Original Article

Ethnicity and Management of Colon Cancer in New Zealand

Do Indigenous Patients Get a Worse Deal?

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BACKGROUND: Racial and ethnic inequalities in colon cancer treatment have been reported in the United States but not elsewhere. The authors of this report compared cancer treatment in a nationally representative cohort of Maori (indigenous) and non-Maori New Zealanders with colon cancer. **METHODS:** On the basis of cancer registry data, 301 Maori patients and 329 randomly selected non-Maori patients were identified who were diagnosed with colon cancer between 1996 and 2003. Medical notes were reviewed, and surgical and oncology treatments were compared by indigenous status. **RESULTS:** Maori and non-Maori patients had similar rates of surgical resection, although Maori patients were less likely to undergo extensive lymph node clearance and were more likely to die during the postoperative period. Maori patients were significantly less likely to receive chemotherapy for stage III disease (relative risk [RR], 0.69; 95% confidence interval [CI], 0.53-0.91) and were more likely to experience a delay of at least 8 weeks before starting chemotherapy (RR, 1.98; 95%CI, 1.23-3.16). Treatment disparities were not explained by differences in tumor characteristics or patient comorbidity. **CONCLUSIONS:** Maori New Zealanders with colon cancer were less likely to receive adjuvant chemotherapy and experienced a lower quality of care compared with non-Maori patients. The authors concluded that attention to health system factors is needed to ensure equal access and quality of cancer treatment for indigenous and ethnic minority populations. ***Cancer*** **2010;116:3205–14.** *© 2010 American Cancer Society.*

KEYWORDS: colonic neoplasms, delivery of healthcare, ethnic groups, indigenous populations, New Zealand.

Ethnic or racial disparities in cancer are observed in many countries and populations. Indigenous populations in New Zealand, Australia, and North America have higher cancer incidence and mortality and poorer cancer survival compared with the nonindigenous population in each country.[1-5] Similarly, black and Hispanic populations in the United States and Pacific populations in New Zealand have higher cancer mortality than the majority white or European population in each country.[5-7] Although a few specific cancers (such as melanoma) are less common in these groups,[1,4,5] the overall burden of cancer often falls disproportionately on indigenous and ethnic minority populations.

Treatment plays an important role in ethnic inequalities in cancer outcomes. Patients in the United States are less likely to receive appropriate cancer care if they are black or from another ethnic minority.[7,8] Indigenous Australians with cancer are less likely to receive surgery, chemotherapy, or radiotherapy compared with nonindigenous patients.[3] Similar disparities recently have been described in New Zealanders diagnosed with lung cancer, indicating that Maori patients are less likely to receive curative treatment and more likely to experience treatment delays compared with European patients.[9]

Colon cancer is a major cause of cancer-related death in most developed countries[10] and is particularly common in New Zealand.[11,12] New Zealand has a publicly funded health system with universal access to cancer treatment for all

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residents. Private healthcare also is available on a fee-for-service basis (commonly paid through voluntary private health insurance).

Disparities in colon cancer treatment can occur at many points along the pathway of care, including diagnosis, surgery, and adjuvant and palliative treatment (Fig. 1). Surgical resection is the mainstay of treatment for colon cancer,[13,14] whereas adjuvant chemotherapy has been recommended for stage III disease since the early 1990s.[15] "Palliative" chemotherapy is received by patients with stage IV disease in an effort to improve survival.[16]

Evidence from the United States indicates consistent differences in treatment received by black patients and white patients with colon cancer.[7] Black patients with colorectal cancer are significantly less likely to undergo surgery, even after adjustment for site and extent of disease and patient comorbidity.[17-19] Among patients with stage III disease, black patients receive lower rates of chemotherapy than white patients,[20-23] although this gap has narrowed more recently.[21] Currently, data are scarce that compare colon cancer treatment between ethnic groups outside the United States; and, to our knowledge, none compare treatment between indigenous and nonindigenous patients.

We examined cancer treatment in a cohort of New Zealanders with newly diagnosed colon cancer and compared Maori (indigenous) and non-Maori patients in terms of surgery, adjuvant therapy, and palliative therapy. We adjusted Maori/non-Maori treatment ratios first for clinical factors (tumor characteristics and patient comorbidity) and then for broad categories of treatment facility type (public cancer center hospital, public noncancer center hospital, private hospital) to establish whether ethnic disparities persist after taking patient-level factors into account and whether health facility type contributes to treatment inequalities. Unlike audits based on cancer databases, in our study, we used information collected specifically for this purpose from detailed physician review of medical records from over 80 public and private health providers, allowing comprehensive assessment of treatment processes, quality indicators, and potential confounders.

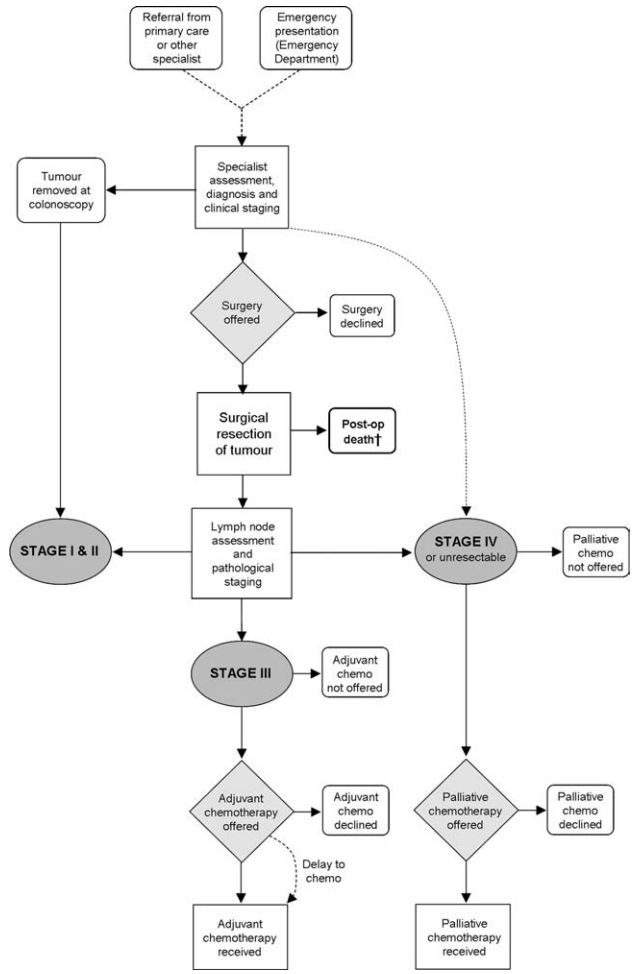

Figure 1. Steps in the clinical management of colon cancer are illustrated. Post-op indicates postoperative; chemo, chemotherapy.

MATERIALS AND METHODS

Study cohorts were drawn from all New Zealand residents who were diagnosed with colon cancer and reported to the New Zealand cancer registry between 1996 and 2003. We selected all eligible Maori patients and an equally sized, random sample of non-Maori patients. Patient ethnicity was taken from the cancer registry, which in turn, is based on self-identified ethnicity recorded in health service records. All patients who were not recorded as Maori were considered non-Maori; this group was predominantly European (>93%) but also included a small proportion of Pacific Islanders, Asians, and other ethnic groups. Patients were eligible for inclusion if they were New Zealand residents aged ≥25 years, had a primary diagnosis of cancer of the colon or rectosigmoid junction (International Classification of Diseases, 10th Revision, Australian Modification codes C18.0 to C19.0, excluding C18.1 [cancer of the appendix]), and had cancer morphology consistent with adenocarcinoma. Patients were excluded if they received a previous diagnosis of colon cancer or were diagnosed after death.

Clinical data were obtained from physician review of medical and pathology records for the relevant patients. These records were sourced from over 80 public and private health providers throughout New Zealand. At least 1 chart was reviewed for each patient; and, if a patient had received care through more than 1 health provider, then multiple charts were reviewed. Data were entered onto a standard questionnaire that included tumor details, comorbid conditions, surgical treatment, postoperative outcomes, oncology assessment, adjuvant therapy, and follow-up. All patients were staged according to the TNM classification system[24] on the basis of information in their operative, pathology, and medical records. Specific comorbid conditions were considered present if they were documented in the patient's medical history at the time of diagnosis. Postoperative complications referred to the 30 days after surgery and included any serious adverse health event that was attributed to surgery or anesthesia and any death. Postoperative mortality outcomes were obtained from review of medical records and systematic record linkage to the national mortality database. We categorized patients as having been offered chemotherapy if there was any record that medical staff had discussed chemotherapy with them without explicitly opposing it.

Maori and non-Maori patients were compared in terms of demographics, tumor characteristics, comorbid conditions, and broad categories of treatment facility type (public cancer center hospital, public noncancer center hospital, or private hospital). All patients were evaluated for resection of their primary tumor. Patients who underwent abdominal surgery also were compared for the presence of obstruction or perforation at surgery, operation type, surgeon type, postoperative complications, and regional lymph node assessment. The National Cancer Institute recommends assessment of at least 12 lymph nodes,[13] and evaluation of a higher number is associated with better quality care and improved survival[25]; therefore, we assessed whether 0 to 11 lymph nodes, 12 to 29 lymph nodes, or $\geq$30 lymph nodes were reported in the pathology specimen. Patients with stage III or IV disease who survived for $>$3 months after diagnosis were compared for oncology referral, assessment, and treatment. In patients with stage III disease, we assessed delays $\geq$8 weeks between from surgery and the start of chemotherapy (a delay $\geq$8 weeks is associated with poorer cancer survival[26]).

Prevalence "rates" (proportions) were adjusted for age and sex using direct standardization to the total study population. Prevalence ratios were adjusted for age, sex, and year of diagnosis (Model 1) using log Poisson regression with robust variance estimation.[27] To assess the contribution of clinical factors and facility type to apparent disparities in treatment, baseline prevalence ratios were adjusted further using 2 additional multivariate models. The second model (Model 2) included comorbid conditions and tumor characteristics (site, grade, and stage of disease) in addition to the variables that were included in the baseline model (age, sex, and year of diagnosis). Comorbid conditions were adjusted using specific disease categories.[28] The third model (Model 3) included all variables that were included in Model 2 with the addition of treatment facility type (public cancer center, public noncancer center, or private hospital). The models were adapted slightly according to the outcome of interest (for example, when modeling operation type, the Model 2, which was adjusted for clinical factors, included a variable for the presence of obstruction or perforation at surgery). All analyses were undertaken in SAS (version 9.1; SAS Institute Inc., Cary, NC). Approval for this study was granted by the New Zealand Multi-Region Ethics Committee (MEC/05/06/069).

RESULTS

On the basis of New Zealand cancer registry records, we identified an initial cohort of 776 patients who were diagnosed with colon cancer during 1996 to 2003 and met the study eligibility criteria. This sample included all 376 Maori patients who met the eligibility criteria and another 400 non-Maori patients who were sampled randomly from the registry for the same period. Approximately 10% of these patients were deemed ineligible after review of medical records: 33 patients (21 Maori and 12 non-Maori) had miscoded cancer site on their cancer registry records (most commonly, rectal cancer coded as colon cancer), 45 patients (21 Maori and 24 non-Maori) had no histologic diagnosis or histology other than adenocarcinoma, 6 patients (all non-Maori) had a previous colon cancer, and 5 patients (2 Maori and 3 non-Maori) resided outside New Zealand. Exclusion of these 91 patients yielded an eligible sample of 685. We excluded another 56 patients (equal numbers of Maori and non-Maori individuals) who had missing information on key variables, including date of diagnosis,[26] tumor histology,[17] tumor site and/or grade,[9] and key demographic data.[4] The final study cohort (n = 629) represented 92% of all eligible individuals and comprised 301 Maori patients and 328 non-Maori patients.

Table 1. Characteristics (Demographics, Disease Characteristics, Comorbid Conditions, and Treatment Facility) of Maori and Non-Maori Patients With Colon Cancer

	Maori, n=301		Non-Maori, n=328		
Characteristic	No.	%[a]	No.	%[a]	*P*[b]
Demographics					
Mean age at diagnosis, y	61.3		70.6		<.001
Women	132	43.9	172	52.4	.03
Tumor characteristics					
TNM stage of disease					
I	33	12.4	46	13.3	.7
II	90	31.2	101	29.3	.7
III	87	30.7	112	34.7	.2
IV	87	24.4	66	22.2	.2
Unstaged	4	1.3	3	0.6	.08
Tumor site					
Right colon	108	34.6	153	44.1	.04
Left colon	135	44.	97	31.1	.01
Rectosigmoid	48	17.4	53	17.3	.7
Synchronous	10	4	25	7.5%	.06
Bowel obstruction/perforation at diagnosis	87	27.3	68	21.2	.05
Tumor grade					
Well differentiated	36	13.7	25	7	.01
Moderately differentiated	214	69.2	241	74.3	.2
Poorly differentiated	51	17.1	62	18.7	.6
Comorbid conditions					
Hypertension	120	47	117	32.3	<.001
Previous heart attack	24	8.3	27	7.9	.5
Heart failure	35	15.7	30	7.3	<.001
Diabetes	63	22.6	35	9.3	<.001
Respiratory disease	21	7.2	12	2.8	.02
Previous stroke or TIA	20	9.2	30	7.8	.5
Renal disease	20	7.7	13	3.2	.01
Neurologic disease[c]	16	5.7	25	7.4	.3
Treatment facility					
Public hospital, noncancer center	184	64.9	152	46.5	<.001
Public hospital, cancer center	88	27	109	30.8	.4
Private hospital	15	3.4	58	20.1	<.001

TIA indicates transient ischemic attack.

[a] Except for patient sex, all prevalence rates (%) were standardized for age and sex using direct standardization to the total study population.

[b] *P* values (2-tailed) for binomial and continuous variables were calculated from chi-square tests and Wilcoxon tests, respectively.

[c] Significant neurologic and psychiatric disorders other than cerebrovascular disease included dementia (13 patients); epilepsy (10 patients); schizophrenia (5 patients); intellectual impairment (4 patients); bipolar disorder (2 patients); Parkinson disease (2 patients); and blindness, idiopathic peripheral neuropathy, multiple sclerosis, polio, previous head injury, and spinal stenosis (1 patient each). One patient had both epilepsy and intellectual impairment.

Maori patients were approximately 9 years younger at diagnosis than non-Maori patients and were less likely to be women (Table 1). There were no significant ethnic differences in cancer stage at diagnosis, and just less than 25% of the study cohort was diagnosed with metastatic disease. Maori patients had a higher prevalence of left-sided colon cancers and were more likely to have bowel obstruction or perforation present at diagnosis. They were almost twice as likely as non-Maori to have well differentiated or low-grade tumors. Compared with non-Maori patients, Maori patients had a significantly higher prevalence of comorbid conditions, including hypertension, heart failure, diabetes, respiratory disease, and renal disease.

There were significant differences in the types of health facilities that treated Maori and non-Maori patients (Table 1). Maori patients were much more likely to receive care from public hospitals without cancer centers, which treated 65% of Maori patients compared with 47% of non-Maori patients ($P < .001$). Non-Maori patients with colon cancer were much more likely to be treated in private hospitals, which provided cancer treatment to 20% of non-Maori patients compared with only 3% of Maori patients ($P < .001$). Public hospitals with cancer centers provided care to <33% of both Maori and non-Maori patients.

The vast majority of both Maori and non-Maori patients underwent surgical treatment for their colon cancer (Table 2). Maori patients were slightly less likely to have their primary tumor removed (90% vs 94% of non-Maori patients; $P = .01$) and were more likely to undergo palliative bypass or stoma formation (6.3% vs 3%; $P = .03$). There were no significant differences in the types of surgeons operating on Maori and non-Maori patients, and 75% of all operations were undertaken by general surgeons.

Non-Maori patients appeared to be more likely to undergo extensive lymph node clearance at the time their primary tumor was removed (Table 2). Compared with non-Maori patients, Maori patients were more likely to have <12 lymph nodes reported in their surgical specimen (relative risk [RR], 1.14; 95% confidence interval [CI], 1.01-1.29) and were less likely to have ≥30 lymph nodes reported (RR, 0.25; 95% CI, 0.13-0.50). Maori patients were significantly more likely to die in the 30-day postoperative period, especially after elective surgery (although the numbers were small): the Maori/non-Maori risk ratio for postoperative mortality was 3.49 (95% CI, 1.54-7.91) after all surgery and 5.31 (95% CI, 1.54-18.32) after elective surgery. Most deaths after elective surgery were caused by postoperative pneumonia or organ failure; all of these patients had preexisting and often multiple comorbidities. Almost all Maori patients who died after elective surgery underwent surgery in public non-cancer centers (9 of 11 patients) compared with only 1 in 5 non-Maori deaths. Rates of nonfatal postoperative complications were similar for Maori and non-Maori patients.

Maori patients with stage III disease were significantly less likely to be offered or to receive adjuvant chemotherapy (which is recommended for all patients with stage III disease) despite similar rates of oncology referral and review compared with non-Maori patients (Table 2). When they did receive adjuvant chemotherapy, Maori patients were more likely to experience a significant delay: >50% waited ≥8 weeks to start chemotherapy compared with 25% of non-Maori patients. Among patients with stage IV disease (to whom "palliative" chemotherapy may be offered in hope of prolonging survival), Maori patients were less likely be offered or to receive palliative chemotherapy.

Clinical factors (disease characteristics and comorbid conditions) contributed to differences in surgery between Maori and non-Maori patients, but the rates of primary tumor removal did not differ significantly after adjusting for these factors (Table 3). Higher rates of palliative bypass or stoma formation in Maori patients were not explained by either clinical factors (including bowel obstruction/perforation) or type of treatment facility. These factors also failed to account for higher postoperative mortality in Maori patients.

Differences in adjuvant therapy were not explained by clinical factors or broad categories of treatment facility type (Table 3). After adjustment for these variables, Maori patients with stage III disease remained significantly less likely to be offered or to receive chemotherapy (RR, 0.80 [95% CI, 0.65-0.98] to be offered chemotherapy; RR, 0.71 [95% CI, 0.53-0.96] to receive chemotherapy) and were twice as likely to wait ≥8 weeks to start treatment (RR, 2.02; 95% CI, 1.10-3.71). Clinical factors may explain at least some of the difference in palliative chemotherapy, with attenuation of the Maori/non-Maori difference from a prevalence ratio of 0.53 (95% CI, 0.32-0.87) to 0.64 (95% CI, 0.37-1.11) after adjustment for patient comorbidity and tumor characteristics.

DISCUSSION

The current study provides evidence of significant disparities at a national level in the treatment of Maori and non-Maori patients with colon cancer in New Zealand. After adjustment for clinical factors, Maori and non-Maori patients had similar rates of surgical intervention, although Maori patients were more likely to number among the small proportion of patients undergoing palliative surgery without removal of the primary cancer. Perhaps the most notable treatment disparity was that Maori patients with stage III disease were less likely to be offered or to receive adjuvant chemotherapy even after clinical factors were taken into account. In addition, there is some evidence that Maori patients received a lower quality of care compared with non-Maori patients and had higher postoperative mortality, a tendency to undergo less

Table 2. Surgical and Oncology Treatment (Standardized Percentages and Adjusted Prevalence Ratios) in Maori Patients and Non-Maori Patients

	Maori Patients		Non-Maori Patients		Prevalence Ratio		
Treatment	No.	%[a]	No.	%[a]	RR[b]	95% CI	*P*
Surgical treatment							
Removal of primary tumor	264	88.9	307	93.5	0.93	0.88-0.98	.01
At colonoscopy	1	0.3	7	2.0	0.26	0.03-2.07	.2
At surgery	263	88.6	300	91.6	1.01	1.00-1.03	.1
Surgery offered	289	95.8	316	96.2	0.99	0.96-1.02	.5
Surgery declined	3	0.7	4	0.8	1.29	0.44-3.73	.2
Of those undergoing surgery	286		312				
Emergency surgery	87	29.6	68	22.1	1.35	1.00-1.83	.05
Type of surgery							
Right hemicolectomy	91	32.6	145	42.9	0.76	0.61-0.95	.01
Left hemicolectomy	117	41.8	119	40.5	1.01	0.81-1.26	.9
Total colectomy	15	5.1	18	6.6	0.65	0.31-1.38	.3
Hartmann procedure	34	12.1	13	4.4	2.47	1.27-4.80	.01
Palliative bypass or stoma	21	6.3	9	3	2.53	1.08-5.95	.03
Presence of bowel obstruction or perforation at surgery	87	28.8	68	22.3	1.37	1.01-1.85	.04
Surgeon specialization							
Colorectal surgeon	43	13.6	51	16.8	0.73	0.49-1.08	.1
General surgeon	217	77.8	239	76.0	1.03	0.94-1.14	.5
Surgical trainee	26	8.6	22	7.3	1.38	0.76-2.48	.3
No. of lymph nodes removed							
0-11	191	67.2	197	62.8	1.14	1.01-1.29	.03
12-29	62	22.3	77	24.1	0.82	0.60-1.12	.2
≥30	9	2.4	18	6.3	0.25	0.12-0.50	<.001
Postoperative complications							
Death	23	10.3	10	3.5	3.49	1.54-7.91	.01
After elective surgery	11	9.2	5	1.8	5.31	1.54-18.32	.01
After emergency surgery	12	13.3	5	8.1	2.00	0.65-6.14	.2
Reoperation[c]	24	8.3	20	7	1.13	0.60-2.12	.7
Sepsis	29	8.9	19	6.7	1.37	0.74-2.53	.3
Pneumonia	19	7.2	18	4.9	1.71	0.91-3.23	.1
Other complications[d]	29	11.4	35	11.5	1.07	0.65-1.77	.8
Oncology treatment							
Stage III disease	82		108				
Referred to oncologist	70	79.3	85	83.4	0.92	0.81-1.05	.2
Reviewed by oncologist	67	75.1	81	80	0.89	0.77-1.03	.1
Offered adjuvant chemotherapy	57	65.4	77	77.1	0.76	0.63-0.92	.01
Declined adjuvant chemotherapy	11	15	16	12.1	1.12	0.54-2.32	.8
Received adjuvant chemotherapy	45	49.9	59	63.7	0.69	0.53-0.91	.01
Time from surgery to chemotherapy when received, d							
1-28	3	5.5	4	7.2	1.07	0.27-4.29	.9
29-56	19	42	36	65.5	0.64	0.42-0.97	.03
≥57	23	52.4	17	27.3	1.98	1.23-3.16	.01
Received radiotherapy	5	5.2	4	4.8	1.61	0.43-6.12	.5
Stage IV disease	65		56				
Referred to oncologist	46	58.6	37	70.5	0.81	0.61-1.08	.2
Reviewed by oncologist	43	55.6	36	68.9	0.76	0.56-1.04	.08
Offered palliative chemotherapy	35	46.8	34	66.1	0.62	0.43-0.87	.01
Declined palliative chemotherapy	6	14.3	12	22.8	0.50	0.16-1.55	.2
Received palliative chemotherapy	25	27.6	22	43.3	0.53	0.32-0.87	.01

RR indicates relative risk; CI, confidence interval.

[a] Prevalence rates (%) were standardized for age and sex using direct standardization to the total study population.

[b] RR is the prevalence ratio adjusted for age, sex, and year of diagnosis using log Poisson regression. The *P* value (2-tailed) was derived from the chi-square test.

[c] The most common reasons for reoperation were anastamotic leakage, intra-abdominal abscess, bowel obstruction, and wound reclosure.

[d] Other complications (<5% each) included cardiac failure, respiratory failure, myocardial infarction, thromboembolism, stroke, and renal failure.

Table 3. Adjusted Treatment Ratios for Maori Patients Compared With Non-Maori Patients

Treatment	Prevalence Ratio (95% CI)[a]		
	Model 1: Demographics	Model 2: Plus Clinical Factors	Model 3: Plus Treatment Facility
Surgical treatment			
Removal of primary tumor	0.93 (0.88-0.98)	0.96 (0.91-1.01)	0.95 (0.90-1.00)
Patients who underwent surgery, n=598			
Palliative bypass or stoma	2.55 (1.10-5.92)	2.98 (1.29-6.87)	3.42 (1.40-8.34)
Postoperative death	3.49 (1.54-7.91)	3.17 (1.51-6.63)	2.97 (1.43-6.18)
After elective surgery	5.31 (1.54-18.32)	5.29 (1.36-20.55)	5.56 (1.47-20.98)
Regional lymph node clearance			
0-11	1.14 (1.01-1.29)	1.04 (0.91-1.18)	1.02 (0.89-1.16)
≥30	0.25 (0.13-0.50)	0.30 (0.15-0.61)	0.32 (0.15-0.69)
Oncology treatment			
Stage III disease, n=190			
Offered chemotherapy	0.76 (0.63-0.92)	0.81 (0.66-0.98)	0.80 (0.65-0.98)
Received chemotherapy	0.69 (0.53-0.91)	0.70 (0.53-0.94)	0.71 (0.53-0.96)
Delay of 8 wks before chemotherapy	1.98 (1.23-3.16)	2.01 (1.15-3.53)	2.02 (1.10-3.71)
Stage IV disease, n=121			
Offered chemotherapy	0.62 (0.43-0.87)	0.72 (0.50-1.05)	0.71 (0.49-1.03)
Received chemotherapy	0.53 (0.32-0.87)	0.64 (0.37-1.11)	0.67 (0.38-1.19)

CI indicates confidence interval.

[a] Adjusted prevalence ratios were calculated from log Poisson models. Model 1 was adjusted for age, sex, and year of diagnosis; Model 2 was adjusted for Model 1 covariates plus tumor site and grade, patient comorbidity (all patients), tumor stage, and the presence of bowel obstruction/perforation (patients who underwent surgery); and Model 3 was adjusted for Model 2 covariates plus treatment facility type.

comprehensive assessment of regional lymph nodes, and longer delays in starting adjuvant chemotherapy.

Treatment disparities may occur at many points along the cancer management pathway (Fig. 1) and may involve differences in diagnosis, intervention rates, quality of care, or waiting times. Maori patients in our study appeared more likely to have bowel obstruction or perforation at the time of diagnosis. This difference may reflect differences in tumor distribution but may also indicate that Maori patients experience longer delays to diagnosis and surgical treatment compared with non-Maori patients. Maori patients also were more likely to have their cancer site miscoded on cancer registry records, suggesting differences in diagnostic accuracy. We were unable to assess the role of primary health services in our cohort, although other audits have demonstrated that Maori patients face greater unmet needs for primary care and cancer screening[29] and are more likely to experience delays in the investigation and diagnosis of possible cancers.[30]

Differences in care were particularly pronounced for adjuvant cancer therapy. Among the patients with stage III disease, Maori patients were 30% less likely to receive adjuvant chemotherapy than non-Maori patients. For patients to receive chemotherapy, they must progress through a series of management steps, including oncology referral, review, offer of chemotherapy, and receipt of chemotherapy (Fig. 1). Although the rates of oncology referral and review were slightly lower for Maori patients compared with non-Maori patients (Table 2), the Maori/non-Maori difference did not reach statistical significance until the point at which chemotherapy was offered (to 77% of non-Maori and to 65% of Maori patients; $P = .004$). This pattern suggests that there is no single point in the management process at which Maori patients suddenly experience less care; rather, the impression is 1 of a slight disadvantage at each step leading (finally) to Maori patients being half as likely as non-Maori to receive chemotherapy within 8 weeks of surgery for stage III disease. Maori patients were more likely to suffer from comorbid conditions (such as ischemic heart disease) that may be considered relative contraindications to chemotherapy; however Maori/non-Maori disparities in the offer and receipt of adjuvant chemotherapy largely were unaltered by adjustment for clinical factors (Table 3).

Our data also suggest that Maori patients may receive lower quality care compared with non-Maori

patients. Maori patients underwent less comprehensive lymph node assessment (a marker of the quality of colon cancer management[25]) and had greater postoperative mortality even after adjustment for clinical factors. We observed a 9.2% mortality rate in Maori patients who underwent elective surgery compared with 1.8% in non-Maori patients. Although these proportions are based on small numbers, the mortality rate for Maori patients is considerably higher than the 3% to 7% guideline provided by the British Association of Coloproctology.[31,32] In terms of oncology treatment, >50% of all Maori patients who received adjuvant chemotherapy waited for >8 weeks to start their treatment compared with slightly more than 25% of non-Maori recipients. At the time of the current study, adjuvant cancer therapy was provided almost exclusively through public hospitals; therefore, this finding supports previous research suggesting that Maori patients may receive a lower quality of public hospital care compared with European New Zealanders.[33]

Ethnic inequalities in treatment may arise at the level of health systems, healthcare processes, and individual patients.[7,8] Our study produced no evidence that Maori patients refuse treatment more often than non-Maori patients, and <1% of all patients (both Maori and non-Maori) declined surgical treatment. The rates of decline were somewhat higher for chemotherapy but were no different for Maori and non-Maori patients. Maori patients had higher documented comorbidity, which contributed to lower rates of primary tumor removal and palliative chemotherapy in this group; however, these factors did not account for differences in adjuvant chemotherapy or indicators of treatment quality. Therefore, we conclude that patient-level factors contribute to Maori/non-Maori disparities in cancer surgery and palliative therapy but do not explain the more serious differences in adjuvant therapy and quality of care.

In contrast, health systems factors are likely to be major drivers of ethnic disparities in cancer treatment. Approximately 66% of Maori patients received their care at noncancer centers compared with <50% of non-Maori patients. Public hospitals without cancer centers are spread throughout New Zealand and vary from large urban facilities with several hundred beds to small rural hospitals with <20 beds. Maori patients were more likely to live in rural areas (data not shown), which means that they are more likely to access care from small hospitals with fewer resources (such as intensive care facilities and specialized staff) and lower cancer case loads.

Apparent differences in treatment processes and quality of care, thus, may reflect the different characteristics and practices of health providers who treat Maori and non-Maori patients. It is known that variations between health facilities contribute to treatment disparities in other countries,[18,34-39] particularly the United States, where ethnic segregation of healthcare is marked[36,40] and is likely to be a major cause of treatment differences between black and white patients.[35,37,41,42] We made some attempt to assess the influence of facility differences on Maori/non-Maori treatment disparities by adjusting for the type of hospital where patients underwent surgery (treating this as the patient's primary treatment facility). However, our crude categorization (public cancer center hospitals, public hospitals without cancer centers, and private hospitals) failed to capture the considerable variation that exists within these groups and may not have captured relevant facility type in cases where patients underwent surgical and oncology treatment in different facilities. Given these limitations, it is difficult to interpret the presence of residual treatment disparities between Maori and non-Maori patients after adjustment for facility type.

Our study did not include information on the clinical decision-making process, so we cannot comment on whether individual physicians provided different care to their Maori and non-Maori patients. Survey data indicate that Maori New Zealanders are more likely to report having experienced discrimination from health professionals on the basis of their ethnicity.[43] Evidence from the United States suggests that interpersonal discrimination contributes to ethnic disparities in care,[7,9] but treatment inequities there are driven more by differences between healthcare providers than by differential care within the same facility.[35,37,42] The balance of these factors may be somewhat different in New Zealand, where ethnic segregation is less marked than in the United States.

A key strength of our study is our comprehensive assessment of clinical factors based on a detailed review of medical records rather than administrative data. This improved the accuracy of our staging and comorbidity data[44] and allowed us to look at whether patients were offered or refused treatment and whether or not they received it. Thus, we were able to examine treatment differences at multiple points on the cancer management pathway and to adjust accurately for tumor characteristics and comorbid conditions.

In summary, we have established evidence of disparities in the treatment of Maori and non-Maori New Zealanders with colon cancer, including differences in cancer

interventions, quality of care, and waiting times. Clinical factors contributed to ethnic disparities in primary tumor removal and palliative chemotherapy but did not explain other treatment inequalities. We observed no evidence of ethnic differences in patient preferences for treatment. Ethnic disparities in the provision and quality of colon cancer care in New Zealand are likely to reflect discriminatory healthcare structures and processes, including differences in the type and quality of care provided by facilities that treat Maori and non-Maori patients. Attention to health service planning, funding, and support will be important to ensure that Maori and non-Maori patients receive the same high standards of cancer care in the future.

CONFLICT OF INTEREST DISCLOSURES

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