

The Independent Association of Provider and Information Continuity on Outcomes After Hospital Discharge: Implications for Hospitalists

Carl van Walraven, MD, MSc, FRCPC^{1,2}
Monica Taljaard, PhD¹
Edward Etchells, MD, MSc³
Chaim M. Bell, MD, PhD, FRCPC^{2,3,4}
Ian G. Stiell, MD, FRCPC, MSc⁵
Kelly Zarnke, MD, MSc, FRCPC⁶
Alan J. Forster, MD, MSc, FRCPC¹

¹ Ottawa Hospital Research Institute, Ottawa, Ontario, Canada.

² Institute for Clinical Evaluative Sciences, Toronto, Ontario, Canada.

³ Department of Medicine, University of Toronto, Toronto, Ontario, Canada.

⁴ Department of Health Policy Management and Evaluation, University of Toronto, Toronto, Ontario, Canada.

⁵ Department of Emergency Medicine, University of Ottawa, Ottawa, Ontario, Canada.

⁶ University of Calgary, Alberta, Canada.

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BACKGROUND: Since hospitalist physicians do not frequently see patients in follow-up after discharge from the hospital, patient continuity of care will decrease. To determine how this influenced patient outcomes, we examined the independent association of several physician continuity and information continuity measures on death or urgent readmission after discharge from hospital.

DESIGN: Multicenter, prospective cohort study of patients discharged to the community after elective or emergency hospitalization. We measured three physician continuity scores (preadmission; hospital; and postdischarge) and two information continuity scores (discharge summary; postdischarge visit information) as time-dependent covariates. Continuity scores ranged from 0 (perfect discontinuity) to 1 (perfect continuity). The primary outcomes were time to all-cause death or urgent readmission.

RESULTS: A total of 3876 people were followed for a median of 175 days. Death rate was 2.6 events per 100 patient-years observation (pys) (95% confidence interval [CI], 2.0-3.4) and urgent readmission rate was 19.6 events per 100 pys (95% CI, 15.9-24.3). After adjusting for important covariates and other continuity scores, increased preadmission physician continuity was independently associated with a decreased risk of urgent readmission (adjusted hazard ratio 0.94 [95% CI, 0.91-0.98] for each absolute increase in continuity of 0.1). Other continuity measures—including hospital physician continuity—were not associated with either outcome.

CONCLUSIONS: After discharge from the hospital, increased continuity with physicians who routinely treated the patient prior to the admission was significantly and independently associated with a decreased risk of urgent readmission. These data suggest that continuity with the hospital physician after discharge did not independently influence the risk of patient death or urgent readmission. *Journal of Hospital Medicine* 2010;5:398–405. © 2010 Society of Hospital Medicine.

KEYWORDS: continuity, death, readmission.

Additional Supporting Information may be found in the online version of this article.

Hospitalists are common in North America.^{1,2} Hospitalists have been associated with a range of beneficial outcomes including decreased length of stay.^{3,4} A primary concern of the hospitalist model is its potential detrimental effect on

continuity of care⁵ partly because patients are often not seen by their hospitalists after discharge.

Continuity of care⁶ is primarily composed of provider continuity (an ongoing relationship between a patient and a

particular provider over time) and information continuity (availability of data from prior events for subsequent patient encounters).⁶ The association between continuity of care and patient outcomes has been quantified in many studies.^{7–20} However, the relationship of continuity and outcomes is especially relevant after discharge from the hospital since this is a time when patients have a high risk of poor patient outcomes²¹ and poor provider²² and information continuity.^{23–25}

The association between continuity and outcomes after hospital discharge has been directly quantified in 2 studies. One found that patients seen by a physician who treated them in the hospital had a significant adjusted relative risk reduction in 30-day death or readmission of 5% and 3%, respectively.²² The other study found that patients discharged from a general medicine ward were less likely to be readmitted if they were seen by physicians who had access to their discharge summary.²³ However, neither of these studies concurrently measured the influence of provider and information continuity on patient outcomes.

Determining whether and how continuity of care influences patient outcomes after hospital discharge is essential to improve health care in an evidence-based fashion. In addition, the influence that hospital physician follow-up has on patient outcomes can best be determined by measuring provider and information continuity in patients after hospital discharge. This study sought to measure the independent association of several provider and information continuity measures on death or urgent readmission after hospital discharge.

Methods

Study Design

This was a multicenter prospective cohort study of consecutive patients discharged to the community from the medical or surgical services of 11 Ontario hospitals (6 university-affiliated hospitals and 5 community hospitals) in 5 cities after an elective or emergency hospitalization. Patients were invited to participate in the study if they were cognitively intact, had a telephone, and provided written informed consent. Patients were excluded if they were less than 18 years old, were discharged to nursing homes, or were not proficient in English and did not have someone to help communicate with study staff. Enrolled patients were excluded from the analysis if they had less than 2 physician visits prior to one of the study's outcomes or the end of patient observation (which was 6 months postdischarge). This final exclusion criterion was necessary since 2 continuity measures (including postdischarge physician continuity and postdischarge information continuity) were incalculable with less than 2 physician visits during follow-up (Supporting information). The study was approved by the research ethics board of each participating hospital.

Data Collection

Prior to hospital discharge, patients were interviewed by study personnel to identify their baseline functional status,

their living conditions, all physicians who regularly treated the patient prior to admission (including both family physicians and consultants), and chronic medical conditions. The latter were confirmed by a review of the patient's chart and hospital discharge summary, when available. Patients also provided principal contacts whom we could contact in the event patients could not be reached. The chart and discharge summary were also used to identify diagnoses in hospital—including complications (diagnoses arising in the hospital)—and medications at discharge.

Patients or their designated contacts were telephoned 1, 3, and 6 months after hospital discharge to identify the date and the physician of all postdischarge physician visits. For each postdischarge physician visit, we determined whether the physician had access to a discharge summary for the index hospitalization. We also determined the availability of information from all previous postdischarge visits that the patient had with other physicians. The methods used to collect these data were previously detailed.²⁶ Briefly, we used three complementary methods to elicit this information from each follow-up physician. First, patients gave the physician a survey on which the physician listed all prior visits with other doctors for which they had information. If this survey was not returned, we faxed the survey to the physician. If the faxed survey was not returned, we telephoned the physician or their office staff and administered the survey over the telephone.

Continuity Measures

We measured components of both provider and information continuity. For the posthospitalization period, we measured provider continuity for physicians who had provided patient care during three distinct phases: the prehospital period; the hospital period; and the postdischarge period. Prehospital physicians were those classified by the patient as their regular physician(s) (defined as physicians—both family physicians and consultants—that they had seen in the past and were likely to see again in the future). Hospital provider continuity was divided into 2 components: hospital physician continuity (ie, the most responsible physician in the hospital); and hospital consultant continuity (ie, another physician who consulted on the patient during admission). Information continuity was divided into discharge summary continuity and postdischarge visit information continuity.

We quantified provider and information continuity using Breslau's Usual Provider of Continuity (UPC)²⁷ measure. It is a widely used and validated continuity measure whose values are meaningful and interpretable.⁶ The UPC measures the proportion of visits with the physician of interest (for provider continuity) or the proportion of visits having the information of interest (for information continuity). The UPC was calculated as: $UPC = n_i/N$ where UPC is the Usual Provider of Continuity; n_i is the number of postdischarge visits to the physician type of interest (eg, prehospital; hospital; postdischarge) or the number of visits at which the information of interest (eg, discharge summary) was available;

and N is the total number of postdischarge visits. The UPC ranges from 0 to 1 where 0 is perfect discontinuity and 1 is perfect continuity. Details regarding the provider and information continuity measures are given in the supporting information and were discussed in greater detail in a previous study.²⁸

As the formulae in the supporting information suggest, all continuity measures were incalculable prior to the first postdischarge visit and all continuity measures changed value at each visit during patient observation. In addition, a particular physician visit could increase multiple continuity measures simultaneously. For example, a visit with a physician who was the hospital physician and who regularly treated the patient prior to the hospitalization would increase both hospital and prehospital provider continuity. If the patient had previously seen the physician after discharge, the visit would also increase postdischarge physician continuity.

Study Outcomes

Outcomes for the study included time to all-cause death and time to all-cause, urgent readmission. To be classified as “urgent,” readmissions could not be arranged when the patient was originally discharged from hospital or more than 4 weeks prior to the readmission. All hospital admissions meeting these criteria during the 6 month study period were labeled in this study as “urgent readmissions” even if they were unrelated to the index admission.

Principal contacts were called if we were unable to reach the patient to determine their outcomes. If the patient’s vital status remained unclear, we contacted the Office of the Provincial Registrar to determine if and when the patient died during the 6 months after discharge from hospital.

Analysis

Outcome incidence densities and 95% confidence intervals [CIs] were calculated using PROC GENMOD in SAS to account for clustering of patients in hospitals. We used multivariate proportional hazards modeling to determine the independent association of provider and information continuity measures with time to death and time to urgent readmission. Patient observation started when patients were discharged from the hospital. Patient observation ended at the earliest of the following: death; urgent readmission to the hospital; end of follow-up (which was 6 months after discharge from the hospital) or loss to follow-up. Because hospital consultant continuity was very highly skewed (95.6% of patients had a value of “0”; mean value of 0.016; skewness 6.9), it was not included in the primary regression models but was included in a sensitivity analysis.

To adjust for potential confounders in the association between continuity and the outcomes, our model included all factors that were independently associated with either the outcome or any continuity measure. Factors associated with death or urgent readmission were summarized using the LACE index.²⁹ This index combines a patient’s hospital

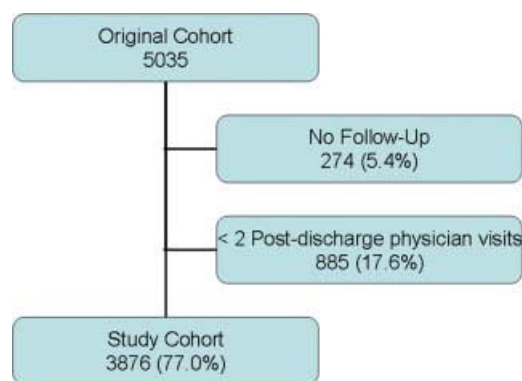


FIGURE 1. Patient follow-up. Creation of the study cohort (n = 3876) from the original cohort is illustrated. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

length of stay, admission acuity, patient comorbidity (measured with the Charlson Score³⁰ using updated disease category weights by Schneeweiss et al.),³¹ and emergency room utilization (measured as the number of visits in the 6 months prior to admission) into a single number ranging from 0 to 19. The LACE index was moderately discriminative and highly accurate at predicting 30-day death or urgent readmission.²⁹ In a separate study,²⁸ we found that the following factors were independently associated with at least one of the continuity measures: patient age; patient sex; number of admissions in previous 6 months; number of regular treating physicians prior to admission; hospital service (medicine vs. surgery); and number of complications in the hospital (defined as new problems arising after admission to hospital). By including all factors that were independently associated with either the outcome or continuity, we controlled for all measured factors that could act as confounders in the association between continuity and outcomes. We accounted for the clustered study design by using conditional proportional hazards models that stratified by hospitals.³² Analytical details are given in the supporting information.

Results

Between October 2002 and July 2006, we enrolled 5035 patients from 11 hospitals (Figure 1). Of the 5035 patients, 274 (5.4%) had no follow up interview with study personnel. A total of 885 (17.6%) had fewer than 2 post discharge physician visits and were not included in the continuity analyses. This left 3876 patients for this analysis (77.0% of the original cohort), of which 3727 had complete follow up (96.1% of the study cohort). A total of 531 patients (10.6% of the original cohort) had incomplete follow-up because: 342 (6.8%) were lost to follow-up; 172 (3.4%) refused participation; and 24 (0.5%) were transferred into a nursing home during the first month of observation.

The 3876 study patients are described in Table 1. Overall, these people had a mean age of 62 and most commonly

TABLE 1. Description of Study Cohort

Factor	Value	Death or Urgent Readmission		All (n = 3876)
		No (n = 3491)	Yes (n = 385)	
Mean patient age, years (±SD)		61.59 ± 16.16	67.70 ± 15.53	62.19 ± 16.20
Female (%)		1838 (52.6)	217 (56.4)	2055 (53.0)
Lives alone (%)		791 (22.7)	107 (27.8)	898 (23.2)
# activities of daily living requiring aids (%)	0	3277 (93.9)	354 (91.9)	3631 (93.7)
	1	125 (3.6)	20 (5.2)	145 (3.7)
	>1	89 (2.5)	11 (2.8)	100 (2.8)
# physicians who see patient regularly (%)	0	241 (6.9)	22 (5.7)	263 (6.8)
	1	3060 (87.7)	333 (86.5)	3393 (87.5)
	2	150 (4.3)	21 (5.5)	171 (4.4)
	>2	281 (8.0)	31 (8.0)	312 (8.0)
# admissions in previous 6 months (%)	0	2420 (69.3)	222 (57.7)	2642 (68.2)
	1	833 (23.9)	103 (26.8)	936 (24.1)
	>1	238 (6.8)	60 (15.6)	298 (7.7)
Index hospitalization description				
Number of discharge medications (IQR)		4 (2-7)	6 (3-9)	4 (2-7)
Admitted to medical service (%)		1440 (41.2)	231 (60.0)	1671 (43.1)
Acute diagnoses:				
CAD (%)		238 (6.8)	23 (6.0)	261 (6.7)
Neoplasm of unspecified nature (%)		196 (5.6)	35 (9.1)	231 (6.0)
Heart failure (%)		127 (3.6)	38 (9.9)	165 (4.3)
Acute procedures				
CABG (%)		182 (5.2)	14 (3.6)	196 (5.1)
Total knee arthroplasty (%)		173 (5.0)	10 (2.6)	183 (4.7)
Total hip arthroplasty (%)		118 (3.4)	(0.5)	120 (3.1)
Complication during admission (%)		403 (11.5)	63 (16.4)	466 (12.0)
LACE index: mean (SD)		8.0 (3.6)	10.3 (3.8)	8.2 (3.7)
Length of stay in days: median (IQR)		4 (2-7)	6 (3-10)	4 (2-8)
Acute/emergent admission (%)		1851 (53.0)	272 (70.6)	2123 (54.8)
Charlson score (%)	0	2771 (79.4)	241 (62.6)	3012 (77.7)
	1	103 (3.0)	17 (4.4)	120 (3.1)
	2	446 (12.8)	86 (22.3)	532 (13.7)
	>2	171 (4.9)	41 (10.6)	212 (5.5)
Emergency room use (# visits ^{1/2} year) (%)	0	2342 (67.1)	190 (49.4)	2532 (65.3)
	1	761 (21.8)	101 (26.2)	862 (22.2)
	>1	388 (11.1)	94 (24.4)	482 (12.4)

Abbreviations: CABG, coronary artery bypass graft; CAD, coronary artery disease; IQR, interquartile range; SD, standard deviation.

had no physical limitations. Almost a third of patients had been admitted to the hospital in the previous 6 months. A total of 7.6% of patients had no regular prehospital physician while 5.8% had more than one regular prehospital physician. Patients were evenly split between acute and elective admissions and 12% had a complication during their admission. They were discharged after a median of 4 days on a median of 4 medications.

Patients were observed in the study for a median of 175 days (interquartile range [IQR] 175-178). During this time they had a median of 4 physician visits (IQR 3-6). The first postdischarge physician visit occurred a median of 10 days (IQR 6-18) after discharge from hospital.

Continuity Measures

Table 2 summarizes all continuity scores. Since continuity scores varied significantly over time,²⁸ Table 2 provides con-

tinuity scores on the last day of patient observation. Preadmission provider, postdischarge provider, and discharge summary continuity all had similar values and distributions with median values ranging between 0.444 and 0.571. 1797 (46.4%) patients had a hospital physician provider continuity score of 0.

Study Outcomes

During a median of 175 days of observation, 45 patients died (event rate 2.6 events per 100 patient-years observation [95% CI 2.0-3.4]) and 340 patients were urgently readmitted (event rate 19.6 events per 100 patient-years observation [95% CI 15.9-24.3]). Figure 2 presents the survival curves for time to death and time to urgent readmission. The hazard of death was consistent through the observation period but the risk of urgent readmission decreased slightly after 90 days postdischarge.

TABLE 2. Ranges of Continuity Measures on Last Day of Patient Observation

	Minimum	25th Percentile	Median	75th Percentile	Maximum
Provider continuity					
A: Pre-admission physician	0	0.143	0.444	0.667	1.000
B: Hospital physician	0	0	0.143	0.400	1.000
C: Post-discharge physician	0	0.333	0.571	0.750	1.000
Information continuity					
D: Discharge summary	0	0.095	0.500	0.800	1.000
E: Post-discharge information	0	0	0.182	0.500	1.000

Association Between Continuity and Outcomes

Table 3 summarizes the association between provider and information continuity with study outcomes. No continuity measure was associated with time to death by itself (Table 3, column A) or with the other continuity measures (Table 3, column B). Preadmission physician continuity was associated with a significantly decreased risk of urgent readmission. When the proportion of postdischarge visits with a prehospital physician increased by 10%, the adjusted risk of urgent readmission decreased by 6% (adjusted hazards ratio (adj-HR)) of 0.94 (95% CI, 0.91-0.98). None of the other continuity measures—including hospital physician—were significantly associated with urgent readmission either by themselves (Table 3, column A) or after adjusting for other continuity measures (Table 3, column B).

Increased patient age and increased LACE index score were both strongly associated with an increased risk of death (adj-HR 1.43 [1.13-1.82] and 1.16 [1.06-1.26], respectively) and urgent readmission (adj-HR 1.18 [1.10-1.28] and 1.10 [1.07-1.14], respectively). Hospitalization in the 6 months prior to admission significantly increased the risk of urgent readmission but not death. The risk of urgent readmission

increased significantly as the number of regular prehospital physicians increased.

Sensitivity Analyses

Our study conclusions did not change in the sensitivity analyses. The number of postdischarge physician visits (expressed as a time-dependent covariate) was not associated with either death or with urgent readmission and preadmission physician continuity remained significantly associated with time to urgent readmission (supporting information). Adding consultant continuity to the model also did not change our results (supporting information). In-hospital consultant continuity was associated with an increased risk of urgent readmission (adj-HR 1.10, 95% CI, 1.01-1.20). The association between pre-admission physician continuity and time to urgent readmission did not interact significantly with patient age, LACE index score, or number of previous admissions.

Discussion

This large, prospective cohort study measured the independent association of several provider and information continuity measures with important outcomes in patients discharged from hospital. After adjusting for potential confounders, we found that increased continuity with physicians who regularly cared for the patient prior to the admission was significantly and independently associated with a decreased risk of urgent readmission. Our data suggest that continuity with the hospital physician did not independently influence the risk of patient death or urgent readmission after discharge.

Although hospital physician continuity did not significantly change patient outcomes, we found that follow-up with a physician who regularly treated the patient prior to their admission was associated with a significantly decreased risk of urgent readmission. This could reflect the important role that a patient's regular physician plays in their health care. Other studies have shown a positive association between continuity with a regular physician and improved outcomes including decreased emergency room utilization^{7,8} and decreased hospitalization.^{10,11}

We were somewhat disappointed that information continuity was not independently associated with improved patient outcomes. Information continuity is likely more

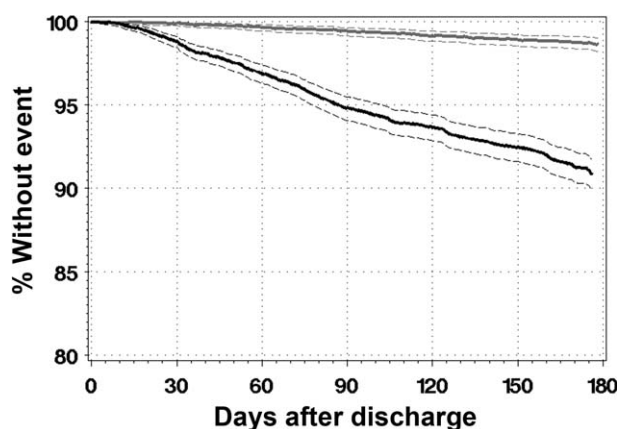


FIGURE 2. Time to death or urgent readmission. This figure summarizes outcomes for the study cohort. The horizontal axis presents days from discharge. The vertical axis presents proportion of the cohort without death or urgent readmission. The gray line presents time to death; the black line presents time to urgent readmission. Dotted lines present the 95% CI for each survival curve.

TABLE 3. Association of Provider and Information Continuity With Post-Discharge Outcomes

	Outcome							
	Death (95% CI)				Urgent Readmission (95% CI)			
	A: Adjusted for Other Confounders Only		B: Adjusted for Other Confounders and Continuity Measures		A: Adjusted for Other Confounders Only		B: Adjusted for Other Confounders and Continuity Measures	
Provider continuity								
A: Pre-admission physician	1.03	(0.95, 1.12)	1.06	(0.95, 1.18)	0.95	(0.92, 0.98)	0.94	(0.91, 0.98)
B: Hospital physician	0.87	(0.74, 1.02)	0.86	(0.70, 1.03)	0.98	(0.94, 1.02)	0.97	(0.92, 1.01)
C: Post-discharge physician	0.97	(0.89, 1.06)	0.93	(0.84, 1.04)	0.98	(0.95, 1.01)	0.98	(0.94, 1.02)
Information continuity								
D: Discharge Summary	0.96	(0.89, 1.04)	0.94	(0.87, 1.03)	1.01	(0.98, 1.04)	1.02	(0.99, 1.05)
E: Post-discharge information	1.01	(0.94, 1.08)	1.03	(0.95, 1.11)	1.00	(0.97, 1.03)	1.03	(0.95, 1.11)
Other confounders								
Patient age in decades*	†		1.43	(1.13, 1.82)	†		1.18	(1.10, 1.28)
Female	†		1.50	(0.81, 2.77)	†		1.16	(0.94, 1.44)
# physicians who see patient regularly								
1 [‡]	†		—	—	†		1.46	(0.92, 2.34)
2	†		—	—	†		2.17	(1.11, 4.26)
>2	†		—	—	†		3.71	(1.55, 8.88)
Complications during admission								
1 [‡]	†		1.38	(0.61, 3.10)	†		0.81	(0.55, 1.17)
>1	†		1.01	(0.28, 3.58)	†		0.91	(0.56, 1.48)
# admissions in previous 6 months								
1 [‡]	†		1.27	(0.59, 2.70)	†		1.34	(1.02, 1.76)
>1	†		1.42	(0.55, 3.67)	†		1.78	(1.26, 2.51)
LACE index*	†		1.16	(1.06, 1.26)	†		1.10	(1.07, 1.14)

NOTE: The adjusted hazards ratio with 95% CI is presented. In columns A, each continuity measure was included in a model without the other continuity measures but with the other confounders. Because this resulted in 5 separate models, adjusted hazard ratios for the other confounders are not given in columns A. In columns B, the model includes all continuity measures and covariates. The hazard ratio for provider and information continuity scores expresses changes in the risk of the outcome when the continuity score increases by 0.1. A hazard ratio could not be estimated in the death model for number of regular physicians because of empty cells (ie, no one who died without a regular physician).

Abbreviation: CI, confidence interval.²⁹

*Hazard ratio expresses the influence of an increase in the variable's unit by 1.

†Variable included in each of the 5 survival models (one for each continuity measure). Results varied between the models.

‡Comparator group is "0".

amenable to modification than is provider continuity. Of course, our study findings do not mean that information continuity does not improve patient outcomes, as in other studies.^{23,33} Instead, our results could reflect that we solely measured the availability of information to physicians. Future studies that measure the quality, relevance, and actual utilization of patient information will be better able to discern the influence of information continuity on patient outcomes.

We believe that our study was methodologically strong and unique. We captured both provider and information continuity in a large group of representative patients using a broad range of measures that captured continuity's diverse components including both provider and information continuity. The continuity measures were expressed and properly analyzed as time-dependent variables in a multivariate model.³⁴ Our analysis controlled for important potential confounders. Our follow-up and data collection was rigorous with 96.1% of our study group having complete follow-up. Finally, the analysis used multiple imputation to appro-

priately handle missing data in the one incomplete variable (post-discharge information continuity).^{35–37}

Several limitations of our study should be kept in mind. We are uncertain how our results might generalize to patients discharged from obstetrical or psychiatric services or people in other health systems. Our analysis had to exclude patients with less than two physician visits after discharge since this was the minimum required to calculate postdischarge physician and information continuity. Data collection for postdischarge information continuity was incomplete with data missing for 19.0% of all 15 401 visits in the original cohort.³⁸ However, a response rate of 81.0% is "very good"³⁹ when compared to other survey-based studies⁴⁰ and we accounted for the missing data using multiple imputation methods. The primary outcomes of our study—time to death or urgent readmission—may be relatively insensitive to modification of quality of care, which is presumably improved by increased continuity.⁴¹ For example, Clarke found that the majority of readmissions in all patient groups were unavoidable with 94% of medical

readmissions 1 month postdischarge judged to be unavoidable.⁴² Future studies regarding the effects of continuity could focus on its association with other outcomes that are more reflective of quality of care such as the risk of adverse events or medical error.²¹ Such outcomes would presumably be more sensitive to improved quality of care from increased continuity.

We believe that our study's major limitation was its inability to establish a causal association between continuity and patient outcomes. Our finding that increased consultant continuity was associated with an increased risk of poor outcomes highlights this concern. Presumably, patient follow-up with a hospital consultant indicates a disease status with a high risk of bad patient outcomes—a risk that is not entirely accounted for by the covariates used in this study. If we accept that unresolved confounding explains this association, the same could also apply to the association between preadmission physician continuity and improved outcomes. Perhaps patients who are doing well after discharge from hospital are able to return to their regular physician. Our analysis would therefore identify an association between increased preadmission physician continuity and improved patient outcomes. Analyses could also incorporate more discriminative measures of severity of hospital illness, such as those developed by Escobar et al.⁴³ Since patients may experience health events after their discharge from hospital that could influence outcomes, recording these and expressing them in the study model as time-dependent covariates will be important. Finally, similar to the classic study by Wasson et al.⁴⁴ in 1984, a proper randomized trial that measures the effect of a continuity-building intervention on both continuity of care and patient outcomes would help determine how continuity influences outcomes.

In conclusion, after discharge from hospital, increased continuity with physicians who routinely care for the patient is significantly and independently associated with a decreased risk of urgent readmission. Continuity with the hospital physician after discharge did not independently influence the risk of patient death or urgent readmission in our study. Further research is required to determine the causal association between preadmission physician continuity and improved outcomes. Until that time, clinicians should strive to optimize continuity with physicians their patients have seen prior to the hospitalization.

Address for correspondence and reprint requests:

Carl van Walraven, MD, MSc, FRCPC, ASB1-003 1053 Carling Ave, Ottawa ON, K1Y 4E9, Canada; Telephone: 613-761-4903; Fax: 613-761-5492; E-mail: carlv@ohri.ca Received 2 November 2009; revision received 10 March 2010; accepted 13 March 2010.

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