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MINIREVIEWS

Training in video capsule endoscopy: Current status and unmet needs

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Abstract

Since its introduction to clinical practice nearly 20 years ago, wireless capsule endoscopy has revolutionized the landscape in the diagnosis and management of small bowel diseases. Over the past 10 years, capsule endoscopy has evolved beyond the small intestine and a range of capsules are now available to examine the esophagus, stomach and colon. Because of its ease of use, tolerability, paucity of complications and ability to visualize the entire gastrointestinal tract, capsule endoscopy has entered the mainstream of clinical practice. This review of the literature summarizes the current state of capsule training and highlights the limited data available to assess reader competence and standards expected of an independent practitioner. There are neither standardized teaching strategies nor national or international metrics for accreditation of physicians and non-physicians interested in mastering this examination. Summating the few publications, there appears to be consensus that diagnostic expertise improves with experience, and that trainees should be fully supervised for at least 20 full case studies. Formative and summative assessment is advisable and the number of taught cases should not be the sole determinant of competence. The review also highlights differences in recommendations from major national gastroenterology societies. Finally, the authors discuss areas of unmet needs in teaching and learning for capsule endoscopy.

Key words: Small bowel capsule endoscopy; Colon capsule endoscopy; Training

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Core tip: Small bowel and colon capsule endoscopy can accurately identify small bowel and colonic pathology. Standardized and structured training is required to optimize

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diagnostic competence.

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INTRODUCTION

Small bowel capsule endoscopy, a minimally-invasive method of direct visualization of the small intestine, was introduced in clinical practice both in the United States and Europe in 2001. Since then, the use of capsule endoscopy has steadily increased for a broadening spectrum of clinical indications including investigation of iron deficiency anemia and/or obscure gastrointestinal (GI) bleeding, Crohn's disease, small bowel tumors, inherited polyposis syndromes, and others[1-3]. The ease of use and non-invasive nature of this diagnostic device led to the development of capsules designed for visualization of the esophagus, stomach or the colon. A first-generation colon capsule endoscopy became available in 2006 and more recently a second-generation colon capsule endoscopy was developed. It allows the examination of the entire colon without the requirement for day case admission, analgesia, sedation or air insufflation[4-6].

National and international societies have issued guidance on the role of wireless capsule diagnostic algorithms and management strategies[7-9]. In 2005, Korman *et al*[10] proposed a standardized and structured terminology for describing findings in capsule endoscopy. This is known as "Capsule Endoscopy Structured Terminology" (CEST), which has been widely adopted for descriptive purposes when reporting. However, there are currently no universally standardized training and educational curricula to assure competency and indeed, a definition of competency is yet to emerge. Mastering the skills required to safely and effectively deliver a capsule service requires appreciation of indications, benefits, risks and limitations of the procedure, in addition to competency in visualizing the esophageal, gastric, small bowel and colonic mucosa.

In this review we have aggregated publications that have addressed capsule training and competency and have drawn conclusions on the current status of skills training in this emerging subspecialty.

LITERATURE STUDY

An extensive bibliographical search was performed via the online databases PubMed and EMBASE. The keywords used were the following: "small bowel capsule endoscopy", "colon capsule endoscopy", "training in capsule endoscopy" and "competence". All selected studies were manually examined to identify further relevant reports. This review included all original research papers published in full. Only those written or translated into English were included.

CAPSULE ENDOSCOPIST EXPERIENCE AND CAPSULE IMAGE INTERPRETATION

Several studies have demonstrated that prior reading experience is associated with a high degree of inter-observer agreement and reader competence. A study published in 2005 assessed reader accuracy in diagnosing celiac disease and reported excellent inter-observer agreement amongst readers with previous experience (kappa = 1). This contrasted with poor agreement amongst novice readers (kappa = 0.2)[11]. Postgate *et al*[12] reported the accuracy of detecting and sizing polyps in an animal model of polyposis. Participants varied in endoscopy and capsule endoscopy experience. Experienced capsule endoscopists achieved the highest polyp detection rate (91%) and prior experience of fiber-optic endoscopy emerged as an independent factor influencing both polyp detection and polyp sizing accuracy. Unsurprisingly, the authors concluded that formal training is required to optimize capsule endoscopy

interpretation[12]. Jang *et al*[13] asked 13 gastroenterology experts and 10 trainees to independently review capsule endoscopy clips and report their findings. Accuracy was significantly higher in the experienced group, especially for subtle lesions. In addition, inter-observer agreement was significantly higher in the expert group. In an Italian study, 75 capsule endoscopy clips were chosen by an expert external investigator, and prospectively read and reported by eight investigators with varied capsule experience. Diagnostic accuracy and inter-observer agreement were more common amongst practitioners who had performed a higher volume of procedures[14].

Postgate *et al*[15] were the first to assess the impact of structured, hands-on training in capsule endoscopy. Two experienced gastroenterologists with experience of 1000 colonoscopies but no capsule experience, and a senior endoscopy nurse with no prior experience of either conventional or capsule endoscopy received structured mentoring and at pre-determined intervals, their reading and reporting was assessed. Sustained improvement was evident in the nurse with only one of the two mentored gastroenterologists showing sustained progress. The report suggested that training could improve performance, that experienced endoscopy nurses could safely report capsule endoscopy and that allowance is required to accommodate variable learning curves.

In an Italian study published in 2012, the authors reported the impact of structured training combining both formal tutorials and hands-on experience[16]. Seventeen participants were asked to review a series of capsule endoscopy cases before and after receiving instruction, based on the 2005 recommendations of the American Society of Gastrointestinal Endoscopy (ASGE)[17]. Overall, the mean detection rate for significant findings was only 50% and no significant differences were observed among study participants with different levels of experience. Both the inter-observer agreement and significant finding detection rates were low regardless of previous experience, and the training program did not significantly improve performance of readers with different levels of experience[16].

In the Korean GUT Image Study Group, 12 trainees and an expert were asked to review 15 capsule endoscopy cases, one each week for 15 wk[18]. They were asked to report small bowel transit time and diagnosis. Inter-observer agreement between trainees and the expert increased as the program progressed, most notably after weeks 9 and 11. The authors concluded that diagnostic accuracy increases with experience and that approximately 10 capsule endoscopy case studies would be appropriate for trainees to attain competence.

Sidhu and colleagues reported the capsule reading performance of 10 gastroenterology trainees, all with previous conventional endoscopy experience, but little or no capsule experience, and five capsule naive medical students. The study indicated that prior endoscopic experience enabled readers to achieve a higher diagnostic accuracy and highlighted the trainees' desire for formal capsule endoscopy training[19].

In a recent retrospective Spanish study, 900 capsule endoscopy studies were reviewed by three gastroenterologists experienced in conventional endoscopy. The authors assessed whether a negative capsule endoscopy report, ruling out small bowel pathology, would change with number of cases reviewed. The study reported that negative predictive values rose with cases reviewed but did not continue increasing after the first 100 reads[20].

Finally, Postgate *et al*[21] studied the effectiveness of a 1-h computer based capsule training module. The study included gastroenterology trainees and medical students, none of whom had previous capsule experience. In both groups, significant improvement in lesion detection was demonstrated following the computer-based learning experience[21].

NATIONAL AND INTERNATIONAL GUIDANCE ON TRAINING IN CAPSULE ENDOSCOPY

In 2005 the ASGE issued guidance on credentialing in capsule endoscopy. The guideline recommended that capsule endoscopy training should be considered independent of other endoscopic procedures, that performance metrics are required to demonstrate competence, and that continuing education and assessment should be a requirement to maintain practitioner privileges. The document recommended that endoscopists wishing to perform capsule endoscopy should have a relevant medical or surgical clinical background and have completed at least 24 mo of a standard GI fellowship (or equivalent). A further requirement was that aspiring capsule practitioners should have completed training in conventional fibre-optic endoscopy. The guidance mandated that competence should be assessed using objective criteria

and by direct observation[17]. The ASGE also recommends that all trainees should undertake formal capsule training during their GI fellowship, and this should include didactic teaching and an adequate case volume. Training could also be undertaken outside of a GI fellowship, requiring at least eight hours of appropriate continuing medical education blended with an accredited hands-on course. Following a period of formative training, it was suggested the trainees review 10 complete studies, each supervised by a credentialed capsule endoscopist[17]. This is in line with the recommendations of the Korean Society of Gastrointestinal Endoscopy that proposed 10 supervised capsule endoscopy examinations, preceded by structured mentoring, before a reader is granted privilege to perform independent capsule endoscopy[18].

The 2007 United States GI core curriculum mandated reading a minimum of 25 capsule studies in order to achieve competency[22]. In 2013 the ASGE updated their guidance, mandating that gastroenterology training programs should provide trainees with formal lecture based instruction in capsule endoscopy. Training could either be undertaken during the 3-year fellowship program, or at a post-fellowship setting. The guidance reiterated that post-fellowship trainees required eight hours of CME credited hands-on training, endorsed by a national or international GI society[23]. The ASGE update mandates a minimum of 20 supervised procedures but states that proficiency should reflect competence rather than the numbers. Summative assessment should include direct observation and objective metrics recommending that trainees achieve a 90% or greater correlation rate when compared to a credentialed capsule endoscopist[23]. In keeping with the above recommendations, the American College of Gastroenterology (ACG) published guidelines in 2017 which recommended that capsule endoscopy should be restricted to readers with documented competency in both the cognitive and technical aspects of this examination[7]. In addition, the ACG maintains an online educational resource that offers a module on capsule endoscopy. Similar learning resources are available, providing e-learning courses and webinars[24].

The European Society of Gastrointestinal Endoscopy (ESGE) guidelines recommend that nurses and/or other technical staff can be trained and credentialed by their ability to accurately identify pathology. However, the final diagnostic report remains the duty of the responsible physician. No recommendations are made regarding training, competency assessment and credentialing in capsule endoscopy[25].

In the United Kingdom, training in capsule endoscopy is not mandatory. In a survey conducted in 2012, most trainees expressed interest in receiving training in capsule endoscopy, but only a small minority had completed a formal accredited course. Despite high interest amongst trainees, as well as non-physicians, and the widespread use of capsule endoscopy in clinical practice, the Joint Advisory Group on Gastrointestinal Endoscopy (JAG) that regulates training in conventional endoscopy has not yet addressed a capsule training curriculum for aspiring capsule endoscopy. In the absence of a formal training structure, the United Kingdom nurses are welcome to attend ad hoc courses endorsed by the British Society of Gastroenterology, JAG and ASGE. e-Learning modules and computer-based courses are also available[26-28].

Guidance issued by different gastroenterology societies is summarized in Table 1.

TRAINING IN COLON CAPSULE ENDOSCOPY

Colon capsule endoscopy was introduced in 2006[4,5]. Currently, there remains uncertainty regarding the criteria of competence, and no standardized training pathway has been agreed on. Colon capsule endoscopy is more challenging than small bowel capsule endoscopy as videos are longer in duration and interpretation more complex[29].

In Europe, formal colon capsule endoscopy training is available in very few countries[27]. In Japan, the 2nd generation of colon capsule endoscopy was approved in 2013 and the Japanese Association for Capsule Endoscopy developed an electronic learning platform for capsule endoscopy (ELCEE). This involves a seven-step training pathway, including both didactic mentoring, as well as review of case studies and colon capsule endoscopy videos. Participants' performance scores are collated via an automated scoring engine [colon capsule endoscopy reading competence assessment test (CCAT)]. Successful completion was determined by a final score. ELCCE was shown to significantly enhance colon capsule endoscopy competence irrespective of the trainees' previous experience of capsule endoscopy[30].

EVALUATION TESTS

Table 1 Summary of main national guidance on training in capsule endoscopy

	ASGE	ESGE	BSG / JAG
CE Core Curriculum	Yes	No	No
Endorsed courses	Yes	No	Yes
Duration of courses	8 h	-	2 d
Formalized assessment of competence	Highly recommended	-	No
Supervised CE studies required after completion of training	20	Not specified	Not specified
Provision for non-physicians	No	Yes	Yes

CE: Capsule endoscopy; ASGE: American Society of Gastrointestinal Endoscopy; ESGE: European Society of Gastrointestinal Endoscopy; BSG: British Society of Gastroenterology; JAG: Joint Advisory Group on Gastrointestinal Endoscopy.

Introducing objective measures to assess competence remains an unmet need. Rajan *et al*[31] performed a single-center 6-year prospective analysis of fellows' competence in capsule endoscopy, following formal training that followed the ASGE recommendations. On completion of training a formalized assessment tool, the Capsule Competency Test (CapCT), was developed comprising three sections including 32 test items and a maximal score of 100. Competence was defined as a CapCT score of ≥ 90% of the mean score achieved by staff capsule endoscopists who underwent the same assessment. The trainees were divided into three groups, according to the number of capsule endoscopy examinations they had reported. Mean scores for trainees with < 10, 11-20 and 21-35 examinations were 79%, 79%, and 85%, respectively. No significant association was found between trainee scores and previous endoscopy experience. The authors concluded that regardless of prior endoscopic experience trainees should complete at least 20 capsule studies before competence is assessed[31].

Watabe *et al*[30] assessed the effectiveness of ELCEE using a validated automated scoring system, called CCAT. Following completion of ELCCE, average CCAT scores improved significantly in all participants. The authors concluded that ELCCE and CCAT provide appropriate metric to substantiate a satisfactory level of competence in colon capsule endoscopy[30].

Albert *et al*[32] developed an evaluation tool (ET-CET) to assess the impact of hands-on capsule endoscopy training on the diagnostic accuracy of the examination. ET-CET consists of 10 capsule endoscopy videoclips. A total of 294 individuals were included in the study, all of whom attended capsule endoscopy training courses in different sites across Europe between 2008 and 2011. The participants were asked to record their findings before and after completing the training course. The primary endpoint was evaluation of the impact of hands-on training courses. A significant improvement in diagnostic skill was demonstrated and this was independent of their previous background or course setting. Prior experience of flexible endoscopy appeared to be of some value before attending a relevant course[32].

CAPSULE ENDOSCOPY AND NON-PHYSICIANS

Studies comparing reading accuracy of capsule endoscopy amongst readers from different backgrounds have demonstrated that an experienced endoscopy nurse may be as competent as a physician[15,17,19,21,33-46]. In the United Kingdom, specialist nurse capsule endoscopists have demonstrated advanced reading skills, enabling safe capsule endoscopy interpretation. However, within many healthcare systems, an extended specialist nurse role is unlikely to gain acceptance[35]. The ESGE has endorsed qualified nurses and trained technicians as pre-readers but mandates that the responsibility for sign off remains the responsibility of an appropriately trained physician[25]. With the increasing demand for capsule endoscopy and physician shortage, pre-selection of pathological images by a credentialed nurse could prove a cost-effective response, reducing the physician review time from 34 to 9 min[46].

CURRENT STATUS AND CONSIDERATIONS FOR THE FUTURE

Recently, Read *et al*[47] disseminated an email survey addressing small bowel endoscopy training in the United States. This included both capsule endoscopy and device-assisted enteroscopy. The survey indicated that during their three year

fellowship, most programs required trainees to complete training in capsule endoscopy and around 80% of GI fellows graduated with credentials to undertake independent capsule endoscopy. However, GI fellowships offered different training curricula and there was no standard for assessing competence with only 3.4% of GI fellowships employing metric-based assessment tools[47]. Despite several accredited courses available to European trainees, capsule endoscopy training has not been formally incorporated in gastroenterology curricula[29].

Fernandez-Urien *et al*[29] proposed a consensus European Core Curriculum for CE training tailored to the needs of different healthcare systems. The authors recommend 12 h dedicated to either small bowel or colon capsule with at least four hours of lecture-based mentoring and six hours of hands-on training, delivered over 1.5 d. The video case mix should focus on normal mucosal appearance, variants of normal and commonly encountered pathology. The consensus document recommends a formal summative assessment. After successful completion of the training, the trainee should be considered a "beginner", with further training required before recognising the practitioner as competent, proficient or expert[29].

Capsule endoscopy is increasingly deployed as a new imaging device in gastroenterology and there is a broadening spectrum of clinical indications. Review of the literature indicates there is little consensus on training and defining competence. This mirrors the evolution of training in conventional endoscopy which was practiced for decades before national and international training standards were agreed and incorporated into training curricula. There is a paucity of quality, evidence based studies for training capsule endoscopy practitioners but the review of the literature suggests an emerging consensus that trainees require a curriculum that includes both theoretical and practical mentoring, a validated metrics-based summative assessment and lifelong learning and appraisal. We recommend that capsule endoscopy training is incorporated formally into gastroenterology curricula. This training could be either undertaken during the gastroenterology training scheme for some trainees, or as part of an endoscopy fellowship program. CME accredited capsule endoscopy courses should involve at least 12 h of training, comprising lecture-based mentoring and hands-on training. Following completion of a course, based on the literature, a minimum of 20 fully supervised cases chosen with graded difficulty should be undertaken, although we feel that the precise number should be individualized based on the trainee's ability and progress. In order for a physician (or non-physicians) to be credentialed, summative assessment including direct observation and objective metrics is a requirement. In our experience, non-physicians may be eligible for accreditation in capsule endoscopy after appropriate training, and there is increasing evidence that they are equally efficient as physicians (at least as pre-readers).

Future research should focus on the capsule endoscopy learning curve, curriculum development, quality assurance and strategies for certification. As the skill requirement is image recognition rather than the dexterity demanded of fiber optic endoscopy, the role of nurse specialist capsule endoscopist requires consideration. As new technologies emerge, medical practitioners need to keep pace with rapid change and the urgency to address new training needs.

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