Patients' Difficulties with Five Different Fecal Immunochemical Tests

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Background: At least 26 different fecal immunochemical tests (FITs) are available for use in the US. Liquid vial and card collection devices are available.

Objectives: 1) assess participant's difficulties with and preferences for types of FITs; 2) assess whether errors in FIT collection were associated with FIT collection difficulty; 3) identify factors associated with difficulty with FIT stool collection.

Methods: Prospective individuals scheduled for a colonoscopy were invited to participate in a study comparing test characteristics of 5 FITs. A product questionnaire asked participants about ease of collection and difficulties.

Results: 2,148 participants; mean age 63 years; 63% females, 83% Whites, and 19% Hispanics. 1265 (61%) preferred use of a liquid vial versus 181 (9%) the card. 49% had no difficulty with Hemoccult ICT, and 66 to 70% had no difficulty with the liquid vials. Difficulties with Hemoccult ICT included: being messy (21%), collection window too small (19%), and getting sample on stick (8%). Difficulties with the liquid vials included difficulty probing or scraping the stool (5% to 8%) and unclear directions (3%). In a multivariable model, the perceived difficulty in FIT collection was significantly higher for Hemoccult ICT compared with OC-Auto Micro (adjusted odds ratio [AOR], 4.05), and it was significantly high for those with a FIT error (AOR, 3.90).

Conclusion: Participants strongly preferred a liquid vial compared with a card. Perceived difficulty was significantly associated with FIT errors and with FIT brand. Medical offices providing FITs should ensure that patients understand the task of FIT collection, so that errors are minimized. (J Am Board Fam Med 2024;37:1014–1026.)

Keywords: Cancer Screening, Colorectal Cancer, Fecal Occult Blood Test, Fecal Immunochemical Tests, Surveys and Questionnaires

Fecal immunochemical tests (FITs) can be a sensitive, specific, and low-cost alternative to colonoscopy.[1] Annual fecal occult blood tests (FOBTs) (FIT or guaiac) are 1 of 5 colorectal cancer (CRC) screening tests recommended by the US Preventive Services Task Force.[2,3] Over a lifetime, FITs completed annually are estimated to avert 25 CRC deaths per 1000 people, compared with 27 deaths per 1000 averted by colonoscopy every 10 years.[3] FITs are preferred over guaiac tests for FOBTs. FITs are widely available, inexpensive, and highly cost-effective compared with colonoscopy for CRC screening.[4] The effectiveness of any CRC screening test depends on the

accuracy of the test characteristics and adherence by patients.[5,6]

Little research with extremely low sample sizes has been conducted on patient preferences regarding use of FITs. In a comparison of 3 methods for transferring stool to a dry-slide collection card in North Dakota, 24 of 47 (51%) convenience sample participants found the traditional wooden stick to be the most preferred method, compared with stool collection of toilet tissue stool smear, or direct smear from the stool to the dry-slide card.[7] In another extremely small study in Oregon, 4 of 11 participants completing 6 FITs reported the Hemoccult ICT wooden stick was difficult to use and 12 participants out of 12 preferred the OC-Light FIT probe for the liquid vial sample collection method.[8]

There are many FITs sold in the US, with the same FIT being marketed under different names by different distribution companies. A detailed search identified 24 distinct Clinical Laboratory Improvement Amendments (CLIA)-waived FITs and 2 automated FITs.[9] For this study, we used the 5 most commonly used FITs certified in pathology laboratories.[9]

Studies comparing difficulties of FITs used in the US have not been conducted. For this study, participants evaluated 5 FITs, while they participated in a main study comparing test characteristics of the FITs with optical colonoscopy.[5] The purposes of this study were to: 1) assess participant's difficulties with and preferences for types of FITs; 2) assess whether errors in FIT collection were associated with FIT collection difficulty; and 3) identify factors associated with difficulty with FIT stool collection.

Methods
The main prospective study invited those 50 to 85 years of age scheduled for a screening or surveillance colonoscopy to participate in a study comparing test characteristics of 5 different FIT products using colonoscopy as the reference standard.[5] Institutional Review Board approval was received at each of the 3 participating sites: University of Iowa (UI) in Iowa City, Iowa; University of North Carolina (UNC) at Chapel Hill, North Carolina; and Texas Tech University Health Sciences Center (TTUHSC) at El Paso, Texas.[5] Clinical trials: NCT03264898.

After a signed informed consent and health questionnaire that included demographics were received, participants were mailed or handed a package with 5 different FITs, detailed enlarged directions for each FIT, a plastic specimen container pan, a card to record the date of stool collection, a cardboard postage-paid return mailer, and a product questionnaire. All samples were returned to the UI where researchers analyzed the tests.[5] On return of the FITs and completion of the colonoscopy, participants were paid $25. The main study started 9/20/2017. When we noticed participants making FIT collection errors, the product questionnaire was developed. The first subject returned the product questionnaire 12/11/2018. The study ended 11/18/2022.

Fecal Immunochemical Tests (FITs)
Each participant was provided 5 FITs: 4 CLIA-waived FITs, Hemoccult ICT (Beckman Coulter, Inc.), Hemosure iFOB (Hemosure, Inc.), QuickVue iFOB Test (Quidel Corporation), and OC-Light S (Eiken Chemical Company distributed by Polymedco, Inc), and a non-CLIA waived moderate complexity automated FIT, OC-Auto Micro FIT (Eiken Chemical Company distributed by Polymedco Inc). The FITs chosen were the most commonly used in pathology proficiency testing programs in the US, required to perform waived tests having a CLIA Certificate of Waiver.[9] The products included 4 liquid vials with screw-on caps and 1 dry-slide card (referred to as card) (Hemoccult ICT). Patient instructions from each manufacturer were enlarged and color coded by FIT liquid vial/card color and placed on 1 large flier for ease of participant use (See Appendix A). Participant FIT collection errors (overall errors, card errors, and liquid vial errors) were tracked during the study.[10]

Product Questionnaire
A 13-item investigator-developed product questionnaire was developed a few months into the study (See Appendix B). For each FIT used in the study, questions were asked about ease of collection and any difficulties with collection, with participants able to choose all that applied from a list of options. For data analyses on FIT preference, the 5-point scale was collapsed to 3 categories: 1) *preferred card* (*strongly preferred* and *preferred*, box next to *strongly preferred*), 2) *no preference*, and 3) *preferred liquid vial* (*strongly preferred* and *preferred*, box next

to *strongly preferred*) (See Appendix B). Two questions to partially assess cognitive impairment instructed the participants to draw a clock depicting the time as ten minutes after eleven and to indicate if anyone helped them draw the clock. The clocks were scored by 2 methods, Watson et al. and Mendes-Santos et al.[10–12]

Data Analysis

All data were double entered by 2 different research assistants. A comparison of all entries was conducted and those with discrepancies were reviewed and corrected. Standard descriptive statistics were used to summarize the variables and assess the distributions of responses for key variables. Participants included in our analyses returned 4 of 5 FITs and the product questionnaire. The main outcome variable for this study was the patients' experience of how easy it was to collect the specimen with scores from 1 = "very easy" to 5 = "very difficult" for each FIT. These scores were dichotomized as follows: scores of 2, 3, 4, and 5 were categorized as having "some difficulty," and a score of 1 was categorized as "no difficulty." For each FIT, if a participant made any errors, that FIT was categorized as having an error. An individual could have up to 5 errors and there was no weighting by FIT.

Generalized linear mixed models, using the SAS GLIMMIX procedure were used, to examine a binary outcome of whether having some difficulty versus no difficulty collecting the stool samples were different among the 5 FITs, adjusting for demographic factors, FIT errors, and each of the clock drawing scores. The participant was specified as the random intercept in the model to account for the correlation of the scores of 5 FIT responses for each participant. The site variable was not specified as a random effect because there was not significant variance among 3 sites. Binary distribution and logit link were specified in the model. Each of the potential associated factors was tested individually with the outcome variable in the model and included FIT brand, patient's age, sex, race, ethnicity, household income, education, FIT collection error (yes or no for each of 5 FITs) and each of 2 clock drawing scores separately. Variables with $P < .15$ in these univariable predictor models were included in the multivariable analyses. Subsequently, the backward stepwise method was used to remove the nonsignificant variables 1 at a time. Age, income, and education interaction terms were not significant in the

multivariable model. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

In this study, 2213 participants returned the product questionnaire. Of these, 65 were excluded because they did not return FITs or did not attempt the clock drawing or had help drawing the clock, leaving a total 2148 participants who returned either 4 (n = 8) or 5 (n = 2140) FITs. Mean age of the participants was 62.8 years; 1353 (63%) were female, 1787 (83%) White, and 403 (19%) Hispanic. 1621 (76%) participants had college education or higher, 942 (44%) had income of $80,000 or higher, 453 (21%) participants had cognitive impairment by the Mendes-Santos method and 581 (27%) by the Watson method (See Table 1).

Nearly half (49%) had no difficulty with Hemoccult ICT collection, whereas only 66% to 70% had no difficulty with the liquid vials. Difficulties with Hemoccult ICT included: 450 (21%) felt it was too messy, 401 (19%) reported the collection window was too small, 306 (14%) had difficulty getting the sample in the collection window, 172 (8%) had difficulty getting the sample on the collection stick, and 73 (3%) reported the instructions were unclear (See Table 2).

Difficulty probing the stool multiple times was an issue for about 5% of the subjects for Hemosure iFOB, OC-Light S, and QuickVue iFOB liquid vials and difficulty scraping the stool was a problem for 8% of the subjects for the OC-Auto Micro liquid vial. Across the 4 liquid vials, about 3% of the participants said it was messy to collect the specimen using a probe. For each type of liquid vial, fewer than 1% of participants reported liquid spilling from the liquid vial itself and about 1% thought the instructions were unclear (See Table 3).

Removing the cap or removing the correct cap was an issue for some individuals with the liquid vials. For OC-Light, 165 (8%) of the subjects had difficulty getting the cap off. For Hemosure iFOB, 66 (3%) had difficulty getting the cap off and notably, that liquid vial has 2 caps at the same end of the liquid vial. For QuickVue iFOB, 137 (6%) of the participants did not know which cap to open, as there was a cap on each end, even though the directions are clear (See Table 2, Appendices A and B). For OC-Auto Micro 53 (2.5%) participants had trouble removing the cap.

Table 1. Demographic Characteristics of Study Participants

	Total (n = 2,148) Mean (SD) or n (%)
Age, mean (SD), years	62.8 (8.0)
<65	1,273 (59.3)
65 to 75	719 (33.5)
>75	156 (7.3)
Sex	
Female	1,353 (63.0)
Male	795 (37.0)
Race	
Black	160 (7.4)
White	1,787 (83.2)
Other	201 (9.4)
Ethnicity	
Hispanic	403 (18.8)
Non-Hispanic	1,731 (80.6)
Unknown	14 (0.6)
Education	
<8th grade	81 (3.8)
HS/GED	428 (19.9)
College or higher	1,621 (75.5)
Not reported	18 (0.8)
Income	
<$40,000	636 (29.6)
$40,000 to <$80,000	483 (22.5)
$80,000 or more	942 (43.9)
Not reported	87 (4.0)
Cigarette smoker	
Current	120 (5.6)
Former	629 (29.3)
Never	1,390 (64.7)
Not reported	9 (0.4)
BMI	
<18.5 (underweight)	20 (0.9)
18.5–24.9 (healthy weight)	630 (29.3)
25.0–29.9 (overweight)	736 (34.3)
≥30.0 (obesity)	757 (35.2)
Missing	5 (0.2)
Watson method score	
Abnormal	581 (27.1)
Normal	1,567 (72.9)
Mendes-Santos method score	
Abnormal	453 (21.1)
Normal	2,148 (78.9)

Abbreviations: SD, Standard Deviation; HS/GED, High School/General Educational Development; BMI, Body Mass Index.

Participants preferred use of the liquid vials compared with the card 1265 (61%) versus 181 (9%), with 633 (30%) reporting no preference. For each of the 5 FITs, those participants who perceived "some difficulty" had significantly more errors than those who perceived "no difficulty." For example, for Hemoccult ICT, 2.4% of participants had "no difficulty" made an error compared with 4.2% of participants who perceived "some difficulty" ($P = .027$). Overall FIT errors ranged from 0.4% to 3.2% with most errors noted on the card (See Table 3). All OC-Auto Micro samples were analyzed in the main pathology lab, regardless of whether there appeared to be stool in the liquid vial; thus no errors were able to be calculated for this FIT.

Univariable results indicated participants had statistically significantly more difficulty collecting the Hemoccult ICT stool sample than the other FITs. There were significant differences in perceived FIT difficulty by age, ethnicity, education, income, and FIT errors. Those with FIT errors had significantly more difficulty collecting their samples. Participants aged younger than 65 years, those with a high school education, those with a household income less than $40,000, and those who were Hispanic reported significantly less difficulty collecting the stool sample than their comparison groups (See Table 4).

In the multivariable model, FIT collection for Hemoccult ICT was significantly more difficult than OC-Auto Micro (Adjusted odds ration [AOR], 4.05; 95% CI, 3.34-4.85); and Hemosure iFOB was significantly less difficult than OC-Auto Micro (AOR, 0.72; 95% CI, 0.59-0.88), after controlling age, education, household income, and FIT errors. Collection difficulties were not statistically significantly different for OC-Light S and QuickVue iFOB compared with OC-Auto Micro. FIT errors were highly associated with perceived difficulty in FIT collection (AOR, 3.90; 95% CI, 2.46-6.17) Those aged younger than 65 years compared with those 65 to 75 years (AOR, 0.65; 95% CI, 0.51-0.83), those with high school education compared with college or higher (AOR, 0.68; 95% CI, 0.49-0.93), and those having a household income less than $40,000 compared with income of $80,000 or more (AOR, 0.60; 95% CI, 0.44-0.81) perceived significantly less difficulty in FIT collection. (See Table 4).

Discussion

This is a large multi-site study that describes patient difficulties with 5 commonly used FITs in

Table 2. FIT Collection Difficulties (n = 2,148)

Difficulties	Hemoccult ICT n (%)	Hemosure iFOB n (%)	OC-Auto Micro FIT n (%)	OC-Light S FIT n (%)	QuickVue iFOB n (%)
None	1044 (48.6)	1540 (70.0)	1454 (67.7)	1419 (66.1)	1435 (66.8)
Getting sample on stick	172 (8.0)				
Getting sample in collection window	306 (14.2)				
Collection window was too small	401 (18.7)				
It was messy	450 (20.9)	71 (3.3)	79 (3.7)	67 (3.1)	66 (3.1)
Instructions were unclear	73 (3.4)	23 (1.1)	21 (1.0)	16 (0.7)	23 (1.1)
Getting the cap off		66 (3.1)	53 (2.5)	165 (7.7)	43 (2.0)
Deciding which cap to open		Not asked		Not asked	137 (6.4)
Probing the stool multiple times		114 (5.3)		110 (5.1)	108 (5.0)
Scraping the stool multiple times			178 (8.3)		
Liquid spilled from the tube		20 (0.9)	11 (0.5)	4 (0.2)	9 (0.4)
Other	113 (5.3)	64 (3.0)	103 (4.8)	80 (3.7)	68 (3.2)

*Could check any that applied.
Abbreviations: ICT, Immunochemical Test; iFOB, Immunochemical Fecal Occult Blood Test; FIT, Fecal Immunochemical Test.

the US, whereas earlier studies assessed patient preferences for FITs.[7,8] A liquid vial with a probe attached to the cap is preferred to the card with wooden stick for collection.

Difficulties with the card included participants feeling the window was too small, being unsure where to place the stool, and feeling that collection was messy. Difficulties with the liquid vials included the cap being on too tight or confusion over which cap to open when there were 2 caps. Three of the 4 liquid vials had 2 caps. OC-Auto Micro had 1 cap and a foil seal on the opposite end. Hemosure iFOB and OC-Light S had the color of the cap to be removed clearly shown in the directions, but some patients removed the wrong cap. Those were slightly minor problems for the liquid vials, and one may

Table 3. FIT Collection Difficulty and FIT Errors**

	Overall N (%)	No Difficulty N (%)	Some Difficulty N (%)	P-values
Hemoccult ICT errors				0.027*
Yes	66 (3.2)	29 (2.4)	37 (4.2)	
No	2,005 (96.8)	1,156 (97.6)	849 (95.8)	
Hemosure iFOB errors				0.001*
Yes	52 (2.5)	31 (1.9)	21 (4.7)	
No	1,996 (97.5)	1,570 (98.1)	426 (95.3)	
OC-Light S FIT errors				<0.001†
Yes	9 (0.4)	1 (0.1)	8 (1.6)	
No	2,041 (99.6)	1,545 (99.9)	496 (98.4)	
QuickVue iFOB errors				<0.001*
Yes	54 (2.6)	26 (1.7)	28 (5.5)	
No	1,994 (97.4)	1,510 (98.3)	484 (94.5)	

*χ^2 for some difficulty versus no difficulty.
†Fisher's exact test for some difficulty versus no difficulty.
**No errors were noted for OC-Auto, because all vials were sent to the main pathology laboratory for analysis, even if it appeared no stool was in the vial.
Abbreviations: ICT, Immunochemical Test; iFOB, Immunochemical Fecal Occult Blood Test; FIT, Fecal Immunochemical Test.

Table 4. Factors Associated with Having Some Difficulty versus No Difficulty in Collection of FIT Sample (n = 2,148)*

Factors	Univariable Model		Multivariable Model[†]	
	Odds Ratio (95% CI)	P-values	Odds Ratio (95% CI)	P-values
FIT brand				<0.0001
Hemoccult ICT (n = 2,071)	4.17 (3.49-4.99)	<0.0001	4.05 (3.34-4.85)	<0.0001
Hemosure iFOB (n = 2,048)	0.74 (0.61-0.91)	0.003	0.72 (0.59-0.88)	0.001
OC-Light S FIT (n = 2,050)	0.99 (0.81-1.20)	0.887	0.98 (0.81-1.19)	0.832
QuickVue iFOB (n = 2,048)	1.02 (0.84-1.24)	0.838	0.98 (0.81-1.19)	0.827
OC-Auto Micro FIT (n = 2,052)	Reference		Reference	
Age, years				0.002
<65 (n = 1,273)	0.65 (0.52-0.81)	0.001	0.65 (0.51-0.83)	0.001
65 to 75 (n = 719)	Reference		Reference	
>75 (n = 156)	0.79 (0.52-1.20)	0.265	0.72 (0.46-1.14)	0.158
Education				0.045
≤8th grade (n = 81)	0.76 (0.43-1.34)	0.342	1.00 (0.52-1.93)	0.996
HS/GED (n = 428)	0.56 (0.43-0.73)	<0.0001	0.68 (0.49-0.93)	0.015
College or higher (n = 1,621)	Reference		Reference	
Income				0.007
<$40,000 (n = 636)	0.34 (0.23-0.51)	<0.0001	0.60 (0.44-0.81)	0.001
$40,000 to <$80,000 (n = 483)	0.74 (0.48-1.14)	0.174	0.84 (0.63-1.13)	0.249
$80,000 or more (n = 942)	Reference		Reference	
FIT errors^				
Yes	4.28 (2.80-6.55)	<0.0001	3.90 (2.46-6.17)	<0.0001
No	Reference		Reference	
Ethnicity				
Hispanic (n = 403)	0.65 (0.49-0.85)	0.002		
Non-Hispanic/unknown (n = 1,745)	Reference			
Sex				
Female (n = 1,353)	0.97 (0.68-1.37)	0.851		
Male (n = 795)	Reference			
Race				
White (n = 1,787)	1.22 (0.81-1.81)	0.341		
Others (n = 201)	0.90 (0.54-1.52)	0.699		
Black (n = 160)	Reference			
Watson method score				
Abnormal (n = 581)	1.24 (0.85-1.81)	0.266		
Normal (n = 1,567)	Reference			
Mendes-Santos method score				
Abnormal (n = 453)	1.17 (0.77-1.76)	0.468		
Normal (n = 1,695)	Reference			

*Outcome variable having "some difficulty" versus "no difficulty" to collect the sample; Original scores ranged from 1 = "very easy" to 5 = "very difficult" by each FIT. Scores were collapsed into a dichotomous variable with scores of 2, 3, 4, and 5 being categorized as having "some difficulty," and a score of 1 categorized as "no difficulty."
[†]Generalized Linear Mixed Model.
^Each FIT was categorized as either having an error or not.
Abbreviations: ICT, Immunochemical Test; iFOB, Immunochemical Fecal Occult Blood Test; FIT, Fecal Immunochemical Test; CI, Confidence Interval.

wonder if the person opening the liquid vial was frail or had other physical or cognitive issues.

Another minor problem was the directions were perceived as unclear by some participants for each of the 5 FITs. The directions for this study were copied verbatim and enlarged from the manufacturer's directions to more closely mimic what patients might receive in practice. In another small study, wordless

directions were developed for FIT collection and preferred by patients in qualitative analysis.[13] Future studies might address whether having a nursing or medical assistant provide verbal instructions, in addition to the written and pictorial directions might improve patient FIT collection.

Four of the 5 FITs had some errors noted on receipt. Although, the overall FIT error rate was low at 3.2% or less, those who perceived difficulty in FIT collection had more errors for 4 of the 5 FITs. Since the OC-Auto Micro was sent to our main pathology laboratory on arrival and it can be analyzed with no stool, no errors were calculated for that FIT.

Fecal blood testing was developed in 1864 with the use of gum guaiac. The dry-slide guaiac card was developed in the 1960s, followed by the development of immunochemical tests in the late 1970s.[14–18] The main collection device became the dry-slide card and remained so until FITs were available with most manufacturers using a liquid vial for collection.[19] FITs are superior to guaiac tests specifically in the detection of advanced neoplasia and colorectal cancer in average-risk individuals.[20] Only a few participants had some difficulty with FIT collection, with Hemoccult ICT being the primary FIT with the most difficulty, as compared with liquid vial FIT tests. Participants in this study had the least difficulty using the liquid vials, similar to other much smaller studies, where the liquid vial was preferred.[8,21] Although most participants preferred the liquid vial, a sizable percentage, 30%, were neutral on the issue. The accuracy of individual FIT tests should be a major consideration in colorectal cancer screening, but there is relatively little data on this.[6,22,23] In 2024, cost for a card and analysis is approximately $14 compared with a liquid vial at $32 (Fischer Scientific online catalog at https://www.fishersci.com). Different FITs have varying sensitivity and specificity for detecting hemoglobin, thus practitioners should note this when choosing a FIT.[5,6,22,23]

Prior studies comparing FIT preferences did not include as many demographic characteristics as this study. A study comparing a wooden stick stool collection against a smear or tissue collection found no difference in preference by sex.[7] Our study also found no differences by sex for difficulty collecting the stool specimens. Other research showed that participants who were younger, female, had higher household income, and had previously used a FIT were significantly more satisfied with using a FIT liquid vial compared with a plain plastic container.[24] Similar to the Shin study,[24] our younger participants had less difficulty collecting the FIT sample. But, in another study comparing guaiac and FIT stool collection, persons over 60 years compared with persons 50 to 60 years of age perceived the collection easy to perform for both tests.[21]

In the multivariable model, among the FITs, Hemoccult ICT was statistically significantly more difficult to complete and Hemosure iFOB less difficult to complete than OC-Auto Micro. FIT collection errors were highly associated with FIT collection difficulty. Factors statistically significantly associated with less difficulty collecting stool specimen were age < 65 years compared with those 65–75 years, those with high school education compared with college or higher education, and having household income of less than $40,000 compared with those with $80,000 or more.

Two results in the generalized linear mixed model seemed counterintuitive: lower income and lower educational level were associated with having a perception of less difficulty with FIT collection. Our study included participant level of education, which had not been collected in other studies assessing preferences of FITs.[7,8,21,24,25] In our prior publication regarding the errors in FIT collection based on a subset of this study sample, those with an eighth grade education or less compared with high school or higher education, being female, and an abnormal clock drawing had a higher odds of a FIT collection error.[10] Stool sample collection requires adequate physical performance and cognitive function to be completed correctly. Directions must be followed to be successful. Our findings indicated some subjects had cognitive impairment by the clock-drawing test, but they did not perceive collecting the specimen as difficult and clock drawing accuracy did not enter the multivariable model. Some subjects may not realize they collected the specimen incorrectly. Perception of less difficulty does not mean the sample was collected correctly.

Strengths and Limitations
This was a large, diverse study of individuals from the US which assessed patient's difficulties with FIT collection with detailed documentation of FIT collection errors. FIT directions per the

manufacturer were enlarged and provided word-for-word onto a single page in colors that correspond to the manufacturer's directions. In addition, to encourage participation by Spanish-speaking individuals, the directions and study materials were translated into Spanish. We were able to control for several demographic factors. We excluded those who did not complete or who had help with the clock drawing. This study is likely to be generalizable to the US and other developed countries due to its large and diverse sample size.

A limitation of the study was that each participant was expected to complete 5 FITs, whereas in practice, a patient would only be completing 1 FIT. There may be some response bias in that those who could not read English or Spanish may have chosen not to participate. Manufacturer's direction sheets were not provided to the participants but instead were copied all on 1 page. The ease of collection for each FIT was collected using a 5-point Likert scale, which was collapsed to a dichotomous variable, as the distribution of the 5-point scales were not normal. Individuals who perceive that they had no difficulty may not have collected their sample correctly.

Conclusion

Nearly two-thirds of participants preferred the liquid vial compared with the card for FIT collection. Although the FIT collection error rate was below 3%, those who perceived more difficulty had significantly more errors in FIT collection. The multivariable model demonstrated that the Hemoccult ICT was substantially more difficult to collect than OC-Auto Micro and Hemosure iFOB was less difficult to collect than OC-Auto Micro. Medical offices providing FITs should ensure that patients understand the task of FIT collection, so that errors are minimized.

To see this article online, please go to: http://jabfm.org/content/37/6/1014.full.

References

1. Young GP, Symonds EL, Allison JE, et al. Advances in fecal occult blood tests: the FIT revolution. Dig Dis Sci 2015;60:609–22.
2. Knudsen AB, Rutter CM, Peterse EFP, et al. U.S. Preventive Services Task Force Evidence Syntheses, formerly Systematic Evidence Reviews. *Colorectal Cancer Screening: An Updated Decision Analysis for the US Preventive Services Task Force*. Agency for Healthcare Research and Quality (US); 2021.
3. Davidson KW, Barry MJ, Mangione CM, US Preventive Services Task Force, et al. Screening for colorectal cancer: US Preventive Services Task Force Recommendation Statement. JAMA 2021;325:1965–77.
4. Zhong GC, Sun WP, Wan L, Hu JJ, Hao FB. Efficacy and cost-effectiveness of fecal immunochemical test versus colonoscopy in colorectal cancer screening: a systematic review and meta-analysis. Gastrointest Endosc 2020;91:684–97.e15.
5. Levy BT, Daly JM, Xu Y, et al. Comparative effectiveness of five fecal immunochemical tests using colonoscopy as the gold standard: study protocol. Contemp Clin Trials 2021;106:106430.
6. Lee JK, Liles EG, Bent S, Levin TR, Corley DA. Accuracy of fecal immunochemical tests for colorectal cancer: systematic review and meta-analysis. Ann Intern Med 2014;160:171.
7. Greenwald B. A pilot study evaluating two alternate methods of stool collection for the fecal occult blood test. Medsurg Nurs 2006;15:89–94.
8. Pham R, Cross S, Fernandez B, et al. "Finding the right FIT": rural patient preferences for fecal immunochemical test (FIT) characteristics. J Am Board Fam Med 2017;30:632–44.
9. Daly JM, Xu Y, Levy BT. Which fecal immunochemical test should I choose? J Prim Care Community Health 2017;8:264–77.
10. Daly JM, Xu Y, Crockett SD, Schmidt ME, Kim P, Levy BT. Clock-drawing test as a screening tool for cognitive impairment associated with fecal immunochemical test collection errors. Ann Fam Med 2022;20:452–9.
11. Watson YI, Arfken CL, Birge SJ. Clock completion: an objective screening test for dementia. J Am Geriatr Soc 1993;41:1235–40.
12. Mendes-Santos LC, Mograbi D, Spenciere B, Charchat-Fichman H. Specific algorithm method of scoring the clock drawing test applied in cognitively normal elderly. Dement Neuropsychol 2015;9:128–35.
13. Coronado GD, Sanchez J, Petrik A, Kapka T, DeVoe J, Green B. Advantages of wordless instructions on how to complete a fecal immunochemical test: lessons from patient advisory council members of a federally qualified health center. J Cancer Educ 2014;29:86–90.
14. Greegor DH. Diagnosis of large-bowel cancer in the asymptomatic patient. JAMA 1967;201:943–5.
15. Songster CL, Barrows GH, Jarrett DD. Immunochemical detection of fecal occult blood–the fecal smear punch-disc test: a new non-invasive screening test for colorectal cancer. Cancer. 1980;45:1099–102.
16. Simon JB. Occult blood screening for colorectal carcinoma: a critical review. Gastroenterology 1985;88:820–37.

17. Barrows GH, Burton RM, Jarrett DD, Russell GG, Alford MD, Songster CL. Immunochemical detection of human blood in feces. Am J Clin Pathol 1978;69:342–6.

18. Irons GV Jr., Kirsner JB. Routine chemical tests of the stool for occult blood: an evaluation. Am J Med Sci 1965;249:247–60.

19. Allison JE. The role of fecal occult blood testing in screening for colorectal cancer. Pract Gastroenterol 2007;0:20–32.

20. Grobbee EJ, Wisse PH, Schreuders EH, et al. Guaiac-based faecal occult blood tests versus faecal immunochemical tests for colorectal cancer screening in average-risk individuals. Cochrane Database Syst Rev 2022;6:Cd009276.

21. Deutekom M, van Rossum LG, van Rijn AF, et al. Comparison of guaiac and immunological fecal occult blood tests in colorectal cancer screening: the patient perspective. Scand J Gastroenterol 2010;45: 1345–9.

22. Coury J, Ramsey K, Gunn R, Judkins J, Davis M. Source matters: a survey of cost variation for fecal immunochemical tests in primary care. BMC Health Serv Res 2022;22:204.

23. Daly JM, Bay CP, Xu Y, Levy BT. Effect of ambient temperature variations on positivity of manual fecal immunochemical tests. J Prim Care Community Health 2015;6:243–9.

24. Shin HY, Suh M, Choi KS, et al. Higher satisfaction with an alternative collection device for stool sampling in colorectal cancer screening with fecal immunochemical test: a cross-sectional study. BMC Cancer 2018;18:365.

25. de Klerk CM, Wieten E, van der Steen A, et al. Participation and ease of use in colorectal cancer screening: a comparison of 2 fecal immunochemical tests. Am J Gastroenterol 2019;114:511–8.

Appendix A. Participant Instructions for Collecting and Returning Five FITs.

Stool Sample Collection
INSTRUCTIONS

PLEASE READ THE INSTRUCTIONS
COMPLETELY BEFORE COLLECTING YOUR SAMPLES.
IF YOU HAVE QUESTIONS, PLEASE CALL: 1-866-890-5963.

YOUR BOX CONTAINS:

Stool Sample Collection Supplies

BUSINESS REPLY LABEL — NO POSTAGE NECESSARY

Stool Sample Collection
INSTRUCTIONS

DO NOT COLLECT SAMPLE IF BLEEDING IS PRESENT FROM HEMORRHOIDS, CONSTIPATION, URINATION, OR MENSTRUATION.

1) Open the Stool Sample Collection Supplies envelope and arrange the following items for ease of use:

Stool Sample Collection Date — MM / DD / YYYY

Hemoccult ICT Collection Card

A   **B**   **C**   **D**   **E**

KEEP THE LIQUID IN THE TUBES

2) Fill in the date of your bowel movement on the yellow Stool Sample Collection Date card.

Stool Sample Collection Date
10.09.2017
MM / DD / YYYY

3) Urinate, if necessary, before positioning the stool collection container.
Do not urinate on stool sample or into the collection container.

4) Lift toilet lid and seat, place the stool collection container on the toilet (rounded end toward back), then lower the seat.

5) Have your bowel movement in the stool collection container.

6) Collect stool samples for tests A, B, C, D, and E following the instructions provided on the next page.
- Use of latex-free gloves is optional.
- A trash bag is provided for waste items.
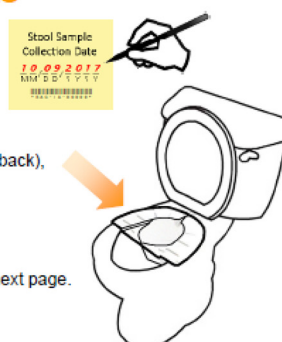
OPEN

A Hemoccult® ICT — Card
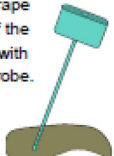
- Lift flap at the tab to open.
- Collect a pea-sized stool sample with provided Applicator Stick.
- Apply stool sample to top half of window.

- Reuse Applicator Stick to collect another pea-sized sample from a <u>different</u> part of the stool. Apply to bottom half of window.

- Spread samples over the entire window by <u>pressing</u> gently while mixing thoroughly.

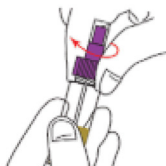- Close flap. Discard the Applicator Stick.

B OC Auto® — Light green FLAT cap

- Open green cap by turning to the left and pulling upwards.

- Randomly scrape the surface of the fecal sample with the sample probe.
- Cover the grooved portion of the sample probe completely with stool sample.

- Close sampling bottle by inserting the sample probe and screwing cap on tightly to the right. Do not reopen.
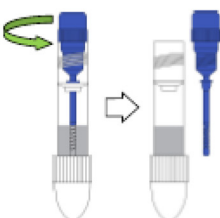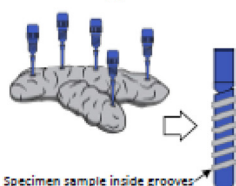
CLICK!

C Hemosure® — Purple cap

- Unscrew the purple cap from the sample collection tube. DO NOT POUR OUT THE LIQUID.
- Poke spiral applicator into stool at 6 different sites.

- Use only enough stool to cover the top of the applicator. DO NOT CLUMP, SCOOP, OR FILL THE TUBE.

- Screw the applicator back into the tube and secure tightly.

D QuickVue® — Dark blue cap

- Unscrew the Sampler from the collection tube.

- Randomly pierce the stool sample with the grooved end of the Sampler in at **least five (5) different sites.**

Specimen sample inside grooves

- Insert the sampler into the collection tube and firmly tighten it.

- Shake the tube to mix the specimen and the buffer solution.

Shake well

E OC-Light™ — Dark green cap

- Open green cap by turning to the left and pulling upwards.

- Scrape surface of the fecal sample with the sample probe or stab it at 5-6 different points.

- Cover the grooved portion of the sample probe completely with stool sample.
- Close Sampling Bottle by inserting the sample probe and screwing the cap tightly to the right. Do not reopen.

Appendix B

FECAL IMMUNOCHEMICAL TEST Product Questionnaire

Bag-XX-XXXXX

For each fecal immunochemical test, please answer both columns of questions below.

1. HOW EASY WAS IT TO COLLECT YOUR SAMPLE?

2. WHAT DIFFICULTIES DID YOU HAVE? CHECK ALL THAT APPLY.

A

VERY EASY ☐ ☐ ☐ ☐ ☐ VERY DIFFICULT
          1 2 3 4 5

- ☐ None
- ☐ Difficulty getting sample on the stick
- ☐ Difficulty getting sample in the collection window
- ☐ Collection window too small
- ☐ It was messy
- ☐ Instructions were unclear
- ☐ Other (please specify) _____

B

VERY EASY ☐ ☐ ☐ ☐ ☐ VERY DIFFICULT
          1 2 3 4 5

- ☐ None
- ☐ Difficulty getting the cap off
- ☐ It was difficult scraping the stool multiple times
- ☐ It was messy
- ☐ Liquid spilled from the tube
- ☐ Instructions were unclear
- ☐ Other (please specify) _____

C

VERY EASY ☐ ☐ ☐ ☐ ☐ VERY DIFFICULT
          1 2 3 4 5

- ☐ None
- ☐ Difficulty getting the cap off
- ☐ It was difficult probing the stool multiple times
- ☐ It was messy
- ☐ Liquid spilled from the tube
- ☐ Instructions were unclear
- ☐ Other (please specify) _____

D

VERY EASY ☐ ☐ ☐ ☐ ☐ VERY DIFFICULT
          1 2 3 4 5

- ☐ None
- ☐ Difficulty deciding which cap to open
- ☐ Difficulty getting the cap off
- ☐ It was difficult probing the stool multiple times
- ☐ It was messy
- ☐ Liquid spilled from the tube
- ☐ Instructions were unclear
- ☐ Other (please specify) _____

E

VERY EASY ☐ ☐ ☐ ☐ ☐ VERY DIFFICULT
          1 2 3 4 5

- ☐ None
- ☐ Difficulty getting the cap off
- ☐ It was difficult probing the stool multiple times
- ☐ It was messy
- ☐ Liquid spilled from the tube
- ☐ Instructions were unclear
- ☐ Other (please specify) _____

Flip page to continue ↪

3. WHICH OF THE TWO TYPES (CARD OR LIQUID-VIAL) DID YOU PREFER TO USE?

STRONGLY PREFER
CARD WITH
APPLICATION STICK

☐

NO
PREFERENCE

☐   ☐   ☐

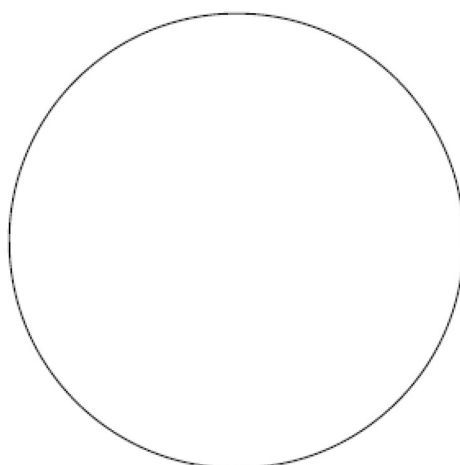STRONGLY PREFER
LIQUID-VIAL WITH
PROBE

☐

Ⓐ   Ⓑ Ⓒ Ⓓ Ⓔ

4. PLEASE DRAW THE FACE OF A CLOCK WITH NUMBERS AND HANDS TO SIGNIFY THE TIME TEN MINUTES AFTER ELEVEN.

5. DID SOMEONE HELP YOU COMPLETE THIS CLOCK DRAWING?

☐ Yes   ☐ No

When you have completed this form, please mail it back using the enclosed BUSINESS REPLY ENVELOPE.