

Participants were digitally guided through the curriculum, which was contained within REDCap (Research Electronic Data Capture). Study data were collected and managed using REDCap electronic data capture tools. REDCap is a secure, web-based software platform designed to support data capture for research studies. The curriculum was designed to review the indications, risks, complications, identification of pathology, and interpretation of diagnoses when performing VCE as recommended by NASPGHAN and ASGE. The curriculum required approximately 10–30 hours to complete, varying on the rate at which participants viewed a minimum of 10 video capsule cases. Participants completed the curriculum at their own pace but could not take longer than 6 months. Participants were allowed to take breaks and complete the curriculum at their convenience.

The participants were guided through the curriculum in a sequential order. After completion of a pretest survey assessing self-reported comfort level with VCE, participants completed a multiple-choice pretest. The pretest questions were created using the NASPGHAN capsule endoscopy clinical report. This test consisted of written and photo identification questions that measured baseline knowledge of pediatric VCE in regard to common indications, contraindications, complications, and VCE technique. Photo identification questions tested the participants' knowledge regarding important landmarks and lesions seen commonly during VCE. Correct answers to the pretest multiple-choice questions were provided immediately upon completion of the test and were further discussed in the assigned reading. Demographic data were collected in the pretest survey. A pediatric VCE case with attached report was provided to all participants so that they could become familiar with an example of an appropriate VCE report.

Participants were then required to interpret a minimum of 10 teaching pediatric VCE cases and were given the option to interpret an additional 5 cases. High yield normal and abnormal pediatric cases were chosen based on their relevance and importance in clinical practice. Participants were instructed to specify identification of landmarks and abnormal findings, providing the location of the finding, and the time it occurred in the video using free text description. Time required to view and interpret each case was self-reported. Participants were provided with the correct description of findings and a VCE report for each case immediately upon its completion.

Upon completion of the VCE cases, participants completed a postcurriculum multiple choice test to assess improvement and retention of knowledge along with a posttest exit survey assessing self-reported comfort level with VCE. Postsurvey knowledge questions were identical to the pretest questions. In this survey, participants were also asked if they found the curriculum to be beneficial, worth recommending to others, their suggestions for curriculum improvement, and challenges they encountered while completing the curriculum. The mean scores for the survey questions and the pre- and posttests were compared using a t-test. Participant characteristics for those who fully versus partially completed the curriculum were compared using a chi-square test for gender and prior VCE experience, and Fisher's exact test for the remaining parameters. This study was approved by the IRB at Yale University (ID no. 2000022682).

RESULTS

A total of 143 pediatric GI fellows and attendings responded by email to express their interest and to obtain details about the curriculum (Fig. 2). Fifty-two (36%) of these began the curriculum. The rest were either unable to commit the time required for completion of the curriculum or had competing clinical demands during the study period. Many also expressed their interest in more formal training

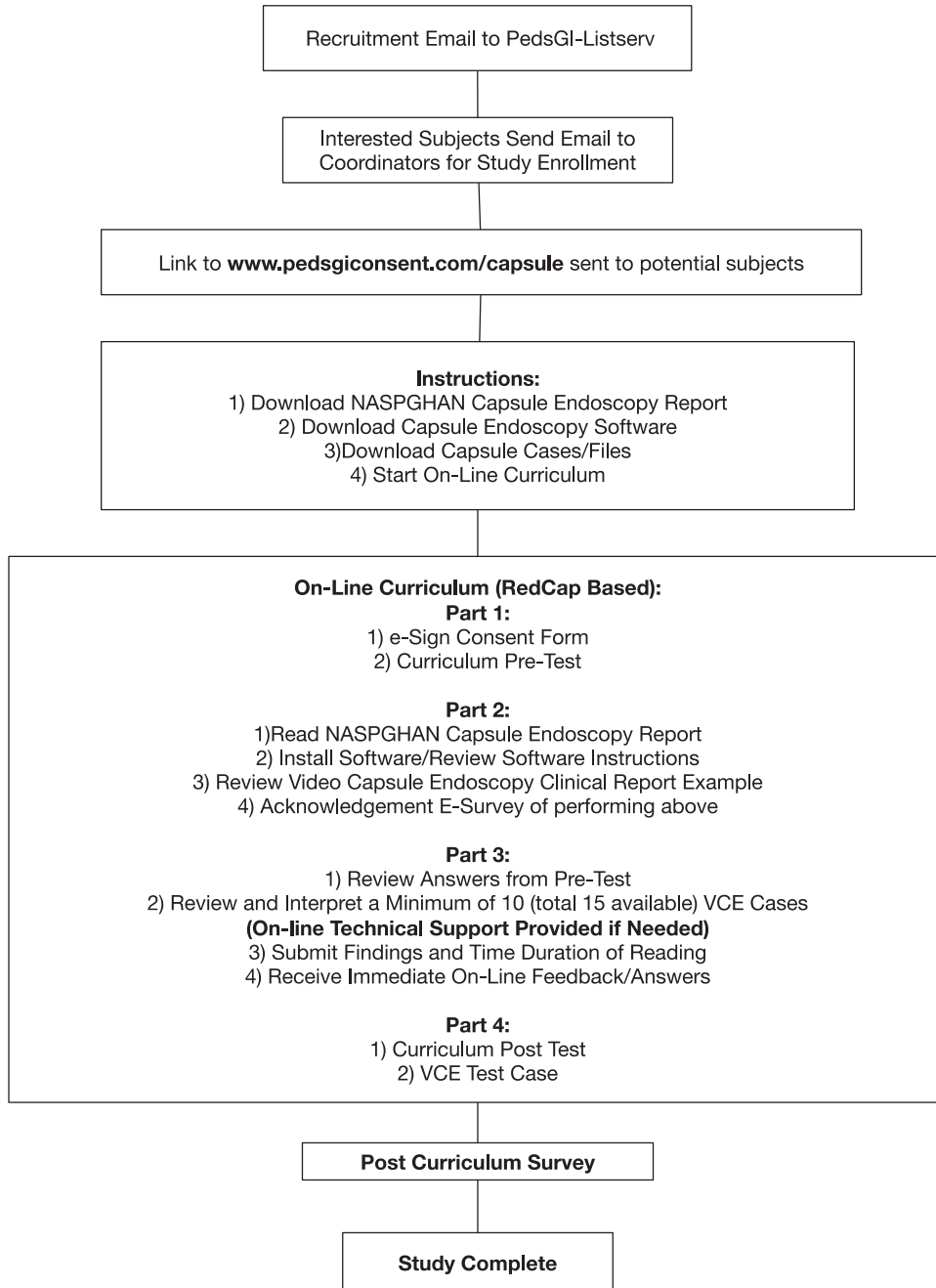


FIGURE 1. Curriculum outline.

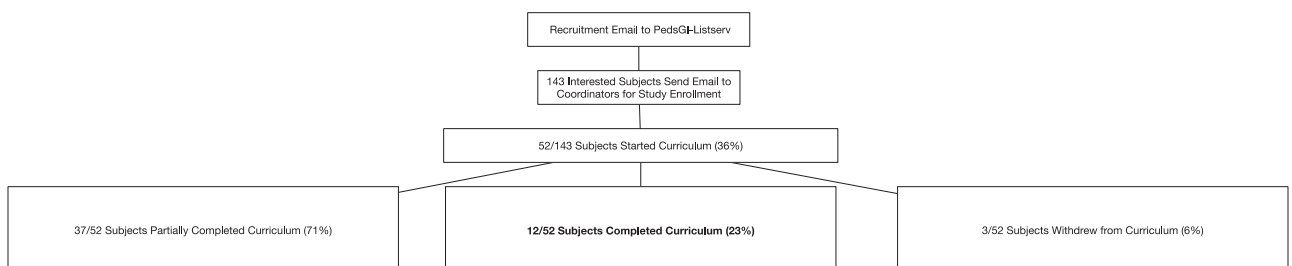


FIGURE 2. Diagram of video capsule endoscopy curriculum completion by subject.

through procurement of CME/MOC credits. Although majority of the participants (49 subjects) who began the curriculum were from North America, there was one participant each from Asia and Europe.

Of the participants who began the curriculum, 37 (71%) partially completed the curriculum, 12 (23%) completed the entire curriculum, and 3 (6%) withdrew due to technological issues (Fig. 2). The participants who partially completed the curriculum completed it in various stages. Sixteen of these participants completed an average of 4–5 VCE cases including the pretest questions and reading materials. Demographic information of the participants who fully versus partially completed the entire curriculum can be seen in Table 1. Significantly greater number of females were noted in the group that fully completed the curriculum. No significant differences in prior VCE experience or level of training were noted among the two groups (Table 1).

In the pre- and postcurriculum surveys, participants self-reported their comfort level with VCE among different VCE categories on a scale of 0–100. The mean pre- and posttest survey scores were compared by a t-test (Table 2). Significant improvement was noted on the self-reported mean comfort level in explaining the indications ($P = 0.0097$) and contraindications ($P = 0.0036$),

managing complications ($P = 0.0048$), using Rapid Reader software ($P = 0.00034$), and interpreting and reporting video capsule findings ($P = 0.00015$). Participants showed significant improvement in their knowledge on the multiple-choice test ($P = 0.041$) and photo atlas ($P = 0.015$) (Table 3). No significant change in the time taken to read and interpret the VCE was noted in the participants as they progressed through the curriculum.

All 12 participants who completed the curriculum reported the curriculum was helpful and would recommend it to others. Participants reported academic firewall security issues that impacted case downloads and an inability to download Rapid Reader on a Macintosh computer as the main challenges, while completing or setting up the curriculum. All inquired about continuing of medical education (CME) credits or maintenance of certification (MOC) points for completion of the course and felt that offering these would make the curriculum more appealing.

DISCUSSION

VCE is a broadly available technology in pediatric gastroenterology that offers a noninvasive modality to primarily image the small bowel (1). In children who can swallow the capsule, it offers the opportunity to avoid the need for anesthesia (12). Although this technology offers significant benefits, its broad implementation and use has been limited due to the significant time needed to read video capsules and by corollary, significant time required to learn the technique (2). Current training is usually performed through mentorship and nonstandardized courses, which require even more significant time from mentors and learners. Some programs also rely on adult gastroenterology colleagues for training. This study demonstrated that a standardized, broadly available curriculum developed by expert capsule endoscopists was successful in improving self-reported and evaluated VCE skills. This program exposed naïve physicians to VCE and initiated training of 37 capsule endoscopists. Although the number of gastroenterologists that completed the curriculum was small it still allowed for the training of 12 new VCE endoscopists within 6 months with limited need for lengthy interaction from outside observers or mentors. All participants found the curriculum helpful and expressed that they would recommend it to their colleagues. Previously, the ASGE developed guidelines around credentialing for VCE in 2005 (13). The group in 2005 recommended to assure an understanding of indications, contraindications, and risks of VCE, a familiarity with hardware/

TABLE 1. Characteristics of participants who completed the curriculum

Characteristics	Entire curriculum (n = 12) N (%)	Partial curriculum (n = 37) N (%)	P*
Age			
20–29 years	1 (8)	0 (0)	0.4296
30–39 years	9 (75)	27 (73)	
40–49 years	2 (17)	5 (13)	
50–59 years	0 (0)	1 (3)	
60–69 years	0 (0)	4 (11)	
Gender			0.0349
Female	10 (83)	18 (49)	
Male	2 (17)	19 (51)	
Region			0.5783
Central America	1 (8)	0 (0)	
North America	11 (92)	35 (94)	
Asia	0 (0)	1 (3)	
Europe	0 (0)	1 (3)	
Type of institution			0.8346
Academic	11 (92)	29 (78)	
Private practice	0 (0)	3 (8)	
Mixed	1 (8)	5 (14)	
Level of training			0.3314
PGY4	0 (0)	4 (11)	
PGY5	5 (42)	9 (24)	
PGY6	4 (33)	6 (16)	
PGY7	0 (0)	1 (3)	
Faculty < 5 years	3 (25)	10 (27)	
Faculty ≥ 5 years	0 (0)	7 (19)	
Prior VCE experience			0.5650
No	6 (50)	22 (60)	
Yes	6 (50)	15 (40)	

TABLE 2. Comparison of mean pre- and postsurvey comfort level among participants (N = 12)

Categories	Before	After	P
Explaining the indication	63.3	84.4	0.0097
Explaining the contraindications	56.1	85.8	0.0036
Managing complications	44.4	83.3	0.0048
Using rapid reader software	44.4	90.4	0.00035
Interpreting and reporting VCE findings	33.7	82.3	0.00015

TABLE 3. Comparison of mean pre- and posttest results among participants (N = 12)

Test	Before	After	P
Multiple choice test (total of 16 questions)	11	12.67	0.041
Photo recognition test (total of 12 questions)	9.75	10.75	0.015

software of VCE, accurate identification and interpretation of findings, and documentation with effective communication to other physicians. This pediatric study and self-learning curriculum attempted to fulfill the guidelines by Faigel et al (13).

Studies have demonstrated that competence with VCE develops in an endoscopist after reading 10–15 VCE studies (6,10). There are some newer guidelines that suggest that this number may be higher (14). Most pediatric gastroenterologists and trainees rely on programs created by VCE manufacturers and on nonstandardized mentorship for their VCE education (8,11,14). Whether these programs are successful in developing competence requires further research. Training for standard pediatric endoscopy uses a similar model of mentorship and feedback, however better tools need to be developed (15). We and others hypothesized the need for better learning tools even for VCE (6). Furthermore, current training opportunities often lack assessment of competence at completion of training, and use number based competence similar to upper and lower endoscopy (15). Our curriculum was the first of its kind created using a hybrid between adult recommendations for minimum number of studies to attempt to achieve competence with a self-learning quiz-based program for self-assessment (6,7,14,16). This study on VCE training assessed participants' self-perceived comfort in performing various aspects of VCE and assessed their change in knowledge via pre- and posttraining testing. Further iterations of this pilot curriculum that could refine the evaluation process might be helpful in assessing true competence more accurately.

Although VCE is a valuable technology, significant time required for training limits its use and trainees' interest in learning this modality. In 2013 only 4% of pediatric fellowship programs reported having a formal VCE module as part of their training program (17). Typically, it takes 30–60 minutes to read and interpret a study (2). The time taken may be even longer when the study is complex or is read by a novice capsule endoscopist (2). Additionally, learning VCE and becoming the expert for your medical center typically involves more than learning the technique itself. Often, it also means being the expert on the use of this technology and, its indications, limitations, and complications. This all requires additional training and education beyond simply learning the skill. Further, many pediatric medical centers typically have a single capsule endoscopist or perhaps a couple. Limited mentors of a time intensive technique also limit the ability for fellows or other faculty to learn and perform research around enhanced use of VCE. This pilot curriculum attempted to address all these issues related to VCE training by creating standardized easily accessible training with decreased need for one-on-one mentoring. The curriculum provided trainees with important high-yield pediatric cases, pediatric societal reading materials and the ability to complete the curriculum at their own pace. The program utilized an educational method of background, self-learning, and practice, which would be considered hands on and valuable VCE training (14).

An important additional aspect of VCE training is that it requires continuous practice. Pediatric gastroenterologists may feel their skills are not adequate when VCEs are not performed on a consistent basis at their institution. In our study, 50% of the participants were not naïve to VCE. It is possible that these participants were either looking to enhance their skills or had the desire to obtain credit for their completed training modules to meet licensing requirements. Future funding and societal support of such VCE curricula would be helpful in achieving these goals.

This pilot study was not without significant limitations. First, multiple participants did not complete the entire curriculum and the overall sample size was small. In our study cohort, significantly greater number of females fully completed the curriculum

(Table 1). No significant differences were noted in regard to age, level of training, practice type, and prior VCE experience within the groups that fully versus partially completed the curriculum (Table 1). Although the data on the reason for the small sample size was not available, it is thought that this may have occurred in part because of the length of curriculum and the substantial commitment that was needed from the participants for its completion within a specified time period. This issue of time and commitment was similar to what is often observed anecdotally during in-person training for VCE and is a noted barrier to the number of trained capsule endoscopists. In addition, multiple subjects had difficulty completing the course due to firewall and technical limitations created by their institutions and the VCE manufacturer system. Future versions of this pilot curriculum that focus on making the course more user friendly and modifications that ensure better retention rates would be valuable in confirming the conclusions of our study. Second, we hypothesized that video capsule endoscopy skills and perhaps expertise in reading could be achieved by using an on-line program that included didactic materials, practice cases, and quizzes without review from an expert endoscopist. Introducing a secondary reviewer to assess progress through the curriculum may have improved and confirmed the findings in this study. Finally, this study only evaluated a single manufacturer's system. It is possible that the results may be different had a different software been evaluated. To improve these weaknesses further research is needed, and technological improvements and funding would be required. Future steps should also seek to validate a pediatric scoring system for competency and the possible addition of such a training to fellowship programs.

CONCLUSIONS

VCE is an important modality for pediatric gastroenterologists in which limitations of education occur and nonstandardized educational methods exist. The study found that a web-based standardized pilot curriculum was possible to build and successful to implement. Further refinement of the curriculum and assessment tools, and research around such curricula would be prudent.

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