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Current status of colon capsule endoscopy in clinical practice

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Colon capsule endoscopy (CCE) is used for restricted indications only. Growing demand for out-of-hospital treatment combined with technical and clinical improvements in quality has made a wider use plausible. Artificial intelligence-supported footage analysis and quality assessment might further improve quality and reduce the price of CCE to a competitive level.

For more than a decade since its market entry, the colon capsule (PillCam Colon) remained in the shadows of its less-endowed (single dome and camera) small bowel counterpart[1] (Supplementary Table 1). By all standards of technology adoption, one would be right to think that colon capsule endoscopy (CCE) had its best shot and was vetted as a practical colon imaging alternative for the very selected few[2]. The ease of colon access with conventional high-definition colonoscopes, the ever-lasting need for colon cleansing before any white-light optical endoscopy and the power requirements placed on button-size batteries helped form such an opinion (Supplementary Table 1).

However, over the past few years, a series of 'unlikely' events (not limited to the striking effects of the COVID-19 pandemic) on the delivery of endoscopy services and the pouring of new evidence[3] have brought CCE again under the spotlight of the broader endoscopic community[4]. First, several meta-analyses have confirmed that CCE provides high diagnostic accuracy in an adequately cleaned colon (Supplementary Table 1). There is sufficient evidence that the quality of high precision, low complication rates and increased patient preference is non-inferior to colonoscopy — more studies indicate that it is superior on all three parameters[3].

One major issue that prevents a more widespread use is the high number of patients that need a colonoscopy after the CCE, either because the CCE was of insufficient quality or because positive findings demand a therapeutic procedure[5]. Studies of patient preference and the economy of CCE delivery indicate that the reinvestigation rate should be lower than approximately 30% to obtain a patient selection over a colonoscopy[6]. A comprehensive cost-efficiency analysis suggests that the gap between CCE and colonoscopy price can be narrowed by combining a low reinvestigation rate with time and money-saving automated image analysis. If current achievements in Scotland, England and Denmark are combined, the reinvestigation rate due to insufficient examination could, theoretically, be reduced to less than 15% (against the ~10% seen in colonoscopy). It is feasible to select patient populations needing a colonic exam with a positive finding rate of less than 15%.

However, CCE is likely only a cost-efficient solution for some. Still, patient groups covering 50–60% of all referred could be identified by combining indications such as first referral from the general practitioner owing to colorectal cancer (CRC)-related symptoms, surveillance for hereditary CRC and follow-up after polypectomy with a faecal immunochemical test (FIT) triage. Data from Scotland show that FIT is a very efficient indicator of the likelihood of positive findings ($n > 2{,}000$) (Supplementary Table 1). Further steps to improve the selection of patients with a high probability for successful investigation could be using pre-test algorithms based on demographics and medical history. This line of research has already started[7], and more algorithms based on big data are under construction.

New studies have proved that exhaustive bowel preparation can be honed into smaller volumes (Supplementary Table 1). At the same time, adding the prokinetic prucalopride can decrease the transit time and increase completion rates of CCE to more than 95% (Supplementary Table 1), one of the main hurdles plaguing the wider adoption of CCE. Furthermore, although there is currently no commercially available artificial intelligence for CCE, promising solutions[8] and ongoing European Union-funded research will soon add to the procedure's clinical effectiveness and quality and enable it to become a mainstream diagnostic option. Artificial intelligence can also significantly reduce the observer variation in the picture and video analysis (κ value 0.53; 95% CI 0.51–0.55), a marked problem in the quality of both colonoscopy and CCE (Supplementary Table 1). In several trials, the polyp and adenoma detection rates (ADRs) are substantially higher in CCE than in colonoscopy (Supplementary Table 1). An even distribution between low-risk and high-risk adenomas causes an increase in ADRs. With the help of artificial intelligence, it is possible to distinguish those taking advantage of the high sensitivity without being overloaded with following therapeutic colonoscopies for polyps, without consequence to the patient. An international definition of a 'realistic medicine' approach is needed to fully utilize these possibilities for therapeutic improvements without an unrealistic increase in workload owing to the resection of clinically irrelevant polyps and adenomas.

What have we learned since the combined guidelines[2] update recommended considering CCE in diagnostic settings with low-risk abdominal symptoms, incomplete diagnostic colonoscopy and expressed patient preference, and incomplete conventional examination in organized CRC screening programmes? We know that outside the scope of academic clinical trials, improvement is needed to increase the reliability of CCE, as less than half of the investigations were considered complete with adequate bowel cleansing. For example, in the big ($n = 689$) French cohort from routine clinical practice, most missed advanced neoplasia was due to distal localization in incomplete CCE (Supplementary Table 1). A first report on a similar-sized cohort ($n = 509$) from Scotland (Supplementary Table 1) confirmed that CCE was a safe, well-tolerated diagnostic test, which reduced the proportion of patients requiring colonoscopy. Only two patients experienced serious adverse events requiring hospital admission: one capsule retention

with obstruction and one dehydration from bowel preparation. Since the Scottish Capsule Programme (ScotCap) was introduced across health boards in Scotland as an integral part of the national redesign of outpatient gastroenterology services, enabling early and effective triage of referrals in the community by combining FIT results and CCE, further evidence has piled up. We should await a complete assessment of the service's effectiveness (over 3,500 colon capsules have been swallowed to date). ScotCap relies on a fully outsourced niche service in which all aspects of the service and capsule delivery are managed without any need for intervention by the end user[9].

In March 2021, the English National Health Service commissioned an evaluation of 11,000 CCEs for patients referred for investigation of cancer alarm symptoms or a positive FIT in the low range of 10–100 µg haemoglobin per gram faeces. Forty-six English sites were invited to participate, and each has been resourced with capsules and kits. The English pilot study is ongoing, and around 4,000 colon capsules have been swallowed since its start. The English pilot relies on in-house CCE reading, whereas the 2,500 procedures performed in the Danish trials were delivered without utilizing hospital facilities (Supplementary Table 1). The current post-pandemic situation leaves us with a severe lack of qualified health-care professionals. Automated and artificial intelligence-supported CCE might add to the solution to this current issue.

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Competing interests

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Additional information

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