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ORIGINAL ARTICLE

Comparison of trends in colorectal cancer screening in the US end-stage renal disease population and the US Medicare population

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Abstract

Background: Although patients treated with maintenance hemodialysis are at an increased risk of colorectal cancer compared with the general population, national practices for colorectal cancer screening have not been reported in this population. We assessed the performance of colorectal cancer screening in the US end-stage renal disease program in comparison with the US Medicare population.

Methods: We studied the United States Renal Data System for US prevalent hemodialysis patients between 2002 and 2011 who had Medicare as their primary insurer. We assessed procedure codes for performance of common colorectal cancer screening tests, including fecal occult blood testing, sigmoidoscopy and colonoscopy. We assessed screening sigmoidoscopy and screening colonoscopy only and excluded patients who had preexisting colon cancer or gastrointestinal hemorrhage. Because colorectal cancer screening recommendations are established for hemodialysis patients who have been listed for kidney transplantation, but no general recommendations exist for patients who are not wait-listed, we assessed colorectal cancer screening separately for the two groups.

Results: We found that 1-year performance of colonoscopy in wait-listed hemodialysis patients was similar to or higher than that in general Medicare patients of the same age, while performance of colonoscopy in non-wait-listed patients was significantly lower than among general Medicare patients of the same age.

Conclusions: Given improved survival among hemodialysis patients in the last decade, the utility of colorectal cancer screening even among non-wait-listed hemodialysis patients should be reassessed.

Key words: colorectal cancer, dialysis, screening, kidney, transplant, USRDS

Introduction

Colorectal cancer (CRC) is the third most commonly reported cancer among US Medicare patients receiving hemodialysis [1], and reported rates are significantly higher than among the general population [2, 3]. However, there is currently no information on practices for CRC screening among end-stage renal disease

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(ESRD) patients. It is therefore impossible to assess whether such practices are appropriate. Prior cost-effectiveness studies indicated that routine CRC screening in the ESRD population would exceed general thresholds for cost-effectiveness [4]. Such analyses have generally not accounted for the way in which the US ESRD population is stratified into a minority of patients who are candidates for kidney transplantation and those who are not candidates, in terms of cancer screening generally. Thus, considering the better health and improved life expectancy for potential and actual transplant candidates, cancer screening for potential transplant candidates is generally aggressive and at least consistent with recommendations for the general population [5–10]. Specifically regarding colonoscopy among potential kidney transplant candidates, it is recommended that 'All patients >50 years of age should have screening colonoscopy' [11]. Conversely, it is often assumed that the reduced life expectancy among dialysis patients who are not transplant candidates attenuates any potential benefits of screening [12, 13].

It has been difficult to assess the impact of recommendations for individualized approaches taking into account basic characteristics such as age, gender and primary disease [14]. However, results of a national survey indicated that nephrologists were likely to recommend screening for breast and cervical cancers but not colon cancer [15].

Screening for CRC is more invasive than for other cancers, since national trends have shifted toward performance of colonoscopy rather than noninvasive fecal occult blood testing (FOBT) [16], which was reported to be useful in identifying polyps in patients treated with dialysis [17]. Colonoscopy, at least at one time, was reported to have specific hazards for patients with chronic kidney disease due to the risk of acute kidney injury from phosphate purgatives, although currently such preparations are not recommended for patients with impaired kidney function or those >50 years of age [18].

In addition to an increased risk of colon cancer, ESRD patients are at an increased risk of upper and lower gastrointestinal (GI) bleeding compared with the general population [19, 20], which would require exclusion or adjustment for such conditions in analyses. Additionally, hemodialysis (HD) and peritoneal dialysis patients are at risk for different GI disorders, with bleeding complications more common among HD patients [21]. Therefore analyses would need to stratify upon dialysis modality.

Because current guidelines for the general population recommend scheduled screening for 'average risk adults' between ages 50 and 75 years [16], we set out to assess the performance of CRC screening in the US ESRD program in comparison with the US Medicare population, using the mutually most recently available data from the United States Renal Data System (USRDS) and the Centers for Medicare and Medicaid Studies (CMS).

Table 1. Selection of hemodialysis patients eligible for colorectal cancer screening in 2011[a]

Inclusion criteria	No. of patients
With year-round hemodialysis treatment	306 355
↓	
With full Medicare Part A and B coverage	208 693
↓	
Without colorectal cancer	206 161
↓	
Without a primary lower gastrointestinal bleeding hospitalization for at least 6 months	201 611

[a]The same criteria were used to identify eligible hemodialysis patients for colorectal cancer screening in other study years.

Materials and methods

Study design, data sources and sample selection

Using standard analysis files from the USRDS, a national ESRD registry, we performed a retrospective cohort study to determine annual rates of CRC screening use in ESRD HD patients compared with a 5% Medicare sample for 2002–11.

We first identified HD patients who had full Medicare Part A and B coverage in each study year in order to ensure collection of complete claims data for patients. The annual cohort of patients eligible for CRC screening was further limited to patients who did not have CRC or a primary lower gastrointestinal bleeding hospitalization for at least 6 months. Medicare inpatient and physician/supplier billing data were used to identify patients' CRC status in this analysis. CRC patients were those with at least one hospitalization and/or two outpatient/physician encounters in a 6-month observation period with a CRC diagnosis in Medicare billing data. [The Supplementary Appendix provides the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes used to identify CRC and lower gastrointestinal bleeding in Medicare claims.] The selection of HD patients in year 2011 is outlined in Table 1. The same criteria were used to identify HD patients eligible for CRC screening in other study years.

Using a 5% Medicare sample, we then identified Medicare beneficiaries eligible for CRC screening in each available data year (2003–06), selecting those who were enrolled in Medicare Part A and B coverage for 12 months (with no managed care enrollment for the year) and who were CRC-free and without a primary lower gastrointestinal bleeding hospitalization. The selection of Medicare beneficiaries in 2006 is outlined in Table 2. The same criteria were used to identify eligible Medicare beneficiaries for CRC screening in other study years.

Patient characteristics and outcome

Patient characteristics were taken from the Centers for Medicare & Medicaid Services Medical Evidence Form (CMS-2728), and included self-reported gender and race (white, black or other). Based on age at ESRD initiation, patients' ages for subsequent years were assigned. We further categorized patients' ages in each year into four groups (0–50, 50–64, 65–74, and ≥75 years).

Table 2. Selection of Medicare population eligible for colorectal cancer screening in 2006[a]

Inclusion criteria	No. of patients
Alive at the end of year	2 176 603
↓	
With full Medicare Part A and B coverage and no managed-care enrollment	1 500 027
↓	
Without colorectal cancer	1 488 161
↓	
Without a primary lower gastrointestinal bleeding hospitalization	1 481 194

[a]The same criteria were used to identify eligible Medicare beneficiaries for colorectal cancer screening in other study years.

Patients' kidney transplant waiting list status in each study year was also identified based on their entry and removal dates in a kidney transplant waiting list file.

Since July 2001, Medicare has covered CRC screening for all beneficiaries with four different tests: colonoscopy, sigmoidoscopy, FOBT and barium enema. This analysis investigated the use of only the first three of these tests, because barium enema is seldom used in the HD population. Because Medicare claims cannot reliably distinguish the original reasons for performing these tests, we used a conservative definition to calculate annual screening test rates, i.e. only tests with screening procedure codes were included. We did not include tests with diagnostic procedure codes. [The Supplementary Appendix provides the Healthcare Common Procedure Coding System/Current Procedural Terminology (HCPCS/CPT) codes used to identify specific CRC screening tests in Medicare physician and supplier billing data.]

Statistical analysis

Annual test-specific rates [and 95% confidence intervals (CIs)] were computed, representing the percentage of eligible individuals in the denominator for each year that had the specific type(s) of test in that year. The following descriptive statistics were calculated: (i) annual percentage of HD patients with an endoscopic procedure (colonoscopy or sigmoidoscopy); (ii) annual percentage of HD patients with an endoscopic procedure or FOBT; (iii) annual percentage of HD patients with colonoscopy in the 50–64 and 65–74 years age groups; (iv) annual percentage of Medicare beneficiaries with colonoscopy in the 50–64 and 65–74 years age groups; (v) annual percentage of HD patients with FOBT in the 50–64 and 65–74 years age groups and (vi) annual percentage of Medicare beneficiaries with FOBT in the 50–64 and 65–74 years age groups. Proportions were compared across age, sex, race and kidney transplant waiting list status groups using chi-square tests.

We also presented the percentage of HD patients with an endoscopic procedure and the percentage of HD patients with an endoscopic procedure or FOBT, by the number of years eligible for CRC screening and kidney transplant waiting list status.

All analyses were conducted using SAS version 9.2 (SAS Institute, Cary, NC, USA).

Results

Table 3 presents the number of HD patients eligible for CRC screening (overall and by age group, sex, race and kidney transplant waiting list status) each year from 2002 to 2011. In 2011, 201 611 HD patients were eligible for CRC screening, a 40.6% increase over the eligible 143 407 HD patients in 2002. As of 2011, 58.2% of HD patients were between the ages of 49 and 75 years (69 582 and 47 834 patients in the 50–64 and 65–74 years age groups, respectively), which is the recommended screening population in guidelines, and 19.3% of HD patients were on a kidney transplant waiting list.

There was a slight annual increase in the proportion of HD patients who received colonoscopy or sigmoidoscopy for CRC screening over the 10-year study period, from 0.5% (95% CI 0.46–0.54) in 2002 to 1.0% (95% CI 0.93–1.02) in 2011. In each year, HD patients 50–74 years old and on a kidney transplant waiting list were more likely to receive a colonoscopy or sigmoidoscopy compared with those in other age groups and those who were not on a kidney transplant waiting list (all $P < 0.001$; Table 4).

The proportion of HD patients receiving any test for CRC screening (colonoscopy, sigmoidoscopy or FOBT) decreased from 6.1% (95% CI 6.01–6.26) in 2002 to 3.3% (3.26–3.41) in 2011, due to decreased use of FOBT (data not shown). The group with the highest screening rate was those >75 years of age from 2002 to 2005 (between 6.7 and 7.5%), the 65–74 years age group in 2006 and 2007 (6.7 and 4.7%, respectively) and the 50–64 years age group in 2008–11 (4.0%). However, patients on kidney transplant waiting lists consistently had higher screening rates than did non-wait-listed patients (all $P < 0.001$; Table 5).

Each CRC screening test has a recommended test interval: annually for FOBT, every 5 years for sigmoidoscopy and every 10 years for colonoscopy. However, due to high mortality in the HD population, only ~20% (121 021 of 560 657 patients) of our study population had >4 eligible years for CRC screening. Table 6 shows a slight increase in the proportion of patients who ever received colonoscopy or sigmoidoscopy by longer eligible years of CRC screening in the wait-listed HD population: from 8.0% (95% CI 7.7–8.2) in the 1–2 eligible years group to 12.0% (11.2–12.8) in the 9–10 eligible years group. Patients not on kidney transplant waiting lists consistently had lower screening rates than did

Table 3. Numbers of hemodialysis patients eligible for colorectal cancer screening, 2002–11

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	143 407	150 330	157 720	164 502	168 193	173 325	179 493	184 614	193 021	201 611
Age (years)										
<50	32 921	33 892	35 117	35 973	36 072	37 088	38 114	38 796	40 195	41 450
50–64	42 589	44 940	48 200	51 340	53 303	55 868	59 255	61 839	65 686	69 582
65–74	36 740	38 021	39 174	40 360	41 071	42 086	43 200	44 176	45 792	47 834
≥75	31 157	33 477	35 229	36 829	37 747	38 283	38 924	39 803	41 348	42 745
Sex										
Male	76 735	80 678	85 001	89 073	91 446	94 779	98 689	101 607	106 521	111 557
Female	66 670	69 650	72 709	75 395	76 707	78 506	80 766	82 967	86 458	90 012
Race										
White	74 380	78 256	82 677	86 868	89 238	92 665	96 394	99 646	104 047	108 566
Black	60 280	62 907	65 534	67 721	68 855	70 423	72 552	74 175	77 796	81 386
Other	8672	9110	9455	9861	10 046	10 183	10 487	10 731	11 110	11 597
Kidney transplant waiting list status										
Yes	22 893	24 497	26 144	28 065	29 386	31 352	33 585	34 936	37 251	38 901
No	120 514	125 833	131 576	136 437	138 807	141 973	145 908	149 678	155 770	162 710

Table 4. Annual colonoscopy or sigmoidoscopy test rates in hemodialysis patients eligible for colorectal cancer screening, 2002–11

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	0.5%	0.6%	0.7%	0.7%	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%
Age (years)										
<50	0.2%	0.3%	0.3%	0.4%	0.3%	0.4%	0.4%	0.4%	0.4%	0.4%
50–64	0.8%	0.9%	1.1%	1.3%	1.4%	1.5%	1.6%	1.6%	1.7%	1.7%
65–74	0.6%	0.6%	0.7%	0.7%	0.9%	0.8%	0.9%	0.9%	0.9%	0.9%
≥75	0.3%	0.3%	0.4%	0.3%	0.4%	0.3%	0.4%	0.3%	0.3%	0.4%
Sex										
Male	0.5%	0.6%	0.7%	0.8%	0.8%	0.9%	0.9%	0.9%	1.0%	1.0%
Female	0.5%	0.5%	0.7%	0.7%	0.8%	0.8%	0.8%	0.9%	0.9%	0.9%
Race										
White	0.5%	0.5%	0.7%	0.7%	0.8%	0.8%	0.8%	0.8%	0.8%	0.8%
Black	0.5%	0.6%	0.7%	0.8%	0.9%	0.9%	1.0%	1.1%	1.1%	1.2%
Other	0.4%	0.5%	0.7%	0.9%	0.6%	0.7%	0.9%	0.8%	0.7%	0.7%
Kidney transplant waiting list status										
Yes	1.0%	1.3%	1.3%	1.6%	1.7%	1.8%	1.9%	1.9%	1.9%	1.8%
No	0.4%	0.4%	0.5%	0.6%	0.6%	0.6%	0.7%	0.7%	0.7%	0.8%

Table 5. Annual rates of colonoscopy, sigmoidoscopy or fecal occult blood testing in hemodialysis patients eligible for colorectal cancer screening, 2002–11

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
All	6.1%	5.7%	6.1%	6.3%	5.7%	4.1%	3.4%	3.3%	3.2%	3.3%
Age (years)										
<50	3.5%	3.4%	3.6%	3.8%	3.4%	2.4%	1.8%	1.8%	1.7%	1.8%
50–64	6.3%	6.1%	6.3%	6.8%	6.2%	4.6%	4.0%	4.0%	4.0%	4.0%
65–74	7.2%	6.6%	6.8%	7.1%	6.7%	4.7%	3.9%	3.8%	3.6%	3.6%
≥75	7.5%	6.7%	7.2%	7.2%	6.1%	4.4%	3.7%	3.3%	3.1%	3.4%
Sex										
Male	5.2%	5.0%	5.4%	5.6%	5.0%	3.7%	3.1%	2.9%	2.9%	3.0%
Female	7.2%	6.7%	6.9%	7.1%	6.6%	4.5%	3.8%	3.8%	3.7%	3.7%
Race										
White	7.0%	6.4%	6.8%	7.0%	6.2%	4.5%	3.7%	3.5%	3.3%	3.5%
Black	5.3%	5.0%	5.2%	5.4%	5.2%	3.5%	3.0%	3.1%	3.1%	3.2%
Other	5.2%	5.4%	5.4%	6.2%	5.1%	4.4%	4.2%	3.7%	3.5%	3.3%
Kidney transplant waiting list status										
Yes	6.9%	6.8%	7.2%	7.8%	7.2%	5.7%	4.9%	4.8%	4.8%	4.7%
No	6.0%	5.5%	5.8%	6.0%	5.4%	3.7%	3.1%	3.0%	2.9%	3.0%

Table 6. Percent of hemodialysis patients with an endoscopic procedure and with an endoscopic procedure or fecal occult blood testing, by number of years eligible for colorectal cancer screening and kidney transplant waiting list status

Number of years eligible for CRC screening	HD patients eligible for CRC screening: ever on transplant waiting list			HD patients eligible for CRC screening: never on transplant waiting list		
	Number of patients	With colonoscopy or sigmoidoscopy (%)	With colonoscopy or sigmoidoscopy or fecal occult blood testing (%)	Number of patients	With colonoscopy or sigmoidoscopy (%)	With colonoscopy or sigmoidoscopy or fecal occult blood testing (%)
1–2 years	50 966	8.0	22.9	242 243	2.0	14.6
3–4 years	32 151	9.6	27.0	114 276	2.9	19.7
5–6 years	16 806	10.2	31.1	52 589	4.0	24.2
7–8 years	8382	10.6	34.2	22 943	5.0	28.4
9–10 years	5938	12.0	36.2	14 363	6.0	30.9
Total	114 243	9.2	26.8	446 414	2.7	18.3

HD, hemodialysis; CRC, colorectal cancer.

wait-listed patients (all $P < 0.001$). The same finding was observed in the proportion of HD patients receiving any test for CRC screening (colonoscopy, sigmoidoscopy or FOBT).

As shown in Figure 1A, in the 50–64 years age group, annual colonoscopy use rates in wait-listed HD patients, in non-wait-listed HD patients and in Medicare beneficiaries slowly increased

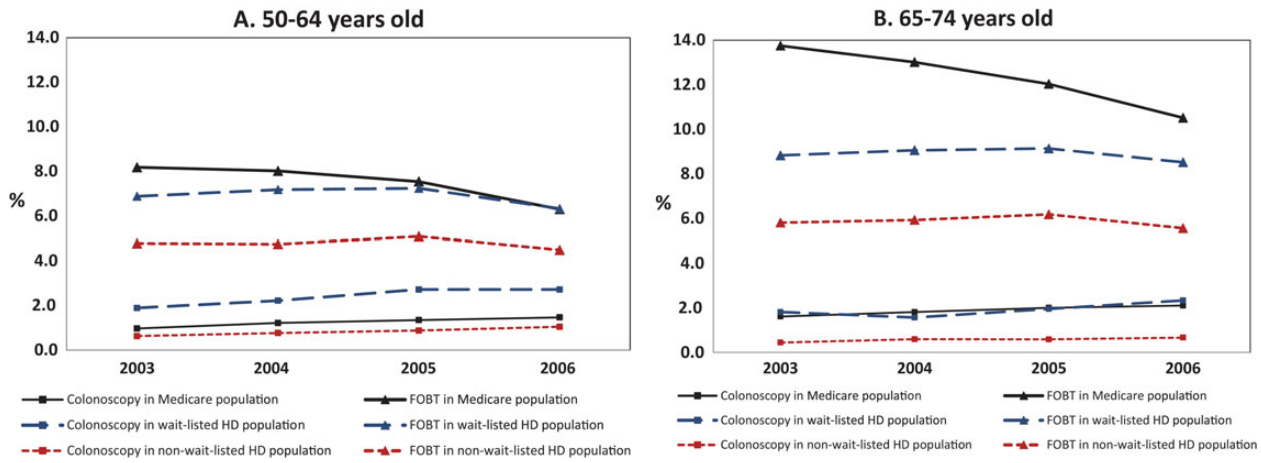

Fig. 1. Annual colonoscopy and fecal occult blood test use rates in hemodialysis patients and Medicare beneficiaries eligible for colorectal cancer screening, 2003–06. ESRD, end-stage renal disease; FOBT, fecal occult blood testing; HD, hemodialysis.

from 2003 to 2006. Rates increased from 1.9% (95% CI 1.62–2.16) to 2.7% (2.43–3.01) in wait-listed HD patients, from 1.0% (0.92–1.02) to 1.5% (1.41–1.53) in Medicare beneficiaries and from 0.6% (0.55–0.71) to 1.1% (0.95–1.15) in non-wait-listed HD patients. FOBT use rates in Medicare beneficiaries steadily decreased from 8.2% (95% CI 8.03–8.32) in 2003 to 6.3% (6.17–6.42) in 2006. FOBT use rates were stable between 6.9% (95% CI 6.37–7.38) in 2003 and 6.3% (5.89–6.77) in 2006 in wait-listed HD patients and between 4.8% (4.56–5.00) and 4.5% (4.29–4.69) in non-wait-listed HD patients, respectively. Similar trends in colonoscopy and FOBT use rates were observed in the 65–74 years age group (Figure 1B). In this age group, however, annual CRC screening rates in non-wait-listed HD patients were considerably lower than those in wait-listed HD patients and general Medicare population (all $P < 0.001$). For the period from 2003 to 2006, colonoscopy use rates increased from 0.4% (95% CI 0.37–0.51) to 0.7% (0.57–0.74) in non-wait-listed HD patients. The colonoscopy use rates in wait-listed HD patients and in Medicare beneficiaries were relatively comparable, and were stable between 1.8% (95% CI 1.36–2.26) in 2003 and 2.3% (1.89–2.78) in 2006, and increased from 1.6% (1.58–1.64) in 2003 to 2.1% (2.06–2.14) in 2006, respectively. FOBT use rates decreased from 13.8% (95% CI 13.67–13.83) to 10.5% (10.43–10.59) in Medicare beneficiaries between 2003 and 2006. FOBT use rates were stable between 8.8% (95% CI 7.86–9.78) and 8.5% (7.70–9.33) in wait-listed HD patients and between 5.8% (5.55–6.05) and 5.6% (5.32–5.79) in non-wait-listed HD patients, respectively.

To provide comparison with other studies [22] we also assessed colonoscopy rates including both diagnostic and screening codes. For the only comparable year, 2005, the percentage of general Medicare patients in the age range of 50–64 years who had a colonoscopy performed that year was 4.5% (95% CI 4.43–4.64). In the non-wait-listed HD patients the rate was 4.8% (95% CI 4.57–4.99), and among the wait-listed HD population, it was 9.4% (8.87–9.94). Among patients in the range of 65–74 years, the percentage of general Medicare patients who had a colonoscopy that year was 6.3% (95% CI 6.21–6.33), of the non-wait-listed HD population it was 5.1% (4.84–5.29) and of the wait-listed HD population it was 10.3% (9.33–11.20).

Discussion

The results of the present study show distinct trends in the comparison of performance of CRC screening between the US HD and general Medicare population and within the ESRD population. Among those 50–64 years old, FOBT was performed more often among the general Medicare population than among wait-listed US HD patients, although recently this difference was negligible. FOBT rates among non-wait-listed HD patients were substantially lower. Performance of colonoscopy for wait-listed HD patients exceeded that in the general Medicare population in this age group. In contrast, colonoscopy rates for the non-wait-listed HD and the general Medicare population were similar.

Among those 65–74 years old, performance of FOBT was substantially higher among the general Medicare population than wait-listed HD patients, and even more so in comparison to non-wait-listed HD patients. FOBT decreased markedly in the general population while remaining more stable in the HD population. Colonoscopy performance was essentially identical in general Medicare and wait-listed HD patients, while non-wait-listed patients had substantially lower screening rates.

National performance of CRC screening was previously reported by Smith *et al.* [22], using data from the National Health Interview Survey (NHIS; http://www.cdc.gov/nchs/nhis.htm) for the years 2005–08, assessing the prior 10-year performance of FOBT in the previous year, sigmoidoscopy in the past 5 years and colonoscopy in the past 10 years. The NHIS had no information on computed tomography colonoscopy or barium enema. Important differences between that report and the present study were that the NHIS was a survey, and did not distinguish between screening and diagnostic colonoscopies, and was also subject to recall bias. Although data are therefore not comparable with the current study due to differences in methods, Smith *et al.* reported an increase in rates of CRC screening, primarily due to the increased use of colonoscopy. Multiplying our annual percentages by 10 to obtain 10-year estimated utilization rates, for the year 2005 (the only year available for comparison in both studies), Smith *et al.* reported that 35% of patients in the age range of 50–64 years and 45% of patients >65 years of age had colonoscopy in the past 10 years. In the present study, 10-year extrapolated percentages for patients in the age range of 50–64 years are ~27% for wait-listed HD patients, 9% for non-wait-listed HD patients and 14% for the general Medicare population. For those in the age range of 65–74 years, extrapolated 10-year percentages are ~20% for wait-listed HD patients, 6% for non-wait-listed HD patients and 20% for general Medicare patients.

Using the methodology of Smith *et al.* [22], and assessing both diagnostic and screening colonoscopies, 10-year extrapolated rates were ~45% for 50–64-year-old general Medicare patients

(compared with 35% for Smith *et al.*) and 63% for general Medicare patients in the age range of 65–74 years (compared with 45% for Smith *et al.*). Ten-year extrapolated percentages for non-wait-listed HD patients in the age range of 50–64 years were ~48%, and for wait-listed HD patients, 94%. For 65–74-year-old non-wait-listed HD patients, the corresponding percentage was 51%, and for wait-listed HD patients, 100%. However, factors such as race, ethnicity and socioeconomic status (regardless of health care coverage) were related to lower use of CRC in those analyses, which we did not confirm. Smith *et al.* report also showed that CRC screening rates were higher among patients >65 years old compared with those 50–64 years old, for reasons not yet determined, but consistent with the present study.

FOBT and colonoscopy both have specific limitations as screening tests in the HD population. The high use of heparin anticoagulation in HD may affect the false positive rate for FOBT, since standard recommendations for FOBT are to discontinue anticoagulants or antiplatelet agents before testing, if possible [23].

Use of a more invasive test such as colonoscopy raises concerns among elderly HD patients, many of whom are frail and prone to iatrogenic complications. However, the current literature does not show a higher complication rate for colonoscopy in HD patients, although there are almost no published data on this topic. Earlier cases of acute phosphate nephropathy presumably would not be an issue in the HD population due to contraindications of associated colonoscopy preparations [24–27].

The present analysis shows a clear disparity among HD patients on the transplant waiting list compared with those who were not. This could be expected given current recommendations, which encourage universal screening for wait-listed candidates, while no recommendations apply to non-wait-listed HD patients. In fact, existing cost-effectiveness studies and editorials discourage such screening [12, 13].

Because existing guidelines for transplant candidates recommend colonoscopy and not FOBT, the most relevant screening in this group for comparison purposes is colonoscopy. Wait-listed HD and Medicare patients have similar colonoscopy rates. In fact, among HD patients in the age range of 50–64 years, use of colonoscopy was higher than in the general Medicare population. Among those in the age range of 65–75 years, the use was essentially identical. To some extent this is appropriate, since screening is recommended for all wait-listed HD patients before an intermediate-risk elective surgery (kidney transplantation), while the general Medicare population is a mixed group. Also, the 50–64-year-old general Medicare population is Medicare eligible on the basis of disability (the cause of which cannot be disclosed), not solely by age, and thus may represent a higher-risk population for whom a lower screening rate is appropriate. However, this does not explain the lower use of colonoscopy among 50–64-year-olds found in the general population by Smith *et al.* [22] compared with patients >65 years.

Additionally, although cancer screening is recommended for HD patients on a transplant waiting list, in this study we showed comparable rates of CRC screening between wait-listed HD patients and the general Medicare population, and a lower rate in non-wait-listed patients. This is somewhat surprising, as patients on the transplant waiting list are supposed to be documented as free of cancer generally, and colon cancer specifically, which is a more stringent standard than for the general population. The low rates among non-wait-listed HD patients are likely due to either lack of existing guidelines or less stringent guidelines for this group. However, given the steadily declining mortality among the dialysis patient population, previous assumptions may need to be verified. Unfortunately, the data available to us are not sufficient to determine a cause of these rates, but do highlight that this is an area worthy of further investigation.

Our ascertainment of the screening procedures was mainly based on annual procedures. Based on available data and because of the high mortality rate in the HD population, for only a small portion of patients were we able to assess the 10-year use. However, given the large sample size (essentially the entire HD population and a 5% Medicare subsample), 10-year extrapolation from annual use seems reasonable. Annual use was the only way to compare HD and general Medicare patients directly. Our ascertainment using Medicare billing data has been widely used for other procedures, and has been reported for colonoscopy in other studies [28, 29]. Dialysis patients are not more likely to present at a later stage of cancer compared with the general population [30]. However, in the same analysis, CRCs were significantly more likely to be diagnosed early in dialysis patients.

While the use of colonoscopy seems equivalent among wait-listed HD patients and general Medicare patients, among the non-wait-listed HD patients it was much lower. Given the reduced life expectancy of age-comparable HD patients and the general population, this might seem reasonable. However, even among a cohort of patients enrolled on the transplant waiting list (who, according to guidelines, should be free of cancer prior to consideration for transplant and treatment with immunosuppressive medications), rates reported in this analysis are still low. Reasons for this should be further investigated. The same is true for non-wait-listed HD patients, who, although they do not meet the same standard as patients requiring immunosuppression, may have excess mortality from low rates of CRC screening. Further, mortality has steadily declined among HD patients during the last 10–15 years, and earlier estimates of life expectancy may no longer be valid. Given the high risk of CRC in this population, new cost-effectiveness/utility studies are needed.

Supplementary data

Supplementary data are available online at http://ndt.oxfordjournals.org.

Authors' contribution

All authors were involved in the design of the study, interpretation of the data and the writing of the manuscript.

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Conflict of interest statement

None declared. The results presented in this paper have not been published previously in whole or part, except in abstract format.

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