Predictors of CT Colonography Utilization Among Asymptomatic Medicare Beneficiaries

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BACKGROUND: Although the Centers for Medicare and Medicaid Services (CMS) denied coverage for screening computed tomography colonography (CTC) in March 2009, little is understood about whether CTC was targeted to the appropriate patient population prior to this decision.

OBJECTIVE: Evaluate patient characteristics and known relative clinical indications for screening CTC among patients who received CTC compared to optical colonoscopy (OC).

DESIGN/PARTICIPANTS: Cross-sectional study of all 10,538 asymptomatic Medicare beneficiaries who underwent CTC between January 2007 and December 2008, compared to a cohort of 160,113 asymptomatic beneficiaries who underwent OC, matched on county of residence and year of examination.

MAIN MEASURES: Patient characteristics and known relative appropriate and inappropriate clinical indications for screening CTC.

KEY RESULTS: CTC utilization was higher among women, patients > 65 years of age, white patients, and those with household income > 75 % ($p=0.001$). Patients with relatively appropriate clinical indications for screening CTC were more likely to undergo CTC than OC including presumed incomplete OC (OR 80.7, 95 % CI 76.01–85.63); sedation risk (OR 1.11, 95 % CI 1.05–1.17); and chronic anticoagulation risk (OR 1.46, 95 % CI 1.38–1.54), after adjusting for patient characteristics and known clinical indications. Conversely, patients undergoing high-risk screening, an inappropriate indication, were less likely to receive CTC (OR 0.4, 95 % CI 0.37–0.42). Overall, 83 % of asymptomatic patients referred to CTC had at least one clinical indication relatively appropriate for CTC (8,772/10,538).

CONCLUSION: During the 2 years preceding CMS denial for screening, CTC was targeted to asymptomatic patients with relatively appropriate clinical indications for CTC/not receiving OC. However, CTC utilization was lower among certain demographic groups, including minority patients. These findings raise the possibility that future coverage of screening CTC might exacerbate

disparities in colorectal cancer screening while increasing overall screening rates.

KEY WORDS: colorectal cancer; health care utilization; Medicare; radiology; gastroenterology.

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INTRODUCTION

Although colorectal cancer is largely preventable through screening, only 59 % of the eligible US population receives recommended screening.¹ As such, it is unsurprising that colorectal cancer is estimated to be the third most commonly diagnosed cancer among men and women, as well as the third leading cause of cancer death for 2012 in the US.^{2,3} Screening is of particular relevance among older patients, given lower rates of complete screening in this population and the increased incidence of colorectal cancer with aging.^{4,5}

Computed tomography colonography (CTC) is an alternative to traditional or optical colonoscopy (OC) for colorectal cancer screening. This minimally invasive method of visualizing the colon and rectum does not require sedation, and can be performed using a low dose CT technique. CTC demonstrates 90–94 % sensitivity in the detection of cancers and adenomas > 10 mm and similar rates of advanced neoplasia detection when compared to OC.^{6–8} CTC is both safe and effective among the elderly,⁹ and may even improve overall colorectal cancer screening rates by reaching patients who would not otherwise receive OC because of medical contraindications and patient preference.^{10–15}

In March 2009, the Centers for Medicare and Medicaid Services (CMS) denied coverage of CTC for asymptomatic patients (i.e. screening CTC), leading to substantial controversy about the potential value of CTC in the elderly population. Currently, little is understood about whether asymptomatic Medicare patients received CTC prior to this

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change in coverage and whether CTC was utilized appropriately to target beneficiaries with accepted clinical indications for CTC instead of OC. Per guidelines, relative appropriate clinical indications for CTC in the asymptomatic population include incomplete or failed OC, chronic anticoagulation among patients who cannot safely discontinue therapy, and sedation risk in the setting of cardiovascular or pulmonary disease.^{16,17} CTC is not appropriate, however, for high-risk screening (e.g. inflammatory bowel disease, hereditary syndromes), given the increased risk of cancer in this population.¹⁶

Our objective was to evaluate the relationship between receipt of CTC or OC and patient characteristics, as well as known relative appropriate and inappropriate clinical indications for CTC among asymptomatic beneficiaries, between January 2007 and December 2008; the 2 years preceding CMS denial of screening CTC coverage. Understanding differences among Medicare beneficiaries who received CTC versus OC during this time interval can illustrate the potential impact of this method of colorectal cancer screening.

METHODOLOGY

Cohort Identification

This Health Insurance Portability and Accountability Act (HIPAA)-compliant study was exempt from institutional review board approval. We performed a cross sectional study using 100 % Medicare Outpatient and Carrier files from January 2007 to December 2008. All Medicare beneficiaries in the United States who received CTC were randomly matched without replacement 1:9 to all patients who received OC by county of residence and year of examination.

Patients were excluded if they (a) enrolled in a Medicare Health Maintenance Organization (HMO) within the year prior to or 30 days following the date of receipt of either the index CTC or OC because HMOs do not submit detailed claims to Medicare ($n=9,076$); or (b) disenrolled from Medicare Part A or B coverage during the same time interval because claims data were not reliably submitted for this cohort ($n=631$). Based on a previously utilized algorithm, we used codes from the claim associated with the CTC or OC to excluded patients with symptoms reflective of a diagnostic examination ($n=6,753$ CTC, 47,089 OC).¹⁸ No patients were excluded on the basis of matching or an incomplete procedure. This left us with a final study population of 170,651 patients.

Patient level predictors and clinical indications were derived from the following Medicare files: Beneficiary Summary; Medicare Provider Analysis and Review; Outpatient; and Carrier. All data sets were obtained from CMS with a data user agreement that met requirements for HIPAA compliance. Appendix 1 lists the Current Procedural Terminology/Healthcare Common Procedure Coding System (CPT/HCPCS) and International Classification of Disease,

Ninth Edition, Clinical Modification (ICD-9-CM) codes used to identify all diagnoses and procedures in this analysis.

Variables

Patient Level Predictors. All patients who received CTC and OC were compared by gender, age, race, median household income and comorbidity status. Gender, age, race, and socioeconomic status were determined from the Beneficiary Summary file. Age was categorized into four groups (≤ 65 , 65–74, 75–84, and 85–99 years) and race into five groups (white, black, Hispanic, Asian, and other). Medicare does not collect individual patient-level socioeconomic status information. Therefore, we used either small area level median household income data in the patient's 2000 U.S. Census tract as a proxy for individual socioeconomic status if available, or median household income based on zip code of residence. Comorbidity status was assessed by the Charlson comorbidity index¹⁹ which uses administrative claims for comorbid conditions that occurred within the year preceding the index date of CTC or OC. Comorbidity was divided into five categories for the univariate analysis including 0 (no preexisting comorbid condition), one, two, three and four or more comorbid conditions and into two groups for the multivariate analysis, including 0 (no preexisting comorbid condition) and one or more comorbid conditions.

Appropriate and Inappropriate Clinical Indications for CTC in the Asymptomatic Population. We explored differences among known relative appropriate and inappropriate indications associated with CTC for all asymptomatic patients using the prevalence of diagnoses and/or procedures in the 12 months preceding the index date of CTC or OC, as well as reasons obtained from billing claims restricted to the index date of CTC or OC.

Presumed Incomplete OC. We approximated incomplete OCs in the 12 months preceding the index date of OC using CPT/HCPCS codes from billing claims rather than claims modifiers, which demonstrate low sensitivity in the identification of incomplete OC.²⁰ Because many institutions perform same day CTC for incomplete OC, patients with billing claims for OC and CTC within 5 days were considered same day procedures and included in the CTC cohort. The prevalence of prior surgical procedures and diagnoses thought to cause incomplete OC, such as hysterectomy and diverticular disease,^{21–23} were not evaluated separately as they should already be captured in this group.

Chronic Anticoagulation Risk. Chronic anticoagulation risk was estimated using the presence of any ICD-9-CM code for atrial fibrillation/flutter, valvular heart disease,

arrythmia or coagulopathy from claims data in the 12 months preceding the index date of CTC or OC.

Sedation Risk. Sedation risk is ideally estimated through the American Society for Anesthesiologist physical status classification system, which cannot be derived from claims data. Therefore, we estimated sedation risk using the presence of any ICD-9-CM codes for conditions included in this grading system including congestive heart failure, chronic pulmonary disease, renal disease, moderate or severe liver disease, asthma, obesity and sleep apnea from claims data in the 12 months preceding the index date of CTC or OC.

Asymptomatic High-Risk Screening (Surveillance). We estimated the prevalence of patients eligible for high-risk screening by evaluating ICD-9-CM codes for Crohn's disease, ulcerative colitis, personal or family history of colorectal cancer and personal history of polyps, using billing claims restricted to the index date of CTC or OC.

STATISTICS

Differences in the proportions of patients who received CTC versus OC were compared for all patient level characteristics and clinical indications using χ^2 tests of association. Multivariate logistic regression was performed to determine independent patient level characteristics and clinical indications predictive of undergoing CTC, holding

all other factors equal. Odds ratios represent the odds of an exposure in patients who have the outcome of interest, receipt of CTC, compared to the odds of exposure in patients who do not have the outcome of interest, receipt of OC. Two and three way interactions between age, gender and race were examined, but did not improve model fit or meet statistical significance and thus were not included in the final model. Predicted probabilities for categories of age, gender and race were determined from the adjusted regression coefficients by holding all other values at the population mean. All tests were two sided with significance level at $\alpha=0.05$. All analyses were performed using STATA statistical software (version 11.0, College Station, Texas).

RESULTS

Our final study population included 10,538 asymptomatic patients who received CTC and 160,113 asymptomatic patients who received OC examinations. The number of beneficiaries who received CTC increased from 4,381 in 2007 to 6,157 in 2008.

Patient Level Predictors

Univariate analysis demonstrated that patients who received CTC for screening were more likely to be female, older, white, have median household income $>75\%$, and to have at least two comorbidities (all p values < 0.001) (Table 1). Multivariate analysis demonstrated that female gender, and

Table 1. Patient Level Predictors Among Asymptomatic Patients by Type of Examination

	N	OC (n=160,113)	N	CTC (n=10,538)	p value
Gender					
Male	75,828	47.4 % (47.1 %–47.6 %)	3,524	33.4 % (32.5 %–34.3 %)	< 0.001
Female	84,285	52.6 % (52.4 %–52.9 %)	7,014	66.6 % (65.7 %–67.5 %)	
Age					
≤65	16,945	10.6 % (10.4 %–10.7 %)	787	7.5 % (7.0 %–8.0 %)	< 0.001
66–74	85,962	53.7 % (53.4 %–53.9 %)	4,577	43.4 % (42.5 %–44.4 %)	
75–84	48,875	30.5 % (30.3 %–30.8 %)	4,123	39.1 % (38.2 %–40.1 %)	
≥85	8,331	5.2 % (5.1 %–5.3 %)	1,051	10.0 % (9.4 %–10.5 %)	
Race					
White	139,055	86.8 % (86.7 %–87.0 %)	9,614	91.2 % (90.7 %–91.8 %)	< 0.001
Black	12,144	7.6 % (7.5 %–7.7 %)	585	5.6 % (5.1 %–6.0 %)	
Other*	3,368	2.1 % (2.0 %–2.2 %)	137	1.3 % (1.1 %–1.5 %)	
Asian	2,935	1.8 % (1.8 %–1.9 %)	86	0.8 % (0.6 %–1.0 %)	
Hispanic	2,611	1.6 % (1.6 %–1.7 %)	116	1.1 % (0.9 %–1.3 %)	
Median household income					
0–25 %	38,723	24.4 % (24.2 %–24.7 %)	2,630	25.2 % (24.4 %–26.1 %)	< 0.001
> 25–50 %	40,395	25.5 % (25.3 %–25.7 %)	2,763	26.5 % (25.7 %–27.4 %)	
> 50–75 %	38,955	24.6 % (24.4 %–24.8 %)	2,619	25.1 % (24.3 %–26.0 %)	
> 75–100 %	40,378	25.5 % (25.3 %–25.7 %)	2,411	23.1 % (22.3 %–23.9 %)	
Charlson Comorbidity					
0	38,889	24.3 % (24.1 %–24.5 %)	2,137	20.3 % (19.5 %–21.0 %)	< 0.001
1	39,402	24.6 % (24.4 %–24.8 %)	2,530	24.0 % (23.2 %–24.8 %)	
2	32,917	20.6 % (20.4 %–20.8 %)	2,242	21.3 % (20.5 %–22.1 %)	
3	22,181	13.9 % (13.7 %–14.0 %)	1,586	15.1 % (14.4 %–15.7 %)	
≥4	26,724	16.7 % (16.5 %–16.9 %)	2,043	19.4 % (18.6 %–20.1 %)	

CTC computed tomography colonography; OC optical colonoscopy

*Other includes Unknown and Native American

age > 65 (relative to age < 65) were associated with a higher likelihood of receiving screening CTC, while non-white race and median household income > 75 % was associated with a lower likelihood (all *p* values < 0.001 except age 66–74 [*p* = .017] and median household income > 75 % [*p* = 0.002]) (Table 3). Focusing on gender, age and race, the adjusted probability of receiving CTC was consistently lower for minority patients at every age group, and for men relative to women (data not shown).

Appropriate and Inappropriate Clinical Indications for CTC among Asymptomatic Patients

Overall, 83 % (95 % CI 82.5–84.0 %) of patients who underwent CTC had a relative appropriate clinical indication for receipt of CTC (Table 2). Just over half (53 %, 95 % CI 52.3–54.2 %) of patients referred to CTC had a presumed incomplete OC; 2,611 (47 %) on the same day as OC. Among the 47 % of patients (4,930/10,538, 95 % CI 45.5–48.1 %) who did not undergo CTC for presumed incomplete OC, 64 % (3,164/4,930, [95 % CI 62.4–66.0 %]) had a relative appropriate clinical indication for the use of CTC as a method of primary colorectal cancer screening including sedation or chronic anticoagulation risk. Put another way, nearly one third of asymptomatic patients who received CTC (30 %, 3,164/10,538, [95 % CI 28.9–31.2 %]) had a relative appropriate clinical indication for the use of CTC as a method of primary colorectal cancer screening. In contrast, asymptomatic patients were less likely to undergo CTC than OC for high-risk screening (surveillance), a relative inappropriate clinical indication for CTC. The prevalence of all indications were significantly different in the CTC group than the OC group (all *p* values < 0.001).

Multivariate analysis revealed that presumed incomplete OC was significantly associated with referral to CTC rather

than OC (OR 80.7, 95 % CI 76.01–85.63) (Table 3). Similarly, CTC was more likely to be performed among asymptomatic patients with sedation (OR 1.11, 95 % CI 1.05–1.17) or chronic anticoagulation risk (OR 1.46, 95 % CI 1.38–1.54). Conversely, asymptomatic patients undergoing high-risk screening were less likely to undergo CTC than OC (OR 0.4, 95 % CI 0.37–0.42).

DISCUSSION

Although colorectal cancer screening rates have improved over the past decade, current rates of 59 % fall well below the Healthy People 2020 target of 71 %.¹ One potential method of improving screening is through the use of alternative techniques, such as CTC. However, reimbursement for routine screening CTC remains controversial for several reasons including whether CTC is targeted to patients with appropriate clinical indications, is utilized to expand screening beyond the population receiving OC instead of simply replacing OC, and is as effective in older patients as it is in younger patients.²⁴ Due in part to these reasons, CMS elected in March 2009 to reimburse for diagnostic CTC but denied coverage of screening CTC. Our results provide several important insights on CTC utilization in the presumed asymptomatic Medicare population in the last 2 years preceding this coverage decision. First, the vast majority of asymptomatic patients who underwent CTC had either a presumed incomplete OC or a relative indication for CTC as a potential method of primary screening. This suggests that CTC may have expanded colorectal cancer screening rather than replacing OC. Second, CTC was less likely to be performed among asymptomatic patients with relative inappropriate clinical indications such as high-risk screening (surveillance).

Table 2. Appropriate and Inappropriate Clinical Indications for Computed Tomography Colonography (CTC) Among Asymptomatic Patients by Type of Examination

		<i>N</i>	OC (<i>n</i>=160,113)	<i>N</i>	CTC (<i>n</i>=10,538)	p value
Appropriate Indications for CTC Among Asymptomatic Patients						
Incomplete OC*	No	157,781	98.5 % (98.5 %–98.6 %)	4,930	46.8 % (45.8 %–47.7 %)	< 0.001
	Yes	2,332	1.5 % (1.4 %–1.5 %)	5,608	53.2 % (52.3 %–54.2 %)	
Sedation Risk†	No	102,672	64.1 % (63.9 %–64.4 %)	6,001	56.9 % (56.0 %–57.9 %)	< 0.001
	Yes	57,441	35.9 % (35.6 %–36.1 %)	4,537	43.1 % (42.1 %–44.0 %)	
Chronic Anticoagulation Risk‡	No	111,385	69.6 % (69.3 %–69.8 %)	6,344	60.2 % (59.3 %–61.1 %)	< 0.001
	Yes	48,728	30.4 % (30.2 %–30.7 %)	4,194	39.8 % (38.9 %–40.7 %)	
Any Appropriate Indication	No	79,146	49.4 % (49.2 %–49.7 %)	1,766	16.8 % (16.0 %–17.5 %)	< 0.001
	Yes	80,967	50.6 % (50.3 %–50.8 %)	8,772	83.2 % (82.5 %–84.0 %)	
Inappropriate indications for CTC Among Asymptomatic Patients						
High-risk screening §	No	113,614	71.0 % (70.7 %–71.2 %)	8,889	84.4 % (83.7 %–85.0 %)	< 0.001
	Yes	46,499	29.0 % (28.8 %–29.3 %)	1,649	15.6 % (15.0 %–16.3 %)	

CTC computed tomography colonography; OC optical colonoscopy

*Includes patients with OC in 12 months preceding the index date of screening and patients who received both CTC and OC on the index date of screening or sleep apnea

†Includes patients with CHF, chronic pulmonary disease, renal disease, moderate/severe liver disease, asthma or obesity

‡Includes patients with atrial fibrillation/flutter, valvular heart disease, cardiac arrhythmias or coagulopathy

§Includes any patient with ICD-9-CM for high-risk screening defined as Crohn's disease or Ulcerative colitis, personal or family history of colorectal cancer and personal history of polyps

Table 3. Regression Analysis of Computed Tomography Colonography (CTC) Utilization by Patient Level Predictors and Clinical Indications Associated with Receipt of CTC Among Asymptomatic Patients

		OR	95 % CI	p value
Patient level predictors				
Gender	Male	reference		
	Female	1.7	[1.61, 1.79]	< 0.001
Age	< 65	reference		
	66–74	1.12	[1.02, 1.24]	0.017
	75–84	1.59	[1.44, 1.75]	< 0.001
	≥ 85	2.56	[2.27, 2.89]	< 0.001
Race	White	reference		
	Black	0.58	[0.52, 0.65]	< 0.001
	Other*	0.71	[0.57, 0.87]	0.001
	Asian	0.42	[0.33, 0.54]	< 0.001
	Hispanic	0.45	[0.35, 0.57]	< 0.001
Median Household Income	0–25 %	reference		
	> 25–50 %	1.02	[0.95, 1.09]	0.633
	> 50–75 %	1.03	[0.96, 1.10]	0.445
	> 75–100 %	0.89	[0.83, 0.96]	0.002
Charlson Comorbidity	0	reference		
	≥ 1	0.96	[0.90, 1.02]	0.196
Clinical Indications Associated with Receipt of CTC Among Asymptomatic Patients				
Appropriate Indications for Among Asymptomatic Patients CTC				
	Incomplete OC	80.67	[76.01, 85.63]	< 0.001
	Sedation Risk	1.11	[1.05, 1.17]	< 0.001
	Chronic Anticoagulation Risk	1.46	[1.38, 1.54]	< 0.001
	High risk screening	0.39	[0.37, 0.42]	< 0.001

CTC computed tomography colonography; OC optical colonoscopy

*Other includes Unknown and Native American

Third, despite these findings, specific patient predictors were significantly associated with decreased receipt of CTC, including non-white race.

The strong relationship between CTC receipt and a history of OC in the preceding 12 months or on the same day reflects appropriate utilization of CTC in order to complete colorectal cancer screening among patients with presumed failed OC. It is striking that almost half of the patients who underwent CTC for this indication (47 %, 2,611/5,608) presented on the same day as OC. Given that bowel preparation is a strong barrier to screening,^{25,26} offering same day CTC could improve completion of screening by eliminating the need for an additional bowel preparation. As such, it is reassuring that CTC following incomplete OC is currently covered by most payors.

Also noteworthy is the finding that nearly one third of the presumed asymptomatic patients who received CTC did not have a history consistent with incomplete OC, but did have clinical indications relatively appropriate for the use of CTC as a potential method of primary colorectal cancer screening including sedation risk or chronic anticoagulation risk. Although this does not demonstrate that these patients could not have undergone OC, it does suggest that during the study period CTC may have expanded colorectal cancer screening rather than replacing OC. It cannot be determined from claims data how many of the 30 % of patients referred to CTC as a potential method of primary colorectal evaluation would not have undergone screening in the absence of CTC. However, prior research has demonstrated that nearly 30 % of patients would not receive OC if CTC were not available.¹⁵ Additional research is needed in this

area, given that approximately 40–50 % of Medicare patients do not undergo any recommended method of colon cancer screening.^{1,27}

We are uncertain if lower utilization of CTC among non-white patients reflects overall lower rates of colorectal cancer screening in this cohort, patient preference, or diminished access to imaging technology.^{3,28–32} Minority populations are less likely to be aware of colorectal cancer screening procedures,³³ and more likely to believe that screening is only needed after symptoms develop,^{30,31} both barriers to colorectal cancer screening compliance.^{29,34} Alternatively, decreased utilization may reflect lower levels of satisfaction and preference for CTC among non-white patients, compared to OC.³⁵ Finally, decreased utilization may stem from diminished access to high quality diagnostic imaging, among providers who care for minority patients.³⁶ Although CTC can be performed using any multi detector CT, it is possible that access to CTC for minority patients was restricted during this relatively early stage of adoption; similar to discrepant adoption of other types of new imaging technology among non-white patients.^{37,38} Given the higher incidence and mortality from colorectal cancer among black patients and lower rates of screening in minority patients overall, this cohort could benefit most through CTC.^{2,39} However, further research is needed on the factors contributing to this disparity.

Higher receipt of CTC among women and older patients may be driven by patient preference, by provider preference, or a combination of both. Overall women and elderly patients are more likely than men and younger patients to

have increased anxiety, fear and discomfort associated with invasive methods of colorectal cancer screening.^{13,40–44} Accordingly, these cohorts may prefer CTC over OC because it is noninvasive, less painful and does not require sedation. Alternatively, increased utilization of CTC among women and elderly patients may reflect provider preference, which strongly influences screening compliance.^{29,45} Over the last several decades, there has been a shift to more proximally located colon cancers among women and elderly patients. At the same time, both women and older patients are more likely to have incomplete OC/flexible sigmoidoscopy,^{21,23,46–50} As such, primary care physicians and gastroenterologists may preferentially refer women and older patients to CTC because of the desire to perform complete colon cancer screening.^{4,51–53} Given the higher incidence of cancer among the elderly,^{1,4} increased utilization of CTC may potentially improve colorectal cancer screening in this population. Whether this potential can be realized, however, is uncertain.

Our study had limitations associated with the use of a large claims database. Several Medicare patients were excluded according to our criteria, including those enrolled in health maintenance organizations and those without Part A or B coverage during the study period. Inability to access clinical data limited our ability to gather chart data on precise patient symptoms as well as clinical indications/contraindications associated with CTC. Finally, our findings may not be as relevant to patients younger than age 65; however, colorectal cancer is predominantly a disease of the elderly.

In conclusion, during the 2 years preceding CMS denial for screening CTC, we found evidence that CTC was utilized appropriately among asymptomatic patients to expand screening beyond the population receiving OC instead of simply replacing OC. The most common indication for CTC receipt was completion of screening after presumed incomplete OC. However, nearly one third of patients who underwent CTC had no history consistent with incomplete OC but did have clinical indications relatively appropriate for the use of CTC as a method of potential primary colorectal cancer screening. This raises the possibility that some of these patients would not have undergone screening in the absence of CTC coverage. It is unclear why CTC utilization was lower among specific demographic groups. This finding could translate into further widening of disparities in colorectal cancer screening rates following coverage of CTC for routine screening. Further research is needed to determine and address the barriers to utilization among these demographic groups, particularly non-white patients.

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APPENDIX

Table 4. CPT/HCPS and ICD-9-CM codes

Variable	CPT/HCPCS and ICD-9-CM codes
CT Colonography	0066T, 0067T
Optical Colonoscopy	45378, 44388, 45380, 44389, 45384, 44392, 45385, 44394, 45382, 44391, 45379, 45381, 45383, 45384, 45386, 45387, 44390, 44393, 44397
Determination of diagnostic indications for CTC and OC	
Diagnostic procedures	787.3, 789.X, 280.XX, 285.XX, 564.XX, 569.89, 569.9, 558.XX, 787.XX, 9.2, 9.3, 783.0, 783.20-783.22, 569.3, 578.XX, 792.1, 560.X, 552.0, V47.1, 751.5, 793.4
Appropriate Indications for screening CTC	
Presumed incomplete OC in prior 12 months	45378, 44388, 45380, 44389, 45384, 44392, 45385, 44394, 45382, 44391, 45379, 45381, 45383, 45384, 45386, 45387, 44390, 44393, 44397
Sedation Risk	
• CHF	398.91, 402.01, 402.11, 402.91, 404.01, 404.03, 404.11, 404.13, 404.91, 404.93, 425.4-425.9, 428.x
• Chronic Pulmonary disease	416.8, 416.9, 490.x-505.x, 506.4, 508.1, 508.8
• Renal disease	403.01, 403.11, 403.91, 404.02, 404.03, 404.12, 404.13, 404.92, 404.93, 582.x, 583.0-583.7, 585.x, 586.x, 588.0, V42.0, V45.1, V56.x
• Moderate/Severe liver disease	456.0-456.2, 572.2-572.8
• Asthma	493.XX
• Obesity	278.0,
• Sleep Apnea	327.2X
Chronic Anticoagulation Risk	
• Atrial fibrillation and flutter	427.3
• Valvular heart disease	093.2, 394.x-397.x, 424.x, 746.3-746.6, V42.2, V43.3
• Cardiac arrhythmia	426.0, 426.13, 426.7, 426.9, 426.10, 426.12, 427.0-427.4, 427.6-427.9, 785.0, 996.01, 996.04, V45.0, V53.3
• Coagulopathy	286.x, 287.1, 287.3-287.5
Inappropriate Indications for screening CTC	
High-risk screening (surveillance)	HCPCS G0105, 556.X, 555.X, V16.0, V10.05, V10.06, 153.X, 154.X, V12.72, 569.0