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Can concordance between actual care received and a pathway map be measured on a population level in Ontario? A pilot study

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ABSTRACT

Background Clinical pathways are associated with improved adherence to clinical guidelines; however, most studies have evaluated pathways for a single intervention at a single institution. The objective of the present study was to develop and evaluate a method of measuring concordance with a population-based clinical pathway map to determine if that method could be feasible for assessing overall health system performance.

Methods Patients with stage II or III colon cancer diagnosed in 2010 were identified, and clinical data were obtained through linkages to administrative databases. Pathway concordance was defined *a priori* based on receipt of key elements of the Ontario Health (Cancer Care Ontario) colorectal pathway maps. For stages II and III colon cancer alike, concordance was reported as the proportion of patients receiving care that followed the predefined key elements of the pathway map. Regression analysis was used to identify predictors of concordant care.

Results Our study identified 816 patients with stage II and 800 patients with stage III colon cancer. Of the patients with stage II disease, 70% (n = 571) received concordant care. Of the patients with stage III disease, results showed high concordance for all key elements except receipt of chemotherapy, leading to an overall concordance rate of 39% for that cohort.

Conclusions Our method of measuring concordance was feasible on a population-based level, but future studies to validate it and to develop more sophisticated methods to measure concordance in larger cohorts and various disease sites are necessary. Measurement of clinical pathway concordance on a population-based level has the potential to be a useful tool for assessing system performance.

Key Words Clinical pathways, concordance, quality improvement, system performance, colon cancer

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INTRODUCTION

Clinical pathways are structured multidisciplinary care plans that outline key actions in the care of patients with a specific health condition[1]. Increasingly, pathways have been used in clinical practice because they have been shown to improve the quality of care and to promote desirable clinical outcomes. Based on the results of twenty-seven studies that compared standardized clinical pathways with usual care, a Cochrane systematic review found that reduced in-hospital complications and improved documentation can result when clinical pathways are used[2]. Clinical pathways have also been associated with adherence to clinical practice guidelines, reduction in repetition of diagnostic tests, increased patient satisfaction, and survival[3,4]. To date, however, most studies have evaluated pathways for a single intervention at a single institution, and no standardized methods

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have been developed to measure the effectiveness of clinical pathways[5].

More recently, Ontario Health (Cancer Care Ontario) [OH(CCO)], the government agency responsible for cancer care in the province of Ontario, developed clinical pathway maps for 11 cancers, including breast, prostate, lung, and colorectal cancer (https://www.cancercareontario.ca/en/pathway-maps). All of the OH(CCO) pathway maps apply to the entire province rather than to a single institution and include the continuum of care from diagnosis to follow-up rather than a single intervention[6]. Those attributes of the OH(CCO) pathway maps provide a unique opportunity to explore strategies to measure concordance of actual care received with care recommended by the pathway map. The resulting concordance measure could be used to assess overall system performance and to facilitate quality improvement by identifying unwarranted variation so that targeted quality improvement strategies could be implemented.

Currently, no method to measure concordance along a population-based clinical pathway has been established; thus, the overall objective of the present study was to develop and evaluate a method of measuring concordance along population-based clinical pathways, providing proof-of-concept that such an approach to assessing overall health system performance would be feasible.

METHODS

Study Design and Population

For the purposes of the present study, we used a pre-established cohort of colon cancer patients with sufficient duration of follow-up to assess overall survival. We selected that cohort because it was of sufficient sample size and because survival rates and mean survival times allowed for a meaningful comparison of survivors and non-survivors within the timeframe of the study. We specifically included only stage II and stage III colon cancer because the pathway maps for those two groups were felt to be the most clearly specified. The original cohort included all patients from the Ontario Cancer Registry who were diagnosed with colorectal cancer (International Classification of Diseases, 10th revision, codes C18–C21) between 1 January 2010 and 31 December 2010. The Ontario Cancer Registry is a patient-specific population-based cancer registry that includes staging and pathology data for all newly diagnosed cases[7]. Patients were excluded if they did not have a valid health card number, had non-diagnostic pathology, had more than 1 primary tumour, or resided outside of Ontario.

Using health card numbers, the final cohort was linked with 5 health utilization databases to obtain patient-level clinical data, including screening with fecal occult blood testing (FOBT), diagnostic imaging, surgical treatment, adjuvant chemotherapy, emergency room visits, re-admission to hospital, outpatient clinic visits, and death.

The OHIP (Ontario Health Insurance Plan) administrative database provides information about physician services provided on a fee-for-service basis. The OHIP database was used to abstract data for screening by FOBT, colonoscopy, abdominal computed tomography (CT), and consultation with a medical oncologist. Screening by FOBT was defined according to a previously validated algorithm that categorizes patients into 4 groups based on exposure to FOBT during the 5-year period before diagnosis[8]:

- None (no record of FOBT)
- Pre-diagnostic (only 1 FOBT performed within 9 months of diagnosis)
- Repeated (2 or more FOBTs, with the most recent FOBT being performed within 9 months of diagnosis, and a 2nd being performed 12–24 months before the most recent FOBT)
- Sporadic (all other cases)

The National Ambulatory Care Reporting System is a national database that collects administrative, clinical, and service-specific ambulatory and outpatient data. The National Ambulatory Care Reporting System was used to abstract data for chemotherapy treatment and emergency room visits.

The Discharge Abstract Database is a national database containing information about admissions to acute-care institutions. It was used to abstract data for details pertaining to surgical treatment and the Charlson comorbidity index[9].

The Postal Code Conversion File is a database created by Statistics Canada that assigns a range of socioeconomic variables to standard geographic areas based on postal code[10]. All socioeconomic variables—including urban–rural status, immigration tertile, and neighbourhood median income quintile—were obtained from that database.

The Registered Persons Database maintained by the Ontario Ministry of Health and Long-Term Care is a population based registry of all deaths in the province. The Registered Persons Database was used to abstract data for patient deaths and to calculate survival rates for the study.

Pathway Concordance

A priori, the elements of the OH(CCO) pathway maps most critical to optimizing treatment and survival in stages II and III colorectal cancer were established in consultation with clinical experts. Those elements included pretreatment endoscopy, pretreatment abdominal CT, surgery, medical oncology consultation, and receipt of chemotherapy. For the study, only patients undergoing a bowel resection were included in the analysis. Patients undergoing a non-resection surgery (such as diverting ileostomy, colostomy, or exploratory laparotomy) were excluded.

For each of the key elements, specific time intervals and a maximum permitted number of encounters were assigned based on expert consensus. Pretreatment endoscopy and abdominal CT were defined as concordant events if those elements occurred within 180 days before the diagnosis date and the date of resection, or within 60 days after the date of diagnosis, whichever came first. Resection was defined as an event if that element occurred within 180 days from the date of diagnosis and before the date of the first chemotherapy visit (when applicable). To allow for repeat testing that might be considered discordant, the maximum number of encounters permitted was 3 for pretreatment endoscopy, 2 for abdominal CT, and 1 for resection. Consultation with a medical oncologist was defined as a concordant event if it occurred within 270 days from the date of diagnosis and before the date of the first chemotherapy visit, when applic-

able. Chemotherapy treatment was defined as a concordant event if it occurred after the date of surgery and within 180 days of the date of diagnosis.

Using those 5 key elements, 4 groups of possible sequences were established. Sequence A included all 5 elements: endoscopy, abdominal CT, surgery, medical oncologist consultation, and chemotherapy. Sequence B included 4 elements: endoscopy, abdominal CT, surgery, and medical oncologist consultation. Sequence C included 3 elements: endoscopy, abdominal CT, and surgery. Sequence D included any 2 elements or fewer.

Patients with stage II colon cancer who followed sequences A, B, or C were considered concordant with the pathway map because consultation with a medical oncologist and chemotherapy treatment were considered optional. Patients with stage III colon cancer who followed sequence A were considered concordant because chemotherapy is considered mandatory.

Statistical Analysis

Descriptive statistics are used to report demographics and health care use. For stage II colon cancer, concordance was reported as the proportion of patients assigned to any of sequences A, B, and C. For stage III colon cancer, concordance was reported as the proportion of patients assigned to sequence A.

Logistic regression was used to identify predictors of concordance for both stage II and stage III colon cancer. The independent variables were substage at diagnosis (that is, stages IIA, IIB, or IIC, and IIIA, IIIB, or IIIC), age group, sex, score on the Charlson comorbidity index, screening group, type of surgery (elective vs. urgent), emergency room visits in the 30 days before the date of diagnosis, length of stay after surgery, urban–rural status, immigration tertile, and neighborhood median income quintile. The Wald test was used to evaluate the significance of the odds ratios of the covariates[11]. The *C* statistic was used to measure the goodness of fit of the logistic regression models for patients with stages II and III disease. For the study, a *C* statistic of 0.5 was considered to indicate a poor model; 0.7–0.8, to indicate a good model; and more than 0.8, to indicate a strong model[11].

Given that no "gold standard" for measuring concordance along a pathway has been established, our group hypothesized, *a priori,* that the level of concordance between stages II and III colon cancer would differ, because those pathways have different key elements and because concordant care and survival would be associated. For the present analysis, Kaplan–Meier survival curves were used to predict unadjusted survival outcomes, and the log-rank test was used to compare survival distributions for the concordant and non-concordant groups of patients with stages II and III disease (combined and separately)[12].

Statistical analyses were conducted using the SAS software application (version 9.4: SAS Institute, Cary, NC, U.S.A.).

RESULTS

Study Cohort

Initially, 5671 patients with colon cancer in the Ontario Cancer Registry were identified. Of those 5671 patients, 1616 with stage II or III colon cancer who underwent resection were identified and included in the study (Figure 1). The cohort was fairly evenly divided between those diagnosed with stage II (n = 816) and stage III (n = 800) disease.

Table I reports patient characteristics. Overall, mean age at diagnosis in this cohort was 70 years, and the distribution of male and female patients was relatively even. Most patients lived in urban areas and, based on the Charlson comorbidity index, had few comorbidities. Most also lived in areas with low concentrations of immigrants (foreign-born individuals). Median income quintiles were relatively evenly distributed. The overall 4-year survival for the cohort since diagnosis was 72.5% (stage II: 79.2%; stage III: 65.6%).

Health Services Use

Table II reports the results for services use by patients. During the diagnostic phase, most patients underwent pretreatment colonoscopy or flexible sigmoidoscopy (79.3%) and abdominal CT (95.1%). During the treatment phase, almost all patients (99.4%) underwent resection within 180 days of the date of diagnosis. Approximately two thirds underwent elective resection; the remaining third required urgent surgery. Median time from date of diagnosis to date of surgery was 17 days, and the median length of stay for surgery was 7 days. Of the patients with stage III colon cancer, 92.4% had a consultation with a medical oncologist, and 53.5% received chemotherapy at a median of 56.5 days from the date of surgery.

Overall, 41.1% of the patients had at least 1 emergency room visit in the 30 days preceding the date of diagnosis, and 55.0% had at least 1 emergency room visit within 180 days after the date of diagnosis.

Pathway Concordance

Of the patients with stage II colon cancer, 70% (n = 571) followed sequence A, B, or C and received care concordant with the OH(CCO) pathway map (Table III). Multivariable regression analysis showed that patients staged IIA, under-

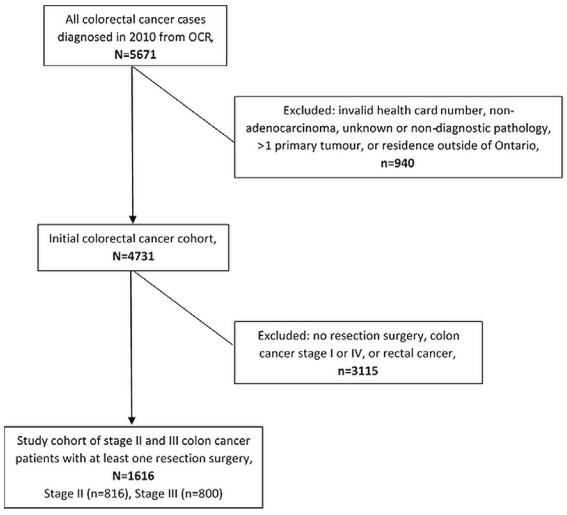

FIGURE 1 Flowchart for the final study cohort. OCR = Ontario Cancer Registry.

TABLE I Cohort characteristics

Characteristic	Cohort					
	Overall		Stage II		Stage III	
	(n)	(%)	*(n)*	(%)	*(n)*	(%)
Patients	1616		816	50.5	800	49.5
Age group						
<55 Years	211	13.1	82	10.0	129	16.1
55–64 Years	299	18.5	136	16.7	163	20.4
65–74 Years	433	26.8	230	28.2	203	25.4
≥75 Years	673	41.6	368	45.1	305	38.1
Sex						
Men	779	48.2	385	47.2	394	49.3
Women	837	51.8	431	52.8	406	50.8
Score on the CCI						
0	1449	89.7	719	88.1	730	91.3
1	79	4.9	47	5.8	32	4.0
≥ 2	88	5.4	50	6.1	38	4.8
Urban–rural index						
Urban	1389	86.0	693	84.9	696	87.0
Rural	227	14.0	123	15.1	104	13.0
Immigration tertile						
Low	1010	62.5	508	62.3	502	62.8
Middle	366	22.6	183	22.4	183	22.9
Highest	225	13.9	119	14.6	106	13.3
Neighbourhood income						
Low	328	20.3	158	19.4	170	21.3
Medium to low	322	19.9	173	21.2	149	18.6
Middle	321	19.9	167	20.5	154	19.3
Medium to high	325	20.1	154	18.9	171	21.4
High	313	19.4	162	19.9	151	18.9
4-Year survival						
Alive	1171	72.5	646	79.2	525	65.6
Died	445	27.5	170	20.8	275	34.4

CCI = Charlson comorbidity index.

going elective surgery, and having a higher immigration tertile and income quintile were significantly more likely to receive care concordant with the OH(CCO) pathway map (*C* statistic: 0.733; Table IV).

Of the patients with stage III colon cancer, 39% (n = 312) followed sequence A and received care concordant with the OH(CCO) pathway map (Table III). Multivariable regression analysis showed that patients of younger age, with a lower score on the Charlson comorbidity index, receiving elective surgery, and having a shorter length of stay were significantly more likely to receive care concordant with the OH(CCO) pathway map (*C* statistic: 0.763; Table IV).

Overall Survival

The 4-year overall survival was 79.2% (n = 646) for patients with stage II disease and 65.6% (n = 525) for those with stage III disease. For patients with stage III colon cancer, 4-year overall survival was significantly better when they received concordant care than when they did not receive concordant care (82% for sequence A vs. 60%, 51%, and 52% for sequences B, C, and D respectively; $p < 0.0001$). For patients with stage II colon cancer, a trend toward improved 4-year overall survival was observed when they received concordant care; however, that trend was not statistically significant (88%, 81%, and 77% for sequences A, B, and C respectively vs. 76% for sequence D; $p = 0.228$).

DISCUSSION

We developed a method for measuring concordance between actual care received and the care prescribed in the OH(CCO) pathway map. The overall results showed that, based on incident cases from 2010, concordant care was provided in 70% of stage II and 39% of stage III colon cancer cases in the province of Ontario. Those results also supported our *a priori* hypotheses, given that we found different levels of concordance for stages II and III colon cancer and that concordant care was associated with improved survival.

Those results have therefore established "proof of concept" that our method of measuring concordance along a population-based pathway is feasible. Although more work will be necessary to validate the method, it might, in future, be a useful strategy for assessing overall health system performance and assisting with quality improvement by identifying unwarranted variations in care and implementing targeted strategies to reduce those variations.

TABLE II Health service utilization

Service	Cohort					
	Overall		Stage II		Stage III	
	(n)	(%)	*(n)*	(%)	*(n)*	(%)
Screening with FOBT						
Pre-diagnostic	204	12.6	102	12.5	102	12.8
No screening	843	52.2	410	50.3	433	54.1
Repeating	81	5.0	38	4.7	43	5.4
Sporadic	488	30.2	266	32.6	222	27.8
Endoscopy and imaging						
Full or partial endoscopy	1281	79.3	653	80.0	628	78.5
Abdominal CT	1537	95.1	771	94.5	766	95.8
Surgery						
Resection	1606	99.4	811	99.4	795	99.4
Elective surgery	1102	68.6	578	71.3	524	65.9
Surgical length of stay (days)						
Median	7		7		7	
IQR	6.0		7.0		6.0	
30-Day ER visit	360	22.4	175	21.6	185	23.3
30-Day readmission	123	7.7	74	9.1	49	6.2
Chemotherapy (CTx)						
Medical oncology consultation	1362	84.3	623	76.4	739	92.4
CTx received	509	31.7	81	9.9	428	53.5
Surgery-to-CTx interval (days)						
Median	57		62		56.5	
IQR	26.0		33.0		24.0	
ER visits close to Dx						
Within 30 days before	664	41.1	324	39.7	340	42.5
Within 180 days after	889	55.0	409	50.1	480	60.0

FOBT = fecal occult blood test; CT = computed tomography; IQR = interquartile range; ER = emergency room; Dx = diagnosis.

TABLE III Concordance by sequence and stage

Service	Cohort					
	Overall		Stage II		Stage III	
	(n)	(%)	*(n)*	(%)	*(n)*	(%)
By sequence						
Sequence A[a]	363	22.5	51	6.3	312	39.0
Sequence B[b]	566	35.0	375	46.0	191	23.9
Sequence C[c]	200	12.4	145	17.8	55	6.9
Sequence D[d]	487	30.1	245	30.0	242	30.3
By stage						
Sequence A[a]					312	39.0
Sequence A[a], B[b], or C[c]			571	70.0		

[a] All of endoscopy, abdominal computed tomography, surgery, medical oncology consultation, and chemotherapy.
[b] All of endoscopy, abdominal computed tomography, surgery, and medical oncology consultation.
[c] All of endoscopy, abdominal computed tomography, and surgery.
[d] Any 2 of endoscopy, abdominal computed tomography, surgery, medical oncology consultation, and chemotherapy.

TABLE IV Multivariate regression results for receipt of pathway-concordant care[a]

Variable	Stage II				Stage III			
	Odds ratio	Confidence limits		*p* Value	Odds ratio	Confidence limits		*p* Value
		Lower	Upper			Lower	Upper	
Stage at diagnosis								
IIA		Reference			NA			
IIB	**0.60**	**0.40**	**0.90**	**0.0131**				
IIIA	NA					Reference		
IIIB					1.02	0.57	1.83	0.9541
IIIC					1.30	0.71	2.40	0.3958
Age group								
<55 Years	0.60	0.34	1.06	0.0800	**5.34**	**3.25**	**8.79**	**<0.0001**
55–64 Years	1.00	0.61	1.64	0.9890	**4.01**	**2.53**	**6.35**	**<0.0001**
65–74 Years	0.72	0.48	1.07	0.1032	**3.21**	**2.09**	**4.93**	**<0.0001**
≥75 Years		Reference				Reference		
Sex								
Men		Reference				Reference		
Women	1.14	0.81	1.59	0.4551	0.81	0.59	1.13	0.2195
Score on the CCI	1.03	0.86	1.24	0.7201	**0.70**	**0.50**	**0.97**	**0.0298**
FOBT screening group								
Pre-diagnostic	1.58	0.89	2.80	0.1210	1.29	0.78	2.13	0.324
Repeating	1.13	0.50	2.57	0.7700	0.99	0.49	1.99	0.977
Sporadic	1.16	0.79	1.71	0.4520	1.37	0.93	2.02	0.1164
No screening		Reference				Reference		
Type of surgery								
Elective		Reference				Reference		
Urgent	**0.27**	**0.18**	**0.42**	**<0.0001**	**0.48**	**0.31**	**0.76**	**0.0014**
ER visits 30 days before Dx								
No		Reference				Reference		
Yes	0.77	0.51	1.16	0.2114	0.74	0.49	1.11	0.1486
Length of stay	0.94	0.70	1.26	0.6836	**0.58**	**0.42**	**0.79**	**0.0006**
Urban–rural								
Urban		Reference				Reference		
Rural	0.99	0.62	1.58	0.9520	0.97	0.59	1.62	0.9191
Immigration tertile								
Low		Reference				Reference		
Middle	1.52	0.99	2.33	0.0539	1.03	0.68	1.54	0.9057
High	**2.68**	**1.54**	**4.67**	**0.0005**	1.00	0.60	1.67	0.9973
Neighbourhood income								
Low		Reference				Reference		
Medium to low	1.06	0.64	1.78	0.8118	1.20	0.72	2.03	0.4833
Middle	0.81	0.49	1.35	0.4211	1.19	0.71	2.02	0.5083
Medium to high	1.38	0.81	2.35	0.2430	1.66	0.99	2.78	0.0532
High	**1.95**	**1.13**	**3.38**	**0.0171**	1.14	0.67	1.93	0.6392

[a] Significant results shown in boldface type.

NA = not applicable; CCI = Charlson comorbidity index; FOBT = fecal occult blood test; ER = emergency room; Dx = diagnosis.

For stage III colon cancer, our results showed high concordance with all of the key elements, except for receipt of chemotherapy—an omission that led to an overall concordance rate of 39% for that patient cohort. That finding is not unique; a systematic review by Etzioni *et al.*[13] reported rates of chemotherapy use ranging from 39% to 71% in twenty-two studies of patients with stage III colon cancer. Our findings that more than 90% of patients had a medical oncology consultation is important, because one of the major limitations of our study is that we were unable to capture patients receiving oral chemotherapy alone. Considering that oral chemotherapy alone is most often reserved for older patients and that, of our stage III cohort members, approximately 40% (305 of 800 patients) were 75 years or older, it is quite likely that our inability to capture oral chemotherapy alone led to an underestimate of the rate of chemotherapy use and thus the overall concordance rate in the cohort. Difficulty in capturing those patients might also in part explain why increasing age and comorbidity were more likely to be associated with non-concordant care. Access to oral chemotherapy data will therefore be important for monitoring the effectiveness of any future quality improvement initiatives aimed at increasing chemotherapy uptake. However, given that other studies have also shown variation in chemotherapy use in stage III colon cancer, further studies of physician and patient factors driving the decision for chemotherapy might also be warranted to better understand those practice variations.

Another limitation of the present study is that our measure of concordance was relatively crude. It included only 5 key elements of care, none of which were weighted with respect to their relative association with survival. Currently, our group is developing and evaluating more sophisticated measures of concordance that will incorporate more elements of the pathway map and consider their relative association with survival, and that will also consider other important clinical and patient-reported outcomes. Lastly, our results are based on a limited set of incident patients with colon cancer in 2010 and will therefore have to be further validated with a larger cohort of patients and with other disease sites before our proposed method can be adopted into full-scale use for quality improvement across the province.

CONCLUSIONS

The overall results of our study showed that, in 70% of stage II and 39% of stage III colon cancer cases, patients received concordant care in the province of Ontario. The rate of concordance in the stage III cohort was likely underestimated because of an inability to capture receipt of oral chemotherapy alone. Our method of measuring concordance seems feasible on a population level, but future studies to validate the method and to develop more sophisticated ways of measuring concordance in larger cohorts and other disease sites will be necessary before it can be adopted into full-scale use. From a health system perspective, measurement of clinical pathway concordance on a population level has the potential to be a useful tool for assessing system performance by identifying unwarranted clinical variation.

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CONFLICT OF INTEREST DISCLOSURES

We have read and understood *Current Oncology*'s policy on disclosing conflicts of interest, and we declare that we have none.

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