The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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Article title

The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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Keywords

Colorectal neoplasms, general practice, continuity of care, health services research, colonoscopy, surgery

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Article Focus

- Primary health care providers have an important contribution to make in the process of colorectal cancer management. However, in Australia, the extent of GP involvement remains unknown as does their level of influence on the treatment referral pathway.
- We investigated key patient clinical and demographic characteristics associated with seeing a GP between colonoscopy and surgery, for colorectal cancer patients in New South Wales, Australia.
- We also investigated whether seeing a GP leading up to surgery was associated with time between colonoscopy and surgery, choice of treatment centre, or seeing a GP after surgery.

Key Messages

- Less than half (43%) of the patients who had a colonoscopy and surgery saw a GP between the procedures; seeing a GP was associated with poorer health.
- Those who saw a GP pre-surgery had longer time between colonoscopy and surgery, and more commonly saw a GP post-surgery, but were no more likely to have treatment in a specialist cancer centre.
- A more defined approach to CRC management by GPs might be required.

Strengths and Limitations

- A relatively large population-based sample of patients, with reliable GP and surgery information for both public and private hospitals.
- We could not assess other treatment types and surgeon specialties were not known so specialist centres were identified as institutions with radiotherapy facilities.

ABSTRACT

Objectives: To describe general practitioner (GP) involvement in the treatment referral pathway for colorectal cancer (CRC) patients.

Design: A retrospective cohort analysis of linked data.

Setting and participants: A population-based sample of CRC patients diagnosed August 2004 to December 2007 in New South Wales, Australia, using the 45 and Up Study, cancer registry diagnosis records, inpatient hospital records, and Medicare claims records. We analysed 407 CRC patients who had a colonoscopy followed by surgery.

Primary outcome measures: Patterns of GP consultations between diagnosis and surgery. We also investigated whether seeing a GP pre-surgery was associated with time to surgery, having surgery in a specialist cancer centre, or post-surgical GP consultations.

Results: Of the 407 patients, 43% (n=175) had at least one GP consultation between colonoscopy and surgery. The median time from colonoscopy to surgery was 27 days for those with and 15 days for those without an intervening GP consultation. One-quarter (n=99) had their surgery in a specialist cancer centre, with no difference between those who did and did not see a GP pre-surgery (24% and 25% respectively). Fifty-five percent (55%, n=223) had a GP consultation up to 30 days post-surgery; it was more common for cases who saw a GP pre-surgery than for those who did not (65% and 47% respectively, adjusted odds ratio 2.71, 95% confidence interval 1.50-4.89, p=0.001).

Conclusions: Seeing a GP between colonoscopy and surgery was associated with a longer interval between the procedures, and with further GP consultations post-surgery, but not with treatment in a specialist centre. GPs might require a more defined and systematic approach to CRC management.

Keywords

Colorectal cancer, health care delivery, health services research, general practice, continuity of care, colonoscopy, surgery

BACKGROUND

Primary healthcare providers have an important contribution to make in the process of colorectal cancer (CRC) management. General Practitioners (GPs) refer the majority of patients with symptoms or positive screening tests for a diagnostic colonoscopy.[1] Following diagnosis GPs may continue to be involved in the decision-making around definitive treatment and then subsequently during treatment, in providing psychological support, and management of comorbidities and side-effects of cancer treatment.[2-6] The coordination of care during this process is difficult for patients and health professionals given the number and complexity of services involved.[7] Little is known about the extent of primary healthcare worker involvement in or their level of influence on the treatment referral pathway.

A patient may take one of multiple pathways prior and subsequent to diagnosis [8] and the lack of a clear referral pathway [9] may increase the time to treatment. Referrals are most frequently made to surgeons, followed by gastroenterologists and oncologists.[10] In addition, patients often move back and forth between services.[11,12] In Australia, GPs refer patients for diagnostic colonoscopy and can be involved in the patient's subsequent decision to have treatment and post-treatment follow-up. However little is known about the actual level of GP involvement in this pathway, which now also includes referral of patients who come into the referral pathway through the National Bowel Cancer Screening Program. In the program, people turning 50, 55 or 65 are screened using a faecal occult blood test (FOBT), and those with a positive result are sent to their GP who refers them for further investigations.[13] The relationship between the GP and referral specialist may also be an important factor in determining the ongoing role of the GP during and after treatment.[14] One study reported that greater use of primary care pre-diagnosis is associated with better CRC outcomes,[15] although it is a complex relationship that varies across cancer types.[16]

Despite the availability of clinical guidelines,[17] many CRC patients do not receive optimal care.[18,19] The choices GPs make about referral of patients in certain health systems can have profound effects on patient outcomes.[20] A European study reported that 1-year cancer survival was lower in health systems where the GP acted as a “gatekeeper”.[21] Furthermore, a recent systematic review found a significant relationship between hospital case volume and short-term mortality for cancer surgery patients.[22] However, inconsistent results mean the relative importance of surgeon/hospital volume remains unclear, clouding the usefulness of using case volume alone.[22] Nevertheless, treatment in a specialist cancer treatment centre is important for patient care, especially for rectal cancer cases.[23-26]

The aim of this study was to use linked population-based data to describe GP involvement in the referral pathway after diagnosis for CRC in New South Wales (NSW), Australia. Specifically, we sought to determine whether there is an opportunity for GP involvement in patient care, as evidenced by GP consultations in the period between diagnosis and admission for surgery. We were also interested in whether pre-surgical GP consultations were associated with time to surgery, having surgery in a specialist cancer centre, or post-surgical GP consultations.

METHODS

Data sources

The data sources and linkage process for this study have been described in detail elsewhere.[27] Briefly, we used linked records from the population-based 45 and Up Study,[28] the NSW Central Cancer Registry (CCR), the NSW Admitted Patient Data Collection (APDC) and claims for medical services from Medicare Australia. The 45 and Up Study is a cohort study of 266,000 NSW residents aged 45 years or more, sampled from the Medicare Australia registration database.[28] Participants completed baseline questionnaires between January 2006 and May 2008 and consented to linkage to the other data collections used here. CCR records were obtained for people diagnosed with CRC between January 2001 and December 2007, along with APDC hospital separation records from July 2000 to June 2008 and claims for medical services through the Medicare Benefits Scheme (MBS) between June 2004 and January 2009.

Probabilistic linkage between the 45 and Up Study, the CCR and the APDC was done by the Centre for Health Record Linkage,[29] while MBS claims records were linked by the Sax Institute using encrypted Medicare identification numbers. Ethical approvals for the 45 and Up Study, this specific study and the linkage were given by the University of NSW Human Research Ethics Committee and the NSW Population and Health Services Research Ethics Committee. The provision of Medicare records was approved by the Department of Health and Ageing Ethics Committee.

The group of interest comprised 45 and Up Study participants diagnosed with CRC who had both a colonoscopy leading up to their diagnosis and surgical treatment after diagnosis. Included cases were diagnosed from August 2004 to December 2007 and were linked with

the APDC and MBS, so all cases had records for treatments and consultations at least two months prior to and at least 6 months after diagnosis.

The CCR provided data regarding month and year of diagnosis, age, place of residence at diagnosis, disease stage (localised, regional, distant metastases, unknown), and cancer site (colon, rectum (including rectosigmoid junction)). We identified patients' comorbidities from APDC diagnosis codes, including cardiovascular disease, chronic obstructive pulmonary disease (COPD), diabetes, and other diseases in the Charlson Comorbidity Index ("other key comorbidities").[30] Other sociodemographic characteristics (in Table 1) were obtained from the self-completed 45 and Up Study baseline questionnaire.

Procedures and consultations

A specialist clinical panel identified relevant procedure codes and items for consultations, colonoscopies and surgery in the APDC and MBS. GP consultations were indicated by MBS items 1-51, 601-603, 700-719, 5000-5067, 10996-10997. Surgical treatment comprised hemicolectomies, total colectomies, partial colectomies, total proctocolectomies, anterior rectal resections, Hartmann's procedure (rectosigmoidectomy), abdominoperineal resections, and "other" resections of the colon or rectum. Chemotherapy and radiotherapy are generally performed on an outpatient basis, for which data were not available, so they were not included in this study.

Diagnosis dates were available as month and year only, so chronology around diagnosis was based on calendar month and year. However, we were able to analyse the actual dates of GP consultations from the MBS and colonoscopies and surgeries from the APDC and MBS. We included surgical procedures performed in or after the month of diagnosis, and the last pre-surgery colonoscopy no earlier than two months prior to the month of diagnosis. For GP consultations occurring between colonoscopy and surgery, only consultations from the day of

colonoscopy and at least two days prior to surgery were considered, to allow for the consultation to have an impact on the treatment pathway and exclude consultations that were most likely for pre-operative checks.

Outcomes

The primary outcome was the pattern of GP consultations between colonoscopy and treatment. This was then used as the key study factor in examining time between colonoscopy and surgery, receiving surgery in a specialist cancer centre – defined to be an institution having radiotherapy facilities – and patterns of GP consultations following surgery.

Statistical analysis

Chi-square tests were used to compare patient groups and unconditional multivariable logistic regression identified factors associated with the outcomes of interest. Cox's proportional hazards regression was used to investigate factors associated with time between colonoscopy and surgery. Factors of interest included patient characteristics such as age, disease stage and place of residence, along with seeing a GP between colonoscopy and surgery for associations with treatment in a specialist cancer centre, time to surgery, and having a GP consultation after surgery. Having a specialist consultation was considered a possible confounder and was included as a covariate. A small number of patients with missing values for variables of interest were excluded from analyses. All analyses were carried out in SAS version 9.1 (SAS Institute Inc., Cary, NC, US).

RESULTS

The study sample has been described in detail elsewhere.[27] Briefly, 1023 CRC cases diagnosed between January 2001 and December 2007 were identified from the CCR among the first 102,938 participants in the 45 and Up Study. The sample was restricted to 569 CRC cases diagnosed from August 2004 to December 2007 whose identifiers linked to the APDC and MBS. Of these, 407 cases (72%) received surgery in or after the month of diagnosis and had a previous colonoscopy (up to two months before the month of diagnosis) (Figure 1). These 407 are the cases in whose GP consultations we were interested; their characteristics are described in Table 1.

Insert Figure 1 and Table 1 around here

GP consultations between colonoscopy and surgery

Forty-three percent (n=175) of cases having colonoscopy and surgery had at least one GP consultation between the procedures (Figure 2), with 23% having one consultation, 10% having two consultations and 9% having three or more consultations in that time. Of the cases who had a colonoscopy and surgery there were higher odds of seeing a GP between the procedures for those who saw a specialist between the procedures, along with those reporting poorer health, those with diabetes, those without COPD, ever smokers, and those who were diagnosed with CRC after participating in the 45 and Up Study (Table 1).

Insert Figure 2 here

Time between colonoscopy and surgery

The median time from colonoscopy to surgery was 19 days; 27 days for those with and 15 days for those without an intervening GP consultation (Figure 2). The time to surgery was more than 28 days for 43% of cases seeing a GP compared to 15% of cases who did not see a GP. For those seeing a GP the median time from colonoscopy to the first GP consultation was 7 days and the median time of the last consultation prior to surgery was 10 days (including multiple GP consultations, excluding those 1 or 2 days pre-surgery). After adjusting for all covariates, the time from colonoscopy to surgery remained significantly longer for cases seeing a GP between procedures than for those who did not. This was also true for those who saw a specialist between procedures compared with those who did not, and for rectal cancer cases compared with colon cancer cases (Table 2). Separate analyses for colon and rectal cancer cases found that for both cancer types there was a longer time to surgery for those seeing a GP or a specialist between procedures (Table 3).

Insert Table 2 & Table 3 here

Treatment in a specialist cancer centre

Twenty-four percent (n=99) of cases had their surgery in a specialist cancer centre; 24% of those with and 25% of those without a pre-surgery GP consultation. An additional 17% had a non-surgical admission to a specialist cancer centre within the study period. After adjusting for all measured characteristics there was no association between seeing a GP pre-surgery and having the surgery in a specialist cancer centre (odds ratio [OR] 1.22 vs no pre-surgical GP consultation, 95% confidence interval [CI] 0.64-2.35, p=0.54). Having rectal cancer was also not associated with greater use of a specialist cancer centre (OR 1.16 vs colon cancer, 95% CI 0.63-2.16, p=0.63). In a separate analysis for rectal cancer cases, though limited by smaller cell sizes, there was no association between seeing a GP pre-surgery and being treated in a specialist cancer centre (OR 0.84, 95% CI 0.27-2.63, p=0.76).

GP consultations after treatment

Twenty-six percent (26%, n=106) of cases had a GP consultation up to two weeks post-surgery, 55% (n=223) saw a GP up to 30 days post-surgery and 80% (n=327) saw a GP up to 3 months post-surgery. After adjusting for all covariates, cases who saw a GP in the interval between colonoscopy and surgery were more likely to see a GP in the 30 days post-surgery (65% vs 47% for those not seeing a GP pre-surgery, OR 2.71, 95% CI 1.50-4.89, p=0.001).

DISCUSSION

Around two in five newly-diagnosed CRC cases who had colonoscopy and surgery had a GP consultation between the two procedures, potentially allowing the GP to have some influence in individual patient's treatment pathways. Seeing a GP in this time was associated with longer time to surgery (but not necessarily causally) and seeing a GP post-surgery, but not with treatment in a specialist cancer centre.

Seeing a GP between colonoscopy and surgery was more likely for cases with poorer self-reported health, those with diabetes, those without COPD, and those who had ever been a smoker. Almost half of the cases who saw a GP between the procedures had more than one consultation in this time period. This suggests that GPs may be seeing the most appropriate group: coordinating the care of those patients at higher risk because of poor general health.

The time from colonoscopy to surgery was substantially longer (a difference in medians of 12 days) for cases who saw a GP between the procedures, even after adjustment for cancer site, comorbidities, disadvantage and health status. However, we were unable to determine whether there was a causal link between GP consultations and time to surgery; it may be that a longer time simply allows a greater opportunity for GP consultations in the interval. It could also be due to more patients who consulted a GP having pre-surgical radiotherapy. If increased time to surgery was a consequence of the engagement of the GP this may have allowed a more considered decision by the GP about the optimal referral pathway with the increased interval being unlikely to have a material influence on the physical outcome, although it may raise psychological issues for the patient.[31,32] It is worth considering if there are other ways in which GPs could be involved in decisions regarding care following diagnosis that do not increase the interval between diagnosis and treatment. This might

include arranging follow-up GP visits sooner after the colonoscopy, especially as the first GP consultation was a median of 7 days afterwards. It might also include earlier email, text or telephone communication between the GP and patient to initiate referral.

Seeing a GP prior to surgery was not associated with having the surgical procedure in a specialist cancer centre. Around 1 in 4 patients had their surgery in a specialist cancer centre, while less than half were admitted to a specialist cancer centre at some point. This suggests an under-utilisation of specialist cancer centres, in particular for rectal cancer patients.[25,26]

Seeing a GP after surgery was more likely for cases who saw a GP in the lead-up to surgery, suggesting greater continuity of primary care for these cases. Again this might be especially appropriate for those who had comorbidities or poorer health status. It might also assist lower socioeconomic patients who, because of poorer health literacy, may have had more difficulty navigating the complexities of the healthcare system.

This study is subject to a number of limitations. The 45 and Up Study had a response rate of 18% (similar to other cohort studies of this nature) and oversampled people from rural areas. While 45 and Up Study participants resemble the general population in many respects, they are in general of higher socioeconomic status and more 'healthy'.[33] However, empirical data from the study show risk estimates relating to a wide range of exposures and outcomes in the cohort are very similar to those calculated using 'representative' population survey data.[33] We didn't include treatment with chemotherapy or radiotherapy as the available data were not comprehensive for all people receiving these treatments. Specialist cancer centres were identified as institutions with radiotherapy facilities. It is difficult to sort out cause and effect of GP visits and an increased interval between diagnosis and surgery using these data alone as the Medicare data do not identify the reasons for GP visits. It may have been in relation to CRC or some other pre-existing illness. Similarly, we could not determine the nature of

specialist consultations, and longer time to surgery for those with a specialist consultation could be beneficial if it means patients are getting the most appropriate treatment.

The National Bowel Cancer Screening Program commenced in August 2006,[13] so this study does not fully address what happens in the presence of the screening program. Within this program, a GP refers a patient to colonoscopy after a positive FOBT result and is then involved in the referral process for cases diagnosed with CRC. The program is being expanded to include people in other age groups,[13] giving further opportunity for GP involvement. This means there is some urgency to optimise potential benefits of engagement of GPs (e.g. in providing better guidance about where to refer), and a need to address potential reasons for an increased interval between diagnosis and surgery associated with seeing a general practitioner, especially for patients with rectal cancer.

Conclusion

This is one of the first studies to examine the role of the GP in the pathway following CRC diagnosis and prior to surgery. Less than half of the patients had a GP consultation in this period but those who did appeared to be among those who most needed it. The association between seeing a GP pre-treatment and post-treatment is a strong rationale for GP engagement in the early stages of the patient pathway and will improve longer-term continuity of care. Further research is needed to explore the directions of the association between GP visits and the interval between diagnosis and surgery. However a more systematic approach might be needed for GP involvement in the treatment pathway, perhaps including official guidelines from primary care/GP organisations. This would not only encourage GP engagement but also ensure that this does not lead to unnecessary delays.

TABLES

Table 1. *Characteristics of colorectal cancer (CRC) cases diagnosed between August 2004 and December 2007 who had colonoscopy and surgery, and characteristics associated with seeing a GP between colonoscopy and surgery (n=407).*

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Sex						0.79
Female	152	64	42	1.10	0.56-2.15	
Male	255	111	44	1.00	(ref)	
Age						0.77
<60	78	28	36	1.38	0.58-3.30	
60-69	108	42	39	1.13	0.57-2.28	
70-79	150	75	50	1.00	(ref)	
80+	71	30	42	1.50	0.62-3.65	
Country of birth						0.09
Australia	320	141	44	1.00	(ref)	
Other	81	30	37	0.50	0.22-1.12	
Unknown	6	4	67	not incl.	not incl.	
Language spoken at home						0.41
English	377	163	43	1.00	(ref)	
Non-English	30	12	40	0.59	0.17-2.06	
Place of residence at diagnosis						0.62
Metropolitan	186	75	40	1.00	(ref)	
Other urban	103	45	44	0.63	0.24-1.62	
Rural	118	55	47	1.65	0.58-4.69	
Type of housing						0.93
House	296	130	44	1.00	(ref)	
Flat/unit	50	19	38	1.17	0.46-2.93	
House on farm	28	12	43	1.22	0.40-3.66	
Elderly accommodation	26	11	42	0.79	0.24-2.58	
Other/unspecified	7	3	43	not incl.	not incl.	
Socioeconomic status						0.27
Least disadvantaged quintile	143	54	38	1.00	(ref)	
Quintile 2	64	28	44	1.65	0.58-4.69	
Quintile 3	126	55	44	1.17	0.43-3.21	
Quintile 4	58	28	48	2.40	0.87-6.60	
Most disadvantaged quintile	16	10	63	3.18	0.63-16.01	
Highest education level attained						0.27
No School Certificate/Other	48	22	46	1.20	0.47-3.09	
School/Intermediate Certificate	102	41	40	1.00	(ref)	
Higher School/Leaving Certificate	28	12	43	1.49	0.47-4.67	
Trade/Apprenticeship	56	21	38	1.01	0.40-2.55	
Certificate/Diploma	83	36	43	1.47	0.63-3.43	
University degree or higher	80	37	46	2.94	1.19-7.26	
Unspecified	10	6	60	not incl.	not incl.	
Marital status						0.08
Married / Living as married	288	120	42	1.00	(ref)	
Single / Divorced / Separated	51	28	55	2.65	1.11-6.30	
Widowed	65	26	40	1.03	0.44-2.39	
Unspecified	3	1	33	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	51	46	1.00	(ref)	
$20K-<$40K p.a.	83	45	54	1.79	0.76-4.25	
$40K-<$70K p.a.	62	22	35	0.68	0.26-1.75	
$70K+ p.a.	52	15	29	0.56	0.19-1.68	
Unspecified	98	42	43	0.74	0.33-1.67	

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.19
Private with extras	190	83	44	1.00	(ref)	
Private no extras	70	26	37	0.45	0.21-0.97	
DVA/Healthcare card	101	46	46	1.20	0.55-2.62	
None of these	37	16	43	0.67	0.24-1.85	
Missing	9	4	44	1.24	0.24-6.47	
Body Mass Index (BMI)[c]						0.21
Underweight/Normal (<25kg/m^2)	155	59	38	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	69	44	1.56	0.83-2.93	
Obese/Morbidly obese (>=30kg/m^2)	66	31	47	1.30	0.58-2.94	
Null/Not specified	29	16	55	2.93	0.98-8.74	
Smoking status						0.05
Never smoker	203	80	39	1.00	(ref)	
Ever smoker	204	95	47	1.81	1.01-3.26	
Self-reported health status						0.002
Good-Excellent	307	115	37	1.00	(ref)	
Fair/Poor	78	47	60	2.76	1.30-5.82	
Unspecified	22	13	59	5.60	1.59-19.81	
Cardiovascular disease						0.11
Yes	47	26	55	2.09	0.85-5.13	
No	360	149	41	1.00	(ref)	
COPD						0.04
Yes	29	10	34	0.30	0.09-0.95	
No	378	165	44	1.00	(ref)	
Diabetes						0.001
Yes	50	33	66	5.15	2.02-13.16	
No	357	142	40	1.00	(ref)	
Other key comorbidities						0.88
Yes	56	26	46	0.94	0.40-2.18	
No	351	149	42	1.00	(ref)	
Family history of CRC						0.51
Yes	75	37	49	1.27	0.63-2.57	
No	332	138	42	1.00	(ref)	
Disease stage						0.08
Localised	185	73	39	1.00	(ref)	
Regional	176	76	43	1.66	0.91-3.02	
Distant metastases	27	13	48	1.57	0.47-5.19	
Unknown	19	13	68	5.05	1.35-18.91	
Cancer site						0.52
Colon	265	114	43	1.00	(ref)	
Rectum	142	61	43	1.21	0.68-2.18	
Year of diagnosis						0.64
2004	43	17	40	1.24	0.46-3.36	
2005	113	43	38	0.93	0.44-1.93	
2006	111	56	50	1.46	0.72-2.95	
2007	140	59	42	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.01
Before (prevalent)	327	131	40	0.35	0.16-0.75	
After (incident)	80	44	55	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						<0.0001
Yes	285	156	55	17.64	7.71-40.34	
No	122	19	16	1.00	(ref)	

[a] Adjusted for all other variables in this table; [b] Overall p-value from multivariable logistic regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in logistic regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 2. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer (CRC) surgery for all CRC cases (n=407).*

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
GP consultation between colonoscopy and surgery						<0.0001
Yes	175	27	18-42	0.44	0.34-0.58	
No	232	15	8-23	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						0.002
Yes	285	21	14-35	0.62	0.47-0.84	
No	122	13	7-22	1.00	(ref)	
Sex						0.53
Female	152	19	12-28	1.10	0.82-1.46	
Male	255	20	12-31	1.00	(ref)	
Age						0.33
<60	78	17	8-29	0.78	0.54-1.13	
60-69	108	19	13-32	0.80	0.59-1.09	
70-79	150	21	12-29	1.00	(ref)	
80+	71	20	12-28	1.05	0.73-1.52	
Country of birth						0.34
Australia	320	19	13-29	1.00	(ref)	
Other	81	19	8-30	0.85	0.61-1.19	
Unknown	6	12	10-40	not incl.	not incl.	
Language spoken at home						0.20
English	377	19	12-29	1.00	(ref)	
Non-English	30	21	10-38	1.40	0.84-2.31	
Place of residence at diagnosis						0.95
Metropolitan	186	19	11-28	1.00	(ref)	
Other urban	103	20	13-28	1.07	0.71-1.63	
Rural	118	20	11-33	1.04	0.69-1.57	
Type of housing						0.63
House	296	19	12-29	1.00	(ref)	
Flat/unit	50	19	10-29	0.93	0.64-1.35	
House on farm	28	21	12-48	0.76	0.48-1.20	
Elderly accommodation	26	22	17-42	0.86	0.53-1.40	
Other/unspecified	7	29	19-31	not incl.	not incl.	
Socioeconomic status						0.13
Least disadvantaged quintile	143	17	11-28	1.00	(ref)	
Quintile 2	64	20	12-34	0.94	0.60-1.46	
Quintile 3	126	20	8-29	1.24	0.80-1.92	
Quintile 4	58	22	14-33	0.82	0.53-1.26	
Most disadvantaged quintile	16	22	14-27	1.60	0.80-3.19	
Highest education level attained						0.53
No School Certificate/Other	48	20	14-31	1.09	0.74-1.60	
School/Intermediate Certificate	102	22	16-33	1.00	(ref)	
Higher School/Leaving Certificate	28	18	12-34	0.96	0.59-1.56	
Trade/Apprenticeship	56	18	13-28	1.36	0.92-2.00	
Certificate/Diploma	83	20	10-29	0.94	0.68-1.32	
University degree or higher	80	16	8-36	1.16	0.80-1.70	
Unspecified	10	13	3-22	not incl.	not incl.	
Marital status						0.09
Married / Living as married	288	24	12-37	1.00	(ref)	
Single / Divorced / Separated	51	18	11-28	1.04	0.72-1.52	
Widowed	65	22	17-34	0.69	0.48-0.97	
Unspecified	3	20	9-21	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	21	14-31	1.00	(ref)	
$20K-<$40K p.a.	83	21	13-31	1.03	0.71-1.49	
$40K-<$70K p.a.	62	18	9-35	0.83	0.56-1.23	
$70K+ p.a.	52	13	8-29	1.50	0.95-2.35	
Unspecified	98	19	13-28	1.19	0.85-1.66	

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.42
Private with extras	190	18	9-28	1.00	(ref)	
Private no extras	70	17	11-28	1.01	0.73-1.40	
DVA/Healthcare card	101	21	14-29	0.90	0.66-1.24	
None of these	37	28	19-41	0.67	0.44-1.03	
Missing	9	25	16-28	1.09	0.51-2.33	
Body Mass Index (BMI)[c]						0.48
Underweight/Normal (<25kg/m^2)	155	18	10-28	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	20	12-35	0.86	0.66-1.13	
Obese/Morbidly obese (>=30kg/m^2)	66	22	13-31	0.95	0.68-1.34	
Null/Not specified	29	19	11-29	0.72	0.45-1.15	
Smoking status						0.33
Never smoker	203	19	10-29	1.00	(ref)	
Ever smoker	204	19	12-30	1.13	0.89-1.44	
Self-reported health status						0.37
Good-Excellent	307	18	11-29	1.00	(ref)	
Fair/Poor	78	21	15-40	0.89	0.64-1.23	
Unspecified	22	22	14-28	0.70	0.41-1.21	
Cardiovascular disease						0.77
Yes	47	20	9-29	0.95	0.65-1.38	
No	360	19	12-30	1.00	(ref)	
COPD						0.47
Yes	29	20	11-27	1.19	0.74-1.92	
No	378	19	12-30	1.00	(ref)	
Diabetes						0.18
Yes	50	26	14-36	1.30	0.89-1.90	
No	357	19	11-29	1.00	(ref)	
Other key comorbidities						0.67
Yes	56	20	12-29	1.08	0.76-1.52	
No	351	19	12-30	1.00	(ref)	
Family history of CRC						0.99
Yes	75	20	13-33	1.00	0.75-1.34	
No	332	19	12-29	1.00	(ref)	
Disease stage						0.08
Localised	185	19	13-29	1.00	(ref)	
Regional spread	176	19	10-29	1.16	0.91-1.48	
Distant metastases	27	20	12-39	0.73	0.43-1.21	
Unknown	19	35	13-48	0.65	0.37-1.16	
Cancer site						<0.0001
Colon	265	18	10-27	1.00	(ref)	
Rectum	142	22	14-37	0.58	0.45-0.74	
Year of diagnosis						0.53
2004	43	19	9-26	1.32	0.86-2.02	
2005	113	19	12-29	1.01	0.75-1.37	
2006	111	21	14-32	1.13	0.84-1.52	
2007	140	18	11-32	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.61
Before (prevalent)	327	19	11-29	1.09	0.79-1.50	
After (incident)	80	21	14-31	1.00	(ref)	

[a] Adjusted for all other variables in this table (hazard ratio <1 indicates longer time between colonoscopy and surgery); [b] Overall p-value from Cox proportional hazards regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in proportional hazards regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 3. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer surgery, for colon and rectum cancer cases.*

	Colon cancer (n=265)			Rectal cancer (n=142)		
Category	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**
GP consultation between colonoscopy and surgery			0.001			<0.0001
Yes	0.54	0.38-0.79		0.25	0.13-0.48	
No	1.00	(ref)		1.00	(ref)	
Specialist consultation between colonoscopy and surgery			0.01			0.01
Yes	0.57	0.38-0.86		0.41	0.21-0.79	
No	1.00	(ref)		1.00	(ref)	
Country of birth[c]			0.36			0.01
Australia	1.00	(ref)		1.00	(ref)	
Other	1.22	0.80-1.87		0.37	0.17-0.78	
Marital status[c]			0.28			0.02
Married/Living as married	1.00	(ref)		1.00	(ref)	
Single/Divorced/Separated	0.92	0.54-1.58		1.52	0.70-3.26	
Widowed	0.68	0.42-1.10		0.42	0.20-0.86	
Income level			0.13			0.03
<$20K p.a.	1.00	(ref)		1.00	(ref)	
$20K-<$40K p.a.	0.78	0.46-1.31		0.65	0.32-1.33	
$40K-<$70K p.a.	0.85	0.50-1.44		0.30	0.12-0.75	
$70K+ p.a.	1.62	0.88-2.99		0.52	0.19-1.41	
Unspecified	0.91	0.58-1.42		1.07	0.52-2.21	
Health insurance			0.02			0.01
Private with extras	1.00	(ref)		1.00	(ref)	
Private no extras	0.67	0.43-1.04		1.71	0.88-3.33	
DVA/Healthcare card	0.54	0.36-0.80		3.36	1.56-7.24	
None of these	0.51	0.27-0.95		0.79	0.35-1.78	
Missing	0.46	0.14-1.58		2.09	0.63-6.99	
Disease stage			0.02			0.72
Localised	1.00	(ref)		1.00	(ref)	
Regional spread	1.17	0.85-1.62		0.79	0.48-1.30	
Distant metastases	0.66	0.35-1.25		0.60	0.18-2.01	
Unknown	0.43	0.21-0.89		1.13	0.29-4.38	

[a] *Adjusted for all other variables in this table, as well as for sex, age, language spoken at home, place of residence at diagnosis, type of housing, socioeconomic status, education level, BMI, smoking status, self-reported health status, comorbidities, family history of colorectal cancer, year of diagnosis and diagnosis before/after completing study questionnaire. The variables not shown in the table were not associated with time to surgery for colon or rectal cancers. Hazard ratio <1 indicates longer time between colonoscopy and surgery.*

[b] *Overall p-value from Cox proportional hazards regression*

[c] *Excludes missing values (n=6 for country of birth, n=3 for marital status, n=9 overall)*

(ref): reference category

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COMPETING INTERESTS

No funding agreements limit the authors' ability to fairly complete and publish this research and the authors have no potential conflicts of interest to declare.

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AUTHORS' CONTRIBUTIONS

DO'C and MH helped conceive the study, advised on the data analysis and helped draft the manuscript. DG assisted with obtaining the data and data management, undertook the analysis and drafted the manuscript. SP, AS, CV, DW, IO, JB and MB helped conceive of the study, participated in its coordination, and helped draft the manuscript. All authors read and approved the final manuscript.

DATA SHARING

There are no additional data available.

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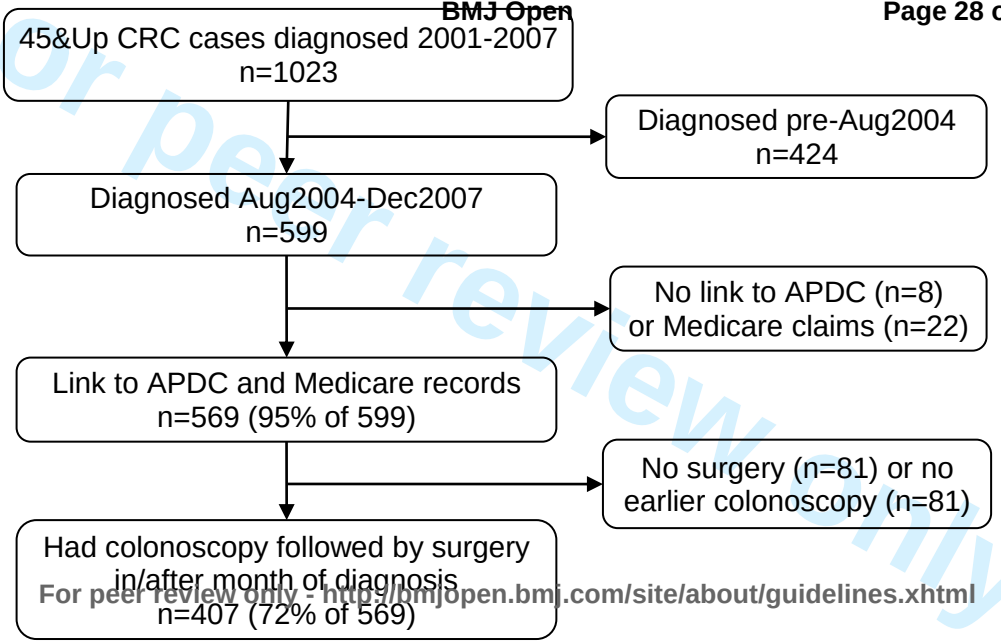
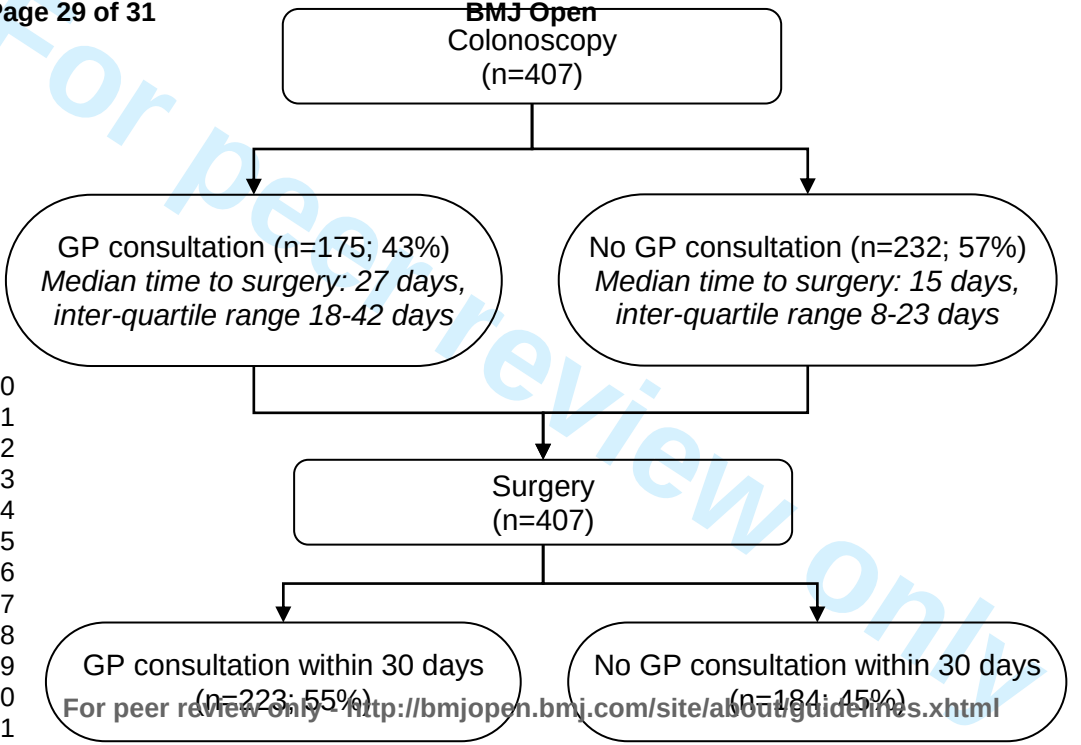
FIGURES

Figure 1. Selection of cases with colorectal cancer (CRC) for analysis.

Figure 2. Flowchart of procedures and consultations for the 407 colorectal cancer cases who had a colonoscopy and surgery.





STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	4-5
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8-11
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8-10
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	8-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, explain how loss to follow-up was addressed	-
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13, 27 (Figure 1)
		(b) Give reasons for non-participation at each stage	11, 27 (Figure 1)
		(c) Consider use of a flow diagram	27 (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11, 17-21 (Tables)
		(b) Indicate number of participants with missing data for each variable of interest	17-21 (Tables)
		(c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	17-21 (Tables)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-13, 17-21 (Tables)
		(*b*) Report category boundaries when continuous variables were categorized	17-21 (Tables)
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-15
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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Colorectal neoplasms, general practice, continuity of care, health services research, colonoscopy, surgery

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Abstract word count: 280

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Article Focus

- Primary health care providers have an important contribution to make in the process of colorectal cancer management. However, in Australia, the extent of GP involvement remains unknown as does their level of influence on the treatment referral pathway.
- We investigated key patient clinical and demographic characteristics associated with consulting a GP between colonoscopy and surgery (i.e. between diagnosis and treatment), for colorectal cancer patients in New South Wales, Australia.
- We also investigated whether consulting a GP leading up to surgery was associated with time between colonoscopy and surgery, choice of treatment centre, or consulting a GP after surgery.

Key Messages

- Less than half (43%) of the patients who had a colonoscopy and surgery consulted a GP between the procedures; consulting a GP was associated with poorer health.
- Those who consulted a GP pre-surgery had longer time between colonoscopy and surgery, and more commonly consulted a GP post-surgery, but were no more likely to have treatment in a multidisciplinary cancer centre with radiotherapy facilities.
- A more defined approach to CRC management by GPs might be required.

Strengths and Limitations

- A relatively large population-based sample of patients, with reliable information on GP consultations and surgical treatmentfor both public and private hospitals.
- We could not assess other treatment types and surgeon specialties were not known so multidisciplinary cancer centres were identified as institutions with radiotherapy facilities.

ABSTRACT

Objectives: To describe general practitioner (GP) involvement in the treatment referral pathway for colorectal cancer (CRC) patients.

Design: A retrospective cohort analysis of linked data.

Setting and participants: A population-based sample of CRC patients diagnosed August 2004 to December 2007 in New South Wales, Australia, using the 45 and Up Study, cancer registry diagnosis records, inpatient hospital records, and Medicare claims records. We analysed 407 CRC patients who had a colonoscopy followed by surgery.

Primary outcome measures: Patterns of GP consultations between colonoscopy and surgery (i.e. between diagnosis and treatment). We also investigated whether consulting a GP pre-surgery was associated with time to surgery, having surgery in a multidisciplinary cancer centre with radiotherapy facilities, or post-surgical GP consultations.

Results: Of the 407 patients, 43% (n=175) had at least one GP consultation between colonoscopy and surgery. The median time from colonoscopy to surgery was 27 days for those with and 15 days for those without an intervening GP consultation. One-quarter (n=99) had their surgery in a multidisciplinary cancer centre with radiotherapy facilities, with no difference between those who did and did not consult a GP pre-surgery (24% and 25% respectively). Fifty-five percent (55%, n=223) had a GP consultation up to 30 days post-surgery; it was more common for cases who consulted a GP pre-surgery than for those who did not (65% and 47% respectively, adjusted odds ratio 2.71, 95% confidence interval 1.50-4.89, p=0.001).

Conclusions: Consulting a GP between colonoscopy and surgery was associated with a longer interval between diagnosis and treatment, and with further GP consultations post-surgery, but not with treatment in a multidisciplinary cancer centre with radiotherapy facilities. GPs might require a more defined and systematic approach to CRC management.

Keywords

Colorectal cancer, health care delivery, health services research, general practice, continuity of care, colonoscopy, surgery

BACKGROUND

Primary healthcare providers have an important contribution to make in the process of colorectal cancer (CRC) management. General Practitioners (GPs) refer the majority of patients with symptoms or positive screening tests for a diagnostic colonoscopy.[1] Following diagnosis GPs may continue to be involved in the decision-making around definitive treatment and then subsequently during treatment, in providing psychological support, and management of comorbidities and side-effects of cancer treatment.[2-6] The coordination of care during this process is difficult for patients and health professionals given the number and complexity of services involved.[7] Little is known about the extent of primary healthcare worker involvement in or their level of influence on the treatment referral pathway.

A patient may take one of multiple pathways prior and subsequent to diagnosis [8] and the lack of a clear referral pathway [9] may increase the time to treatment. Referrals are most frequently made to surgeons, followed by gastroenterologists and oncologists.[10] In addition, patients often move back and forth between services.[11,12] In Australia, GPs refer patients for diagnostic colonoscopy and can be involved in the patient's subsequent decision to have treatment and post-treatment follow-up. However little is known about the actual level of GP involvement in this pathway, which now also includes referral of patients who come into the referral pathway through the National Bowel Cancer Screening Program. In the program, people turning 50, 55 or 65 are screened using a faecal occult blood test (FOBT), and those with a positive result are sent to their GP who refers them for further investigations.[13] The relationship between the GP and referral specialist may also be an important factor in determining the ongoing role of the GP during and after treatment.[14] One study reported that greater use of primary care pre-diagnosis is associated with better CRC outcomes,[15] although it is a complex relationship that varies across cancer types.[16]

Despite the availability of clinical guidelines,[17] many CRC patients do not receive optimal care.[18,19] The choices GPs make about referral of patients in certain health systems can have profound effects on patient outcomes.[20] A European study reported that 1-year cancer survival was lower in health systems where the GP acted as a “gatekeeper”.[21] Furthermore, a recent systematic review found a significant relationship between hospital case volume and short-term mortality for cancer surgery patients.[22] However, inconsistent results mean the relative importance of surgeon/hospital volume remains unclear, clouding the usefulness of using case volume alone.[22] Nevertheless, treatment in a multidisciplinary cancer centre with radiotherapy facilities is important for patient care, especially for rectal cancer cases.[23-26]

The aim of this study was to use linked population-based data to describe GP involvement in the referral pathway after diagnosis for CRC in New South Wales (NSW), Australia.This is one part of a four-phase study that also includes an audit of surgeons’ referral letters and focus groups with clinicians and patients relating to the treatment referral pathway.[27-29] In this phase we sought to determine whether there is an opportunity for GP involvement in patient care, as evidenced by GP consultations in the period between diagnosis and admission for surgery. We were also interested in whether pre-surgical GP consultations were associated with time to surgery, having surgery in a multidisciplinary cancer centre with radiotherapy facilities, or post-surgical GP consultations.

METHODS

Data sources

The data sources and linkage process for this study have been described in detail elsewhere.[28] Briefly, we used linked records from the population-based 45 and Up Study,[30] the NSW Central Cancer Registry (CCR), the NSW Admitted Patient Data Collection (APDC) and claims for medical services from Medicare Australia. The 45 and Up Study is a cohort study of 266,000 NSW residents aged 45 years or more, sampled from the Medicare Australia registration database.[30] Participants completed baseline questionnaires between January 2006 and May 2008 and consented to linkage to the other data collections used here. CCR records were obtained for people diagnosed with CRC between January 2001 and December 2007, along with APDC hospital separation records from July 2000 to June 2008 and claims for medical services through the Medicare Benefits Scheme (MBS) between June 2004 and January 2009.

Probabilistic linkage between the 45 and Up Study, the CCR and the APDC was done by the Centre for Health Record Linkage,[31] as described previously, resulting in approximately 0.1% false positive and <0.1% false negative linkages.[28] MBS claims records were linked by the Sax Institute using encrypted Medicare identification numbers. Ethical approvals for the 45 and Up Study, this specific study and the linkage were given by the University of NSW Human Research Ethics Committee and the NSW Population and Health Services Research Ethics Committee. The provision of Medicare records was approved by the Department of Health and Ageing Ethics Committee.

The group of interest comprised 45 and Up Study participants diagnosed with CRC who had both a colonoscopy leading up to their diagnosis and surgical treatment after diagnosis.

Included cases were diagnosed from August 2004 to December 2007 and were linked with the APDC and MBS, so all cases had records for treatments and consultations at least two months prior to and at least 6 months after diagnosis.

The CCR provided data regarding month and year of diagnosis, age, place of residence at diagnosis, disease stage (localised, regional, distant metastases, unknown), and cancer site (colon, rectum including rectosigmoid junction). We identified patients' comorbidities from APDC diagnosis codes, including cardiovascular disease, chronic obstructive pulmonary disease (COPD), diabetes, and other diseases in the Charlson Comorbidity Index ("other key comorbidities").[32] Other sociodemographic characteristics (in Table 1) were obtained from the self-completed 45 and Up Study baseline questionnaire.

Procedures and consultations

A specialist clinical panel identified relevant procedure codes and items for consultations, colonoscopies and surgery in the APDC and MBS. GP consultations were indicated by MBS items 1-51, 601-603, 700-719, 5000-5067, 10996-10997. Surgical treatment comprised hemicolectomies, total colectomies, partial colectomies, total proctocolectomies, anterior rectal resections, Hartmann's procedure (rectosigmoidectomy), abdominoperineal resections, and "other" resections of the colon or rectum. Previous studies have shown that these data sources record over 90% of colonoscopies and surgical treatment for cancer patients.[33,34] Chemotherapy and radiotherapy are generally performed on an outpatient basis, for which data were not available, so they were not included in this study.

Diagnosis dates were available as month and year only, so chronology around diagnosis was based on calendar month and year. However, we were able to analyse the actual dates of GP consultations from the MBS and colonoscopies and surgeries from the APDC and MBS. We included surgical procedures performed in or after the month of diagnosis, and the last pre-

surgery colonoscopy no earlier than two months prior to the month of diagnosis. For GP consultations occurring between colonoscopy and surgery, only consultations from the day of colonoscopy and at least two days prior to surgery were considered, to allow for the consultation to have an impact on the treatment pathway and exclude consultations that were most likely for pre-operative checks.

Outcomes

The primary outcome was the pattern of GP consultations between colonoscopy andsurgery. This was then used as the key study factor in examining time between colonoscopy and surgery, receiving surgery in a multidisciplinary cancer centre with radiotherapy facilities, and patterns of GP consultations following surgery.

Statistical analysis

Chi-square tests were used to compare patient groups and unconditional multivariable logistic regression identified factors associated with the outcomes of interest. Cox's proportional hazards regression was used to investigate factors associated with time between colonoscopy and surgery. Factors of interest included patient characteristics such as age, disease stage and place of residence. Consulting a GP between diagnosis and treatment was analysed for associations with treatment in a multidisciplinary cancer centre with radiotherapy facilities, time to surgery, and having a GP consultation after surgery. Having a specialist consultation was considered a possible confounder and was included as a covariate. A small number of patients with missing values for variables of interest were excluded from analyses. All analyses were carried out in SAS version 9.1 (SAS Institute Inc., Cary, NC, US).

RESULTS

The study sample has been described in detail elsewhere.[28] Briefly, 1023 CRC cases diagnosed between January 2001 and December 2007 were identified from the CCR among the first 102,938 participants in the 45 and Up Study. The sample was restricted to 569 CRC cases diagnosed from August 2004 to December 2007 whose identifiers linked to the APDC and MBS. Of these, 407 cases (72%) received surgery in or after the month of diagnosis and had a previous colonoscopy (up to two months before the month of diagnosis) (Figure 1). These 407 are the cases in whose GP consultations we were interested; their characteristics are described in Table 1.

Insert Figure 1 and Table 1 around here

GP consultations between diagnosis and treatment

Forty-three percent (n=175) of the 407 cases had at least one GP consultation between diagnosis and treatment (Figure 2), with 23% having one consultation, 10% having two consultations and 9% having three or more consultations in that time. There were higher odds of consulting a GP between diagnosis and treatment for those who consulted a specialist prior to surgery, along with those reporting poorer health, those with diabetes, those without COPD, ever smokers, and those who were diagnosed with CRC after participating in the 45 and Up Study (Table 1).

Insert Figure 2 here

Time between diagnosis and treatment

The median time from colonoscopy to surgery was 19 days; 27 days for those with and 15 days for those without an intervening GP consultation (Figure 2). The time to surgery was more than 28 days for 43% of cases consulting a GP compared to 15% of cases who did not

consult a GP. For those consulting a GP the median time from colonoscopy to the first GP consultation was 7 days and the median time of the last consultation prior to surgery was 10 days (including multiple GP consultations, excluding those 1 or 2 days pre-surgery). After adjusting for all covariates, the time from diagnosis to treatment remained significantly longer for cases who consulted a GP between diagnosis and treatment than for those who did not. This was also true for those who consulted a specialist between diagnosis and treatment compared with those who did not, and for rectal cancer cases compared with colon cancer cases (Table 2). Separate analyses for colon and rectal cancer cases found that for both cancer types there was a longer time to surgery for those consulting a GP or a specialist between diagnosis and treatment (Table 3).

Insert Table 2 & Table 3 here

Treatment in a multidisciplinary cancer centre with radiotherapy facilities

Twenty-four percent (n=99) of cases had their surgery in a multidisciplinary cancer centre with radiotherapy facilities; 24% of those with and 25% of those without a pre-surgery GP consultation. An additional 17% had a non-surgical admission to a multidisciplinary cancer centre with radiotherapy facilities within the study period. After adjusting for all measured characteristics there was no association between consulting a GP pre-surgery and having the surgery in a multidisciplinary cancer centre with radiotherapy facilities (odds ratio [OR] 1.22 vs no pre-surgical GP consultation, 95% confidence interval [CI] 0.64-2.35, p=0.54). Patients with rectal cancer were not more or less likely to have surgery in a multidisciplinary cancer centre with radiotherapy facilities (OR 1.16 vs colon cancer, 95% CI 0.63-2.16, p=0.63). In a separate analysis for rectal cancer cases, though limited by smaller cell sizes, there was no association between consulting a GP pre-surgery and being treated in a multidisciplinary cancer centre with radiotherapy facilities (OR 0.84, 95% CI 0.27-2.63, p=0.76).

GP consultations after treatment

Twenty-six percent (26%, n=106) of cases had a GP consultation up to two weeks post-surgery, 55% (n=223) consulted a GP up to 30 days post-surgery and 80% (n=327) consulted a GP up to 3 months post-surgery. After adjusting for all covariates, cases who consulted a GP in the interval between diagnosis and treatment were more likely to consult a GP in the 30 days post-surgery (65% vs 47% for those not consulting a GP pre-surgery, OR 2.71, 95% CI 1.50-4.89, p=0.001).

DISCUSSION

Around two in five newly-diagnosed CRC cases who had colonoscopy and surgery had a GP consultation between diagnosis and treatment, potentially allowing the GP to have some influence in individual patient's treatment pathways. Having a GP consultation in this time was associated with longer time to surgery (but not necessarily causally) and consulting a GP post-surgery, but not with treatment in a multidisciplinary cancer centre with radiotherapy facilities.

Having a GP consultation between diagnosis and treatment was more likely for cases with poorer self-reported health, those with diabetes, those without COPD, and those who had ever been a smoker. Almost half of the cases who consulted a GP between diagnosis and treatment had more than one consultation in this time period. This suggests that GP consultations may be occurring for the most appropriate group: coordinating the care of those patients at higher risk because of poor general health.

The time from colonoscopy to surgery was substantially longer (a difference in medians of 12 days) for cases who consulted a GP between diagnosis and treatment, even after adjustment for cancer site, comorbidities, disadvantage and health status. However, we were unable to determine whether there was a causal link between GP consultations and time to surgery; it may be that a longer time simply allows a greater opportunity for GP consultations in the interval. It could also be due to more patients who consulted a GP having pre-surgical radiotherapy. If increased time to surgery was a consequence of the engagement of the GP this may have allowed a more considered decision by the GP about the optimal referral pathway with the increased interval being unlikely to have a material influence on the physical outcome, although it may raise psychological issues for the patient.[35,36] It is worth

considering if there are other ways in which GPs could be involved in decisions regarding care following diagnosis that do not increase the interval between diagnosis and treatment. This might include arranging follow-up GP visits sooner after the colonoscopy, especially as the first GP consultation was a median of 7 days afterwards. It might also include earlier email, text or telephone communication between the GP and patient to initiate referral.

Having a GP consultation prior to surgery was not associated with having the surgical procedure in a multidisciplinary cancer centre with radiotherapy facilities. Around 1 in 4 patients had their surgery in a multidisciplinary cancer centre with radiotherapy facilities, while less than half were admitted to this type of centre at some point. This suggests an under-utilisation of specialist cancer centres, in particular for rectal cancer patients.[25,26]

Having a GP consultation after surgery was more likely for cases who consulted a GP in the lead-up to surgery, suggesting greater continuity of primary care for these cases. Again this might be especially appropriate for those who had comorbidities or poorer health status. It might also assist lower socioeconomic patients who, because of poorer health literacy, may have had more difficulty navigating the complexities of the healthcare system.

This study is subject to a number of limitations. The 45 and Up Study had a response rate of 18% (similar to other cohort studies of this nature) and oversampled people from rural areas. While 45 and Up Study participants resemble the general population in many respects, they are in general of higher socioeconomic status and more 'healthy'.[37] However, empirical data from the study show risk estimates relating to a wide range of exposures and outcomes in the cohort are very similar to those calculated using 'representative' population survey data.[37] We didn't include treatment with chemotherapy or radiotherapy as the available data were not comprehensive for all people receiving these treatments: this may have explained some of the differences in time to surgery. The definition of a specialist centre as one with a

radiotherapy unit was considered to be an indicator that all cancer treatment modalities were available at the one centre, thereby making it a more comprehensive cancer facility particularly given the importance of being able to offer radiotherapy for rectal cancer. It is difficult to sort out cause and effect of GP visits and an increased interval between diagnosis and treatment using these data alone as the Medicare data do not identify the reasons for GP visits. It may have been in relation to CRC or some other pre-existing illness. Similarly, we could not determine the nature of specialist consultations, and longer time to surgery for those with a specialist consultation could be beneficial if it means patients are getting the most appropriate treatment.

The National Bowel Cancer Screening Program commenced in August 2006,[13] so this study does not fully address what happens in the presence of the screening program. Within this program, a GP refers a patient to colonoscopy after a positive FOBT result and is then involved in the referral process for cases diagnosed with CRC. The program is being expanded to include people in other age groups,[13] giving further opportunity for GP involvement. This means there is some urgency to optimise potential benefits of engagement of GPs (e.g. in providing better guidance about where to refer), and a need to address potential reasons for an increased interval between diagnosis and treatment associated with consulting a general practitioner, especially for patients with rectal cancer.

Conclusion

This is one of the first studies to examine the role of the GP in the pathway following CRC diagnosis and prior to surgery. Less than half of the patients had a GP consultation in this period but those who did appeared to be among those who most needed it. The association between consulting a GP pre-treatment and post-treatment is a strong rationale for GP engagement in the early stages of the patient pathway and will improve longer-term continuity of care. Further research is needed to explore the directions of the association between GP

visits and the interval between diagnosis andtreatment. However a more systematic approach might be needed for GP involvement in the treatment pathway, perhaps including official guidelines from primary care/GP organisations. This would not only encourage GP engagement but also ensure that this does not lead to unnecessary delays.

TABLES

Table 1. *Characteristics of colorectal cancer (CRC) cases diagnosed between August 2004 and December 2007 who had colonoscopy and surgery, and characteristics associated with consulting a GP between colonoscopy and surgery (n=407).*

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Sex						0.79
Female	152	64	42	1.10	0.56-2.15	
Male	255	111	44	1.00	(ref)	
Age						0.77
<60	78	28	36	1.38	0.58-3.30	
60-69	108	42	39	1.13	0.57-2.28	
70-79	150	75	50	1.00	(ref)	
80+	71	30	42	1.50	0.62-3.65	
Country of birth						0.09
Australia	320	141	44	1.00	(ref)	
Other	81	30	37	0.50	0.22-1.12	
Unknown	6	4	67	not incl.	not incl.	
Language spoken at home						0.41
English	377	163	43	1.00	(ref)	
Non-English	30	12	40	0.59	0.17-2.06	
Place of residence at diagnosis						0.62
Metropolitan	186	75	40	1.00	(ref)	
Other urban	103	45	44	0.63	0.24-1.62	
Rural	118	55	47	1.65	0.58-4.69	
Type of housing						0.93
House	296	130	44	1.00	(ref)	
Flat/unit	50	19	38	1.17	0.46-2.93	
House on farm	28	12	43	1.22	0.40-3.66	
Elderly accommodation	26	11	42	0.79	0.24-2.58	
Other/unspecified	7	3	43	not incl.	not incl.	
Socioeconomic status						0.27
Least disadvantaged quintile	143	54	38	1.00	(ref)	
Quintile 2	64	28	44	1.65	0.58-4.69	
Quintile 3	126	55	44	1.17	0.43-3.21	
Quintile 4	58	28	48	2.40	0.87-6.60	
Most disadvantaged quintile	16	10	63	3.18	0.63-16.01	
Highest education level attained						0.27
No School Certificate/Other	48	22	46	1.20	0.47-3.09	
School/Intermediate Certificate	102	41	40	1.00	(ref)	
Higher School/Leaving Certificate	28	12	43	1.49	0.47-4.67	
Trade/Apprenticeship	56	21	38	1.01	0.40-2.55	
Certificate/Diploma	83	36	43	1.47	0.63-3.43	
University degree or higher	80	37	46	2.94	1.19-7.26	
Unspecified	10	6	60	not incl.	not incl.	
Marital status						0.08
Married / Living as married	288	120	42	1.00	(ref)	
Single / Divorced / Separated	51	28	55	2.65	1.11-6.30	
Widowed	65	26	40	1.03	0.44-2.39	
Unspecified	3	1	33	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	51	46	1.00	(ref)	
$20K-<$40K p.a.	83	45	54	1.79	0.76-4.25	
$40K-<$70K p.a.	62	22	35	0.68	0.26-1.75	
$70K+ p.a.	52	15	29	0.56	0.19-1.68	
Unspecified	98	42	43	0.74	0.33-1.67	

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.19
Private with extras	190	83	44	1.00	(ref)	
Private no extras	70	26	37	0.45	0.21-0.97	
DVA/Healthcare card	101	46	46	1.20	0.55-2.62	
None of these	37	16	43	0.67	0.24-1.85	
Missing	9	4	44	1.24	0.24-6.47	
Body Mass Index (BMI)[c]						0.21
Underweight/Normal (<25kg/m^2)	155	59	38	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	69	44	1.56	0.83-2.93	
Obese/Morbidly obese (>=30kg/m^2)	66	31	47	1.30	0.58-2.94	
Null/Not specified	29	16	55	2.93	0.98-8.74	
Smoking status						0.05
Never smoker	203	80	39	1.00	(ref)	
Ever smoker	204	95	47	1.81	1.01-3.26	
Self-reported health status						0.002
Good-Excellent	307	115	37	1.00	(ref)	
Fair/Poor	78	47	60	2.76	1.30-5.82	
Unspecified	22	13	59	5.60	1.59-19.81	
Cardiovascular disease						0.11
Yes	47	26	55	2.09	0.85-5.13	
No	360	149	41	1.00	(ref)	
COPD						0.04
Yes	29	10	34	0.30	0.09-0.95	
No	378	165	44	1.00	(ref)	
Diabetes						0.001
Yes	50	33	66	5.15	2.02-13.16	
No	357	142	40	1.00	(ref)	
Other key comorbidities						0.88
Yes	56	26	46	0.94	0.40-2.18	
No	351	149	42	1.00	(ref)	
Family history of CRC						0.51
Yes	75	37	49	1.27	0.63-2.57	
No	332	138	42	1.00	(ref)	
Disease stage						0.08
Localised	185	73	39	1.00	(ref)	
Regional	176	76	43	1.66	0.91-3.02	
Distant metastases	27	13	48	1.57	0.47-5.19	
Unknown	19	13	68	5.05	1.35-18.91	
Cancer site						0.52
Colon	265	114	43	1.00	(ref)	
Rectum	142	61	43	1.21	0.68-2.18	
Year of diagnosis						0.64
2004	43	17	40	1.24	0.46-3.36	
2005	113	43	38	0.93	0.44-1.93	
2006	111	56	50	1.46	0.72-2.95	
2007	140	59	42	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.01
Before (prevalent)	327	131	40	0.35	0.16-0.75	
After (incident)	80	44	55	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						<0.0001
Yes	285	156	55	17.64	7.71-40.34	
No	122	19	16	1.00	(ref)	

[a] Adjusted for all other variables in this table; [b] Overall p-value from multivariable logistic regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in logistic regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 2. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer (CRC) surgery for all CRC cases (n=407).*

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
GP consultation between colonoscopy and surgery						<0.0001
Yes	175	27	18-42	0.44	0.34-0.58	
No	232	15	8-23	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						0.002
Yes	285	21	14-35	0.62	0.47-0.84	
No	122	13	7-22	1.00	(ref)	
Sex						0.53
Female	152	19	12-28	1.10	0.82-1.46	
Male	255	20	12-31	1.00	(ref)	
Age						0.33
<60	78	17	8-29	0.78	0.54-1.13	
60-69	108	19	13-32	0.80	0.59-1.09	
70-79	150	21	12-29	1.00	(ref)	
80+	71	20	12-28	1.05	0.73-1.52	
Country of birth						0.34
Australia	320	19	13-29	1.00	(ref)	
Other	81	19	8-30	0.85	0.61-1.19	
Unknown	6	12	10-40	not incl.	not incl.	
Language spoken at home						0.20
English	377	19	12-29	1.00	(ref)	
Non-English	30	21	10-38	1.40	0.84-2.31	
Place of residence at diagnosis						0.95
Metropolitan	186	19	11-28	1.00	(ref)	
Other urban	103	20	13-28	1.07	0.71-1.63	
Rural	118	20	11-33	1.04	0.69-1.57	
Type of housing						0.63
House	296	19	12-29	1.00	(ref)	
Flat/unit	50	19	10-29	0.93	0.64-1.35	
House on farm	28	21	12-48	0.76	0.48-1.20	
Elderly accommodation	26	22	17-42	0.86	0.53-1.40	
Other/unspecified	7	29	19-31	not incl.	not incl.	
Socioeconomic status						0.13
Least disadvantaged quintile	143	17	11-28	1.00	(ref)	
Quintile 2	64	20	12-34	0.94	0.60-1.46	
Quintile 3	126	20	8-29	1.24	0.80-1.92	
Quintile 4	58	22	14-33	0.82	0.53-1.26	
Most disadvantaged quintile	16	22	14-27	1.60	0.80-3.19	
Highest education level attained						0.53
No School Certificate/Other	48	20	14-31	1.09	0.74-1.60	
School/Intermediate Certificate	102	22	16-33	1.00	(ref)	
Higher School/Leaving Certificate	28	18	12-34	0.96	0.59-1.56	
Trade/Apprenticeship	56	18	13-28	1.36	0.92-2.00	
Certificate/Diploma	83	20	10-29	0.94	0.68-1.32	
University degree or higher	80	16	8-36	1.16	0.80-1.70	
Unspecified	10	13	3-22	not incl.	not incl.	
Marital status						0.09
Married / Living as married	288	24	12-37	1.00	(ref)	
Single / Divorced / Separated	51	18	11-28	1.04	0.72-1.52	
Widowed	65	22	17-34	0.69	0.48-0.97	
Unspecified	3	20	9-21	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	21	14-31	1.00	(ref)	
$20K-<$40K p.a.	83	21	13-31	1.03	0.71-1.49	
$40K-<$70K p.a.	62	18	9-35	0.83	0.56-1.23	
$70K+ p.a.	52	13	8-29	1.50	0.95-2.35	
Unspecified	98	19	13-28	1.19	0.85-1.66	

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.42
Private with extras	190	18	9-28	1.00	(ref)	
Private no extras	70	17	11-28	1.01	0.73-1.40	
DVA/Healthcare card	101	21	14-29	0.90	0.66-1.24	
None of these	37	28	19-41	0.67	0.44-1.03	
Missing	9	25	16-28	1.09	0.51-2.33	
Body Mass Index (BMI)[c]						0.48
Underweight/Normal (<25kg/m^2)	155	18	10-28	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	20	12-35	0.86	0.66-1.13	
Obese/Morbidly obese (>=30kg/m^2)	66	22	13-31	0.95	0.68-1.34	
Null/Not specified	29	19	11-29	0.72	0.45-1.15	
Smoking status						0.33
Never smoker	203	19	10-29	1.00	(ref)	
Ever smoker	204	19	12-30	1.13	0.89-1.44	
Self-reported health status						0.37
Good-Excellent	307	18	11-29	1.00	(ref)	
Fair/Poor	78	21	15-40	0.89	0.64-1.23	
Unspecified	22	22	14-28	0.70	0.41-1.21	
Cardiovascular disease						0.77
Yes	47	20	9-29	0.95	0.65-1.38	
No	360	19	12-30	1.00	(ref)	
COPD						0.47
Yes	29	20	11-27	1.19	0.74-1.92	
No	378	19	12-30	1.00	(ref)	
Diabetes						0.18
Yes	50	26	14-36	1.30	0.89-1.90	
No	357	19	11-29	1.00	(ref)	
Other key comorbidities						0.67
Yes	56	20	12-29	1.08	0.76-1.52	
No	351	19	12-30	1.00	(ref)	
Family history of CRC						0.99
Yes	75	20	13-33	1.00	0.75-1.34	
No	332	19	12-29	1.00	(ref)	
Disease stage						0.08
Localised	185	19	13-29	1.00	(ref)	
Regional spread	176	19	10-29	1.16	0.91-1.48	
Distant metastases	27	20	12-39	0.73	0.43-1.21	
Unknown	19	35	13-48	0.65	0.37-1.16	
Cancer site						<0.0001
Colon	265	18	10-27	1.00	(ref)	
Rectum	142	22	14-37	0.58	0.45-0.74	
Year of diagnosis						0.53
2004	43	19	9-26	1.32	0.86-2.02	
2005	113	19	12-29	1.01	0.75-1.37	
2006	111	21	14-32	1.13	0.84-1.52	
2007	140	18	11-32	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.61
Before (prevalent)	327	19	11-29	1.09	0.79-1.50	
After (incident)	80	21	14-31	1.00	(ref)	

[a] Adjusted for all other variables in this table (hazard ratio <1 indicates longer time between colonoscopy and surgery); [b] Overall p-value from Cox proportional hazards regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in proportional hazards regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 3. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer surgery, for colon and rectum cancer cases.*

	Colon cancer (n=265)			Rectal cancer (n=142)		
Category	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**
GP consultation between colonoscopy and surgery			0.001			<0.0001
Yes	0.54	0.38-0.79		0.25	0.13-0.48	
No	1.00	(ref)		1.00	(ref)	
Specialist consultation between colonoscopy and surgery			0.01			0.01
Yes	0.57	0.38-0.86		0.41	0.21-0.79	
No	1.00	(ref)		1.00	(ref)	
Country of birth[c]			0.36			0.01
Australia	1.00	(ref)		1.00	(ref)	
Other	1.22	0.80-1.87		0.37	0.17-0.78	
Marital status[c]			0.28			0.02
Married/Living as married	1.00	(ref)		1.00	(ref)	
Single/Divorced/Separated	0.92	0.54-1.58		1.52	0.70-3.26	
Widowed	0.68	0.42-1.10		0.42	0.20-0.86	
Income level			0.13			0.03
<$20K p.a.	1.00	(ref)		1.00	(ref)	
$20K-<$40K p.a.	0.78	0.46-1.31		0.65	0.32-1.33	
$40K-<$70K p.a.	0.85	0.50-1.44		0.30	0.12-0.75	
$70K+ p.a.	1.62	0.88-2.99		0.52	0.19-1.41	
Unspecified	0.91	0.58-1.42		1.07	0.52-2.21	
Health insurance			0.02			0.01
Private with extras	1.00	(ref)		1.00	(ref)	
Private no extras	0.67	0.43-1.04		1.71	0.88-3.33	
DVA/Healthcare card	0.54	0.36-0.80		3.36	1.56-7.24	
None of these	0.51	0.27-0.95		0.79	0.35-1.78	
Missing	0.46	0.14-1.58		2.09	0.63-6.99	
Disease stage			0.02			0.72
Localised	1.00	(ref)		1.00	(ref)	
Regional spread	1.17	0.85-1.62		0.79	0.48-1.30	
Distant metastases	0.66	0.35-1.25		0.60	0.18-2.01	
Unknown	0.43	0.21-0.89		1.13	0.29-4.38	

[a] *Adjusted for all other variables in this table, as well as for sex, age, language spoken at home, place of residence at diagnosis, type of housing, socioeconomic status, education level, BMI, smoking status, self-reported health status, comorbidities, family history of colorectal cancer, year of diagnosis and diagnosis before/after completing study questionnaire. The variables not shown in the table were not associated with time to surgery for colon or rectal cancers. Hazard ratio <1 indicates longer time between colonoscopy and surgery.*

[b] *Overall p-value from Cox proportional hazards regression*

[c] *Excludes missing values (n=6 for country of birth, n=3 for marital status, n=9 overall)*

(ref): reference category

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COMPETING INTERESTS

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AUTHORS' CONTRIBUTIONS

DO'C and MH helped conceive the study, advised on the data analysis and helped draft the manuscript. DG assisted with obtaining the data and data management, undertook the analysis and drafted the manuscript. SP, AS, CV, DW, IO, JB and MB helped conceive the study, participated in its coordination, and helped draft the manuscript. All authors read and approved the final manuscript.

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FIGURES

Figure 1. Selection of cases with colorectal cancer (CRC) for analysis.

Figure 2. Flowchart of procedures and consultations for the 407 colorectal cancer cases who had a colonoscopy and surgery.

Article title

The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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Keywords

Colorectal neoplasms, general practice, continuity of care, health services research, colonoscopy, surgery

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Abstract word count: 280~~264~~

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Article Focus

- Primary health care providers have an important contribution to make in the process of colorectal cancer management. However, in Australia, the extent of GP involvement remains unknown as does their level of influence on the treatment referral pathway.
- We investigated key patient clinical and demographic characteristics associated with ~~see~~consulting a GP between colonoscopy and surgery (i.e. between diagnosis and treatment), for colorectal cancer patients in New South Wales, Australia.
- We also investigated whether ~~see~~consulting a GP leading up to surgery was associated with time between colonoscopy and surgery, choice of treatment centre, or ~~see~~consulting a GP after surgery.

Key Messages

- Less than half (43%) of the patients who had a colonoscopy and surgery ~~saw~~consulted a GP between the procedures; ~~see~~consulting a GP was associated with poorer health.
- Those who ~~saw~~consulted a GP pre-surgery had longer time between colonoscopy and surgery, and more commonly ~~saw~~consulted a GP post-surgery, but were no more likely to have treatment in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities.
- A more defined approach to CRC management by GPs might be required.

Strengths and Limitations

- A relatively large population-based sample of patients, with reliable information on GP consultations and surgical treatment~~ery information~~ for both public and private hospitals.
- We could not assess other treatment types and surgeon specialties were not known so ~~specialist~~ multidisciplinary cancer centres were identified as institutions with radiotherapy facilities.

ABSTRACT

Objectives: To describe general practitioner (GP) involvement in the treatment referral pathway for colorectal cancer (CRC) patients.

Design: A retrospective cohort analysis of linked data.

Setting and participants: A population-based sample of CRC patients diagnosed August 2004 to December 2007 in New South Wales, Australia, using the 45 and Up Study, cancer registry diagnosis records, inpatient hospital records, and Medicare claims records. We analysed 407 CRC patients who had a colonoscopy followed by surgery.

Primary outcome measures: Patterns of GP consultations between ~~diagnosis~~ colonoscopy and surgery (i.e. between diagnosis and treatment). We also investigated whether ~~see~~consulting a GP pre-surgery was associated with time to surgery, having surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities, or post-surgical GP consultations.

Results: Of the 407 patients, 43% (n=175) had at least one GP consultation between colonoscopy and surgery. The median time from colonoscopy to surgery was 27 days for those with and 15 days for those without an intervening GP consultation. One-quarter (n=99) had their surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities, with no difference between those who did and did not ~~see~~consult a GP pre-surgery (24% and 25% respectively). Fifty-five percent (55%, n=223) had a GP consultation up to 30 days post-surgery; it was more common for cases who ~~saw~~consulted a GP pre-surgery than for those

who did not (65% and 47% respectively, adjusted odds ratio 2.71, 95% confidence interval 1.50-4.89, p=0.001).

Conclusions: ~~See~~Consulting a GP between colonoscopy and surgery was associated with a longer interval between ~~the procedures~~diagnosis and treatment, and with further GP consultations post-surgery, but not with treatment in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities. GPs might require a more defined and systematic approach to CRC management.

Keywords

Colorectal cancer, health care delivery, health services research, general practice, continuity of care, colonoscopy, surgery

BACKGROUND

Primary healthcare providers have an important contribution to make in the process of colorectal cancer (CRC) management. General Practitioners (GPs) refer the majority of patients with symptoms or positive screening tests for a diagnostic colonoscopy.[1] Following diagnosis GPs may continue to be involved in the decision-making around definitive treatment and then subsequently during treatment, in providing psychological support, and management of comorbidities and side-effects of cancer treatment.[2-6] The coordination of care during this process is difficult for patients and health professionals given the number and complexity of services involved.[7] Little is known about the extent of primary healthcare worker involvement in or their level of influence on the treatment referral pathway.

A patient may take one of multiple pathways prior and subsequent to diagnosis [8] and the lack of a clear referral pathway [9] may increase the time to treatment. Referrals are most frequently made to surgeons, followed by gastroenterologists and oncologists.[10] In addition, patients often move back and forth between services.[11,12] In Australia, GPs refer patients for diagnostic colonoscopy and can be involved in the patient's subsequent decision to have treatment and post-treatment follow-up. However little is known about the actual level of GP involvement in this pathway, which now also includes referral of patients who come into the referral pathway through the National Bowel Cancer Screening Program. In the program, people turning 50, 55 or 65 are screened using a faecal occult blood test (FOBT), and those with a positive result are sent to their GP who refers them for further investigations.[13] The relationship between the GP and referral specialist may also be an important factor in determining the ongoing role of the GP during and after treatment.[14] One study reported that greater use of primary care pre-diagnosis is associated with better CRC outcomes,[15] although it is a complex relationship that varies across cancer types.[16]

Despite the availability of clinical guidelines,[17] many CRC patients do not receive optimal care.[18,19] The choices GPs make about referral of patients in certain health systems can have profound effects on patient outcomes.[20] A European study reported that 1-year cancer survival was lower in health systems where the GP acted as a “gatekeeper”.[21] Furthermore, a recent systematic review found a significant relationship between hospital case volume and short-term mortality for cancer surgery patients.[22] However, inconsistent results mean the relative importance of surgeon/hospital volume remains unclear, clouding the usefulness of using case volume alone.[22] Nevertheless, treatment in a ~~specialist~~ multidisciplinary cancer ~~treatment~~ centre with radiotherapy facilities is important for patient care, especially for rectal cancer cases.[23-26]

The aim of this study was to use linked population-based data to describe GP involvement in the referral pathway after diagnosis for CRC in New South Wales (NSW), Australia. ~~Specifically,~~This is one part of a four-phase study that also includes an audit of surgeons’ referral letters and focus groups with clinicians and patients relating to the treatment referral pathway.[27-29] In this phase we sought to determine whether there is an opportunity for GP involvement in patient care, as evidenced by GP consultations in the period between diagnosis and admission for surgery. We were also interested in whether pre-surgical GP consultations were associated with time to surgery, having surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities, or post-surgical GP consultations.

METHODS

Data sources

The data sources and linkage process for this study have been described in detail elsewhere.[~~27~~28] Briefly, we used linked records from the population-based 45 and Up Study,[~~28~~30] the NSW Central Cancer Registry (CCR), the NSW Admitted Patient Data Collection (APDC) and claims for medical services from Medicare Australia. The 45 and Up Study is a cohort study of 266,000 NSW residents aged 45 years or more, sampled from the Medicare Australia registration database.[~~28~~30] Participants completed baseline questionnaires between January 2006 and May 2008 and consented to linkage to the other data collections used here. CCR records were obtained for people diagnosed with CRC between January 2001 and December 2007, along with APDC hospital separation records from July 2000 to June 2008 and claims for medical services through the Medicare Benefits Scheme (MBS) between June 2004 and January 2009.

Probabilistic linkage between the 45 and Up Study, the CCR and the APDC was done by the Centre for Health Record Linkage,[~~29~~31] as described previously, resulting in approximately 0.1% false positive and <0.1% false negative linkages.[28]~~while~~ MBS claims records were linked by the Sax Institute using encrypted Medicare identification numbers. Ethical approvals for the 45 and Up Study, this specific study and the linkage were given by the University of NSW Human Research Ethics Committee and the NSW Population and Health Services Research Ethics Committee. The provision of Medicare records was approved by the Department of Health and Ageing Ethics Committee.

The group of interest comprised 45 and Up Study participants diagnosed with CRC who had both a colonoscopy leading up to their diagnosis and surgical treatment after diagnosis.

Included cases were diagnosed from August 2004 to December 2007 and were linked with the APDC and MBS, so all cases had records for treatments and consultations at least two months prior to and at least 6 months after diagnosis.

The CCR provided data regarding month and year of diagnosis, age, place of residence at diagnosis, disease stage (localised, regional, distant metastases, unknown), and cancer site (colon, rectum including rectosigmoid junction). We identified patients' comorbidities from APDC diagnosis codes, including cardiovascular disease, chronic obstructive pulmonary disease (COPD), diabetes, and other diseases in the Charlson Comorbidity Index ("other key comorbidities").[~~30~~32] Other sociodemographic characteristics (in Table 1) were obtained from the self-completed 45 and Up Study baseline questionnaire.

Procedures and consultations

A specialist clinical panel identified relevant procedure codes and items for consultations, colonoscopies and surgery in the APDC and MBS. GP consultations were indicated by MBS items 1-51, 601-603, 700-719, 5000-5067, 10996-10997. Surgical treatment comprised hemicolectomies, total colectomies, partial colectomies, total proctocolectomies, anterior rectal resections, Hartmann's procedure (rectosigmoidectomy), abdominoperineal resections, and "other" resections of the colon or rectum. Previous studies have shown that these data sources record over 90% of colonoscopies and surgical treatment for cancer patients.[33,34] Chemotherapy and radiotherapy are generally performed on an outpatient basis, for which data were not available, so they were not included in this study.

Diagnosis dates were available as month and year only, so chronology around diagnosis was based on calendar month and year. However, we were able to analyse the actual dates of GP consultations from the MBS and colonoscopies and surgeries from the APDC and MBS. We included surgical procedures performed in or after the month of diagnosis, and the last pre-

surgery colonoscopy no earlier than two months prior to the month of diagnosis. For GP consultations occurring between colonoscopy and surgery, only consultations from the day of colonoscopy and at least two days prior to surgery were considered, to allow for the consultation to have an impact on the treatment pathway and exclude consultations that were most likely for pre-operative checks.

Outcomes

The primary outcome was the pattern of GP consultations between colonoscopy and ~~treatment~~surgery. This was then used as the key study factor in examining time between colonoscopy and surgery, receiving surgery in a ~~specialist~~ multidisciplinary cancer centre ~~– defined to be an institution having~~ with radiotherapy facilities, ~~–~~ and patterns of GP consultations following surgery.

Statistical analysis

Chi-square tests were used to compare patient groups and unconditional multivariable logistic regression identified factors associated with the outcomes of interest. Cox's proportional hazards regression was used to investigate factors associated with time between colonoscopy and surgery. Factors of interest included patient characteristics such as age, disease stage and place of residence. ~~, along with see~~Consulting a GP between ~~colonoscopy~~ diagnosis and ~~surgery~~ treatment was analysed for associations with treatment in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities, time to surgery, and having a GP consultation after surgery. Having a specialist consultation was considered a possible confounder and was included as a covariate. A small number of patients with missing values for variables of interest were excluded from analyses. All analyses were carried out in SAS version 9.1 (SAS Institute Inc., Cary, NC, US).

RESULTS

The study sample has been described in detail elsewhere.[~~27~~28] Briefly, 1023 CRC cases diagnosed between January 2001 and December 2007 were identified from the CCR among the first 102,938 participants in the 45 and Up Study. The sample was restricted to 569 CRC cases diagnosed from August 2004 to December 2007 whose identifiers linked to the APDC and MBS. Of these, 407 cases (72%) received surgery in or after the month of diagnosis and had a previous colonoscopy (up to two months before the month of diagnosis) (Figure 1). These 407 are the cases in whose GP consultations we were interested; their characteristics are described in Table 1.

Insert Figure 1 and Table 1 around here

GP consultations between ~~colonoscopy~~ diagnosis and ~~surgery~~treatment

Forty-three percent (n=175) of the 407 cases ~~having colonoscopy and surgery~~ had at least one GP consultation between ~~the procedures~~ diagnosis and treatment (Figure 2), with 23% having one consultation, 10% having two consultations and 9% having three or more consultations in that time. ~~Of the cases who had a colonoscopy and surgery t~~There were higher odds of ~~see~~consulting a GP between ~~the procedures~~ diagnosis and treatment for those who ~~saw~~consulted a specialist prior to surgery~~between the procedures~~, along with those reporting poorer health, those with diabetes, those without COPD, ever smokers, and those who were diagnosed with CRC after participating in the 45 and Up Study (Table 1).

Insert Figure 2 here

Time between ~~colonoscopy~~ diagnosis and ~~surgery~~treatment

The median time from colonoscopy to surgery was 19 days; 27 days for those with and 15 days for those without an intervening GP consultation (Figure 2). The time to surgery was more than 28 days for 43% of cases ~~see~~consulting a GP compared to 15% of cases who did not ~~see~~consult a GP. For those ~~see~~consulting a GP the median time from colonoscopy to the first GP consultation was 7 days and the median time of the last consultation prior to surgery was 10 days (including multiple GP consultations, excluding those 1 or 2 days pre-surgery). After adjusting for all covariates, the time from ~~colonoscopy~~ diagnosis to ~~surgery~~ treatment remained significantly longer for cases ~~seeing~~who consulted a GP between ~~procedures~~ diagnosis and treatment than for those who did not. This was also true for those who ~~saw~~consulted a specialist between ~~procedures~~ diagnosis and treatment compared with those who did not, and for rectal cancer cases compared with colon cancer cases (Table 2). Separate analyses for colon and rectal cancer cases found that for both cancer types there was a longer time to surgery for those ~~see~~consulting a GP or a specialist between ~~procedures~~ diagnosis and treatment (Table 3).

Insert Table 2 & Table 3 here

Treatment in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities

Twenty-four percent (n=99) of cases had their surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities; 24% of those with and 25% of those without a pre-surgery GP consultation. An additional 17% had a non-surgical admission to a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities within the study period. After adjusting for all measured characteristics there was no association between ~~see~~consulting a GP pre-surgery and having the surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities (odds ratio [OR] 1.22 vs no pre-surgical GP consultation, 95% confidence interval [CI] 0.64-2.35, p=0.54). Patients with rectal cancer were not more or less likely to have surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities

(OR 1.16 vs colon cancer, 95% CI 0.63-2.16, p=0.63). In a separate analysis for rectal cancer cases, though limited by smaller cell sizes, there was no association between ~~see~~consulting a GP pre-surgery and being treated in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities (OR 0.84, 95% CI 0.27-2.63, p=0.76).

GP consultations after treatment

Twenty-six percent (26%, n=106) of cases had a GP consultation up to two weeks post-surgery, 55% (n=223) ~~saw~~consulted a GP up to 30 days post-surgery and 80% (n=327) ~~saw~~consulted a GP up to 3 months post-surgery. After adjusting for all covariates, cases who ~~saw~~consulted a GP in the interval between ~~colonoscopy and surgery~~ diagnosis and treatment were more likely to ~~see~~consult a GP in the 30 days post-surgery (65% vs 47% for those not ~~see~~consulting a GP pre-surgery, OR 2.71, 95% CI 1.50-4.89, p=0.001).

DISCUSSION

Around two in five newly-diagnosed CRC cases who had colonoscopy and surgery had a GP consultation between ~~the two procedures~~diagnosis and treatment, potentially allowing the GP to have some influence in individual patient's treatment pathways. ~~See~~Having a GP consultation in this time was associated with longer time to surgery (but not necessarily causally) and ~~see~~consulting a GP post-surgery, but not with treatment in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities.

~~See~~Having a GP consultation between ~~colonoscopy and surgery~~ diagnosis and treatment was more likely for cases with poorer self-reported health, those with diabetes, those without COPD, and those who had ever been a smoker. Almost half of the cases who ~~saw~~consulted a GP between ~~the procedures~~ diagnosis and treatment had more than one consultation in this time period. This suggests that GP consultations may be occurring for~~seeing~~ the most appropriate group: coordinating the care of those patients at higher risk because of poor general health.

The time from colonoscopy to surgery was substantially longer (a difference in medians of 12 days) for cases who ~~saw~~consulted a GP between ~~the procedures~~diagnosis and treatment, even after adjustment for cancer site, comorbidities, disadvantage and health status. However, we were unable to determine whether there was a causal link between GP consultations and time to surgery; it may be that a longer time simply allows a greater opportunity for GP consultations in the interval. It could also be due to more patients who consulted a GP having pre-surgical radiotherapy. If increased time to surgery was a consequence of the engagement of the GP this may have allowed a more considered decision by the GP about the optimal referral pathway with the increased interval being

unlikely to have a material influence on the physical outcome, although it may raise psychological issues for the patient.[~~31~~35,~~32~~36] It is worth considering if there are other ways in which GPs could be involved in decisions regarding care following diagnosis that do not increase the interval between diagnosis and treatment. This might include arranging follow-up GP visits sooner after the colonoscopy, especially as the first GP consultation was a median of 7 days afterwards. It might also include earlier email, text or telephone communication between the GP and patient to initiate referral.

~~See~~Having a GP consultation prior to surgery was not associated with having the surgical procedure in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities. Around 1 in 4 patients had their surgery in a ~~specialist~~ multidisciplinary cancer centre with radiotherapy facilities, while less than half were admitted to ~~a specialist cancer~~ this type of centre at some point. This suggests an under-utilisation of specialist cancer centres, in particular for rectal cancer patients.[25,26]

~~See~~Having a GP consultation after surgery was more likely for cases who ~~saw~~consulted a GP in the lead-up to surgery, suggesting greater continuity of primary care for these cases. Again this might be especially appropriate for those who had comorbidities or poorer health status. It might also assist lower socioeconomic patients who, because of poorer health literacy, may have had more difficulty navigating the complexities of the healthcare system.

This study is subject to a number of limitations. The 45 and Up Study had a response rate of 18% (similar to other cohort studies of this nature) and oversampled people from rural areas. While 45 and Up Study participants resemble the general population in many respects, they are in general of higher socioeconomic status and more 'healthy'.[~~33~~37] However, empirical data from the study show risk estimates relating to a wide range of exposures and outcomes in the cohort are very similar to those calculated using 'representative' population survey

data.[~~33~~37] We didn't include treatment with chemotherapy or radiotherapy as the available data were not comprehensive for all people receiving these treatments: this may have explained some of the differences in time to surgery. The definition of a specialist centre as one with a radiotherapy unit was considered to be an indicator that all cancer treatment modalities were available at the one centre, thereby making it a more comprehensive cancer facility particularly given the importance of being able to offer radiotherapy for rectal cancer.~~Specialist cancer centres were identified as institutions with radiotherapy facilities.~~ It is difficult to sort out cause and effect of GP visits and an increased interval between diagnosis and ~~surgery~~ treatment using these data alone as the Medicare data do not identify the reasons for GP visits. It may have been in relation to CRC or some other pre-existing illness. Similarly, we could not determine the nature of specialist consultations, and longer time to surgery for those with a specialist consultation could be beneficial if it means patients are getting the most appropriate treatment.

The National Bowel Cancer Screening Program commenced in August 2006,[13] so this study does not fully address what happens in the presence of the screening program. Within this program, a GP refers a patient to colonoscopy after a positive FOBT result and is then involved in the referral process for cases diagnosed with CRC. The program is being expanded to include people in other age groups,[13] giving further opportunity for GP involvement. This means there is some urgency to optimise potential benefits of engagement of GPs (e.g. in providing better guidance about where to refer), and a need to address potential reasons for an increased interval between ~~diagnosis and surgery~~ diagnosis and treatment associated with ~~see~~consulting a general practitioner, especially for patients with rectal cancer.

Conclusion

This is one of the first studies to examine the role of the GP in the pathway following CRC diagnosis and prior to surgery. Less than half of the patients had a GP consultation in this period but those who did appeared to be among those who most needed it. The association between ~~see~~consulting a GP pre-treatment and post-treatment is a strong rationale for GP engagement in the early stages of the patient pathway and will improve longer-term continuity of care. Further research is needed to explore the directions of the association between GP visits and the interval between diagnosis and ~~surgery~~treatment. However a more systematic approach might be needed for GP involvement in the treatment pathway, perhaps including official guidelines from primary care/GP organisations. This would not only encourage GP engagement but also ensure that this does not lead to unnecessary delays.

TABLES

Table 1. *Characteristics of colorectal cancer (CRC) cases diagnosed between August 2004 and December 2007 who had colonoscopy and surgery, and characteristics associated with ~~see~~consulting a GP between colonoscopy and surgery (n=407).*

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Sex						0.79
Female	152	64	42	1.10	0.56-2.15	
Male	255	111	44	1.00	(ref)	
Age						0.77
<60	78	28	36	1.38	0.58-3.30	
60-69	108	42	39	1.13	0.57-2.28	
70-79	150	75	50	1.00	(ref)	
80+	71	30	42	1.50	0.62-3.65	
Country of birth						0.09
Australia	320	141	44	1.00	(ref)	
Other	81	30	37	0.50	0.22-1.12	
Unknown	6	4	67	not incl.	not incl.	
Language spoken at home						0.41
English	377	163	43	1.00	(ref)	
Non-English	30	12	40	0.59	0.17-2.06	
Place of residence at diagnosis						0.62
Metropolitan	186	75	40	1.00	(ref)	
Other urban	103	45	44	0.63	0.24-1.62	
Rural	118	55	47	1.65	0.58-4.69	
Type of housing						0.93
House	296	130	44	1.00	(ref)	
Flat/unit	50	19	38	1.17	0.46-2.93	
House on farm	28	12	43	1.22	0.40-3.66	
Elderly accommodation	26	11	42	0.79	0.24-2.58	
Other/unspecified	7	3	43	not incl.	not incl.	
Socioeconomic status						0.27
Least disadvantaged quintile	143	54	38	1.00	(ref)	
Quintile 2	64	28	44	1.65	0.58-4.69	
Quintile 3	126	55	44	1.17	0.43-3.21	
Quintile 4	58	28	48	2.40	0.87-6.60	
Most disadvantaged quintile	16	10	63	3.18	0.63-16.01	
Highest education level attained						0.27
No School Certificate/Other	48	22	46	1.20	0.47-3.09	
School/Intermediate Certificate	102	41	40	1.00	(ref)	
Higher School/Leaving Certificate	28	12	43	1.49	0.47-4.67	
Trade/Apprenticeship	56	21	38	1.01	0.40-2.55	
Certificate/Diploma	83	36	43	1.47	0.63-3.43	
University degree or higher	80	37	46	2.94	1.19-7.26	
Unspecified	10	6	60	not incl.	not incl.	
Marital status						0.08
Married / Living as married	288	120	42	1.00	(ref)	
Single / Divorced / Separated	51	28	55	2.65	1.11-6.30	
Widowed	65	26	40	1.03	0.44-2.39	
Unspecified	3	1	33	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	51	46	1.00	(ref)	
$20K-<$40K p.a.	83	45	54	1.79	0.76-4.25	
$40K-<$70K p.a.	62	22	35	0.68	0.26-1.75	
$70K+ p.a.	52	15	29	0.56	0.19-1.68	
Unspecified	98	42	43	0.74	0.33-1.67	

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.19
Private with extras	190	83	44	1.00	(ref)	
Private no extras	70	26	37	0.45	0.21-0.97	
DVA/Healthcare card	101	46	46	1.20	0.55-2.62	
None of these	37	16	43	0.67	0.24-1.85	
Missing	9	4	44	1.24	0.24-6.47	
Body Mass Index (BMI)[c]						0.21
Underweight/Normal (<25kg/m^2)	155	59	38	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	69	44	1.56	0.83-2.93	
Obese/Morbidly obese (>=30kg/m^2)	66	31	47	1.30	0.58-2.94	
Null/Not specified	29	16	55	2.93	0.98-8.74	
Smoking status						0.05
Never smoker	203	80	39	1.00	(ref)	
Ever smoker	204	95	47	1.81	1.01-3.26	
Self-reported health status						0.002
Good-Excellent	307	115	37	1.00	(ref)	
Fair/Poor	78	47	60	2.76	1.30-5.82	
Unspecified	22	13	59	5.60	1.59-19.81	
Cardiovascular disease						0.11
Yes	47	26	55	2.09	0.85-5.13	
No	360	149	41	1.00	(ref)	
COPD						0.04
Yes	29	10	34	0.30	0.09-0.95	
No	378	165	44	1.00	(ref)	
Diabetes						0.001
Yes	50	33	66	5.15	2.02-13.16	
No	357	142	40	1.00	(ref)	
Other key comorbidities						0.88
Yes	56	26	46	0.94	0.40-2.18	
No	351	149	42	1.00	(ref)	
Family history of CRC						0.51
Yes	75	37	49	1.27	0.63-2.57	
No	332	138	42	1.00	(ref)	
Disease stage						0.08
Localised	185	73	39	1.00	(ref)	
Regional	176	76	43	1.66	0.91-3.02	
Distant metastases	27	13	48	1.57	0.47-5.19	
Unknown	19	13	68	5.05	1.35-18.91	
Cancer site						0.52
Colon	265	114	43	1.00	(ref)	
Rectum	142	61	43	1.21	0.68-2.18	
Year of diagnosis						0.64
2004	43	17	40	1.24	0.46-3.36	
2005	113	43	38	0.93	0.44-1.93	
2006	111	56	50	1.46	0.72-2.95	
2007	140	59	42	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.01
Before (prevalent)	327	131	40	0.35	0.16-0.75	
After (incident)	80	44	55	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						<0.0001
Yes	285	156	55	17.64	7.71-40.34	
No	122	19	16	1.00	(ref)	

[a] Adjusted for all other variables in this table; [b] Overall p-value from multivariable logistic regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in logistic regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 2. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer (CRC) surgery for all CRC cases (n=407).*

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
GP consultation between colonoscopy and surgery						<0.0001
Yes	175	27	18-42	0.44	0.34-0.58	
No	232	15	8-23	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						0.002
Yes	285	21	14-35	0.62	0.47-0.84	
No	122	13	7-22	1.00	(ref)	
Sex						0.53
Female	152	19	12-28	1.10	0.82-1.46	
Male	255	20	12-31	1.00	(ref)	
Age						0.33
<60	78	17	8-29	0.78	0.54-1.13	
60-69	108	19	13-32	0.80	0.59-1.09	
70-79	150	21	12-29	1.00	(ref)	
80+	71	20	12-28	1.05	0.73-1.52	
Country of birth						0.34
Australia	320	19	13-29	1.00	(ref)	
Other	81	19	8-30	0.85	0.61-1.19	
Unknown	6	12	10-40	not incl.	not incl.	
Language spoken at home						0.20
English	377	19	12-29	1.00	(ref)	
Non-English	30	21	10-38	1.40	0.84-2.31	
Place of residence at diagnosis						0.95
Metropolitan	186	19	11-28	1.00	(ref)	
Other urban	103	20	13-28	1.07	0.71-1.63	
Rural	118	20	11-33	1.04	0.69-1.57	
Type of housing						0.63
House	296	19	12-29	1.00	(ref)	
Flat/unit	50	19	10-29	0.93	0.64-1.35	
House on farm	28	21	12-48	0.76	0.48-1.20	
Elderly accommodation	26	22	17-42	0.86	0.53-1.40	
Other/unspecified	7	29	19-31	not incl.	not incl.	
Socioeconomic status						0.13
Least disadvantaged quintile	143	17	11-28	1.00	(ref)	
Quintile 2	64	20	12-34	0.94	0.60-1.46	
Quintile 3	126	20	8-29	1.24	0.80-1.92	
Quintile 4	58	22	14-33	0.82	0.53-1.26	
Most disadvantaged quintile	16	22	14-27	1.60	0.80-3.19	
Highest education level attained						0.53
No School Certificate/Other	48	20	14-31	1.09	0.74-1.60	
School/Intermediate Certificate	102	22	16-33	1.00	(ref)	
Higher School/Leaving Certificate	28	18	12-34	0.96	0.59-1.56	
Trade/Apprenticeship	56	18	13-28	1.36	0.92-2.00	
Certificate/Diploma	83	20	10-29	0.94	0.68-1.32	
University degree or higher	80	16	8-36	1.16	0.80-1.70	
Unspecified	10	13	3-22	not incl.	not incl.	
Marital status						0.09
Married / Living as married	288	24	12-37	1.00	(ref)	
Single / Divorced / Separated	51	18	11-28	1.04	0.72-1.52	
Widowed	65	22	17-34	0.69	0.48-0.97	
Unspecified	3	20	9-21	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	21	14-31	1.00	(ref)	
$20K-<$40K p.a.	83	21	13-31	1.03	0.71-1.49	
$40K-<$70K p.a.	62	18	9-35	0.83	0.56-1.23	
$70K+ p.a.	52	13	8-29	1.50	0.95-2.35	
Unspecified	98	19	13-28	1.19	0.85-1.66	

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.42
Private with extras	190	18	9-28	1.00	(ref)	
Private no extras	70	17	11-28	1.01	0.73-1.40	
DVA/Healthcare card	101	21	14-29	0.90	0.66-1.24	
None of these	37	28	19-41	0.67	0.44-1.03	
Missing	9	25	16-28	1.09	0.51-2.33	
Body Mass Index (BMI)[c]						0.48
Underweight/Normal (<25kg/m^2)	155	18	10-28	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	20	12-35	0.86	0.66-1.13	
Obese/Morbidly obese (>=30kg/m^2)	66	22	13-31	0.95	0.68-1.34	
Null/Not specified	29	19	11-29	0.72	0.45-1.15	
Smoking status						0.33
Never smoker	203	19	10-29	1.00	(ref)	
Ever smoker	204	19	12-30	1.13	0.89-1.44	
Self-reported health status						0.37
Good-Excellent	307	18	11-29	1.00	(ref)	
Fair/Poor	78	21	15-40	0.89	0.64-1.23	
Unspecified	22	22	14-28	0.70	0.41-1.21	
Cardiovascular disease						0.77
Yes	47	20	9-29	0.95	0.65-1.38	
No	360	19	12-30	1.00	(ref)	
COPD						0.47
Yes	29	20	11-27	1.19	0.74-1.92	
No	378	19	12-30	1.00	(ref)	
Diabetes						0.18
Yes	50	26	14-36	1.30	0.89-1.90	
No	357	19	11-29	1.00	(ref)	
Other key comorbidities						0.67
Yes	56	20	12-29	1.08	0.76-1.52	
No	351	19	12-30	1.00	(ref)	
Family history of CRC						0.99
Yes	75	20	13-33	1.00	0.75-1.34	
No	332	19	12-29	1.00	(ref)	
Disease stage						0.08
Localised	185	19	13-29	1.00	(ref)	
Regional spread	176	19	10-29	1.16	0.91-1.48	
Distant metastases	27	20	12-39	0.73	0.43-1.21	
Unknown	19	35	13-48	0.65	0.37-1.16	
Cancer site						<0.0001
Colon	265	18	10-27	1.00	(ref)	
Rectum	142	22	14-37	0.58	0.45-0.74	
Year of diagnosis						0.53
2004	43	19	9-26	1.32	0.86-2.02	
2005	113	19	12-29	1.01	0.75-1.37	
2006	111	21	14-32	1.13	0.84-1.52	
2007	140	18	11-32	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.61
Before (prevalent)	327	19	11-29	1.09	0.79-1.50	
After (incident)	80	21	14-31	1.00	(ref)	

[a] Adjusted for all other variables in this table (hazard ratio <1 indicates longer time between colonoscopy and surgery); [b] Overall p-value from Cox proportional hazards regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in proportional hazards regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 3. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer surgery, for colon and rectum cancer cases.*

	Colon cancer (n=265)			Rectal cancer (n=142)		
Category	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**
GP consultation between colonoscopy and surgery			0.001			<0.0001
Yes	0.54	0.38-0.79		0.25	0.13-0.48	
No	1.00	(ref)		1.00	(ref)	
Specialist consultation between colonoscopy and surgery			0.01			0.01
Yes	0.57	0.38-0.86		0.41	0.21-0.79	
No	1.00	(ref)		1.00	(ref)	
Country of birth[c]			0.36			0.01
Australia	1.00	(ref)		1.00	(ref)	
Other	1.22	0.80-1.87		0.37	0.17-0.78	
Marital status[c]			0.28			0.02
Married/Living as married	1.00	(ref)		1.00	(ref)	
Single/Divorced/Separated	0.92	0.54-1.58		1.52	0.70-3.26	
Widowed	0.68	0.42-1.10		0.42	0.20-0.86	
Income level			0.13			0.03
<$20K p.a.	1.00	(ref)		1.00	(ref)	
$20K-<$40K p.a.	0.78	0.46-1.31		0.65	0.32-1.33	
$40K-<$70K p.a.	0.85	0.50-1.44		0.30	0.12-0.75	
$70K+ p.a.	1.62	0.88-2.99		0.52	0.19-1.41	
Unspecified	0.91	0.58-1.42		1.07	0.52-2.21	
Health insurance			0.02			0.01
Private with extras	1.00	(ref)		1.00	(ref)	
Private no extras	0.67	0.43-1.04		1.71	0.88-3.33	
DVA/Healthcare card	0.54	0.36-0.80		3.36	1.56-7.24	
None of these	0.51	0.27-0.95		0.79	0.35-1.78	
Missing	0.46	0.14-1.58		2.09	0.63-6.99	
Disease stage			0.02			0.72
Localised	1.00	(ref)		1.00	(ref)	
Regional spread	1.17	0.85-1.62		0.79	0.48-1.30	
Distant metastases	0.66	0.35-1.25		0.60	0.18-2.01	
Unknown	0.43	0.21-0.89		1.13	0.29-4.38	

[a] *Adjusted for all other variables in this table, as well as for sex, age, language spoken at home, place of residence at diagnosis, type of housing, socioeconomic status, education level, BMI, smoking status, self-reported health status, comorbidities, family history of colorectal cancer, year of diagnosis and diagnosis before/after completing study questionnaire. The variables not shown in the table were not associated with time to surgery for colon or rectal cancers. Hazard ratio <1 indicates longer time between colonoscopy and surgery.*

[b] *Overall p-value from Cox proportional hazards regression*

[c] *Excludes missing values (n=6 for country of birth, n=3 for marital status, n=9 overall)*

(ref): reference category

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COMPETING INTERESTS

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AUTHORS' CONTRIBUTIONS

DO'C and MH helped conceive the study, advised on the data analysis and helped draft the manuscript. DG assisted with obtaining the data and data management, undertook the analysis and drafted the manuscript. SP, AS, CV, DW, IO, JB and MB helped conceive the study, participated in its coordination, and helped draft the manuscript. All authors read and approved the final manuscript.

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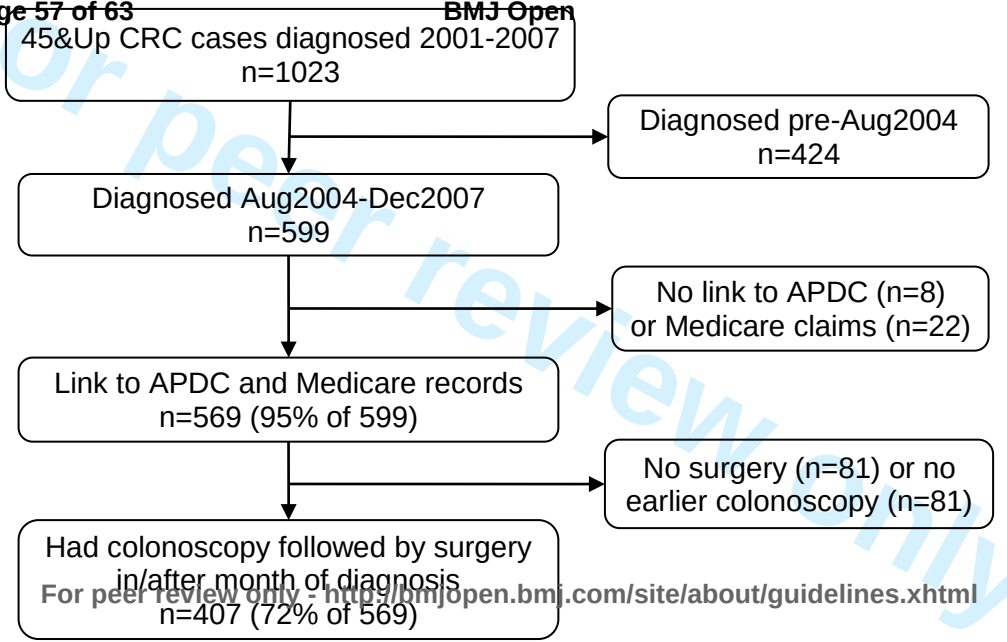
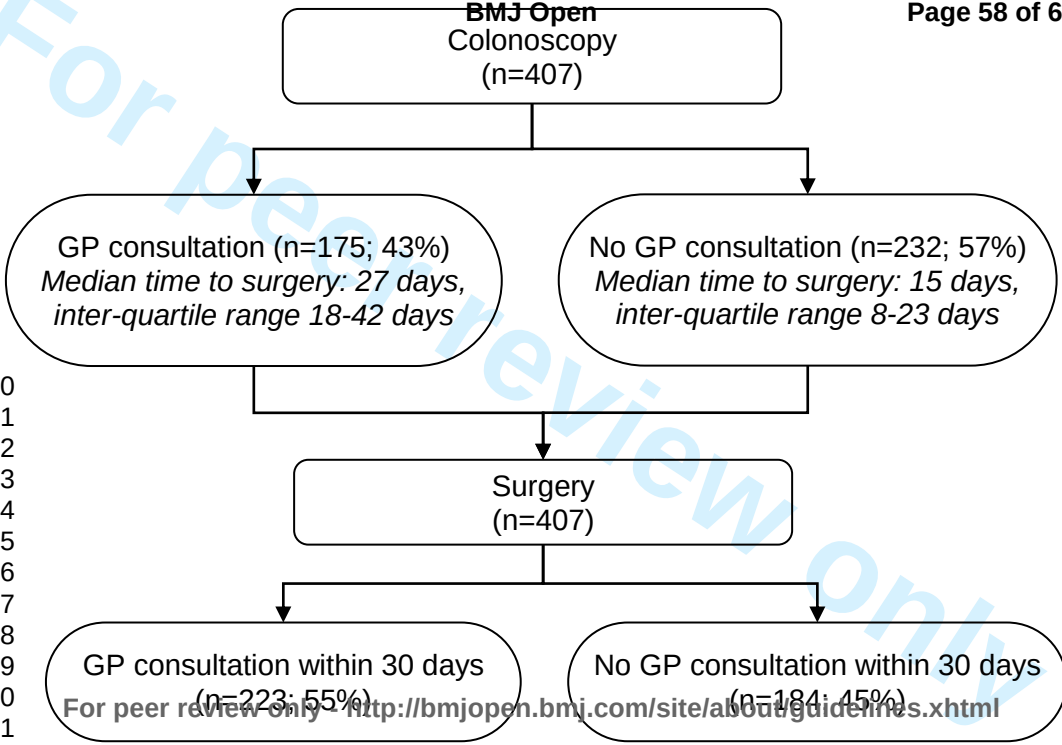
FIGURES

Figure 1. Selection of cases with colorectal cancer (CRC) for analysis.

Figure 2. Flowchart of procedures and consultations for the 407 colorectal cancer cases who had a colonoscopy and surgery.





The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

Responses to comments of Reviewer 1

Comment: This is a linkage study, and I have some concerns about whether the linkage actually links to the correct or appropriate data, and I have some concerns about the assumptions made in the linkage strategy. This reflects my response to the question on limitations. See below. The sample studied must be questioned with respect to its representativeness, though the authors do try to address this.

Response: We initially attempted to link cancer registry records, inpatient hospital records and Medicare claims records for all colorectal cancer cases across the state. However, we were unable to access the Medicare claims records, which are essential for this study, so we approached the research question using data collected for the 45 and Up Study as described in the manuscript, where Medicare claims records were available. The cancer registry, inpatient hospital records and Medicare claims records provide reasonably comprehensive data for the purposes of this study, and we have added references regarding this point to the "Procedures and consultations" paragraph of the Methods section as shown below.

"Previous studies have shown that these data sources record over 90% of colonoscopies and surgical treatment for cancer patients.[33,34]"

We have added more detail about the linkage process in the "Data sources" section of the Methods as shown below, including a reference to a more detailed description of the linkage process.

"Probabilistic linkage between the 45 and Up Study, the CCR and the APDC was done by the Centre for Health Record Linkage,[31] as described previously, resulting in approximately 0.1% false positive and <0.1% false negative linkages.[27]~~while~~ MBS claims records were linked by the Sax Institute using encrypted Medicare identification numbers."

The 45 and Up Study provided the sample, and some may question the generalisability of the results, but as noted by the reviewer we have addressed this in the manuscript in the Discussion (reproduced below) and the resulting relative measures of effect (odds ratios) are not biased in this sample.

"The 45 and Up Study had a response rate of 18% (similar to other cohort studies of this nature) and oversampled people from rural areas. While 45 and Up Study participants resemble the general population in many respects, they are in general of higher socioeconomic status and more 'healthy'.[~~33~~37] However, empirical data from the study show risk estimates relating to a wide range of exposures and outcomes in the cohort are very similar to those calculated using 'representative' population survey data.[~~33~~37]"

Comment: The definition of a specialist cancer centre (for colorectal surgery) as being one with radiotherapy, is trite. I would argue that most of the best colorectal surgeons do not work in centres where there is radiotherapy. Therefore this aspect of the work is flawed.

Response: The definition of a specialist centre as one with a radiotherapy unit was considered to be an indicator that all cancer treatment modalities are available at the one centre, thereby making it a more comprehensive cancer facility particularly given the importance of being able to offer radiotherapy for rectal cancer. To reflect this, we have now changed the term to "multidisciplinary cancer centre with radiotherapy facilities" and added the following text to the consideration of limitations in the Discussion section.

"The definition of a specialist centre as one with a radiotherapy unit was considered to be an indicator that all cancer treatment modalities were available at the one centre, thereby making it a

more comprehensive cancer facility particularly given the importance of being able to offer radiotherapy for rectal cancer."

Comment: The contemporary practice of pre-operative radiotherapy in rectal cancer seems to preclude most patients with Stage 2 or 3 rectal cancer from being included in the study, as these pts would typically have surgery well after the month of colonoscopy - quite appropriately. The study interval should be extended for the analysis, at least for rectal cancer.

Response: The study sample included people diagnosed between August 2004 and December 2007, with hospital records up to June 2008, so we have at least 6 months of follow-up for all cases. For a different study, the investigators have access to inpatient hospital records for all cancer patients in New South Wales diagnosed in 2001-2007, and less than 3% of rectal cancer surgery cases had their surgery more than 6 months post-diagnosis. Therefore, extending the follow-up period in this study is unlikely to detect many more cases who have surgery. We have amended the consideration of limitations in the Discussion section as given in the following underlined text to reflect the lack of information on adjuvant treatment.

"We didn't include treatment with chemotherapy or radiotherapy as the available data were not comprehensive for all people receiving these treatments: this may have explained some of the differences in time to surgery."

Comment: How confident are the investigators that the APDC data will capture colonoscopies in public, perhaps done somewhat incidentally to the main purpose of the admission?

Response: While working on this study we were also finalising a validation study of inpatient hospital records for the treatment of colorectal cancer. The results have just been published and they show that the hospital records alone capture over 90% of colonoscopies, including 86% of those in public hospitals. A previous study showed that the inclusion of Medicare claims records improved the accuracy with which hospital procedures are enumerated. As described previously, we have added the text below to the "Procedures and consultations" section in the Methods.

"Previous studies have shown that these data sources record over 90% of colonoscopies and surgical treatment for cancer patients.[33,34]"

Comment: The results would be usefully explored with respect to public and private care. Can the authors do this please?

Response: The initial focus of this paper was on factors associated with having a GP consultation between diagnosis and surgery, and there was no association with patient health insurance status (Table 1). After this we focused on the comparison of various outcomes for people who had a GP consultation and those who did not, without describing the other factors for which we had adjusted and which are shown in Tables 2 and 3. We believe this is the best approach to address our study aims.

For the reviewer's information, here are the results with respect to the other outcomes, noting that some of these associations were probably not statistically significant because of the relatively small number of cases (9%) with no private health insurance or DVA/healthcare card. Time to surgery was non-significantly longer for cases with no insurance (median 28 days vs 18 days for those with private insurance, adjusted odds ratio 0.67, 95% confidence interval 0.44-1.03, p=0.07), although it was significantly longer when restricted to cases with colon cancer (Table 3). A non-significantly higher proportion with no insurance had surgery in a multidisciplinary cancer centre (32% vs 23% of those with insurance, adjusted OR 2.70, 95% CI 0.97-7.52, p=0.06) and there was no association with having a GP consultation post-surgery (65% of those without insurance vs 55% of those with insurance, adjusted OR 1.37, 95% CI 0.55-3.41, p=0.50).

Comment: An equally important question is whether the colonoscopy was done by a gastroenterologist or a surgeon, as the inclusion of a gastroenterologist in the pathway of care will also influence subsequent management decisions. Although not the purpose of this article, do the authors have the data to investigate this? It would add nicely to the paper. It would be interesting to know if, where a surgeon was the colonoscopist, whether the subsequent surgical care changed hands, or moved more, or less, towards their definition of a specialist cancer centre.

Response: We agree that this would be a useful addition to the study, however we were not able to access this information using the available data sets.

Responses to comments of Reviewer 2

Comment: It is hard to see the justification for this study as the method has led to data that cannot be safely interpreted. The data that suggests a correlation but it is impossible to see if there is a robust association between the observation of an apparent median delay of 12 days in surgery for cases who had consulted a GP after colonoscopy. The discussion section has a great deal of speculation that cannot be sustained by the data. There is no way of knowing why this trend has been observed- it can't be that it is because GPs are more actively coordinating care- that is in my view unlikely.

Response: This study is one part of a four-phase project that also includes an audit of surgeons' referral letters and focus groups with clinicians and patients. This particular phase aimed to identify whether the pathway that patients followed meant that it was possible for a GP to have some influence on the coordination of care. As described in the existing Background section "we sought to determine whether there is an opportunity for GP involvement in patient care, as evidenced by GP consultations in the period between diagnosis and admission for surgery." We have added the following underlined text to the Background section to further clarify our aims.

"This is one part of a four-phase study that also includes an audit of surgeons' referral letters and focus groups with clinicians and patients relating to the treatment referral pathway.[27-29] In this phase we sought to determine whether there is an opportunity for GP involvement in patient care, as evidenced by GP consultations in the period between diagnosis and admission for surgery."

We were careful to not say that the GP caused a 'delay' and explained that we could not conclude whether the longer time to surgery was due to GPs taking time to coordinate the care or if the longer time spent waiting for surgery allowed time for a further GP consultation. We do not believe that we speculated beyond the scope of these data

Comment: The message from this study is not clear. The authors could be much clearer. When they speak of 'seeing' a GP they mean consulting and between procedures they mean post diagnosis and pre-treatment.

Response: We have adjusted the text accordingly, using the terms "consulting a GP" and "between diagnosis and treatment".

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	4-5
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8-11
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8-10
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	8-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, explain how loss to follow-up was addressed	-
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13, 27 (Figure 1)
		(b) Give reasons for non-participation at each stage	11, 27 (Figure 1)
		(c) Consider use of a flow diagram	27 (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11, 17-21 (Tables)
		(b) Indicate number of participants with missing data for each variable of interest	17-21 (Tables)
		(c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	17-21 (Tables)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-13, 17-21 (Tables)
		(*b*) Report category boundaries when continuous variables were categorized	17-21 (Tables)
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-15
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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Article title

The varying role of the GP in the pathway between colonoscopy and surgery for colorectal cancer: a retrospective cohort study

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Article Focus

- Primary health care providers have an important contribution to make in the process of colorectal cancer management. However, in Australia, the extent of GP involvement remains unknown as does their level of influence on the treatment referral pathway.
- We investigated key patient clinical and demographic characteristics associated with consulting a GP between colonoscopy and surgery (i.e. between diagnosis and treatment), for colorectal cancer patients in New South Wales, Australia.
- We also investigated whether consulting a GP leading up to colorectal cancer surgery was associated with time between colonoscopy and surgery, consulting a GP after surgery, or place of treatment for rectal cancer cases.

Key Messages

- Less than half (43%) of the patients who had a colonoscopy and surgery consulted a GP between the procedures; consulting a GP was associated with poorer health.
- Those who consulted a GP pre-surgery had longer time between colonoscopy and surgery, and more commonly consulted a GP post-surgery, but rectal cancer cases were no more likely to have treatment in a centre with radiotherapy facilities.
- A more defined approach to CRC management by GPs might be required.

Strengths and Limitations

- A relatively large population-based sample of patients, with reliable information on GP consultations and surgical treatment for both public and private hospitals.
- We could not assess other treatment types and we did not have data on specific GP recommendations or physician specialties.

ABSTRACT

Objectives: To describe general practitioner (GP) involvement in the treatment referral pathway for colorectal cancer (CRC) patients.

Design: A retrospective cohort analysis of linked data.

Setting and participants: A population-based sample of CRC patients diagnosed August 2004 to December 2007 in New South Wales, Australia, using the 45 and Up Study, cancer registry diagnosis records, inpatient hospital records, and Medicare claims records. We analysed 407 CRC patients who had a colonoscopy followed by surgery.

Primary outcome measures: Patterns of GP consultations between colonoscopy and surgery (i.e. between diagnosis and treatment). We also investigated whether consulting a GP pre-surgery was associated with time to surgery, post-surgical GP consultations, or rectal cancer cases having surgery in a centre with radiotherapy facilities.

Results: Of the 407 patients, 43% (n=175) had at least one GP consultation between colonoscopy and surgery. The median time from colonoscopy to surgery was 27 days for those with and 15 days for those without an intervening GP consultation. Fifty-five percent (n=223) had a GP consultation up to 30 days post-surgery; it was more common for cases who consulted a GP pre-surgery than for those who did not (65% and 47% respectively, adjusted odds ratio 2.71, 95% confidence interval 1.50-4.89, p=0.001). Of the 142 rectal cancer cases, 23% (n=33) had their surgery in a centre with radiotherapy facilities, with no difference between those who did and did not consult a GP pre-surgery (21% and 25% respectively, adjusted odds ratio 0.84, 95% confidence interval 0.27-2.63, p=0.76).

Conclusions: Consulting a GP between colonoscopy and surgery was associated with a longer interval between diagnosis and treatment, and with further GP consultations post-surgery, but for rectal cancer cases it was not associated with treatment in a centre with radiotherapy facilities. GPs might require a more defined and systematic approach to CRC management.

Keywords

Colorectal cancer, health care delivery, health services research, general practice, continuity of care, colonoscopy, surgery

BACKGROUND

Primary healthcare providers have an important contribution to make in the process of colorectal cancer (CRC) management. General Practitioners (GPs) refer the majority of patients with symptoms or positive screening tests for a diagnostic colonoscopy.[1] Following diagnosis GPs may continue to be involved in the decision-making around definitive treatment and then subsequently during treatment, in providing psychological support, and management of comorbidities and side-effects of cancer treatment.[2-6] The coordination of care during this process is difficult for patients and health professionals given the number and complexity of services involved.[7] Little is known about the extent of primary healthcare worker involvement in or their level of influence on the treatment referral pathway.

A patient may take one of multiple pathways prior and subsequent to diagnosis [8] and the lack of a clear referral pathway [9] may increase the time to treatment. Referrals are most frequently made to surgeons, followed by gastroenterologists and oncologists.[10] In addition, patients often move back and forth between services.[11,12] In Australia, GPs refer patients for diagnostic colonoscopy and can be involved in the patient's subsequent decision to have treatment and post-treatment follow-up. However little is known about the actual level of GP involvement in this pathway, which now also includes referral of patients who come into the referral pathway through the National Bowel Cancer Screening Program. In the program, people turning 50, 55 or 65 are screened using a faecal occult blood test (FOBT), and those with a positive result are sent to their GP who refers them for further investigations.[13] The relationship between the GP and referral specialist may also be an important factor in determining the ongoing role of the GP during and after treatment.[14] One study reported that greater use of primary care pre-diagnosis is associated with better CRC outcomes,[15] although it is a complex relationship that varies across cancer types.[16]

Despite the availability of clinical guidelines,[17] many CRC patients do not receive optimal care.[18,19] The choices GPs make about referral of patients in certain health systems can have profound effects on patient outcomes.[20] A European study reported that 1-year cancer survival was lower in health systems where the GP acted as a "gatekeeper".[21] Furthermore, a recent systematic review found a significant relationship between hospital case volume and short-term mortality for cancer surgery patients.[22] However, inconsistent results mean the relative importance of surgeon/hospital volume remains unclear, clouding the appropriateness of using case volume alone.[22] Nevertheless, treatment in a multidisciplinary cancer centre with radiotherapy facilities is important for patient care, especially for rectal cancer cases.[23-26]

The aim of this study was to use linked population-based data to describe GP involvement in the referral pathway after diagnosis for CRC in New South Wales (NSW), Australia. This is one part of a four-phase study that also includes an audit of surgeons' referral letters and focus groups with clinicians and patients relating to the treatment referral pathway.[27-29] In this phase we sought to determine whether there is an opportunity for GP involvement in patient care, as evidenced by GP consultations in the period between diagnosis and admission for surgery. We were also interested in whether pre-surgical GP consultations were associated with time to surgery, post-surgical GP consultations, or, among rectal cancer cases, having surgery in a centre with radiotherapy facilities.

METHODS

Data sources

The data sources and linkage process for this study have been described in detail elsewhere.[28] Briefly, we used linked records from the population-based 45 and Up Study,[30] the NSW Central Cancer Registry (CCR), the NSW Admitted Patient Data Collection (APDC) and claims for medical services from Medicare Australia. The 45 and Up Study is a cohort study of 266,000 NSW residents aged 45 years or more, sampled from the Medicare Australia registration database.[30] Participants completed baseline questionnaires between January 2006 and May 2008 and consented to linkage to the other data collections used here. CCR records were obtained for people diagnosed with CRC between January 2001 and December 2007, along with APDC hospital separation records from July 2000 to June 2008 and claims for medical services through the Medicare Benefits Scheme (MBS) between June 2004 and January 2009.

Probabilistic linkage between the 45 and Up Study, the CCR and the APDC was done by the Centre for Health Record Linkage,[31] as described previously, resulting in approximately 0.1% false positive and <0.1% false negative linkages.[28] MBS claims records were linked by the Sax Institute using encrypted Medicare identification numbers. Ethical approvals for the 45 and Up Study, this specific study and the linkage were given by the University of NSW Human Research Ethics Committee and the NSW Population and Health Services Research Ethics Committee. The provision of Medicare records was approved by the Department of Health and Ageing Ethics Committee.

The group of interest comprised 45 and Up Study participants diagnosed with CRC who had both a colonoscopy leading up to their diagnosis and surgical treatment after diagnosis.

Included cases were diagnosed from August 2004 to December 2007 and were linked with the APDC and MBS, so all cases had records for treatments and consultations at least two months prior to and at least 6 months after diagnosis.

The CCR provided data regarding month and year of diagnosis, age, place of residence at diagnosis, disease stage (localised, regional, distant metastases, unknown), and cancer site (colon, rectum including rectosigmoid junction). We identified patients' comorbidities from APDC diagnosis codes, including cardiovascular disease, chronic obstructive pulmonary disease (COPD), diabetes, and other diseases in the Charlson Comorbidity Index ("other key comorbidities").[32] Other sociodemographic characteristics (in Table 1) were obtained from the self-completed 45 and Up Study baseline questionnaire.

Procedures and consultations

A specialist clinical panel identified relevant procedure codes and items for consultations, colonoscopies and surgery in the APDC and MBS. GP consultations were indicated by MBS items 1-51, 601-603, 700-719, 5000-5067, 10996-10997. Surgical treatment comprised hemicolectomies, total colectomies, partial colectomies, total proctocolectomies, anterior rectal resections, Hartmann's procedure (rectosigmoidectomy), abdominoperineal resections, and "other" resections of the colon or rectum. Previous studies have shown that these data sources record over 90% of colonoscopies and surgical treatment for cancer patients.[33,34] Chemotherapy and radiotherapy are generally performed on an outpatient basis, for which data were not available, so they were not included in this study.

Diagnosis dates were available as month and year only, so chronology around diagnosis was based on calendar month and year. However, we were able to analyse the actual dates of GP consultations from the MBS and colonoscopies and surgeries from the APDC and MBS. We included surgical procedures performed in or after the month of diagnosis, and the last pre-

surgery colonoscopy no earlier than two months prior to the month of diagnosis. For GP consultations occurring between colonoscopy and surgery, only consultations from the day of colonoscopy and at least two days prior to surgery were considered, to allow for the consultation to have an impact on the treatment pathway and exclude consultations that were most likely for pre-operative checks.

Outcomes

The primary outcome was the pattern of GP consultations between colonoscopy and surgery. This was then used as the key study factor in examining time between colonoscopy and surgery, patterns of GP consultations following surgery, and for rectal cancer cases, receiving surgery in a centre with radiotherapy facilities.

Statistical analysis

Chi-square tests were used to compare patient groups and unconditional multivariable logistic regression identified factors associated with the outcomes of interest. Cox's proportional hazards regression was used to investigate factors associated with time between colonoscopy and surgery. Factors of interest included patient characteristics such as age, disease stage and place of residence. Consulting a GP between diagnosis and treatment was analysed for associations with time to surgery, having a GP consultation after surgery, and for rectal cancer cases, having treatment in a centre with radiotherapy facilities. Having a specialist consultation was considered a possible confounder and was included as a covariate. A small number of patients with missing values for variables of interest were excluded from analyses. All analyses were carried out in SAS version 9.1 (SAS Institute Inc., Cary, NC, US).

RESULTS

The study sample has been described in detail elsewhere.[28] Briefly, 1023 CRC cases diagnosed between January 2001 and December 2007 were identified from the CCR among the first 102,938 participants in the 45 and Up Study. The sample was restricted to 569 CRC cases diagnosed from August 2004 to December 2007 whose identifiers linked to the APDC and MBS. Of these, 407 cases (72%) received surgery in or after the month of diagnosis and had a previous colonoscopy (up to two months before the month of diagnosis) (Figure 1). These 407 are the cases in whose GP consultations we were interested; their characteristics are described in Table 1.

Insert Figure 1 and Table 1 around here

GP consultations between diagnosis and treatment

Forty-three percent (n=175) of the 407 cases had at least one GP consultation between diagnosis and treatment (Figure 2), with 23% having one consultation, 10% having two consultations and 9% having three or more consultations in that time. There were higher odds of consulting a GP between diagnosis and treatment for those who consulted a specialist prior to surgery, along with those reporting poorer health, those with diabetes, those without COPD, ever smokers, and those who were diagnosed with CRC after participating in the 45 and Up Study (Table 1).

Insert Figure 2 here

Time between diagnosis and treatment

The median time from colonoscopy to surgery was 19 days; 27 days for those with and 15 days for those without an intervening GP consultation (Figure 2). The time to surgery was more than 28 days for 43% of cases consulting a GP compared to 15% of cases who did not

consult a GP. For those consulting a GP the median time from colonoscopy to the first GP consultation was 7 days and the median time of the last consultation prior to surgery was 10 days (including multiple GP consultations, excluding those 1 or 2 days pre-surgery). After adjusting for all covariates, the time from diagnosis to treatment remained significantly longer for cases who consulted a GP between diagnosis and treatment than for those who did not. This was also true for those who consulted a specialist between diagnosis and treatment compared with those who did not, and for rectal cancer cases compared with colon cancer cases (Table 2). Separate analyses for colon and rectal cancer cases found that for both cancer types there was a longer time to surgery for those consulting a GP or a specialist between diagnosis and treatment (Table 3).

Insert Table 2 & Table 3 here

GP consultations after treatment

Twenty-six percent (26%, n=106) of cases had a GP consultation up to two weeks post-surgery, 55% (n=223) consulted a GP up to 30 days post-surgery and 80% (n=327) consulted a GP up to 3 months post-surgery. After adjusting for all covariates, cases who consulted a GP in the interval between diagnosis and treatment were more likely to consult a GP in the 30 days post-surgery (65% vs 47% for those not consulting a GP pre-surgery, odds ratio [OR] 2.71, 95% confidence interval [CI] 1.50-4.89, p=0.001).

Rectal cancer surgery in a centre with radiotherapy facilities

Of the 142 rectal cancer cases, 23% (n=33) had their surgery in a centre with radiotherapy facilities; 21% of those with and 25% of those without a pre-surgery GP consultation. After adjusting for key characteristics there was no association between consulting a GP pre-surgery and having the surgery in a centre with radiotherapy facilities (OR 0.84 vs no pre-surgical GP consultation, 95% CI 0.64-2.35, p=0.54). An additional 21% had their surgery in a

hospital co-located with a centre that had radiotherapy facilities, and a further 8% had a non-surgical admission to a centre with radiotherapy facilities within the study period.

DISCUSSION

Around two in five newly-diagnosed CRC cases who had colonoscopy and surgery had a GP consultation between diagnosis and treatment, potentially allowing the GP to have some influence in individual patient's treatment pathways. Having a GP consultation in this time was associated with longer time to surgery (but not necessarily causally) and consulting a GP post-surgery, but for rectal cancer cases it was not associated with treatment in a centre with radiotherapy facilities.

Having a GP consultation between diagnosis and treatment was more likely for cases with poorer self-reported health, those with diabetes, those without COPD, and those who had ever been a smoker. Almost half of the cases who consulted a GP between diagnosis and treatment had more than one consultation in this time period. This suggests that GP consultations may be occurring for the most appropriate group: coordinating the care of those patients at higher risk because of poor general health.

The time from colonoscopy to surgery was substantially longer (a difference in medians of 12 days) for cases who consulted a GP between diagnosis and treatment, even after adjustment for cancer site, comorbidities, disadvantage and health status. However, we were unable to determine whether there was a causal link between GP consultations and time to surgery; it may be that a longer time simply allows a greater opportunity for GP consultations in the interval. It could also be due to more patients who consulted a GP having pre-surgical radiotherapy. If increased time to surgery was a consequence of the engagement of the GP this may have allowed a more considered decision by the GP about the optimal referral pathway with the increased interval being unlikely to have a material influence on the physical outcome, although it may raise psychological issues for the patient.[35,36] It is worth

considering if there are other ways in which GPs could be involved in decisions regarding care following diagnosis that do not increase the interval between diagnosis and treatment. This might include arranging follow-up GP visits sooner after the colonoscopy, especially as the first GP consultation was a median of 7 days afterwards. It might also include earlier email, text or telephone communication between the GP and patient to initiate referral.

Having a GP consultation after surgery was more likely for cases who consulted a GP in the lead-up to surgery, suggesting greater continuity of primary care for these cases. Again this might be especially appropriate for those who had comorbidities or poorer health status. It might also assist lower socioeconomic patients who, because of poorer health literacy, may have had more difficulty navigating the complexities of the healthcare system.

Given the importance of being able to offer radiotherapy for rectal cancer,[17] we investigated any potential association between pre-surgical GP consultations and surgery in hospitals with radiotherapy facilities, reflecting another aspect of continuity of care. For rectal cancer cases, having a GP consultation prior to surgery was not associated with having the surgical procedure in a centre with radiotherapy facilities. Fewer than 1 in 4 had their surgery in a centre with radiotherapy facilities, although this increased to around 1 in 2 when allowing for surgery in hospitals co-located with another hospital that has a radiotherapy centre. Others have previously reported the potential under-utilisation of specialist cancer centres for rectal cancer patients.[25,26]

This study is subject to a number of limitations. The 45 and Up Study had a response rate of 18% (similar to other cohort studies of this nature) and oversampled people from rural areas. While 45 and Up Study participants resemble the general population in many respects, they are in general of higher socioeconomic status and more 'healthy'.[37] However, empirical data from the study show risk estimates relating to a wide range of exposures and outcomes in the

cohort are very similar to those calculated using 'representative' population survey data.[37] We didn't include treatment with chemotherapy or radiotherapy as the available data were not comprehensive for all people receiving these treatments, nor did we have information on patients' decisions regarding treatment. These may have influenced the place of treatment and explained some of the differences in time to surgery. We analysed rectal cancer surgery in hospitals with radiotherapy facilities as an indicator that all cancer treatment modalities were available at the one centre, thereby making it a more comprehensive cancer facility. This could have been improved with information regarding patients' decisions, GPs' recommendations and the specialties of all physicians involved in the care of each patient.

It is difficult to sort out cause and effect of GP visits and an increased interval between diagnosis and treatment using these data alone as the Medicare data do not identify the reasons for GP visits. It may have been in relation to CRC or some other pre-existing illness. Similarly, we could not determine the nature of specialist consultations, and longer time to surgery for those with a specialist consultation could be beneficial if it means patients are getting the most appropriate treatment. Furthermore, we did not have information on individual physicians or their specialties so we could not assess other aspects potentially related to the referral pathway, such as whether the colonoscopy was performed by a gastroenterologist or a surgeon, or whether the same surgeon then carried out the surgical procedure.

The National Bowel Cancer Screening Program commenced in August 2006,[13] so this study does not fully address what happens in the presence of the screening program. Within this program, a GP refers a patient to colonoscopy after a positive FOBT result and is then involved in the referral process for cases diagnosed with CRC. The program is being expanded to include people in other age groups,[13] giving further opportunity for GP involvement. This means there is some urgency to optimise potential benefits of engagement

of GPs (e.g. in providing better guidance about where to refer), and a need to address potential reasons for an increased interval between diagnosis and treatment associated with consulting a general practitioner, especially for patients with rectal cancer.

Conclusion

This is one of the first studies to examine the role of the GP in the pathway following CRC diagnosis and prior to surgery. Less than half of the patients had a GP consultation in this period but those who did appeared to be among those who most needed it. The association between consulting a GP pre-treatment and post-treatment is a strong rationale for GP engagement in the early stages of the patient pathway and will improve longer-term continuity of care. Further research is needed to explore the directions of the association between GP visits and the interval between diagnosis and treatment. However a more systematic approach might be needed for GP involvement in the treatment pathway, perhaps including official guidelines from primary care/GP organisations. This would not only encourage GP engagement but also ensure that this does not lead to unnecessary delays.

TABLES

Table 1. *Characteristics of colorectal cancer (CRC) cases diagnosed between August 2004 and December 2007 who had colonoscopy and surgery, and characteristics associated with consulting a GP between colonoscopy and surgery (n=407).*

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Sex						0.79
Female	152	64	42	1.10	0.56-2.15	
Male	255	111	44	1.00	(ref)	
Age						0.77
<60	78	28	36	1.38	0.58-3.30	
60-69	108	42	39	1.13	0.57-2.28	
70-79	150	75	50	1.00	(ref)	
80+	71	30	42	1.50	0.62-3.65	
Country of birth						0.09
Australia	320	141	44	1.00	(ref)	
Other	81	30	37	0.50	0.22-1.12	
Unknown	6	4	67	not incl.	not incl.	
Language spoken at home						0.41
English	377	163	43	1.00	(ref)	
Non-English	30	12	40	0.59	0.17-2.06	
Place of residence at diagnosis						0.62
Metropolitan	186	75	40	1.00	(ref)	
Other urban	103	45	44	0.63	0.24-1.62	
Rural	118	55	47	1.65	0.58-4.69	
Type of housing						0.93
House	296	130	44	1.00	(ref)	
Flat/unit	50	19	38	1.17	0.46-2.93	
House on farm	28	12	43	1.22	0.40-3.66	
Elderly accommodation	26	11	42	0.79	0.24-2.58	
Other/unspecified	7	3	43	not incl.	not incl.	
Socioeconomic status						0.27
Least disadvantaged quintile	143	54	38	1.00	(ref)	
Quintile 2	64	28	44	1.65	0.58-4.69	
Quintile 3	126	55	44	1.17	0.43-3.21	
Quintile 4	58	28	48	2.40	0.87-6.60	
Most disadvantaged quintile	16	10	63	3.18	0.63-16.01	
Highest education level attained						0.27
No School Certificate/Other	48	22	46	1.20	0.47-3.09	
School/Intermediate Certificate	102	41	40	1.00	(ref)	
Higher School/Leaving Certificate	28	12	43	1.49	0.47-4.67	
Trade/Apprenticeship	56	21	38	1.01	0.40-2.55	
Certificate/Diploma	83	36	43	1.47	0.63-3.43	
University degree or higher	80	37	46	2.94	1.19-7.26	
Unspecified	10	6	60	not incl.	not incl.	
Marital status						0.08
Married / Living as married	288	120	42	1.00	(ref)	
Single / Divorced / Separated	51	28	55	2.65	1.11-6.30	
Widowed	65	26	40	1.03	0.44-2.39	
Unspecified	3	1	33	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	51	46	1.00	(ref)	
$20K-<$40K p.a.	83	45	54	1.79	0.76-4.25	
$40K-<$70K p.a.	62	22	35	0.68	0.26-1.75	
$70K+ p.a.	52	15	29	0.56	0.19-1.68	
Unspecified	98	42	43	0.74	0.33-1.67	

Category	n	GP consult n	GP consult %	Adjusted odds ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.19
Private with extras	190	83	44	1.00	(ref)	
Private no extras	70	26	37	0.45	0.21-0.97	
DVA/Healthcare card	101	46	46	1.20	0.55-2.62	
None of these	37	16	43	0.67	0.24-1.85	
Missing	9	4	44	1.24	0.24-6.47	
Body Mass Index (BMI)[c]						0.21
Underweight/Normal (<25kg/m^2)	155	59	38	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	69	44	1.56	0.83-2.93	
Obese/Morbidly obese (>=30kg/m^2)	66	31	47	1.30	0.58-2.94	
Null/Not specified	29	16	55	2.93	0.98-8.74	
Smoking status						0.05
Never smoker	203	80	39	1.00	(ref)	
Ever smoker	204	95	47	1.81	1.01-3.26	
Self-reported health status						0.002
Good-Excellent	307	115	37	1.00	(ref)	
Fair/Poor	78	47	60	2.76	1.30-5.82	
Unspecified	22	13	59	5.60	1.59-19.81	
Cardiovascular disease						0.11
Yes	47	26	55	2.09	0.85-5.13	
No	360	149	41	1.00	(ref)	
COPD						0.04
Yes	29	10	34	0.30	0.09-0.95	
No	378	165	44	1.00	(ref)	
Diabetes						0.001
Yes	50	33	66	5.15	2.02-13.16	
No	357	142	40	1.00	(ref)	
Other key comorbidities						0.88
Yes	56	26	46	0.94	0.40-2.18	
No	351	149	42	1.00	(ref)	
Family history of CRC						0.51
Yes	75	37	49	1.27	0.63-2.57	
No	332	138	42	1.00	(ref)	
Disease stage						0.08
Localised	185	73	39	1.00	(ref)	
Regional	176	76	43	1.66	0.91-3.02	
Distant metastases	27	13	48	1.57	0.47-5.19	
Unknown	19	13	68	5.05	1.35-18.91	
Cancer site						0.52
Colon	265	114	43	1.00	(ref)	
Rectum	142	61	43	1.21	0.68-2.18	
Year of diagnosis						0.64
2004	43	17	40	1.24	0.46-3.36	
2005	113	43	38	0.93	0.44-1.93	
2006	111	56	50	1.46	0.72-2.95	
2007	140	59	42	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.01
Before (prevalent)	327	131	40	0.35	0.16-0.75	
After (incident)	80	44	55	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						<0.0001
Yes	285	156	55	17.64	7.71-40.34	
No	122	19	16	1.00	(ref)	

[a] Adjusted for all other variables in this table; [b] Overall p-value from multivariable logistic regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in logistic regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 2. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer (CRC) surgery for all CRC cases (n=407).*

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
GP consultation between colonoscopy and surgery						<0.0001
Yes	175	27	18-42	0.44	0.34-0.58	
No	232	15	8-23	1.00	(ref)	
Specialist consultation between colonoscopy and surgery						0.002
Yes	285	21	14-35	0.62	0.47-0.84	
No	122	13	7-22	1.00	(ref)	
Sex						0.53
Female	152	19	12-28	1.10	0.82-1.46	
Male	255	20	12-31	1.00	(ref)	
Age						0.33
<60	78	17	8-29	0.78	0.54-1.13	
60-69	108	19	13-32	0.80	0.59-1.09	
70-79	150	21	12-29	1.00	(ref)	
80+	71	20	12-28	1.05	0.73-1.52	
Country of birth						0.34
Australia	320	19	13-29	1.00	(ref)	
Other	81	19	8-30	0.85	0.61-1.19	
Unknown	6	12	10-40	not incl.	not incl.	
Language spoken at home						0.20
English	377	19	12-29	1.00	(ref)	
Non-English	30	21	10-38	1.40	0.84-2.31	
Place of residence at diagnosis						0.95
Metropolitan	186	19	11-28	1.00	(ref)	
Other urban	103	20	13-28	1.07	0.71-1.63	
Rural	118	20	11-33	1.04	0.69-1.57	
Type of housing						0.63
House	296	19	12-29	1.00	(ref)	
Flat/unit	50	19	10-29	0.93	0.64-1.35	
House on farm	28	21	12-48	0.76	0.48-1.20	
Elderly accommodation	26	22	17-42	0.86	0.53-1.40	
Other/unspecified	7	29	19-31	not incl.	not incl.	
Socioeconomic status						0.13
Least disadvantaged quintile	143	17	11-28	1.00	(ref)	
Quintile 2	64	20	12-34	0.94	0.60-1.46	
Quintile 3	126	20	8-29	1.24	0.80-1.92	
Quintile 4	58	22	14-33	0.82	0.53-1.26	
Most disadvantaged quintile	16	22	14-27	1.60	0.80-3.19	
Highest education level attained						0.53
No School Certificate/Other	48	20	14-31	1.09	0.74-1.60	
School/Intermediate Certificate	102	22	16-33	1.00	(ref)	
Higher School/Leaving Certificate	28	18	12-34	0.96	0.59-1.56	
Trade/Apprenticeship	56	18	13-28	1.36	0.92-2.00	
Certificate/Diploma	83	20	10-29	0.94	0.68-1.32	
University degree or higher	80	16	8-36	1.16	0.80-1.70	
Unspecified	10	13	3-22	not incl.	not incl.	
Marital status						0.09
Married / Living as married	288	24	12-37	1.00	(ref)	
Single / Divorced / Separated	51	18	11-28	1.04	0.72-1.52	
Widowed	65	22	17-34	0.69	0.48-0.97	
Unspecified	3	20	9-21	not incl.	not incl.	
Income level						0.11
<$20K p.a.	112	21	14-31	1.00	(ref)	
$20K-<$40K p.a.	83	21	13-31	1.03	0.71-1.49	
$40K-<$70K p.a.	62	18	9-35	0.83	0.56-1.23	
$70K+ p.a.	52	13	8-29	1.50	0.95-2.35	
Unspecified	98	19	13-28	1.19	0.85-1.66	

Category	n	Median time (days)	Inter-quartile range (days)	Adjusted hazard ratio[a]	95% confidence interval[a]	p-value[b]
Health insurance						0.42
Private with extras	190	18	9-28	1.00	(ref)	
Private no extras	70	17	11-28	1.01	0.73-1.40	
DVA/Healthcare card	101	21	14-29	0.90	0.66-1.24	
None of these	37	28	19-41	0.67	0.44-1.03	
Missing	9	25	16-28	1.09	0.51-2.33	
Body Mass Index (BMI)[c]						0.48
Underweight/Normal (<25kg/m^2)	155	18	10-28	1.00	(ref)	
Overweight (25-<30kg/m^2)	157	20	12-35	0.86	0.66-1.13	
Obese/Morbidly obese (>=30kg/m^2)	66	22	13-31	0.95	0.68-1.34	
Null/Not specified	29	19	11-29	0.72	0.45-1.15	
Smoking status						0.33
Never smoker	203	19	10-29	1.00	(ref)	
Ever smoker	204	19	12-30	1.13	0.89-1.44	
Self-reported health status						0.37
Good-Excellent	307	18	11-29	1.00	(ref)	
Fair/Poor	78	21	15-40	0.89	0.64-1.23	
Unspecified	22	22	14-28	0.70	0.41-1.21	
Cardiovascular disease						0.77
Yes	47	20	9-29	0.95	0.65-1.38	
No	360	19	12-30	1.00	(ref)	
COPD						0.47
Yes	29	20	11-27	1.19	0.74-1.92	
No	378	19	12-30	1.00	(ref)	
Diabetes						0.18
Yes	50	26	14-36	1.30	0.89-1.90	
No	357	19	11-29	1.00	(ref)	
Other key comorbidities						0.67
Yes	56	20	12-29	1.08	0.76-1.52	
No	351	19	12-30	1.00	(ref)	
Family history of CRC						0.99
Yes	75	20	13-33	1.00	0.75-1.34	
No	332	19	12-29	1.00	(ref)	
Disease stage						0.08
Localised	185	19	13-29	1.00	(ref)	
Regional spread	176	19	10-29	1.16	0.91-1.48	
Distant metastases	27	20	12-39	0.73	0.43-1.21	
Unknown	19	35	13-48	0.65	0.37-1.16	
Cancer site						<0.0001
Colon	265	18	10-27	1.00	(ref)	
Rectum	142	22	14-37	0.58	0.45-0.74	
Year of diagnosis						0.53
2004	43	19	9-26	1.32	0.86-2.02	
2005	113	19	12-29	1.01	0.75-1.37	
2006	111	21	14-32	1.13	0.84-1.52	
2007	140	18	11-32	1.00	(ref)	
Timing of CRC diagnosis relative to 45 & Up questionnaire						0.61
Before (prevalent)	327	19	11-29	1.09	0.79-1.50	
After (incident)	80	21	14-31	1.00	(ref)	

[a] Adjusted for all other variables in this table (hazard ratio <1 indicates longer time between colonoscopy and surgery); [b] Overall p-value from Cox proportional hazards regression; [c] Calculated from self-reported weight(kg) / height(m)^2

(ref): reference category; not incl.: this category was not included in proportional hazards regression (n=26 overall)

COPD: chronic obstructive pulmonary disease

Table 3. *Demographic and clinical characteristics associated with time between colonoscopy and colorectal cancer surgery, for colon and rectum cancer cases.*

	Colon cancer (n=265)			Rectal cancer (n=142)		
Category	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**	**Adjusted hazard ratio[a]**	**95% confidence interval**	**p-value[b]**
GP consultation between colonoscopy and surgery			0.001			<0.0001
Yes	0.54	0.38-0.79		0.25	0.13-0.48	
No	1.00	(ref)		1.00	(ref)	
Specialist consultation between colonoscopy and surgery			0.01			0.01
Yes	0.57	0.38-0.86		0.41	0.21-0.79	
No	1.00	(ref)		1.00	(ref)	
Country of birth[c]			0.36			0.01
Australia	1.00	(ref)		1.00	(ref)	
Other	1.22	0.80-1.87		0.37	0.17-0.78	
Marital status[c]			0.28			0.02
Married/Living as married	1.00	(ref)		1.00	(ref)	
Single/Divorced/Separated	0.92	0.54-1.58		1.52	0.70-3.26	
Widowed	0.68	0.42-1.10		0.42	0.20-0.86	
Income level			0.13			0.03
<$20K p.a.	1.00	(ref)		1.00	(ref)	
$20K-<$40K p.a.	0.78	0.46-1.31		0.65	0.32-1.33	
$40K-<$70K p.a.	0.85	0.50-1.44		0.30	0.12-0.75	
$70K+ p.a.	1.62	0.88-2.99		0.52	0.19-1.41	
Unspecified	0.91	0.58-1.42		1.07	0.52-2.21	
Health insurance			0.02			0.01
Private with extras	1.00	(ref)		1.00	(ref)	
Private no extras	0.67	0.43-1.04		1.71	0.88-3.33	
DVA/Healthcare card	0.54	0.36-0.80		3.36	1.56-7.24	
None of these	0.51	0.27-0.95		0.79	0.35-1.78	
Missing	0.46	0.14-1.58		2.09	0.63-6.99	
Disease stage			0.02			0.72
Localised	1.00	(ref)		1.00	(ref)	
Regional spread	1.17	0.85-1.62		0.79	0.48-1.30	
Distant metastases	0.66	0.35-1.25		0.60	0.18-2.01	
Unknown	0.43	0.21-0.89		1.13	0.29-4.38	

[a] *Adjusted for all other variables in this table, as well as for sex, age, language spoken at home, place of residence at diagnosis, type of housing, socioeconomic status, education level, BMI, smoking status, self-reported health status, comorbidities, family history of colorectal cancer, year of diagnosis and diagnosis before/after completing study questionnaire. The variables not shown in the table were not associated with time to surgery for colon or rectal cancers. Hazard ratio <1 indicates longer time between colonoscopy and surgery.*

[b] *Overall p-value from Cox proportional hazards regression*

[c] *Excludes missing values (n=6 for country of birth, n=3 for marital status, n=9 overall)*

(ref): reference category

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COMPETING INTERESTS

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AUTHORS' CONTRIBUTIONS

DO'C and MH helped conceive the study, advised on the data analysis and helped draft the manuscript. DG assisted with obtaining the data and data management, undertook the analysis and drafted the manuscript. SP, AS, CV, DW, IO, JB and MB helped conceive the study, participated in its coordination, and helped draft the manuscript. All authors read and approved the final manuscript.

DATA SHARING

There are no additional data available.

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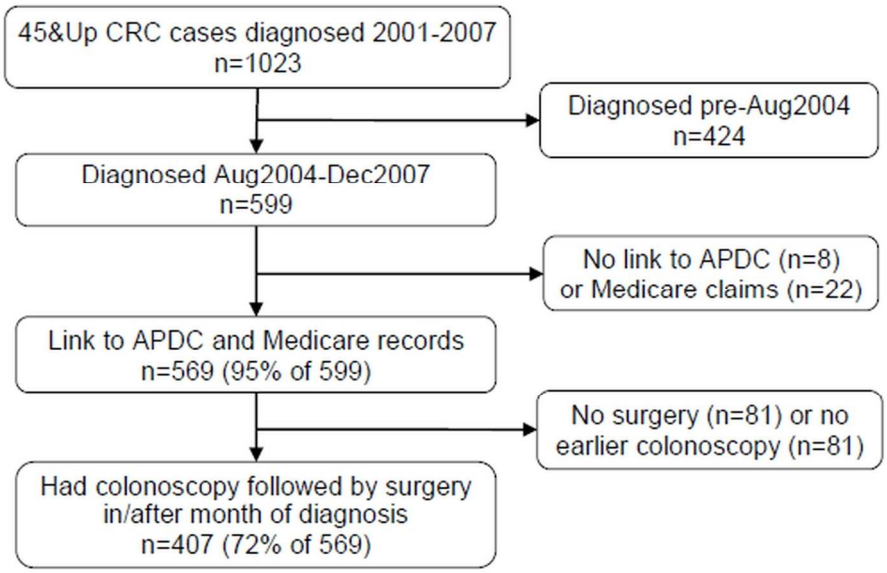
FIGURES

Figure 1. Selection of cases with colorectal cancer (CRC) for analysis.

Figure 2. Flowchart of procedures and consultations for the 407 colorectal cancer cases who had a colonoscopy and surgery.



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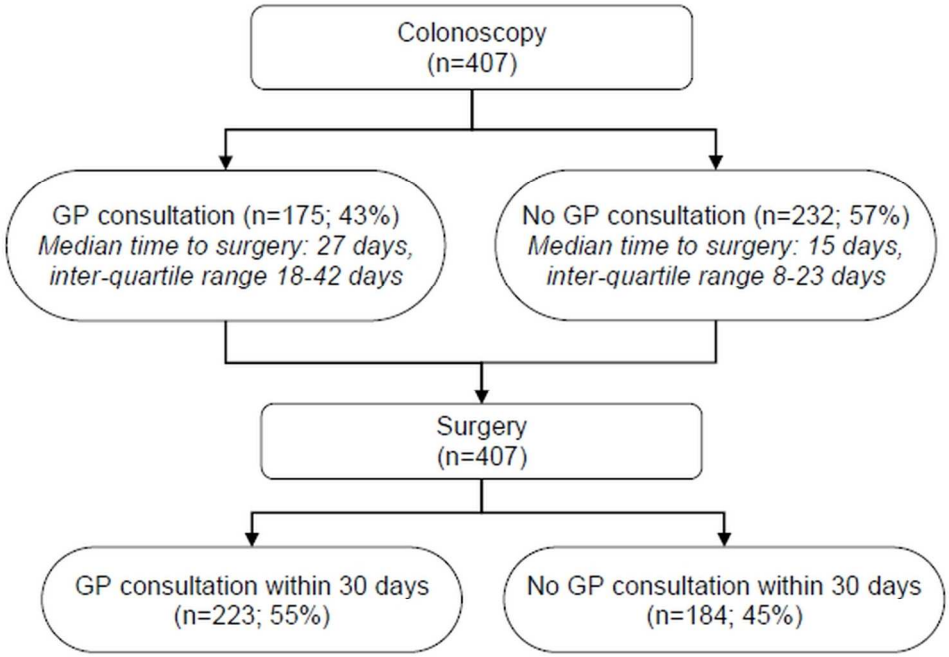

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	4-5
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	8-11
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-11
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	8-10
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	8-11
Bias	9	Describe any efforts to address potential sources of bias	9-10
Study size	10	Explain how the study size was arrived at	8-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9-10
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9-10
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, explain how loss to follow-up was addressed	-
		(*e*) Describe any sensitivity analyses	-
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	11-13, 28 (Figure 1)
		(b) Give reasons for non-participation at each stage	11, 28 (Figure 1)
		(c) Consider use of a flow diagram	28 (Figure 1)
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	11, 18-22 (Tables)
		(b) Indicate number of participants with missing data for each variable of interest	18-22 (Tables)
		(c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	18-22 (Tables)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-13, 18-22 (Tables)
		(*b*) Report category boundaries when continuous variables were categorized	18-22 (Tables)
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-15
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-17
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.