Thieme

Cloud technology and capsule endoscopy: A single-center users' experience of remote online video analysis and reporting

OPEN ACCESS

Authors
Conor Costigan[1,2], Caroline Walker[1,2], Jim O'Connell[1,2], Emmanuel Omallao[1], Thilagaraj Manoharan[1], Niamh Eagle[1], Yvonne Bailey[1], Fintan O'Hara[1,2], Deirdre Mc Namara[1,2]

Institutions
1 Gastroenterology, Tallaght University Hospital, Dublin, Ireland
2 Trinity Academic Gastroenterology Group, Trinity College Dublin, Dublin, Ireland

Key words
Endoscopy Small Bowel, Capsule endoscopy, Training, Quality and logistical aspects, Image and data processing, documentatiton

received 30.6.2023
accepted after revision 4.12.2023
accepted manuscript online 11.12.2023

Bibliography
Endosc Int Open 2024; 12: E227–E230
DOI 10.1055/a-2226-0755
ISSN 2364-3722

Georg Thieme Verlag KG, Rüdigerstraße 14,
70469 Stuttgart, Germany

Corresponding author
Dr. Conor Costigan, Tallaght University Hospital, Gastroenterology, Dublin, Ireland
conorcostigan92@gmail.com
ccostigan99@hotmail.com

ABSTRACT

Background and study aims Telemedicine has progressed significantly in recent years, with newer, more integrated information technology systems improving healthcare delivery. The development of the world's first cloud-based capsule platform could allow safe and timely virtual analysis of videos from a network of linked hospital centers. We aimed to assess the efficacy of Medtronic's PillCam Remote Reader System.

Methods PillCam remote reader technical data were collected from the capsule endoscopy (CE) database over 8 months. User-reported performance was collect using an online survey. Outcomes included overall procedure success, video-upload/report-download rates and speeds, encryption/decryption rates, and user/reader satisfaction.

Results Data from 377 studies encompassing seven different readers was collected (318 small bowel capsules, 59 colon capsules). Overall procedure success was 100% (all videos reported). Two upload delays occurred (< 24 hours). There were no encryption/decryption errors. Seven of seven respondents felt it easy to access and use vs one of seve for the old system. Six of seven respondents felt department efficiency increased. Benefits included off-site reading and multisite-conferences. Issues included offsite difficulty accessing other hospital systems.

Conclusions PillCam remote reader is a reliable, secure, and effective capsule analysis platform and should be incorporated into any CE service development plan.

Introduction

Since video capsule endoscopy (VCE) was introduced in the early 2000 s, it has been found to be a safe and effective tool for investigating gastroenterological symptoms and disease worldwide [1]. The range of indications for its use has expanded in recent years due to improvements in both hardware and software [2, 3], and in certain clinical circumstances, it has replaced endoscopy as investigative or monitoring tools [4, 5]. European guidelines have standardized VCE use for both small bowel and colonic disease. They include technical guidelines and quality performance measures [6, 7, 8].

More recent advances in capsule technology have included the addition of machine learning and artificial intelligence (AI)-assisted reading [9]; however, despite this, reporting continues to be a time-consuming process, which is confined to centers

with expert readers. The time to read each VCE and availability of expert readers is often seen as a barrier to the development or expansion of appropriate capsule services globally. While commercial reading services are available, the cost can be prohibitive for many centers.

Similarly, new legal focus on data protection at a European and global level (General Data Protection Regulation) makes sharing of videos among centers and expert readers for the purposes of quality assurance or report validation challenging.

While AI-assisted VCE is very likely to improve reading speed in the very near future, and therefore, is likely to expand VCE capacity in centers with expert readers, it does not allow for sharing videos between hospital centers. This will continue to be a hindrance for the development of VCE in new and smaller centers.

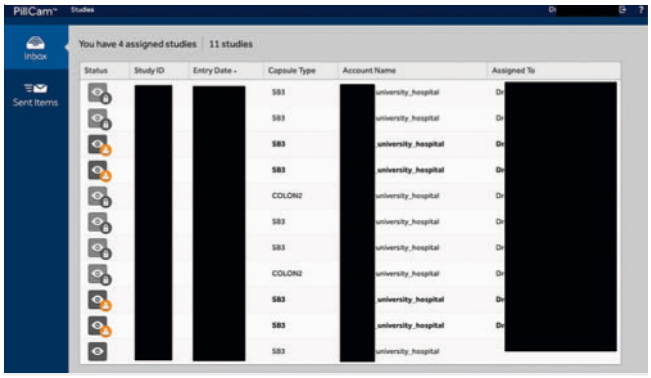
Medtronic (Medtronic Limited, Watford, UK) recently launched a commercial cloud-based platform with two-way encryption, which in theory allows for secure remote reading of VCEs by a selection of pre-approved expert readers located anywhere in the world. This system could improve access to VCE by enabling centers without trained readers to initiate a service for their patients, and would also allow readers to share images and videos with colleagues on a secure platform as a quality assurance process. In addition, it could promote training, a hybrid-working model, and the development of after-hours emergency reading service similar to that used for radiology services. The aim of this study was to assess the performance of a cloud-based VCE reading platform in a busy tertiary referral service.

Patients and methods

The system

PillCam (Medtronic Limited, Watford, UK) remote reading platform (RRP) is a secure encrypted, cloud-based reading environment allowing for remote reading, analysis, and report creation which incorporates the latest RAPID Reader software. PillCam Sync is a component of the platform installed locally at hospitals and enables uploading of de-identified studies for review and downloading of the relevant, locally re-identified reports. The video remains available on the local machine, even while the de-identified copy is in the cloud (▶ **Fig. 1**). Authorized users can access, analyze, and generate reports about these studies via the online RRP, which is identical to the standard Medtronic PillCam Desktop reader (▶ **Fig. 2**).

Remote readers are assigned and given access to a specific archive by a Medtronic system administrator. Any remote reading clinician with access to that specific archive can choose any study that has been uploaded to that archive to read; the study is then locked to this clinician and it can only be unassigned by the same clinician or by the Medtronic system administrator. Once PillCam studies are uploaded, they are available in the cloud for 30 days, even after they have been assigned to a reader, and can be edited during that time. Once the final report is approved and the analyzed video is downloaded, the video is removed from the platform and reader access.



▶ **Fig. 1** Medtronic PillCam Cloud user homepage. [rerif] Source: Medtronic

Study population

Following installation of the system in our unit, and an internal pilot study, all routine VCE studies performed over an 8-month period were automatically uploaded and read from the cloud-based platform. PillCam Colon2 and PillCam SB3 capsules were used as appropriate following standard triage and procedure protocols. There were no changes to procedure protocols (small bowel, colon, pan-intestinal); the only difference was that videos were uploaded and read on the cloud rather than on the local hospital server.

Patient demographic and procedure specifics were recorded from our local VCE database, while remote reader technical information was collected from the PillCam Capsule Endoscopy Platform. Technical outcomes included: video upload/report download success rates and speeds, video analysis and technical success, encryption/decryption rates, and overall procedure success. Reader-reported outcomes were assessed using an online survey including direct questions and invited comments.

Results

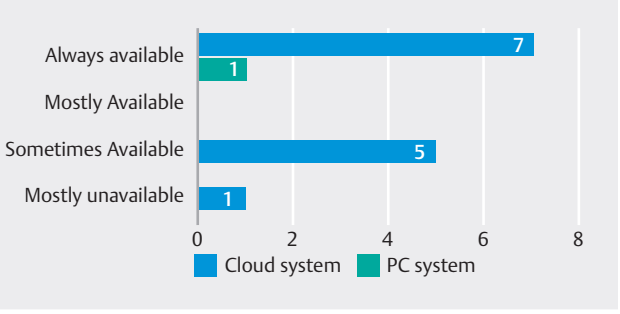
Technical data

A total of 377 VCEs were completed during the timeframe (318 SBCEs, 59 CCEs). Feedback was collected from seven expert users (2 consultants, 3 NCHDs, and 2 nurse specialists). Video upload, video analysis, and report download success rates were 100%. The only technical issue was an upload delay in two studies, both < 24 hours. There were no encryption/decryption errors and no breaches in General Data Protection Regulation protocols. The overall procedure success rate was 100%. In addition, the RRP has been successfully used to support remote access to multiple participants from different sites to review video clips and images at our quality assurance and training meeting.

User-reported outcomes

In all, seven of seven respondents felt the cloud-reading platform was “very easy” to access and use. In contrast, six of seven found it “difficult” or “extremely difficult” to access and use the old desktop hospital server-based system (▶ **Fig. 3**). In addition,

▶ **Fig. 2** PillCam Remote Reading Platform (RRP) [rerif]. Source: Medtronic



▶ **Fig. 3** Comparison of ease of access to reading software.

six of seven felt the RRP increased department efficiency and would "definitely" incorporate the RRP into future practice.

Self-reported additional benefits included off-site/after-hours reading (n = 7), hybrid-working opportunities (n = 6), enabling virtual conferences (n = 4), and higher-definition screens on personal laptops (n = 2). User-reported issues included a lack of access to other hospital system while off-site (n = 3).

Discussion

The performance of the RRP in our center was excellent with 100% technical success and excellent user acceptance. In particular, the improved access to RRP and its potential to increase capacity were underscored by all readers.

Being RRP-enabled, remote reading could support the development of VCE services in new centers and enable these and established smaller units to have access to the expertise in remote tertiary referral VCE centers. Our experience to date suggests this is achievable with this new system. While VCE in our center is not currently available as an after-hours service, the adoption of the RRP could be used to develop a 7-day-a-week, 24-hour emergency VCE service, which would be a significant diagnostic advantage, particularly for patients with obscure gastrointestinal bleeding. If the use of this technology were to spread globally, an international certification system for readers would be necessary to support inter-institution or international reading, and governing bodies should consider the creation of such awards in the future. In addition, a successful RRP is a key component of any future near-patient or at-home colon capsule testing service that may be in development and thought to improve patient acceptance.

The RRP-enabled system has improved access to our VCE quality improvement meeting, allowing multiple readers to review and sign off on video clips and images from multiple locations/institutions, while also allowing trainees the opportunity to participate and have one-on-one feedback and supervision with expert readers. In the future, the RRP could increase access to trainees not currently working at a VCE center to gain skills and expertise in this technology and would have the potential to collect anonymized image clips and reports from the cloud as teaching materials for both young trainees, creating online learning and testing resources, and as input data to help train future AI-assisted reading software.

Finally, this technology provides ease of access to the videos for readers. It has the potential to promote a hybrid-working environment that will undoubtedly see wider adoption of VCE among healthcare professionals in the coming years. This, coupled with increased quality testing capacity at new centers, in-

cluding near-patient services, will further enhance the future role of VCE as a pivotal diagnostic test.

Conclusions

In summary, PillCam remote reader is a reliable, secure and effective capsule analysis platform and should be incorporated into any capsule service development plan.

Conflict of Interest

The authors declare that they have no conflict of interest.

Funding

Medtronic Europe http://dx.doi.org/10.13039/100020192
Technology provided. No monetary grant awarded

References

[1] Idan G, Meron G, Glukhovsky A et al. Wireless capsule endoscopy. Nature 2000; 405: 417

[2] Eliakim R, Yassin K, Niv Y et al. Prospective multicentre performance evaluation of the second-generation colon capsule compared with colonoscopy. Endoscopy 2009; 41: 1026–1031

[3] Spada C, Hassan C, Munoz-Navas M et al. Second-generation colon capsule endoscopy compared with colonoscopy. Gastrointest Endosc 2011; 74: 581–589.e1

[4] Spada C, Pasha SF, Gross SA et al. Accuracy of first- and second-generation colon capsules in endoscopic detection of colorectal polyps: a systematic review and meta-analysis. Clin Gastroenterol Hepatol 2016; 14: 1533–1543 doi:10.1016/j.cgh.2016.04.038

[5] Kjølhede T, Ølholm AM, Kaalby L et al. Diagnostic accuracy of capsule endoscopy compared with colonoscopy for polyp detection: systematic review and metanalyses. Endoscopy 2021; 53: 713–721

[6] Spada C, Hassan C, Galmiche JP et al. Colon capsule endoscopy: European Society of Gastrointestinal Endoscopy (ESGE) Guideline. Endoscopy 2012; 44: 527–536 doi:10.1055/s-0031-1291717

[7] Spada C, Hassan C, Bellini D et al. Imaging alternatives to colonoscopy: CT colonography and colon capsule. European Society of Gastrointestinal Endoscopy 5 (ESGE) and European Society of Gastrointestinal and Abdominal Radiology (ESGAR) Guideline – Update 2020. Endoscopy 2020; 52: 1127–1141 doi:10.1007/s00330-020-07413-4

[8] Pennazio M, Rondonotti E, Despott EJ et al. Small-bowel capsule endoscopy and device-assisted enteroscopy for diagnosis and treatment of small-bowel disorders: European Society of Gastrointestinal Endoscopy (ESGE) Guideline-Update 2022. Endoscopy. Endoscopy 2023; 55: 58–95 doi:10.1055/a-1973-3796

[9] Mascarenhas Saraiva MJ, Afonso J, Ribeiro T et al. Deep learning and capsule endoscopy: automatic identification and differentiation of small bowel lesions with distinct haemorrhagic potential using a convolutional neural network. BMJ Open Gastroenterology 2021; 8: e000753