Team-based versus traditional primary care models and short-term outcomes after hospital discharge

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ABSTRACT

BACKGROUND: Strategies to reduce hospital readmission have been studied mainly at the local level. We assessed associations between population-wide policies supporting team-based primary care delivery models and short-term outcomes after hospital discharge.

METHODS: We extracted claims data on hospital admissions for any cause from 2002 to 2009 in the province of Quebec. We included older or chronically ill patients enrolled in team-based or traditional primary care practices. Outcomes were rates of readmission, emergency department visits and mortality in the 90 days following hospital discharge. We used inverse probability weighting to balance exposure groups on covariates and used marginal structural survival models to estimate rate differences and hazard ratios.

RESULTS: We included 620 656 index admissions involving 312 377 patients. Readmission rates at any point in the 90-day post-discharge period were similar between primary care models. Patients enrolled in team-based primary care practices had lower 30-day rates of emergency department visits not associated with readmission (adjusted difference 7.5 per 1000 discharges, 95% confidence interval [CI] 4.2 to 10.8) and lower 30-day mortality (adjusted difference 3.8 deaths per 1000 discharges,

95% CI 1.7 to 5.9). The 30-day difference for mortality differed according to morbidity level (moderate morbidity: 1.0 fewer deaths per 1000 discharges in team-based practices, 95% CI 0.3 more to 2.3 fewer deaths; very high morbidity: 4.2 fewer deaths per 1000 discharges, 95% CI 3.0 to 5.3; *p* < 0.001).

INTERPRETATION: Our study showed that enrolment in the newer team-based primary care practices was associated with lower rates of postdischarge emergency department visits and death. We did not observe differences in readmission rates, which suggests that more targeted or intensive efforts may be needed to affect this outcome.

Hospital readmissions are costly, representing $1.8 billion in annual health care spending in Canada (excluding fees for physician services).[1] In the weeks following discharge, older or chronically ill patients are at increased risk of adverse events (e.g., complications or errors related to new medications), and many will return to the hospital.[2–5] As many as 1 in 5 Medicare patients (≥ 65 yr) admitted to hospital for any cause in the United States are readmitted within 30 days after discharge, and about 1 in 4 patients return to the emergency department within that time.[6–8] Older age, increased comorbidity and complexity of medical condition are associated with using a disproportionate amount of health care resources across various settings[9–12] and an increased risk of 30-day readmission.[1,13–15]

Hospital readmission has been the focus of much policy attention in the US and elsewhere as a potential intervention point and as a quality measure of hospital care. High rates of 30-day readmission may also indicate poor integration of the health care delivery sys-

tem, one in which care is poorly coordinated across settings.[16,17] Similarly, post-discharge emergency department visits, which account for about 40% of all acute post-discharge care encounters[8] and contribute a meaningful share of hospital spending,[1,18] have also been proposed as a novel marker of inadequate care coordination.[7,8,18] A portion of all-cause hospital readmissions and post-discharge emergency department visits are deemed preventable.[4,5,19,20] High population rates of such events represent opportunities to improve care and use health care resources more efficiently.

Interventions to reduce 30-day readmissions and post-discharge emergency department visits have targeted organizational factors that play a role in care coordination, both in hospital[21–24] and in outpatient settings.[25] Most interventions studied have been resource intensive and implemented in local settings.[26] Investigations of the capacity of innovations in primary care delivery implemented on a large scale to affect post-discharge outcomes are lacking.

Primary care reform initiatives across Canada targeted many of the characteristics of the US Patient-Centered Medical Home model, including improved access, continuity and coordination of care.[27–31] In Canada, the province of Quebec implemented Family Medicine Groups as a new practice model of multidisciplinary team-based primary care. Family Medicine Groups are designed to unite 6 to 12 family physicians and 1 or 2 nurses to provide primary care for a group of enrolled patients, with a broad range of services (e.g., case management, extended hours and emergency on-call services).[32] By the end of 2005, about 100 Family Medicine Groups (230 sites) were operational in the province, although traditional primary care models (group or solo practices) remained the dominant type of primary health care organizations at the time.[33]

Our study objective was to assess whether rates of readmission, emergency department visits and mortality in the 90 days after hospital discharge differed between older or chronically ill patients enrolled in multidisciplinary team-based primary care practices and those enrolled in traditional practices. We performed subgroup analyses by patient morbidity level.

Methods

Data source

The Régie de l'assurance maladie du Québec (RAMQ) pays for health services provided by hospitals and physicians for all people registered with the province's universal health insurance program. We linked data from RAMQ databases using a unique lifetime identifier encrypted from the personal health insurance number. Data were obtained from the registered person files, which contain patient demographics; the physician claims files, which contain physician services performed in hospital, office or clinic; hospital files, which include information about each hospital admission; and physician information files, which contain information on the enrolling primary care physician, including practice type and characteristics, number of patients and services provided, and income source. RAMQ databases also contain information on the specialty of the billing physician.

Study design

The study is based on a large cohort of patients that has been described previously.[34,35] The cohort was created through linkage of data from administrative health databases between November 2002 and January 2009 in Quebec, Canada. We extracted data on hospital admissions, emergency department visits and deaths that occurred during the study period and within 90 days after each hospital discharge. We used the index admission as the unit of analysis, which we defined as any hospital admission not preceded by a hospital discharge within 30 days. We included all index admissions for patients with multiple admissions.

We assigned exposure depending on whether a patient was enrolled with a primary care provider practising in a multidisciplinary team-based primary care practice (i.e., Family Medicine Group) or in a traditional primary care practice on the date of the index admission. Data for patients with multiple index admissions were included in different exposure groups if their type of enrolment changed.

We excluded index admissions to long-term care facilities and those that resulted in a discharge or a transfer to another facility. We also excluded index admissions for mental health[1] and for pregnancy/childbirth using principal diagnostic codes (International Classification of Diseases, 9th and 10th revisions), same-day readmissions, admissions with in-hospital death, pediatric admissions, admissions with a hospital stay of 30 days or more and admissions to hospitals in northern Quebec. These admissions were excluded because they represent patient subgroups that likely differ with regards to the patterns of use and need of health care services.

Study population

Patients were selected into the original cohort study if a primary care physician enrolled them as a "vulnerable patient" between November 2002 and January 2005. Since 2002, primary care physicians enrol "vulnerable patients" into their practice by billing a fee code if a patient is 70 years of age or older or has one or more specified chronic health conditions, including psychosis, chronic obstructive pulmonary disease, moderate to severe asthma, pneumonia, cardiovascular disease, cancer associated with past, present or future chemotherapy or radiotherapy treatments, cancer in a terminal phase, diabetes, alcohol or drug withdrawal, drug addiction treated with methadone, HIV/AIDS or a degenerative disease of the nervous system.[36] The fee code is available to primary care providers in both new and traditional primary care practices.

Outcome measures

We considered the incidence of hospital readmission within 90 days after discharge as our primary outcome. For secondary outcomes, we examined the incidence of an emergency department visit and death up to 90 days after discharge. We further distinguished emergency department visits not associated with readmission, which included all visits for which there was no admission on the same day or following day.

Covariates

All covariates were measured at the time of the index admission. We included patient age, sex and major diagnostic categories, and time since enrolment by a primary care physician. We used a material deprivation index based on the 2006 census dissemination areas as a measure of neighbourhood socioeconomic status, and a categorical variable developed by the Quebec National Institute of Public Health to represent the patient's residential geographic location as a function of the proximity to an urban centre and to a tertiary or secondary referral hospital.[37–39] We controlled for the number of previous admissions, the time since previous use of inpatient care, the patient morbidity level and relative intensity of hospital resource use. We assigned a patient morbidity level from 1 of 3 Resource Utilization Bands (moderate, high or very high) calculated using the Johns Hopkins Adjusted Clinical Groups Case-Mix System and based on diagnostic codes for both inpatient and outpatient utilization in the calendar year before the index admission. Resource Intensity Weights reflect the relative use of hospital resources, adjusted for age, comorbidities

and complexity level.[40] In some specifications, we also included physician characteristics (age, sex, years in practice, total number of patients and income source [e.g., short-term care establishment, salary, emergency services]) and indicator variables for each hospital as covariates (Appendix 1, available at www.cmaj.ca/lookup/suppl/doi:10.1503/160427/-/DC1).

Statistical analysis

We first derived a propensity score from a logistic regression of Family Medicine Group enrolment at index admission on predictors. Covariates and model specifications are listed in Appendix 1. We derived stabilized inverse probability weights from propensity scores to balance covariates across exposure groups. We constructed separate sets of weights to investigate effect heterogeneity by morbidity level. Finally, we built flexible parametric survival mixture models weighted by inverse probability weights that allowed us to estimate both the subdistribution cumulative incidence functions and time-dependent cause-specific hazard ratios (HRs).[41] The use of such models was necessary to account for competing risks (death and readmission) and for complex time-dependent associations in the post-discharge period.[42] We used cluster bootstrapping to obtain 95% confidence intervals (CIs), and indicator variables or single imputation for missing data on covariates. We used Stata/MP 14 for all analyses.

Ethics approval

The Commission d'accès à l'information du Québec gave ethics approval.

Results

The cohort included 351 113 older or chronically ill patients admitted to hospital in Quebec for any cause between November 2002 and January 2009, which represented 749 537 hospital admissions. Of those admissions, we excluded 128 881 (17.2%) from 106 176 patients (Figure 1). We included a total of 620 656 index admissions for any cause (312 377 patients). The stabilized inverse probability weights chosen had a mean close to 1, small standard errors and a reasonable range (Appendix 2, available at www.cmaj.ca/lookup/suppl/doi:10.1503/160427/-/DC1).[43,44] Patient characteristics at index admission and standardized differences between exposure groups before and after weighting are shown in Table 1. After weighting, there were no standardized differences on measured covariates greater than 10% between team-based and traditional practices (Table 1).

We observed no meaningful or statistically significant differences in the cumulative incidence of hospital readmissions between team-based and traditional practices after adjusting for covariates (Table 2). Patients enrolled in team-based practices had a lower adjusted cumulative incidence of emergency department visits, of emergency department visits not associated with readmission and of death at 30 days after discharge and beyond (Table 2).

Table 3 shows cause-specific adjusted HRs estimated from marginal structural survival models for the association between enrolment in a team-based primary care practice at index ad-

mission and readmission or emergency department visits. Relative to patients enrolled in traditional primary care practices, those in team-based practices had similar 30-day rates of readmission, 3% lower rates of emergency department visits and 5% lower rates of emergency department visits not associated with readmission. The HRs typically moved slightly toward the null value between the 30th and the 90th day after discharge, except for readmission rates, which were 4% higher among patients enrolled in team-based practices by the end of the follow-up period (Table 3).

We found no statistically significant interaction between Family Medicine Group enrolment and morbidity level on the multiplicative scale. In Figure 2, we present the adjusted 30-day differences in cumulative incidence of postdischarge outcomes between team-based and traditional primary care practices by subgroup of patient morbidity level (i.e., additive scale). The 30-day difference for emergency department visits not associated with readmission differed according to morbidity level (moderate morbidity: 3.5 fewer visits per 1000 discharges in team-based practices, 95% CI 1.4 more to 8.4 fewer visits; very high morbidity: 10.3 fewer visits per 1000 discharges, 95% CI 5.4 to 15.2), but it was not statistically significant ($p = 0.3$). The 30-day difference for mortality differed significantly according to morbidity level (moderate morbidity: 1.0 fewer deaths per 1000 discharges in team-based practices, 95% CI 0.3 more to 2.3 fewer deaths; very high morbidity: 4.2 fewer deaths per 1000 discharges, 95% CI 3.0 to 5.3; $p < 0.001$).

Interpretation

In our study, about 1 in 4 older or chronically ill patients admitted to hospital for any cause returned to the hospital within 30 days after discharge (including readmission and emergency department
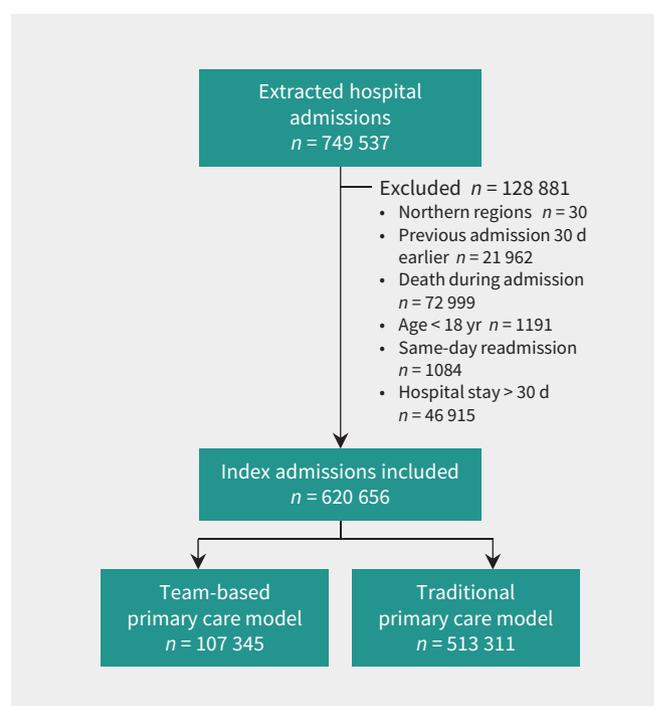


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┌─────────────────────┐
│  Extracted hospital │
│     admissions      │
│     n = 749 537     │
└─────────────────────┘
           │
           │      Excluded  n = 128 881
           │      • Northern regions  n = 30
           │      • Previous admission 30 d
           │        earlier  n = 21 962
           │      • Death during admission
           │        n = 72 999
           │      • Age < 18 yr  n = 1191
           │      • Same-day readmission
           │        n = 1084
           │      • Hospital stay > 30 d
           │        n = 46 915
           ▼
┌─────────────────────┐
│ Index admissions    │
│     included        │
│    n = 620 656      │
└─────────────────────┘
      │          │
      ▼          ▼
┌────────────┐ ┌────────────┐
│ Team-based │ │Traditional │
│primary care│ │primary care│
│   model    │ │   model    │
│ n = 107 345│ │ n = 513 311│
└────────────┘ └────────────┘
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Figure 1: Selection of hospital admissions for the study.

Table 1 (part 1 of 2): Characteristics at index admission of older or chronically ill patients admitted to hospital for any cause, by primary care model, 2002–2009*

Characteristic	Primary care model		Absolute standardized difference, %	
	Team-based *n* = 107 345	Traditional *n* = 513 311	Before weighting	After weighting
Patient characteristics				
Female sex, no. (%)	56 568 (52.7)	270 672 (52.7)	0.1	1.3
Age, yr, mean	73.3	73.3	3.8	3.2
Morbidity level, no. (%)				
Moderate	19 136 (17.8)	86 812 (16.9)	2.4	0.0
High	30 677 (28.6)	143 285 (27.9)	1.5	0.2
Very high	57 532 (53.6)	283 214 (55.2)	3.2	0.2
Admission cost, Can$,† mean	5656	5656	1.3	0.1
Length of hospital stay, d, mean	7.2	7.2	4.8	0.1
Time since last admission, d, mean	400	409	1.9	4.7
Major diagnostic group, no. (%)				
Infectious and parasitic diseases	2184 (2.0)	10 764 (2.1)	0.4	0.0
Tumours	10 618 (9.9)	54 298 (10.6)	2.3	0.7
Endocrine, nutritional and metabolic diseases	2015 (1.9)	10 620 (2.1)	1.4	0.1
Diseases of the blood and blood-forming organs	1971 (1.8)	9341 (1.8)	0.1	0.6
Diseases of the nervous system	2968 (2.8)	13 614 (2.7)	0.7	0.1
Diseases of the circulatory system	14 392 (13.4)	81 220 (15.8)	6.8	1.4
Diseases of the respiratory system	7542 (7.0)	42 433 (8.3)	4.7	0.3
Diseases of the digestive system	20 799 (19.4)	90 639 (17.7)	4.4	0.4
Diseases of the respiratory system	11 226 (10.5)	48 033 (9.4)	3.7	0.2
Diseases of the skin and subcutaneous tissue	1449 (1.3)	7465 (1.5)	0.9	0.3
Diseases of musculoskeletal system and connective tissue	7105 (6.6)	32 451 (6.3)	1.2	0.0
Diseases of the genitourinary tract	3312 (3.1)	13 196 (2.6)	3.1	0.5
Symptoms, signs and ill-defined conditions	4240 (3.9)	23 044 (4.5)	2.7	0.7
Congenital anomalies or birth defect	3797 (3.5)	22 848 (4.5)	4.7	0.4
Extraneous causes of morbidity/mortality, abnormal findings	7014 (6.5)	27 338 (5.3)	5.1	0.4
Injuries and poisoning	5107 (4.8)	19 749 (3.8)	4.5	0.6
Factors influencing health and contact with health services	1606 (1.5)	6258 (1.2)	2.4	0.4
Time since enrolment with primary care physician, yr, mean	2.5	2.5	16.2	0.3
Year of index admission, no. (%)				
2002/03‡	9524 (8.9)	81 184 (15.8)	21.2	1.1
2004	19 088 (17.8)	103 224 (20.1)	5.9	2.2
2005	21 317 (19.9)	105 660 (20.6)	1.8	1.3
2006	19 210 (17.9)	95 528 (18.6)	1.9	0.8
2007	18 556 (17.3)	94 428 (18.4)	2.9	2.8
2008/09‡	19 650 (18.3)	33 287 (6.5)	31.0	0.4
Material deprivation quintile, %				
1 (low)	11 166 (10.4)	71 791 (14.0)	11.0	0.1
2	17 142 (16.0)	83 240 (16.2)	0.7	0.2
3	22 266 (20.7)	99 303 (19.3)	3.5	1.1
4	25 249 (23.5)	107 648 (21.0)	6.1	0.1

Table 1 (part 2 of 2): Characteristics at index admission of older or chronically ill patients admitted to hospital for any cause, by primary care model, 2002–2009*

Characteristic	Primary care model		Absolute standardized difference, %	
	Team-based n = 107 345	Traditional n = 513 311	Before weighting	After weighting
5 (high)	23 418 (21.8)	116 428 (22.7)	2.1	2.1
Missing	8104 (7.5)	34 901 (6.8)	2.9	1.7
Geographic region, no. (%)				
Urban/university§	24 461 (22.8)	184 971 (36.0)	29.4	1.8
Suburban	45 359 (42.3)	197 775 (38.5)	7.6	0.5
Intermediate	30 301 (28.2)	100 593 (19.6)	20.3	0.4
Rural	7014 (6.5)	28 277 (5.5)	4.3	1.8
Missing	210 (0.2)	1695 (0.3)	2.6	0.3
Enrolling primary care physician characteristics				
Female sex, no. (%)	25 339 (23.6)	121 211 (23.6)	7.1	2.0
Time since graduation, yr, mean	23.8	24.7	11.9	5.1
No. of patients per year, mean	2104	1857	23.4	0.6
% of physicians with proportion of income from acute care establishment ≥ 80%	2.0	0.0	15.7	1.1

*Covariate specifications listed here may not reflect the specifications used in statistical models. Refer to Appendix 3 (available at www.cmaj.ca/lookup/suppl/doi:10.1503/160427/-/DC1) for a full list of covariates, specifications and 2-way interactions.
†Costs in current Canadian dollars are based on resource intensity weights for an admission multiplied by its unit cost per fiscal year.
‡These years were grouped because a small number of patients were enrolled in late 2002 (December), and a small number were followed up until early in 2009.
§University regions are regions where there are academic health centres (e.g., Québec, Montréal and Sherbrooke).

visits). Patients enrolled in team-based primary care practices had a 5% lower 30-day risk of emergency department visit not associated with readmission, and significantly fewer patients died in the early period after hospital discharge compared with patients enrolled in traditional primary care practices. The strength of these associations diluted beyond 30 days after discharge. We did not find that team-based primary care delivery models were associated with lower rates of readmission within 30 days. In fact, rates of readmission were on average higher by 4% among patients enrolled in team-based practices over the complete 90 days of follow-up after discharge. Lower 30-day rates of death associated with enrolment in team-based primary care were predominantly observed among patients within the highest level of morbidity.

Several factors or mechanisms may influence rates of readmission, emergency department visits and death, including patient- (e.g., severity of illness), physician- and community-level factors that are not captured in administrative health databases. Unmeasured differences in case-mix across primary care delivery models compared in this study may have biased our analytical results. Family Medicine Group practices may enrol patients with less functional limitations or with lower severity, which in turn would make them appear to perform better in terms of mortality and other postdischarge outcome measures. To minimize the risk of residual confounding, we effectively balanced measured covariates that we believe to be reasonable proxies for patient health status and severity at index admission, and we modelled covariates, time-dependent effects and interactions flexibly (e.g., restricted cubic

splines). Further, physician participation and patient enrolment in primary care models depend largely on physician preferences and characteristics (e.g., physicians who joined Family Medicine Groups have less years of practice), which may in turn affect the way patients are managed in an outpatient setting.[34] The use of inverse probability weights based on measured physician and patient characteristics at index admission may have accounted for this selection bias to some degree, but not completely.

In the absence of unmeasured confounding, that team-based primary care practices were associated with lower mortality but not lower readmission rates suggests that Family Medicine Group practices keep their sickest patients alive longer, which in turn increases their likelihood of being readmitted.[45] This hypothesis is consistent with the lower mortality that occurred predominantly among patients in the higher morbidity subgroups, and with the higher rates of readmission among Family Medicine Group patients that occurred later in the follow-up period rather than earlier. However, in this study, the subdistribution cumulative incidence functions and the cause-specific HRs were qualitatively similar, which suggests that competing events (e.g., death) played a minor role in driving associations with readmission and other postdischarge care encounters.[46,47]

That lower rates of postdischarge emergency department visits not associated with readmission and mortality associated with team-based primary care practices occurred primarily among patients in the highest morbidity level suggests that nurses and physicians in Family Medicine Group practices

achieve better results in the coordination of care for the highest users in the health care system. In a parallel study, we reported that rates of postdischarge follow-up by a primary care physician were higher among patients with very high morbidity enrolled in a Family Medicine Group,[48] which is consistent with the above hypothesis. Nurses in primary care teams likely play a role in providing follow-up services in the postdischarge period, but this information is not captured in Quebec administrative health databases. Although early evaluations of Quebec primary care reforms highlighted important variations in how interdisciplinary collaboration was implemented in Family Medicine Groups,[49] the roles and tasks of nurses in the design of the Family Medicine Group policy include systematic follow-up and case management for patients with complex medical needs. Future research

Table 2: Unadjusted and adjusted* differences in cumulative incidence of postdischarge outcomes among older or chronically ill patients admitted to hospital, by primary care model

Postdischarge outcome	Primary care model; unadjusted rate per 1000 discharges		Difference in rate (95% CI†)	
	Team-based	Traditional	Unadjusted	Adjusted
Within 30 d				
Readmission	136.3	140.6	−4.3 (−6.6 to −1.9)	1.2 (−2.1 to 4.5)
Emergency department visit	201.3	210.0	−8.8 (−13.1 to −5.7)	−4.2 (−8.2 to −0.2)
Emergency department visit not associated with readmission	159.4	170.1	−10.7 (−14.0 to −8.2)	−7.5 (−10.8 to −4.2)
Death	13.1	16.8	−3.7 (−4.4 to −2.9)	−3.8 (−5.9 to −1.7)
Within 90 d				
Readmission	253.0	256.7	−3.5 (−7.5 to 0.1)	5.5 (0.8 to 10.3)
Emergency department visit	321.4	331.4	−10.0 (−14.3 to −7.1)	−5.3 (−10.1 to −0.4)
Emergency department visit not associated with readmission	255.7	269.4	−13.7 (−17.3 to −11.0)	−10.7 (−14.9 to −6.5)
Death	22.6	27.0	−4.4 (−4.4 to −3.4)	−5.0 (−7.9 to −2.2)

Note: CI = confidence interval.
*All index admissions (*n* = 620 656) were included in the analysis. Covariates and 2-way interactions adjusted for are listed in Appendix 1 (available at www.cmaj.ca/lookup/suppl/doi:10.1503/160427/-/DC1).
†Cluster bootstrapping was used to obtain 95% CIs.

Table 3: Unadjusted and adjusted* cause-specific hazard ratios (HRs) for the association between enrolment in team-based primary care practice at index admission and postdischarge outcomes

Postdischarge outcome	Unadjusted HR (95% CI†)	Adjusted HR (95% CI†)
Within 30 d		
Readmission	0.98 (0.95 to 1.01)	1.01 (0.96 to 1.04)
Emergency department visit	0.95 (0.93 to 0.97)	0.97 (0.93 to 1.00)
Emergency department visit not associated with readmission	0.92 (0.90 to 0.95)	0.95 (0.91 to 0.98)
Death	0.88 (0.82 to 0.95)	0.95 (0.92 to 0.98)
Within 90 d		
Readmission	1.01 (0.98 to 1.04)	1.04 (1.00 to 1.07)
Emergency department visit	1.00 (0.97 to 1.03)	0.99 (0.95 to 1.02)
Emergency department visit not associated with readmission	0.97 (0.94 to 1.00)	0.97 (0.92 to 1.00)
Death	0.93 (0.84 to 1.04)	0.97 (0.93 to 1.00)

Note: CI = confidence interval.
*Covariate specifications and 2-way interactions adjusted for are listed in Online Appendix 1.
†Cluster bootstrapping was used to obtain 95% CIs.

should investigate the role played by primary care nurses for recently discharged patients. In addition, because postdischarge follow-up by nurses was not specifically addressed in the Family Medicine Group policy, this represents a potential intervention point that could further affect patient outcomes and cost of care.

Our study is unique in examining patterns of readmissions and other post-discharge events in the context of system-level efforts to transform primary care delivery. Results from other studies that examined practice-level (or "bottom-up") innovations implemented locally and with greater intensity may provide insight into future policy targets to scale up Canadian reforms. In the US, many of the primary care practices studied thus far that undertook transformation for enhanced care coordination within the Patient-Centered Medical Home framework were found to have significantly lower readmission rates.[50–54] These often included case management, multidisciplinary teams and postdischarge follow-up. Of note, the Patient-Centered Medical Home model strongly emphasize care coordination across all elements of the health care system (e.g., hospitals, home health care, community resources and supports). The same level of emphasis on care coordination was not observed when Quebec's Family Medicine Group policy was implemented. Strategies for care coordination examined in recent systematic reviews and meta-analyses of randomized controlled trials also found that involving more individuals in postdischarge care delivery (e.g., multidisciplinary teams and care managers) as well as support-

ing patient capacity for self-care led to significant reductions in hospital admissions or readmissions.[25,55] A compilation of studies also found that postdischarge follow-up was associated with reductions in readmission rates,[56–61] including one study conducted by our research team that highlighted particularly important reductions if follow-up was provided in a timely manner in a primary care setting (unpublished data). Consistent with our results, the evidence on team-based primary care models in Canada have pointed to small improvements in health utilization measures (not specifically in the postdischarge period), mainly lower rates of hospital admission and emergency department visits among older or chronically ill patients, and some improvements in processes of care.[35,62–65]

Limitations and strengths

As discussed earlier, the causal interpretation of our results is tempered by potential sources of bias, most notably by unmeasured confounding due to severity of illness and functional limitations of patients and by selection bias due to physician preferences and practice behaviours.

Our study has several methodologic strengths. We used data for more than 600 000 admissions that occurred from 2002 to 2009. The large database of patients used in this study likely reflects the population of older or chronically ill patients in Quebec who visited a primary care physician, which greatly improves the generalizability of our findings. We also used methods to address various biases,
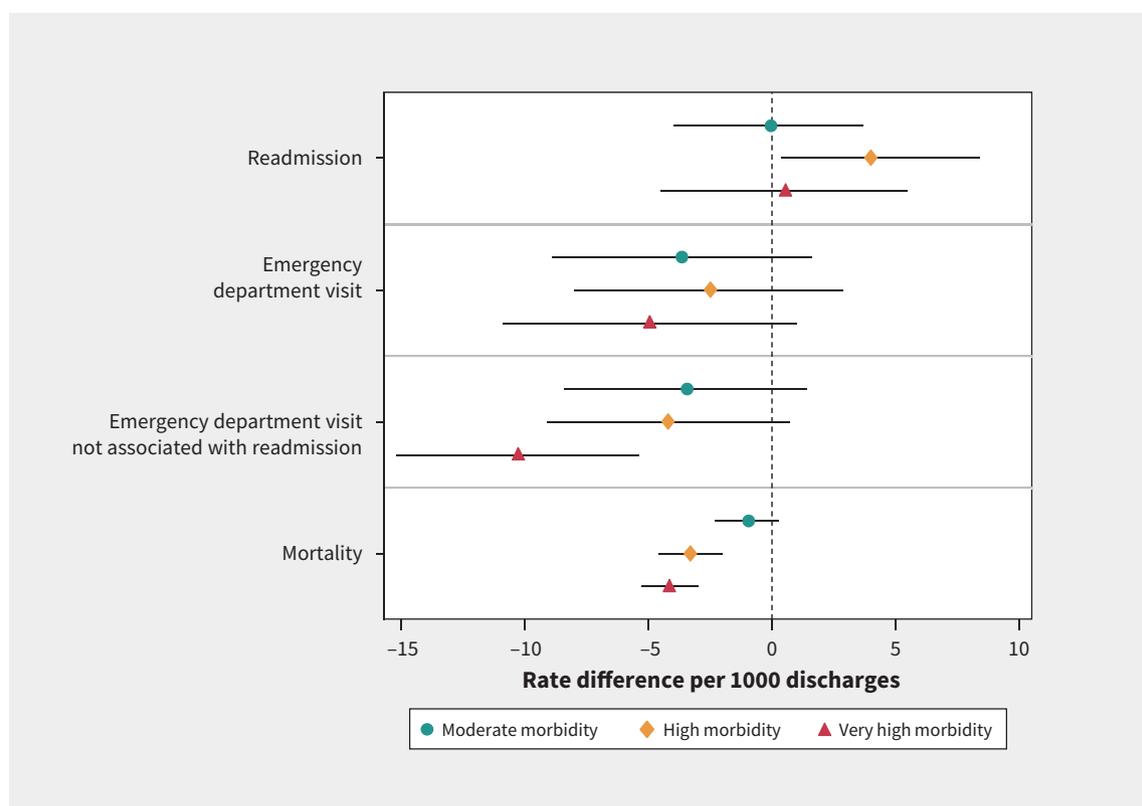
Figure 2: Adjusted differences in 30-day cumulative incidence of postdischarge outcomes between team-based and traditional primary care practices, by morbidity level. Error bars represent clustered 95% confidence intervals. Values less than zero indicate a decreased likelihood of the outcome. Exact numbers associated with this figure are provided in Appendix 3. Covariates and 2-way interactions adjusted for are listed in Appendix 1. (Appendices are available at www.cmaj.ca/lookup/suppl/doi:10.1503/160427/-/DC1.)

including inverse probability weighting to address selection and collider-stratification bias, and flexible modelling of covariates and time-dependent effects to address model misspecification.

Conclusion

Our study showed that the newer team-based primary care delivery model in Quebec was associated with some better post-discharge outcomes among older or chronically ill patients, notably lower rates of emergency department visits and death. We did not observe differences in the 30-day rate of readmission between team-based and traditional practices, although the rate of readmission beyond 30 days seemed to be slightly higher among patients enrolled in team-based practices, which may or may not have been due to patients surviving longer in this group. The lack of an association between enrolment in a team-based primary care practice and readmission, and the lack of differences in any of the outcomes among patients in the lower spectrum of medical complexity, suggests that more targeted or intensive efforts may be needed to improve postdischarge outcomes among older or chronically ill patients.

References

1. *All-cause readmission to acute care and return to the emergency department.* Ottawa: Canadian Institute for Health Information; 2012.
2. Krumholz HM. Post-hospital syndrome — an acquired, transient condition of generalized risk. *N Engl J Med* 2013;368:100-2.
3. Dharmarajan K, Hsieh AF, Kulkarni VT, et al. Trajectories of risk after hospitalization for heart failure, acute myocardial infarction, or pneumonia: retrospective cohort study. *BMJ* 2015;350:h411.
4. Forster AJ, Murff HJ, Peterson JF, et al. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med* 2003;138:161-7.
5. Calder L, Pozgay A, Riff S, et al. Adverse events in patients with return emergency department visits. *BMJ Qual Saf* 2015;24:142-8.
6. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *N Engl J Med* 2009;360:1418-28.
7. Rising KL, White LF, Fernandez WG, et al. Emergency department visits after hospital discharge: a missing part of the equation. *Ann Emerg Med* 2013; 62:145-50.
8. Vashi AA, Fox JP, Carr BG, et al. Use of hospital-based acute care among patients recently discharged from the hospital. *JAMA* 2013;309:364-71.
9. Aminzadeh F, Dalziel WB. Older adults in the emergency department: a systematic review of patterns of use, adverse outcomes, and effectiveness of interventions. *Ann Emerg Med* 2002;39:238-47.
10. Wofford JL, Schwartz E, Timerding BL, et al. Emergency department utilization by the elderly: analysis of the National Hospital Ambulatory Medical Care Survey. *Acad Emerg Med* 1996;3:694-9.
11. Schoen C, Osborn R, Squires D, et al. New 2011 survey of patients with complex care needs in eleven countries finds that care is often poorly coordinated. *Health Aff (Millwood)* 2011;30:2437-48.
12. Wodchis WP, Austin PC, Henry DA. A 3-year study of high-cost users of health care. *CMAJ* 2016;188:182-8.
13. Mudge AM, Kasper K, Clair A, et al. Recurrent readmissions in medical patients: a prospective study. *J Hosp Med* 2011;6:61-7.
14. Bjorvatn A. Hospital readmission among elderly patients. *Eur J Health Econ* 2013;14:809-20.
15. Shadmi E, Flaks-Manov N, Hoshen M, et al. Predicting 30-day readmissions with preadmission electronic health record data. *Med Care* 2015;53:283-9.
16. Monette M. Hospital readmission rates under the microscope. *CMAJ* 2012;184:E651-2.
17. Colla CH, Wennberg DE, Meara E, et al. Spending differences associated with the Medicare Physician Group Practice Demonstration. *JAMA* 2012;308:1015-23.
18. Kocher KE, Nallamothu BK, Birkmeyer JD, et al. Emergency department visits after surgery are common for Medicare patients, suggesting opportunities to improve care. *Health Aff (Millwood)* 2013;32:1600-7.
19. van Walraven C, Bennett C, Jennings A, et al. Proportion of hospital readmissions deemed avoidable: a systematic review. *CMAJ* 2011;183:E391-402.
20. Forster AJ, Clark HD, Menard A, et al. Adverse events among medical patients after discharge from hospital. *CMAJ* 2004;170:345-9.
21. Allen J, Hutchinson AM, Brown R, et al. Quality care outcomes following transitional care interventions for older people from hospital to home: a systematic review. *BMC Health Serv Res* 2014;14:346.
22. Feltner C, Jones CD, Cene CW, et al. Transitional care interventions to prevent readmissions for persons with heart failure: a systematic review and meta-analysis. *Ann Intern Med* 2014;160:774-84.
23. Rennke S, Nguyen OK, Shoeb MH, et al. Hospital-initiated transitional care interventions as a patient safety strategy: a systematic review. *Ann Intern Med* 2013; 158:433-40.
24. Verhaegh KJ, MacNeil-Vroomen JL, Eslami S, et al. Transitional care interventions prevent hospital readmissions for adults with chronic illnesses. *Health Aff (Millwood)* 2014;33:1531-9.
25. Tricco AC, Antony J, Ivers NM, et al. Effectiveness of quality improvement strategies for coordination of care to reduce use of health care services: a systematic review and meta-analysis. *CMAJ* 2014;186:E568-78.
26. Hansen LO, Young RS, Hinami K, et al. Interventions to reduce 30-day rehospitalization: a systematic review. *Ann Intern Med* 2011;155:520-8.
27. Levine D. The reform of health and social services in Quebec. *Healthc Pap* 2007; 8:46-54.
28. *À propos des GMF : Pourquoi créer des groupes de médecine de famille (GMF) ?* Quebec: Ministère de la Santé et des Services Sociaux; 2010.
29. Romanow RJ. *Building on values: the future of health care in Canada*. Saskatoon: Commission on the Future of Healthcare in Canada; 2002. Available: http://publications.gc.ca/collections/Collection/CP32-85-2002E.pdf (accessed 2010 Oct. 31).
30. Benderix Y, Sivberg B. Siblings' experiences of having a brother or sister with autism and mental retardation: a case study of 14 siblings from five families. *J Pediatr Nurs* 2007;22:410-8.
31. Strumpf E, Levesque JF, Coyle N, et al. Innovative and diverse strategies toward primary health care reform: lessons learned from the Canadian experience. *J Am Board Fam Med* 2012;25(Suppl 1):S27-33.
32. *Rapport d'appréciation de la performance du système de santé et de services sociaux. Construire sur les bases d'une première ligne de soins renouvelée : recommandations, enjeux et implications*. Québec (QC): Commissaire à la santé et au bien-être; 2009. Available: www.csbe.gouv.qc.ca/fileadmin/www/2009_PremiereLigne/format2pages/csbe-Recommandations-t4-2p-042009.pdf (accessed 2017 Jan. 30).
33. Dubé F. Direction de l'organisation des services de première ligne intégrés, Quebec: Ministère de la Santé et des Services Sociaux; 2015.
34. Coyle N, Strumpf E, Fiset-Laniel J, et al. Characteristics of physicians and patients who join team-based primary care practices: evidence from Quebec's Family Medicine Groups. *Health Policy* 2014;116:264-72.
35. Héroux J, Moodie EEM, Strumpf E, et al. Marginal structural models for skewed outcomes: identifying causal relationships in health care utilization. *Stat Med* 2014;33:1205-21.
36. Groupe de médecine de famille (GMF) [33–1]. In: 4. Ententes particulières. Brochure 1 – Omnipraticiens. Montréal: Régie de l'assurance maladie du Québec; 2016.
37. Pampalon R. Indice de défavorisation matérielle et sociale: son application au secteur de la santé et du bien-être. *Santé, Société et Solidarité* 2003;1.
38. Pampalon R, Gamache P, Hamel D. Indice de défavorisation matérielle et sociale du Québec: suivi méthodologique de 1991 à 2006. Québec: Institut National de Santé Publique du Québec, 2010.
39. Gauthier J, Haggerty J, Lamarche P, et al. Entre adaptabilité et fragilité: les conditions d'accès aux services de santé des communautés rurales et éloignées. Institut National de Santé Publique du Québec; 2009.
40. Daneault S, Fournier J. *Gravité clinique, niveau d'accès et NIRRU : document synthèse*. Longueuil (QC): Agence de la santé et des services sociaux de la Montérégie; 2014. Available: http://extranet.santemonteregie.qc.ca/depot/document/3612/Gravit%C3%A9_niveau_acces_NIRRU_APR-DRG_2014-04-04.pdf (accessed 2017 Jan. 30).
41. Royston P, Lambert PC. *Flexible parametric survival analysis using Stata: beyond the Cox Model*. College Station (TX): Stata Press; 2011.
42. Lambert PC. Extending the flexible parametric survival model for competing risks. *Stata J* 2013;13:344-55.
43. Cole SR, Hernan MA. Constructing inverse probability weights for marginal structural models. *Am J Epidemiol* 2008;168:656-64.
44. Austin PC, Stuart EA. Moving towards best practice when using inverse probability of treatment weighting (IPTW) using the propensity score to estimate causal treatment effects in observational studies. *Stat Med* 2015;34:3661-79.
45. Joynt KE, Jha AK. Thirty-day readmissions–truth and consequences. *N Engl J Med* 2012;366:1366-9.
46. Austin PC, Lee DS, Fine JP. Introduction to the Analysis of Survival Data in the Presence of Competing Risks. *Circulation* 2016;133:601-9.

47. Lau B, Cole SR, Gange SJ. Competing risk regression models for epidemiologic data. *Am J Epidemiol* 2009;170:244-56.
48. Riverin BD, Li P, Naimi AI, et al. Team-based innovations in primary care delivery in Quebec and timely physician follow-up after hospital discharge: a population-based cohort study. *CMAJ Open* 2017;5:E28-35.
49. Evaluation de l'implantations et des effets des premiers groupes de médecine de famille au Québec. Québec: Ministère de la Santé et des Services Sociaux; 2008.
50. White B, Carney PA, Flynn J, et al. Reducing hospital readmissions through primary care practice transformation. *J Fam Pract* 2014;63:67-73.
51. Gilfillan RJ, Tomcavage J, Rosenthal MB, et al. Value and the medical home: effects of transformed primary care. *Am J Manag Care* 2010;16:607-14.
52. Maeng DD, Khan N, Tomcavage J, et al. Reduced acute inpatient care was largest savings component of Geisinger Health System's Patient-Centered Medical Home. *Health Aff (Millwood)* 2015;34:636-44.
53. Stranges PM, Marshall VD, Walker PC, et al. A multidisciplinary intervention for reducing readmissions among older adults in a Patient-Centered Medical Home. *Am J Manag Care* 2015;21:106-13.
54. Cavanaugh JJ, Jones CD, Embree G, et al. Implementation Science Workshop: primary care-based multidisciplinary readmission prevention program. *J Gen Intern Med* 2014;29:798-804.
55. Leppin AL, Gionfriddo MR, Kessler M, et al. Preventing 30-day hospital readmissions: a systematic review and meta-analysis of randomized trials. *JAMA Intern Med* 2014;174:1095-107.
56. Sharma G, Kuo YF, Freeman JL, et al. Outpatient follow-up visit and 30-day emergency department visit and readmission in patients hospitalized for chronic obstructive pulmonary disease. *Arch Intern Med* 2010;170:1664-70.
57. Misky GJ, Wald HL, Coleman EA. Post-hospitalization transitions: examining the effects of timing of primary care provider follow-up. *J Hosp Med* 2010;5:392-7.
58. Lin CY, Barnato AE, Degenholtz HB. Physician follow-up visits after acute care hospitalization for elderly Medicare beneficiaries discharged to noninstitutional settings. *J Am Geriatr Soc* 2011;59:1947-54.
59. Jackson C, Shahsahebi M, Wedlake T, et al. Timeliness of outpatient follow-up: an evidence-based approach for planning after hospital discharge. *Ann Fam Med* 2015;13:115-22.
60. Hernandez AF, Greiner MA, Fonarow GC, et al. Relationship between early physician follow-up and 30-day readmission among Medicare beneficiaries hospitalized for heart failure. *JAMA* 2010;303:1716-22.
61. Brooke BS, Stone DH, Cronenwett JL, et al. Early primary care provider follow-up and readmission after high-risk surgery. *JAMA Surg* 2014;149:821-8.
62. Manns BJ, Tonelli M, Zhang J, et al. Enrolment in primary care networks: impact on outcomes and processes of care for patients with diabetes. *CMAJ* 2012;184:E144-52.
63. Campbell DJ, Ronksley PE, Hemmelgarn BR, et al. Association of enrolment in primary care networks with diabetes care and outcomes among First Nations and low-income Albertans. *Open Med* 2012;6:e155-65.
64. Kiran T, Kopp A, Moineddin R, et al. Longitudinal evaluation of physician payment reform and team-based care for chronic disease management and prevention. *CMAJ* 2015;187:E494-502.