Evaluating patients’ preferences for type of bowel preparation prior to screening CT colonography: Convenience and comfort vs. sensitivity and specificity

Manuscript type: Original Article

Authors:

Alex Ghanouni\textsuperscript{a23578} BSc MSc
Steve Halligan\textsuperscript{b2378} MD FRCP FCR
Stuart A. Taylor\textsuperscript{b2378} MD MRCP FCR
Darren Boone\textsuperscript{b2378} BSc MRCS FCR
Andrew Plumb\textsuperscript{b578} MRCP FCR
Jane Wardle\textsuperscript{a578} BA MPhil PhD
Christian von Wagner\textsuperscript{a123578} BSc PhD

\textsuperscript{1}guarantor of integrity of the entire study
\textsuperscript{2}study concepts and design
\textsuperscript{3}literature research
\textsuperscript{4}clinical studies (N/A)
\textsuperscript{5}experimental studies / data analysis
\textsuperscript{6}statistical analysis (N/A)
\textsuperscript{7}manuscript preparation
\textsuperscript{8}manuscript editing
**Affiliations:**

a Department of Epidemiology and Public Health, University College London, London, UK

b Centre for Medical Imaging, University College London, London, UK

**Word Count:** 250 / 250 in abstract; 3338 / 4000 in main body

**Corresponding author at:**

Christian von Wagner

Health Behaviour Research Centre

Department of Epidemiology & Public Health

UCL

Gower Street

London

WC1E 6BT

UK

Email: c.wagner@ucl.ac.uk

Tel: +44 (0)20 7679 1940 | Fax: +44 (0)20 7679 8354

**Conflicts of interest:** None to declare.

**Source of Funding:** This article presents independent research funded by the National Institute for Health Research (NIHR) under its Programme Grants for Applied Research funding scheme (RP-PG-0407-10338). The views expressed in this article are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health.

**Acknowledgements:** The authors thank Nichola Bell for identifying and inviting participants.

**Classifications:** Gastrointestinal; CT
Abstract

Aims: Computed tomographic colonography (CTC) is currently the only whole-colon screening test for colorectal cancer (CRC) that can offer reduced or non-laxative forms of bowel preparation. These are likely to be less burdensome for patients compared with full-laxative purgation but may also reduce test sensitivity and specificity. This study explored the relative value patients place on comfort and convenience vs. test sensitivity and specificity in the screening context.

Materials and methods: Twenty semi-structured interviews were carried out with patients attending hospital for radiological tests unrelated to CTC. Preferences for CTC with different types of bowel preparation for CTC screening were examined and interviews were analysed thematically. The discussion guide included separate sections on CTC, bowel preparation methods (non-, reduced- and full-laxative), and sensitivity and specificity. Patients were given information on each topic in turn and asked about their views and preferences during each section.

Results: Following information about the test, patients’ attitudes towards CTC were positive. Following information on bowel preparation, full-laxative purgation was anticipated to cause more adverse physical and lifestyle effects than using reduced- or non-laxative preparation. However, stated preferences were approximately equally divided, largely due to patients anticipating that non-laxative preparations would reduce test accuracy (because the bowel was not thoroughly cleansed). Following information on sensitivity and specificity (which supported patients’ expectations), the predominant stated preference was for full-laxative preparation.

Conclusions: Patients are likely to value test sensitivity and specificity over a more comfortable and convenient preparation. Future research should test this hypothesis on a larger sample.
Introduction

Computed tomographic colonography (CTC) is a relatively novel radiological test for detecting colorectal cancer (CRC) and precancerous polyps. It has the advantage of being less invasive than colonoscopy and as such is often preferred by screening participants (1). CTC has been recommended as a screening test based on data indicating that it achieves similar sensitivity (the ability to detect disease when it is present) for important colonic lesions (polyps ≥10mm or cancer) compared to colonoscopy, which is generally accepted to be the current gold-standard whole-colon examination (2–4). However, CTC has lower sensitivity for smaller polyps compared with colonoscopy (5) and it has lower specificity (i.e. disease is more likely to be suspected when it is absent), giving a higher false-positive rate that results in unnecessary follow-up testing.

A potential benefit of CTC is that it remains the only whole-colon investigation that allows patients to avoid full-laxative purgation required by other modalities. This may represent a major advantage because full laxative preparation is often reported to be the worst part of the entire test experience (6,7) and patients’ experience of reduced-laxative preparations have been found to be superior compared with full-laxative alternatives (e.g. 8–10). It has also been argued that offering full-laxative preparation for CTC discourages people from undergoing the test, therefore reducing uptake and diminishing the population health benefits (11).

A randomised controlled trial found that screening uptake was significantly higher following an invitation to undergo CTC with a reduced-laxative preparation than full-laxative colonoscopy (34% of 982 vs. 22% of 5924 participants; 12). A sub-study on acceptability found that patients expected the preparation be less burdensome in the CTC arm (13). However, as both bowel preparation and test varied between trial arms, it is not possible to be certain that the preparation itself was a specific deterrent to uptake.
The potential downside of reducing the intensity of the laxative component of bowel preparation is a reduction in test sensitivity and specificity for polyps (14). A small number of studies have asked respondents to consider both outcome features of the test (such as sensitivity) and process features (such as discomfort) before stating their preferences and these studies suggest that patients prioritise ‘accuracy’ over test experience in both screening and diagnostic contexts (15–17). Furthermore, even relatively small differences in sensitivity may be considered to be important (18). It is therefore possible that sensitivity and specificity of CTC would be prioritised over the discomfort and inconvenience of the bowel preparation if patients were given this information.

Most studies of preferences and acceptability have not mentioned issues of sensitivity and specificity to participants: A meta-analysis of patients’ preferences for colonoscopy or CTC after experiencing both tests (1) found that 17 out of 23 studies did not provide any information on sensitivity. In the remaining studies, participants were informed that both tests were equally sensitive, despite evidence that CTC has lower sensitivity for smaller precancerous polyps (e.g. 5). No study provided information on specificity directly although three studies informed patients about a 20% referral rate for colonoscopy after CTC. Participants in these studies may have made inaccurate assumptions (for example, that the more recently developed CTC was most sensitive; 16). This lack of information may reflect a common (but perhaps mistaken) assumption among medical staff that patients value comfort over accuracy (19,20).

The aim of the present study was therefore to examine patient trade-offs between the discomfort and inconvenience of the bowel preparation vs. sensitivity and specificity of CTC in the screening context. We conducted semi-structured interviews in which patients were asked to consider a hypothetical context where they were offered CTC for screening. We provided information on three types of bowel preparation (non-, reduced- and full-laxative), first focusing on the practicalities of each method, and then on their associated sensitivity
and specificity. Patients were asked to express preferences and discuss the reasons for their choices at each point.

**Materials and Methods**

**Design and participants**

Following ethical approval by an NHS Proportionate Review Sub-committee, a research assistant identified a consecutive sample of patients scheduled to attend an NHS teaching hospital radiology department for ultrasonography or radiography for reasons unrelated to the present study. Once identified, patients were mailed an information sheet and invitation to participate in a face-to-face interview. Eligibility criteria were patients aged 45-59 years (to eliminate effects of prior experience of CRC screening which starts at 60 years in England); ability to read and speak English; no previous experience of CTC or other colonic investigations and no personal history of CRC. Patients returning a reply slip expressing interest were met on the day of their appointment by a research assistant (BLIND FOR REVIEW) to answer questions, confirm eligibility, and take written consent. Those who consented took part in a 45-60 minute interview shortly after their test or on another day depending on their preference and were offered £10 remuneration.

**Measures**

Semi-structured interviews were carried out with (BLIND FOR REVIEW); patients received key information in sections in order to monitor preferences at different stages and ensure that they were not overburdened. The face-to-face nature of the interviews allowed the interviewer to probe comprehension and provide more detail as necessary. Patients were also able to ask questions and receive explanations of unfamiliar concepts (particularly sensitivity and specificity) before responding. Verbal information was supplemented by a visual presentation (in PowerPoint 2010 for Windows, Microsoft, Redmond, WA, USA) to aid
comprehension. The sections gave information on CRC screening, the percentage of polyps that may turn into cancer (8% after 10 years; 24% after 20 years), the CTC test procedure, a set of non-, reduced- and full-laxative preparation characteristics, representative quotes from patients about their experiences with non- and full-laxative preparations (taken from a previous interview study; 21) and the implications of how preparation affects sensitivity (86%; 89%; 92% respectively) and specificity (89%; 90%; 91%) for pre-cancerous polyps. The order in which each preparation was presented was determined randomly for each participant to counteract possible order effects. Information was derived from the existing literature (22–30) and local CTC information sheets developed by psychologists and radiologists with experience in the area.

After each section, patients were asked questions based on a prepared discussion guide (Tables 1-4). Age, gender, health and employment status were noted. After information on CRC screening and CTC, patients were asked about perceived benefits and barriers towards the test, and their willingness to have it in principle if it were offered in the next month. This was followed with information on the practicalities of each method of bowel preparation, after which patients were asked about expected physical and lifestyle effects. They were also asked how they thought the preparations might affect the test (giving them an opportunity to suggest that there might be differences in terms of sensitivity or specificity) and their overall preferences. Information was then given on sensitivity, and patients were asked about their impressions of this attribute and asked to consider their preferred preparation again. They were also asked about their preferred preparation after receiving information on colonoscopy (as the follow-up test that would be recommended if an abnormality was suspected on CTC) and specificity (i.e. the possibility of false positives on CTC that result in an unnecessary colonoscopy), as well as being asked about their impressions of these aspects of testing. In the concluding section of the interview, patients were asked about their overall impressions of CTC and their willingness to attend for screening.
Analysis

Recordings were transcribed and a thematic analysis carried out (31). Qualitative research software (NVivo 9 for Windows, QSR International, Cambridge, MA, USA) was used to read participants’ responses repeatedly and categorise them based on a framework corresponding to the typical order of the interview (i.e. initial views of CTC, preparation impressions and preferences after information on practicalities, sensitivity, specificity and final views of CTC). Similar responses were grouped in order to detect common themes and determine participants’ preferences within each section of the interview.

Results

Demographics

Participants (n=20, 11 males) had a mean age of 52 years (range: 45-58 years) and 13 were in full- or part-time paid employment. Sixteen reported their health quality to be good or fair. Data on education and socioeconomic status were not collected. At the start of the interview, participants often considered their existing knowledge of CRC or screening to be poor (“I don’t really know anything about screening”; male, 47). However, other participants often referred to possible aims of screening (prevention and early detection) or established screening programmes (“I’ve always had a smear test dead on time, I’ve always had breast cancer screening on time…I would think [the aim of CRC screening], like most screenings, is to diagnose early, because the earlier diagnosed, the better chance you’ve got and to put people’s mind at rest as well”; female, 54).

Initial attitudes towards CTC screening

After learning about the practicalities of CTC and having the opportunity to ask questions, patients were generally positive towards the test, citing factors such as the potential to provide reassurance (“Be nice to have…satisfy myself that I’ve got no problems”; male, 54)
years), a personal sense of risk and the potential to prevent cancer ("I think as you get older, I think possibly it pays for you to look after your health and prevention is better than cure"; male, 56 years). There were some factors that diminished the perceived acceptability such as possible scheduling difficulties, perceived low risk of CRC ("I suppose I would query the likelihood that it was relevant to me"; male, 54 years) and concerns about risks associated with the procedure ("I would definitely give myself a few days, loads of ‘Google-ling’ to find more information…looking at the risk of the scanning itself, looking at alternatives"; male, 49 years).

Preparation preferences after information on practicalities

After receiving information on practicalities for each method of preparation, patients perceived an apparent ordering in terms of physical effects. Non-laxative preparation was expected to cause fewer adverse effects than reduced-laxative preparation and both were perceived as more manageable than more full-laxative preparation ("If the only effect the [non-laxative preparation] has is to change the colour of the stool…I don’t see how you’d have any ill effects"; male, 46 years). Full-laxative preparation was expected to cause the most frequent and inconvenient physical effects including diarrhoea, increased bowel frequency, urgency, cramping, dehydration and fatigue ("You have a powerful laxative and you’re suffering from diarrhoea, you’re going to feel pretty weak, aren’t you?"; male, 56 years). Physical effects from dietary restrictions were expected to be minor in comparison and were generally anticipated to be an issue for reduced- and full-laxative preparations only.

Non-laxative preparation was expected to cause some disruption to daily routine. This was related primarily to work issues such as transporting medicine to the workplace, storing it there and with how other colleagues would respond to it ("If I, unfortunately, found myself with clients, for example, I might find it more difficult…I wouldn’t want to get my special preparation out at the lunch table"; male, 45 years).
The main lifestyle effects anticipated for reduced- and full-laxative preparations related to change in bowel habit. This was expected to cause some slight disruption to social and working life in the case of the former (“If you’re basically caught short with no toilet, that’s the obvious one”; male, 47 years). The latter was expected to cause the most significant lifestyle changes (“I’d probably stay home for the day. Yes, I wouldn’t want to go out”; male, 46 years). Full-laxative preparation was also expected to make travelling difficult. As with anticipated physical effects, the effects of dietary restrictions were expected to be less disruptive to lifestyle than the effects of change in bowel habit.

Despite this ordering of tolerability, when patients were asked to state their preferred preparation (if any), opinion was divided among the three options. Those stating a preference for reduced- or full-laxative preparations often asked about or guessed that there were differences in accuracy between preparations (“Say if your colon is a lot clearer, you’ll be able to detect a lot more, that’s what I’m thinking…’cause it’s clear of any debris”; female, 54 years). At this stage, some patients viewed a reduced-laxative preparation as a good compromise between convenience and the anticipated effect on the test performance.

**Preparation preferences after information on sensitivity**

After receiving information on sensitivity, patients perceived it to be a key attribute and explained their view both in terms of providing greater reassurance that no pre-cancerous polyps had been missed (“If you want to have your bowel completely looked at, including polyps you’re going to have to choose the one that shows everything or what’s the point in having it? There’s no point in half doing it, you’ve got to have it done completely for peace of mind”; female, 54 years) and the harmful consequences of a false negative (“How would you feel if you settled for, say, the lowest one, [non-laxative preparation] and took that and they came back and said ‘no, you’re all clear’ and then two years down the line, bang, ‘oh, you’ve got bowel cancer’?”; male, 56 years). There was a clear overall preference for full-laxative preparation at this stage. Notably, several patients appreciated that the differences were
small but still regarded them as important ("it doesn't look statistically particularly much of a
difference but I would probably put my money on [full-laxative preparation], then...just
subjectively I would feel better about that"); female, 58 years).

Interestingly, some patients reasoned that against the background of undergoing the test,
the differences between preparations would be minimal in terms of overall inconvenience ("If
you're going through all that hassle in some ways to actually have the test, then you might
as well get the most out of it. So, that's why I would possibly change back to [full-laxative
preparation]"); male, 55 years). Few participants expressed a preference for a less intensive
preparation at this stage and most cited external barriers (such as travel) as the reason for
their preference.

Preparation preferences after information on specificity

As part of the discussion guide, we also sought to identify views on false positives. After
receiving information on these attributes, patients generally had a negative view of
colonoscopy as a follow-up test, particularly in relation to issues around dignity and
invasiveness; these represented reasons to value specificity ("I would really hate to have an
unnecessary colonoscopy...The sort of invasiveness of machines on the body, and I feel
that always is very hard"); female, 49 years). They were also concerned about anxiety
associated with an abnormal test result ("Emotionally...cancer's a big sort of, like, no-no with
some people...you wouldn't want to go down the route of...a false alarm, which is not only
upsetting to you, it's upsetting to people around you who think they're going to lose you");

As with sensitivity, there was a clear overall preference for full-laxative preparation in terms
of specificity; patients considered it worth undergoing in order to reduce the risk of a false
alarm ("If you've got [full-laxative preparation] done, you stand a better chance of not being
called back...Yeah, [full-laxative preparation] seems to be the one that would give you more
peace of mind…so, obviously then, looking at that, it’s essential that you use a laxative so the medical staff can see every single thing”; female, 58 years).

Final attitudes towards CTC

After receiving all information at the end of the interview, participants generally felt that they would be willing to have CTC for screening (“I don’t see any reason not to have it. I mean it seems to me, if that were routine it would be fine”; female, 56). Several participants remained ambivalent about accepting any kind of CTC, particularly if they felt that CRC was not as serious as other cancers or they did not consider themselves to be at high risk (“I think it’s one of those things that’s definitely, definitely manageable if you know you’re supposed to be having it done but not the sort of thing you’re going to volunteer to have without good cause”; male, 47). However, there was no clear change in willingness to have CTC compared to participants’ initial attitudes (“I think at the start…I was pretty confident I would take up the offer, unless I found out something that would put me off but nothing I’ve found out today has put me off”; male, 46).

Discussion

These findings support other evidence that potential screening participants value sensitivity and specificity highly in test decisions (15–18). Although full-laxative preparation was expected to cause more adverse physical and lifestyle effects, patients felt they were prepared to accept this additional inconvenience and discomfort in order to maximise the benefits of testing and reduce the risk of harm. It was notable that patients were influenced by even small differences in specificity and, in particular, sensitivity for polyps even though they were informed that most polyps do not become cancers. These findings contribute to a growing body of evidence suggesting that outcome features are valued over process features in the screening and diagnostic contexts, in contrast with clinicians’ assumptions (19,20).
It has been argued that uptake of screening CTC may be optimised through the use of less burdensome reduced-laxative preparations instead of standard full-purgation methods (11).

This reasoning was behind the decision to offer reduced-laxative preparation in a randomised trial of screening CTC vs. colonoscopy (12). Our results support the trial findings that non- and reduced-laxative preparations are perceived as more acceptable in terms of the direct patient experience (10), but they suggest that reduced-laxative preparations may ultimately run counter to patient’ preferences if they also reduce sensitivity or specificity. If the present results are confirmed, it may be necessary for policy-makers and researchers to consider whether full-laxative preparations would be both more clinically advantageous and more consistent with patients' priorities, or perhaps give patients a choice.

It should be noted that this study was based on the premise that an increase in tolerability is associated with a decrease in sensitivity and specificity (14). However, the choice of preparation would be clear for all stakeholders if it were possible to offer a superior patient experience and optimised sensitivity and specificity simultaneously. Although this study assessed perceptions of just three preparations, using estimates of their sensitivity and specificity, many other regimens exist and there is considerable uncertainty regarding the performance characteristics of such a diverse range (3). It is possible that alternative preparations (perhaps developed in the future) would not require patients to compromise to the same extent, if at all. Future research should aim to reduce these uncertainties and determine whether a fully optimised preparation can be achieved.

Our findings regarding preparation preferences should also be put in the broader context of perceptions of CTC and CRC screening: In our interviews, the value of the test itself and factors such as perceived low risk of CRC were more significant barriers than the preparation, suggesting that strategies to address these issues may be more effective at optimising uptake overall than the choice of preparation.
This study has limitations. It was small-scale and exploratory, and therefore larger studies, in other settings, are needed to confirm the findings. It is also possible that statistics on sensitivity and specificity were particularly impactful on preferences because of the study design in which the three types of preparation were presented in parallel, which may have emphasised differences. A more naturalistic design in which only one method is described without the reference points provided by alternatives, may find that participants focus on test specificity and sensitivity to a lesser degree. The most robust validation of these findings would be to evaluate actual screening behaviour outside of a hypothetical context.

**Conclusion**

The results of this study suggest that when given appropriate information, patients favour methods of preparation for CTC screening that maximise test sensitivity and specificity and thereby increase the chance of health benefits and reduce the need for further testing. This suggests that patients attach greater priority to getting the best test than getting the best test experience.

**References**


21. BLIND FOR REVIEW (in press).


**Key information on CRC screening**

- Aims to detect CRC early, when it is more treatable
- Aims to prevent CRC cancer, through detection and removal of pre-cancerous polyps
- 8 out of 100 polyps become cancers after 10 years; 24 out of 100 after 20 years

---

**Key information on CTC**

- Involves two scans being taken and read by a specially-trained doctor
- Scanning is preceded by injections (muscle relaxant, intravenous dye) and rectal insufflation with gas
- Testing takes 20-30 minutes
- Carries a risk of radiation-induced cancer (same risk as smoking 140 cigarettes)
- Carries a risk of a hole in the bowel wall (1 in 3,000)
- Usually, results cannot be given on the same day
- A follow-up test (colonoscopy) would be needed to assess/remove suspected abnormalities

---

**Table 1. showing key information on CRC screening and CTC**
Key information on non-, reduced- & full-laxative preparation

Non-laxative preparation

Medicine: Powdered barium would be mixed with water and drunk with food three times a day on the two days before CTC while the mixture is kept in the fridge

Effects: This medicine is not a laxative but may turn stools pale

Diet: People would have to go without high fibre foods from two days before CTC until four hours before, after which no solid food could be eaten

Reduced-laxative preparation

Medicine: Liquid iodine would be mixed with water and cordial and drunk on the two evenings before CTC

Effects: This medicine is a mild laxative and carries a 1 in 250,000 risk of serious allergic reaction

Diet: People would have to go without high fibre foods from two days before CTC until one day before, after which no solid food could be eaten

Full-laxative preparation

Medicine: “Picolax” powder would be mixed with hot water and drunk on the morning and afternoon before CTC

Effects: This medicine is a powerful laxative

Diet: People would have to go without high fibre foods from two days before CTC until the day of the test and go without snacking between meals or supper on the day before CTC
Representative quotes from patients’ experiences with non and full-laxative preparation (21)

Non-laxative preparation

Diet: “You had to go on a light fibre diet so that meant no fruit or vegetables, no red meat, no whole meal bread, no porridge…That was a bit hard for me because I eat a lot of food with fibre” (female, 76)

“You couldn't eat any meat, which was not a big problem, I can eat meat or leave it alone...there was no vegetable or fruit...I could have poached eggs...It was just not what I would eat on a normal day but it was OK. It was bearable...It wasn’t too much of a hardship” (female, 78)

Medicine: “I had to drink [the mixture] three times a day…Morning, afternoon and evening…I didn’t like it, of course. Well you don’t like drinking that stuff. It says in the notes that it has a pleasant taste but…it’s not really all that pleasant” (female, 76)

“I had to drink this [mixture]…I didn’t find that in any way strenuous…It wasn’t too bad at all…I just drank it down and it made my mouth a bit dry but other than that it was alright” (female 78)

Full-laxative preparation

Diet: “You pretty well starve while you’re on this horrible stuff” (female, 79)

“I managed all that…I just kept to the letter by not eating any solids on the day before and the day previous to that, I had made sure there was no fibre in my diet” (male, 76)

Medicine: “Pretty, pretty awful. I didn’t go to work that day ‘cause I was running to the toilet…I couldn’t have been at work, the toilet at work is down the stairs so you could never make it in time” (female, 69)

“It was very effective, you know, but then I expected it...I didn’t enjoy it particularly. It was necessary” (female, 81)

Table 3. showing quotes describing patients’ experiences with non- and full-laxative preparation
**Key information on differences in sensitivity between preparations**

If 100 people with polyps had a particular preparation:

- 86 would have their polyps found after non-laxative preparation
- 89 would have their polyps found after reduced-laxative preparation
- 92 would have their polyps found after full-laxative preparation

**Key information on follow-up colonoscopy**

- Involves a small tube with a camera being passed through the bowel
- The camera takes pictures that a doctor can see on a screen
- Colonoscopy is preceded by injection of a muscle relaxant, painkiller and a sedative
- Testing takes 30 minutes plus an hour for the sedative to wear off
- Carries a risk of bleeding (1 in 150) and a hole in the bowel wall (1 in 1,000)
- Can take samples and remove polyps

**Key information on differences in specificity between preparations**

If 100 people without polyps had a particular preparation:

- 11 would have an unnecessary colonoscopy after non-laxative preparation
- 10 would have an unnecessary colonoscopy after reduced-laxative preparation
- 9 would have an unnecessary colonoscopy after full-laxative preparation

Table 4. showing key information on sensitivity, colonoscopy and specificity