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

Chyng-Wen Fwu¹, Paul L. Kimmel², Paul W. Eggers² and Kevin C. Abbott²

¹Social & Scientific Systems, Inc., Silver Spring, MD, USA and ²Division of Kidney, Urologic and Hematologic Diseases, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, 6707 Democracy Boulevard, Bethesda, MD 20892-5458, USA

Correspondence and offprint requests to: E-mail: kevin.abbott@nih.gov

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...
Colorectal screening in ESRD

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 1. Selection of hemodialysis patients eligible for colorectal cancer screening in 2011*

| 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 |

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

Table 2. Selection of Medicare population eligible for colorectal cancer screening in 2006*

| 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 |

*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

| Year | 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 | 39 824 | 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 |
| Race | White | 74 380 | 78 256 | 82 677 | 86 868 | 89 238 | 92 665 | 96 394 | 99 646 | 104 047 |
| | Black | 60 280 | 62 907 | 65 534 | 67 721 | 68 855 | 70 423 | 72 552 | 74 175 | 77 796 |
| | Other | 86 729 | 91 110 | 94 555 | 98 681 | 10 046 | 10 183 | 10 487 | 10 731 | 11 110 |
| Kidney transplant waiting list status | Yes | 22 893 | 24 497 | 26 144 | 28 065 | 29 386 | 31 352 | 33 585 | 34 936 | 37 251 |
| | No | 120 514 | 125 833 | 131 576 | 136 437 | 138 807 | 141 973 | 145 908 | 149 678 | 155 770 |
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.
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.
Colorectal screening in ESRD

Among those in the age range of 65–74 years (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 antplatelet 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 editorial discouraging 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 transplantation 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.

Acknowledgements
C.-W.F. is supported by a contract from the National Institute of Diabetes and Digestive and Kidney Diseases (HHSN276201200161U). The abstract from this article was presented to the American Society of Nephrology Kidney Week meeting, November 2015, San Diego, CA, USA. Interpretation and reporting of these data are the responsibility of the authors and the views expressed herein do not necessarily represent the views of the Department of Health and Human Services, the National Institutes of Health, the National Institute of Diabetes and Digestive and Kidney Diseases or the United States government.

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.
References

1. Butler AM, Olshan AF, Kahirsagar AV et al. Cancer incidence among US Medicare ESRD patients receiving hemodialysis, 1996-2009. *Am J Kidney Dis* 2015; 65: 763–772.

2. Wu MY, Chang TC, Chao TY et al. Risk of colorectal cancer in chronic kidney disease: a matched cohort study based on administrative data. *Ann Surg Oncol* 2013; 20: 3885–3891.

3. Lin MY, Kuo MC, Hung CC et al. Association of dialysis with the risks of cancers. *PLoS One* 2015; 10: e0122856.

4. Wong G, Li MW, Howard K et al. Health benefits and costs of screening for colorectal cancer in people or who have received a kidney transplant. *Nephrol Dial Transplant* 2013; 28: 917–926.

5. Kasikse BL, Cangro CB, Hariharan S et al. The evaluation of renal transplantation candidates: clinical practice guidelines. *Am J Transplant* 2001; 1(Suppl 2): 3–95.

6. Bunnapradist S, Danovitch GM. Evaluation of adult kidney transplant candidates. *Am J Kidney Dis* 2007; 50: 890–898.

7. Knoll G, Cockfield S, Blydt-Hansen T et al. Canadian Society of Transplantation consensus guidelines on eligibility for kidney transplantation. *CMJ* 2005; 173: 1181–1184.

8. Kasikse BL, Ramos EL, Gaston RS et al. The evaluation of renal transplant candidates: clinical practice guidelines. Patient Care and Education Committee of the American Society of Transplant Physicians. *J Am Soc Nephrol* 1995; 6: 1–34.

9. Steinman TI, Becker BN, Frost AE et al. Guidelines for the referral and management of patients eligible for solid organ transplantation. *Transplantation* 2001; 71: 1189–1204.

10. Abramowicz D, Cochat P, Claas FH et al. European Renal Best Practice Guideline on kidney donor and recipient evaluation and perioperative care. *Nephrol Dial Transplant* 2015; 30: 1790–1797.

11. Rossi AP, Klein CL. Evaluation of the potential renal transplant recipient. [http://www.uptodate.com/contents/evaluation-of-the-potential-renal-transplant-recipient?source=search_result&search=Evaluation+of+the+potential+renal+transplant+recipient&selectedTitle=1%7E150](https://www.uptodate.com/contents/evaluation-of-the-potential-renal-transplant-recipient) (12 January 2016, date last accessed).

12. Chertow GM, Paltiel AD, Owen WF Jr et al. Cost-effectiveness of cancer screening in end-stage renal disease. *Arch Intern Med* 1996; 156: 1345–1350.

13. Holley JL. Do dialysis patients need screening colonoscopies and mammograms? *Semin Dial* 2011; 24: 364–365.

14. LeBrun GJ, Diehl LF, Abbott KC et al. Life expectancy benefits of cancer screening in the end-stage renal disease population. *Am J Kidney Dis* 2000; 35: 237–243.

15. Wong G, Webster AC, Chapman JR et al. Reported cancer screening practices of nephrologists: results from a national survey. *Nephrol Dial Transplant* 2009; 24: 2136–2143.

16. Wilt TJ, Harris RP, Qaseem A. Screening for cancer: advice for high-value care from the American College of Physicians. *Ann Intern Med* 2015; 162: 718–725.

17. Ajam M, Ramanujam LS, Gandhi VC et al. Colon-cancer screening in dialysis patients. *Artif Organs* 1990; 14: 95–97.

18. Food and Drug Administration Science Background Paper: Acute Phosphate Nephropathy and Renal Failure Associated With the Use of Oral Sodium Phosphate Bowel Cleansing Products. [http://www.fda.gov/downloads/drugs/drugsafety/postmarketdrugsafetyinformationforpatientsandproviders/ucm161579.pdf](https://www.fda.gov/downloads/drugs/drugsafety/postmarketdrugsafetyinformationforpatientsandproviders/ucm161579.pdf) (12 January 2016, date last accessed).

19. Sood MM, Bota SE, McArthur E et al. The three-year incidence of major hemorrhage among older adults initiating chronic dialysis. *Can J Kidney Health Dis* 2014; 1: 21.

20. Gerson LB. Causes of gastrointestinal hemorrhage in patients with chronic renal failure. *Gastroenterology* 2013; 145: 895–897; discussion 897.

21. Lee YC, Hung SY, Wang HH et al. Different risk of common gastrointestinal disease between groups undergoing hemodialysis or peritoneal dialysis or with non-end stage renal disease: a nationwide population-based cohort study. *Medicine (Baltimore)* 2015; 94: e1482.

22. Smith RA, Cokkinides V, Brawley OW. Cancer screening in the United States, 2008: a review of current American Cancer Society guidelines and cancer screening issues. *CA Cancer J Clin* 2008; 58: 161–179.

23. Instructions for the Fecal Occult Blood Test. [http://www.doh.wa.gov/portals/1/Documents/Pubs/342-052_BCCHPInstructions_for_FOBT.pdf](http://www.doh.wa.gov/portals/1/Documents/Pubs/342-052_BCCHPInstructions_for_FOBT.pdf) (12 January 2016, date last accessed).

24. Nyberg C, Hendel J, Nielsen OH. The safety of osmotically actuated cathartics in colonic cleansing. *Nat Rev Gastroenterol Hepatol* 2010; 7: 557–564.

25. Brunelli SM, Lewis JD, Gupta M et al. Risk of kidney injury following oral phosphosoda bowel preparations. *J Am Soc Nephrol* 2007; 18: 3199–3205.

26. Hurst FP, Bohen EM, Osgard EM et al. Association of oral sodium phosphate purgative use with acute kidney injury. *J Am Soc Nephrol* 2007; 18: 3192–3198.

27. Khurana A, McLean L, Atkinson S et al. The three-year incidence of major hemorrhage among older adults initiating chronic dialysis. *AM J Transplant* 2013; 145: 895–897; discussion 897.

28. Cooper GS, Kout TD, Rex DK. Complications following colonoscopy with anesthesia assistance: a population-based analysis. *JAMA Intern Med* 2013; 173: 551–556.

29. Ko CW, Dominitz JA, Neradilek M et al. Cost-effectiveness of colonoscopy indication from administrative claims data. *Med Care* 2014; 52: e21–e29.

30. Taneja S, Mandayam S, Kayani ZZ et al. Comparison of stage at diagnosis of cancer in patients who are on dialysis versus the general population. *Clin J Am Soc Nephrol* 2007; 2: 1008–1013.