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Cost differences following initial CT colonography versus optical colonoscopy in the elderly

Hanna M. Zafar, MD MHS¹, Jianing Yang, BS², Katrina Armstrong, MD MSCE³, and Peter Groeneveld, MD PhD⁴

Hanna M. Zafar: hanna.zafar@uphs.upenn.edu; Jianing Yang: jianing@mail.med.upenn.edu; Katrina Armstrong: karmstrong6@partners.org; Peter Groeneveld: petergro@upenn.edu

¹Department of Radiology, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104

²American Academy of Dermatology, 930 E. Woodfield Road, Schaumburg, IL 60173

³Department of Medicine, Massachusetts General Hospital, 55 Fruit Street-GRB 740, Boston, MA 02114

⁴Department of Medicine, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104

Abstract

Objective—To compare differences in Medicare costs one year following initial CTC or initial OC.

Materials and Methods—We performed a retrospective cohort study of asymptomatic Medicare outpatients 66 years of age who received initial CTC (n=531) or OC (n=17,593) between January 2007 and December 2008; initial OC patients were matched on county of residence and year of screening. Outcomes included differences in total, inpatient and outpatient Medicare costs one year following initial CTC or OC as well as differences in outpatient testing of potential findings in the colon, abdomen, pelvis and lungs.

Results—Higher adjusted costs per patient were revealed in the year following initial CTC compared to initial OC for outpatient testing related to potential colonic [\$50 (95CI \$12, \$88)] (p=.010) and extra colonic findings [\$64 (95CI \$23, \$106)] (p=.002). However, there were no differences in adjusted total costs per patient in the year following either modality [\$2,065 (95CI -\$1,672 - \$5,803)](p=.28). Similarly, adjusted costs did not differ between cohorts for inpatient [(\$267 (95CI -\$1,017, \$1,550)](p=.68) or outpatient care [(\$2,828 (95CI -\$311, \$5,966)](p=.08).

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¹Reprints and Correspondence: Hanna M. Zafar MD MHS, Assistant Professor, Department of Radiology, Silverstein 1, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104, Phone: 215 266 3321, Fax: 215 349 5627, hanna.zafar@uphs.upenn.edu.

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Conclusion—Despite higher adjusted costs of outpatient testing potentially related to colonic and extra colonic findings among asymptomatic elderly patients one year after initial CTC compared to OC, we found no differences in adjusted total, inpatient or outpatient costs between cohorts. Although Medicare does not cover screening CTC, our results suggest that these modalities generate comparable downstream costs to payers.

Introduction

CT Colonography (CTC) is an accurate and safe alternative to traditional or optical colonoscopy (OC) for colorectal cancer screening.¹⁻⁴ CTC has the potential to reach the 40-50% of the unscreened US population because patient preference and medical conditions have limited the uptake of OC in this population.⁵⁻² However, in March 2009 the Centers for Medicare and Medicaid Services (CMS) decided against coverage for screening CTC among asymptomatic individuals. This decision was based, in part, on the scarcity of observed data regarding differences in outcomes and costs between patients who receive CTC and OC; in particular differences related to follow-up testing of colonic and extra colonic findings on CTC.^{13,14} Current estimates of testing rates and costs related to the follow-up of colonic and extra colonic findings are derived from chart review. Moreover, these studies have not included control groups of patients who receive OC or who have no additional findings at the time of CTC in order to assess the incremental costs of these findings. Thus, our objective was to compare total, inpatient and outpatient Medicare costs among asymptomatic elderly patients in the year following either initial CTC or OC (i.e. screening population) between January 2007 and December 2008; in other words the two years preceding the Centers for Medicare and Medicaid (CMS) decision about coverage for screening CTC. We additionally examined differences in costs attributable to testing plausibly related to colonic or extra colonic findings, because of the impact of these findings on CTC.

Methods

Design Overview

We performed a retrospective cohort study using 100% Medicare fee-for-service claims files. All Medicare beneficiaries ≥ 66 years of age in the United States who received CTC between January 2007 and December 2008 were evaluated; an age cutoff of 66 was selected in order to adjust for care in the preceding year. The CTC cohort was compared to a group of patients who received OC, randomly matched by county of residence and year of screening. CTC was not covered for routine screening during this time interval and was performed predominantly among patients at risk for OC due to existing medical conditions. Therefore, we approximated the screening population by selecting asymptomatic patients, defined as patients with no symptoms of colorectal cancer, and patients undergoing initial OC or CTC, defined as no CTC or OC in the preceding year. Claims were used to identify total, outpatient and inpatient Medicare costs as well as testing and costs potentially related to outpatient colonic and extracolonic follow-up. We focused on costs to Medicare rather than costs to the patient (e.g. co-payment), the physician or the facility. Nearly all potentially clinically significant colonic and extra colonic findings are evaluated within one

year of detection.^{15,16} Therefore, we followed all patients for one year window from the date of either procedure.

Setting and Participants

This study was exempt from institutional review board approval due to the use of de-identified claims data. All claims were identified in the 12 months preceding and following the date of CTC or OC on the billing claim (Supplemental Table 1). We excluded patients who (a) were enrolled in a private insurance plan (e.g. Medicare Health Maintenance Organization) within the year preceding or following CTC (n = 13,164); or (b) disenrolled from Medicare Part A or B coverage during the same time interval (n = 6,666) due to incomplete Medicare claims data. Using claims we excluded patients from the OC cohort with another OC in the preceding 12 months (n = 2,519) and patients from the CTC cohort with an OC either on the same day (n=3,293) or within the prior 12 months (n=4,232) as referral to CTC for incomplete OC is usually reimbursed as a diagnostic rather than screening examination.¹⁷ No patients in the OC cohort received a CTC in the prior 12 months. Patients with a CTC in the preceding 12 months (n=23) were also excluded. No validated algorithm exists to determine CTC indication using claims data. We were unable to stratify patients into high and low risk cohorts as data on prior polypectomy or polyposis syndromes cannot be identified through claims. Therefore, we used a validated algorithm for OC indication to exclude patients with billing codes inconsistent with an asymptomatic (i.e. screening) population (n= 5,912 CTC, 135,528 OC).¹⁸ Patients may have been selectively referred to CTC for symptoms attributable to abdominal and pelvic pathology other than colorectal cancer that would not be visualized on OC (e.g. malignancy, abdominal aortic aneurysm). Accordingly, we excluded patients with claims reflective of these diagnoses in the year preceding CTC or OC (n=97 CTC, 2,189 OC) (Supplemental Table 1). The final study population was 18,124 patients (Supplemental Figure 1). This includes 18,111 patients from a prior publication which differed from the current study both in objective and follow-up interval¹⁹.

Outcomes and Follow-up Costs

The total cost to the Medicare program per patient for the year following initial OC or CTC (excluding the date of the procedure) was the main outcome measure. Outpatient cost data was obtained using the Claim Payment Amount from both institutional and provider Part B Medicare claims. Inpatient and outpatient costs were evaluated separately, and outpatient costs were further divided into six procedural categories based on the CPT codes, including: evaluation (e.g. emergency department and consultations), anesthesiology, surgery, radiology, pathology and medicine (Supplemental Table 1).

In addition, differences in the frequencies of potential outpatient colonic or extra colonic follow-up testing and of the associated costs per patient were also compared for one year after either modality. Colonic follow-up was defined as outpatient endoscopy of the colon (i.e. colonoscopy / flexible sigmoidoscopy), and outpatient radiology procedures related to the colon (i.e. barium enema, CTC). Because diagnosis related groups are not specific for colonic diagnoses and procedures, we did not include potential inpatient follow-up related to the colon. Extra-colonic follow-up using claims was restricted to outpatient radiology

procedures. We divided these into imaging of the abdomen and pelvis (i.e. radiographs, ultrasound, CT and magnetic resonance imaging (MRI)) and of the thorax (i.e. radiographs, CT and MRI) (Supplemental Table 1).

Covariates

The gender, age and race of all patients who received initial CTC or OC were obtained from Medicare's enrollment database. Elixhauser comorbidity measures²⁰ were determined from inpatient and outpatient Medicare Claims one year prior to initial CTC or OC using appropriate Current Procedural Terminology / Healthcare Common Procedure Coding System (CPT / HCPCS) and International Classification of Disease, Ninth Edition, Clinical Modification (ICD-9-CM) codes (Supplemental Table 1). Elixhauser provides a measure of acute and chronic diseases significantly associated with in-hospital mortality originally derived from administrative claims data. We evaluated education and income, which are known to influence access to health care,^{21,22} by mean college level education and mean household income using the Area Health Resource File.^{23,24} Census regions and urban versus rural residence was also evaluated using the Area Health Resource File, because geography is associated with differences in colorectal cancer screening preference and CTC utilization.^{25,26} Finally, Medicare beneficiaries residing in higher spending regions are known to receive more health care than those in lower care spending regions^{27,28} Thus, we approximated local health care resource demand using the total 2010 Medicare county reimbursements per enrollee (Part A and B) from the Dartmouth Atlas of Health Care.²⁹

Statistical Analysis

Differences in unadjusted costs for initial CTC and initial OC were tested using ANOVA in the year preceding or the year following the index procedure. For costs, we estimated generalized linear models with a log link and used the modified Park test to identify the optimal distribution for total, inpatient and outpatient Medicare costs as well as total colonic and extra colonic costs.³⁰ A step wise approach was used whereby potential demographic and socioeconomic predictors potentially influencing referral to initial CTC versus OC were initially included in the model before adding health care access predictors that could influence the choice of referral. To facilitate interpretation of model coefficients, we converted the regression results adjusted for potential demographic, socioeconomic and health care access predictors that could influence the choice of screening modality to the original (dollar) scale by computing the average partial effect of receiving CTC or OC using the method of recycled predictions.³¹ Comparison of unadjusted total costs by low, intermediate and high cost care was performed using Chi Square analysis in the year following the index procedure risk by procedure type. Chi Square analysis was also used to compare difference in total Medicare payments between both cohorts for outpatient procedures plausibly related to follow-up of colonic and extracolonic findings. Statistical significance was declared for results with a two-sided p-value of < 0.05. We used STATA, version 11 (STATA Corp) for all statistical analyses.

Results

The final cohort included 531 initial CTC and 17,593 initial OC patients. Patients referred to initial CTC were more likely to be white, > 75 years and to carry a higher burden of comorbid diseases (Table 1). They also differed from patients referred to initial OC in that they were more likely to live in counties with higher mean education and higher income but with diminished health care resource demand evidenced by lower Mean Total Medicare Part A and B reimbursements.

Total unadjusted median health care costs were \$589 higher among patients who received initial CTC compared to initial OC in the year preceding either procedure ($p < .0001$) and \$765 higher in the year following ($p < .0001$) for a total difference of \$175 (Table 2). However, after adjusting for potential demographic and socioeconomic predictors that could influence referral to initial CTC versus OC, there were no differences in total costs 12 months after either procedure ($p = .28$). This lack of difference persisted after further adjusting for health care access predictors that could influence receipt of initial CTC [\$2,065 (-\$1,672 - \$5,803)] ($p = .28$) (Table 3). Similarly, there were no differences between the initial CTC and OC cohorts for inpatient costs [(\$267 (-\$1,017, \$1,550))] ($p = .68$), for outpatient costs [2,828 (-\$311, \$5,966)] ($p = .08$), or for any of the six outpatient procedural categories based on CPT codes including surgery ($p = .45$), which includes endoscopy, and radiology ($p = .48$).

Because we saw evidence that unadjusted median costs were higher in the initial CTC cohort compared to the initial OC cohort, we explored the influence of high cost outliers on total unadjusted costs. Specifically, we evaluated the proportions of patients within each cohort who received low ($< \$2,500$), intermediate ($> \$2,500$ and $< \$7,500$) and high cost ($> \$7,500$) care in the year following the index CTC or OC. Higher proportions of patients in the initial CTC cohort (22%) received high cost care than patients in the initial OC cohort (16%) ($p < .0001$) (Figure 1).

We then evaluated rates of potential colonic and extra colonic testing in the year following either CTC or OC, including OC with polypectomy after CTC. Although the overall frequency of outpatient tests plausibly related to the colon was low, it was twice as common in the initial CTC cohort (13%, 68 / 531) compared to the initial OC cohort (7%, 1,210 / 17,593). This was predominantly due to higher rates of outpatient OC in the initial CTC cohort (20%, 105/531) compared to the initial OC cohort (8%, 1,382/17,593) (Figure 2a). Potential extra colonic follow-up imaging was more frequent than colonic follow-up, seen in 53% of the initial CTC cohort (274/531) compared to 41% of the initial OC cohort (7,160 / 17,593). This was true for all imaging modalities in the abdomen and pelvis as well as the lungs (Figure 2b).

Correspondingly, total unadjusted Medicare payments were higher for potential colonic follow-up testing in the initial CTC versus OC cohort ($p < .0001$) and for outpatient extra colonic imaging of the abdomen and pelvis as well as the lungs ($p < .0001$ for both). In contrast to total costs, these results did not change following adjustment for potential demographic, socioeconomic and health care access predictors (Table 4). Adjusted Medicare

payments were higher per patient in the initial CTC cohort compared to the OC cohort both for potential outpatient colonic follow-up tests [\$50 (95CI \$12, \$88)] ($p=.010$) and for potential outpatient extra colonic following imaging of the abdomen, pelvis and lungs [\$64 (\$23, \$106)] ($p=.002$).

Discussion

Our study is the first to compare differences in overall costs one year following receipt of initial CTC and OC among asymptomatic Medicare patients (i.e., screening population). After adjusting for potential demographic, socioeconomic and health care access predictors that could influence the choice of referral to CTC or OC for colorectal evaluation, we found higher costs of outpatient testing plausibly related to colonic and extra colonic follow-up among patients who received initial CTC compared to OC. However, no differences were revealed in adjusted total costs, inpatient costs or outpatient costs between these two methods of colorectal evaluation.

These findings are an important addition to the existing literature. Prior studies have predominantly focused on health care procedures and costs among patients with extra colonic findings on CTC alone, estimating costs as little as \$28 per patient when follow-up is restricted solely to imaging to as high as \$248 when follow-up is expanded to include surgery, laboratory and physician visits.^{5,32-38} Using claims, we were only able to identify imaging follow-up of the abdomen, pelvis and lungs. This imaging could be related or unrelated to follow-up of extra colonic findings, but permitted us to calculate comparable costs in the initial OC cohort, not possible in prior studies. In addition, our results capture care from all sites of delivery in contrast to institutional studies, which are generally limited to care from a single site. These differences may explain why, even with adjustment, we found higher costs per patient of potential extra colonic imaging following CTC than previously reported [\$182 (95CI \$139 - \$225)]. Our study additionally provides data on the costs of potential colonic follow-up testing among asymptomatic patients who undergo initial CTC or OC, which are relatively unexplored. The Special Interest Group in Gastrointestinal and Abdominal Radiology (SIGGAR) trial also demonstrated higher rates of colonic follow-up testing among symptomatic patients randomized to receive CTC versus OC, but has not yet published differences in colonic follow-up costs between these groups.³⁹

Despite higher adjusted costs of both colonic and extra colonic testing following initial CTC compared to OC, we found no differences in total downstream costs between either modality. Total costs include many things such as care unrelated to the follow-up of colonic or extra-colonic findings as well as care related to colonic and extra colonic follow-up that could not be isolated on claims (e.g., inpatient treatment of colorectal cancer, outpatient laboratory and physician visits). The balancing effects of these other types of care may explain discordance between adjusted potential outpatient colonic and extra colonic costs and adjusted total, inpatient and outpatient costs. It is reassuring that our results are consistent with the SIGGAR trial which found similar downstream costs among symptomatic patients randomized to receive OC and CTC.⁴⁰

Prior decision models have demonstrated variable life years gained and costs associated with screening CTC compared to OC depending on the timing interval between examinations, reimbursement rates, sensitivity for polyps and adherence rates^{13,41-45} Of the two decision models which did include costs related to evaluation of extra colonic testing, our results are concordant with Vijan et al who found that the additional costs of extra colonic testing was negligible on incremental cost effectiveness ratios between patients undergoing screening CTC and OC.⁴⁶ Hassan et al found that screening CTC was more cost effective than OC when extra colonic testing was included, mainly due to a decrease in AAA related deaths rather than down staging of extra colonic cancer.⁴⁷ Direct comparison of our results with these studies is challenging, however, given differences in methodology, follow-up interval, and patient selection.

A limitation of our study is that CTC was not covered for routine screening during this time interval and was performed predominantly among patients at risk for OC due to existing medical conditions. Accordingly, we approximated the screening population by selecting patients with no symptoms referable to colorectal cancer and excluding patients with OC in the prior year. This resulted in the exclusion of a much larger proportion of patients in the CTC cohort for prior OC (48%, 7,525/15,710) than patients in the OC cohort with prior CTC (1%, 2,519/176,037). Incomplete OC is known to be the highest source of referrals to CTC and is currently covered by Medicare as a diagnostic examination. Because our objective was to focus on the asymptomatic population eligible for screening CTC and study cost differences attributable to either CTC or OC we maintained this exclusion. As a result the small number of patients in the initial CTC cohort may have limited our ability to detect small differences in total, outpatient, and inpatient Medicare costs when compared to the larger initial OC cohort. However, we were also unable to adjust fully for differences between these two cohorts using claims, as evidenced by the higher proportion of high cost care among patients referred to initial CTC; as such our results may underestimate differences in costs between these two examinations. The use of a large claims database required us to exclude several Medicare patients according to our criteria, including those enrolled in private insurance plans and those without Part A or B coverage during the study period. Because diagnosis related groups are not specific for colonic diagnoses and procedures, we did not include potential inpatient follow-up related to the colon. However, costs associated with complications of optical colonoscopy, such as perforation, would be captured within our total cost data. Patients in our study were followed through December 2009. However, given that Medicare coverage has not changed over the past five years we have no reason to believe that these results have changed over that time period. 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, despite higher adjusted costs of outpatient testing potentially related to colonic and extra colonic follow-up among asymptomatic elderly patients referred to initial CTC compared to initial OC, we found no differences in adjusted total costs, inpatient costs or outpatient costs between these two cohorts. Although Medicare does not cover screening CTC, our results suggest that these modalities are equivalent from a downstream cost perspective. These findings are of value to payors and policy makers evaluating coverage of screening CTC.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Unadjusted total health care spending in the year following initial CTC or OC

Percentage of low (<\$2,500), intermediate (>\$2,500 & < 7,500) and high cost (>\$7,500) care in the year following initial CTC or OC

a: Endoscopy and radiology follow-up of potential colonic findings

b: Radiology follow-up of potential extra colonic findings

Figure 2.
Population adjusted frequency of colonic and potential extra-colonic outpatient follow-up by modality

Table 1

Patient Characteristics

		Initial CTC	Initial OC	p value
		(n=531)	(n=17593)	
<i>Demographic characteristics</i>				
Gender				
	Females	320 (60.3%)	1,0493 (59.6%)	0.770
Age				
	66-74	315 (59.3)	12,189 (69.3)	<.001
	75-84	182 (34.3)	4,986 (28.3)	
	>85	34 (6.4)	418 (2.4)	
Race				
	White	504 (94.9)	15,211 (86.5)	<.001
	Black	16 (3.0)	1,277 (7.3)	
	Other	11 (2.1)	1,105 (6.3)	
Common elixhauser comorbidities				
	Coronary Artery Disease	34 (6.4)	474 (2.7)	<.001
	Hypertension	55 (10.4)	1,299 (7.4)	0.01
	Chronic Lung Disease	20 (3.8)	314 (1.8)	0.001
	Diabetes Mellitus w/o complications	16 (3.0)	384 (2.2)	0.200
	Hypothyroidism	14 (2.6)	246 (1.4)	0.02
	Fluid and Electrolyte disorders	13 (2.4)	413 (2.3)	0.880
	Deficiency Anemias	15 (2.8)	244 (1.4)	0.006
<i>Socioeconomic characteristics</i>				
Mean % persons with college level education by county of residence				
		32.43 (± 11.3)	30.25 (± 11.0)	<.001
Mean household income by county of residence				
		\$51,796.34 ($\pm$ \$12,889.5)	\$50,615.20 ($\pm$ \$12,933.7)	0.04
<i>Health Care Access</i>				
Mean Total Medicare Part A and B reimbursements by county of residence (2010)				
		\$8,876.95 ($\pm$ \$1,486.7)	\$9,035.00 ($\pm$ \$1,466.0)	0.014
Metropolitan / Rural				
	Rural	86 (16.2)	2566 (14.7)	0.320
	Metropolitan	444 (83.8)	14928 (85.3)	
Census Region				
	Northeast	101 (19.3)	3670 (21.1)	0.490
	Midwest	117 (22.4)	3550 (20.4)	
	South	184 (35.2)	6390 (36.7)	
	West	121 (23.1)	3805 (21.8)	

Table 2
Median total unadjusted costs in year preceding of following CTC or OC (95%CI)

			Difference	p value *
12 months before				
	CTC first line	\$1,826 (\$1,592, \$2,076)	\$589	<.0001
	OC first line	\$1,237 (\$1,208, \$1,267)		
12 months after				
	CTC first line	\$2,264 (\$2,000, \$2,558)	\$764	<.0001
	OC first line	\$1500 (\$1,466, \$1,531)		

* derived from ANOVA

Table 3Adjusted costs by type of colorectal evaluation (95%CI) $\pm$

		Adjusted Costs	Difference	p value
Total				
	CTC first line	\$16,355 (\$5,661 - \$27,048)	\$2,065 (-\$1,672 - \$5,803)	0.280
	OC first line	\$14,289 (\$5,369 - \$23,209)		
Inpatient				
	CTC first line	\$3,117 (\$1,725 - \$4,509)	\$267 (-\$1,017, \$1,550)	0.680
	OC first line	\$2,850 (\$2,254 - \$3,447)		
Outpatient				
	CTC first line	\$20,646 (\$5,688 - \$32,603)	\$2,828 (-\$311, \$5,966)	0.080
	OC first line	\$17,818 (\$7,665 - \$27,971)		
<i>Evaluation</i>	CTC first line	\$10,637 (\$4,386 - \$16,888)	\$1,319 (-\$100, \$2,739)	0.070
	OC first line	\$9,317 (\$3,879 - \$17,456)		
<i>Anesthesiology</i>	CTC first line	\$58 (\$45 - \$71)	\$9 (-\$5, \$22)	0.200
	OC first line	\$49 (\$47 - \$51)		
<i>Surgery</i>	CTC first line	\$1,022 (\$729 - \$1,314)	\$75 (-\$119, \$270)	0.450
	OC first line	\$946 (\$736 - \$1,157)		
<i>Radiology</i>	CTC first line	\$15,570 (-\$11,421 - \$42,561)	\$1,433 (-\$2,545, \$5,411)	0.480
	OC first line	\$14,137 (-\$10,264 - \$38,539)		
<i>Pathology</i>	CTC first line	\$5,119 (\$1,539 - \$8,699)	\$667 (-\$89, \$1,423)	0.080
	OC first line	\$4,452 (\$1,362 - \$7,542)		
<i>Medicine</i>	CTC first line	\$183,954 (-\$45,651 - \$413,559)	\$12,921 (-\$20,355, \$46,197)	0.480
	OC first line	\$171,033 (-\$42,274 - \$384,341)		

Table 4
Adjusted colonic and extracolonic costs by type of outpatient colorectal evaluation (95%CI)[±]

		Adjusted Costs		p value
Outpatient colonic testing				
	CTC first line	\$71 (\$33 - \$109)	\$50 (\$12, \$88)	0.010
	OC first line	\$21 (\$19 - \$24)		
Outpatient extracolonic testing				
	CTC first line	\$182 (\$139 - \$225)	\$64 (\$23, \$106)	0.002
	OC first line	\$118 (\$107 - \$128)		

[±] adjusted for gender, age, race, coronary artery disease, hypertension, chronic pulmonary disease, diabetes without complications, hypothyroidism, fluid and electrolyte disorders, deficiency anemias, education, income, total Medicare reimbursement for county of residence, rural / urban residence, census region and costs in the year preceding the index CTC or OC.