Impact of Hospitalists on Care Outcomes in a Large Integrated Health System in British Columbia

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ABSTRACT

Objective: To study care outcomes associated with a network of hospitalist services compared to traditional providers.

Design: Retrospective review of administrative data.

Setting and participants: Patients from a large integrated health care system in British Columbia in western Canada admitted and cared for by 3 provider groups between April 1, 2012, and March 31, 2018: hospitalists, family physicians (FP), and internal medicine (IM) physicians*:*

Measurements: Average total length of stay (LOS), 30-day readmission, in-hospital mortality, and hospital standardized mortality ratio (HSMR) were the study outcome measures. Multiple logistic regression or generalized regression were completed to determine the relationship between provider groups and outcomes.

Results: A total of 248,412 hospitalizations were included. Compared to patients admitted to hospitalists, patients admitted to other providers had higher odds of mortality (odds ratio [OR] for FP, 1.29; 95% confidence interval [CI], 1.21-1.37; OR for IM, 1.24; 95% CI, 1.15-1.33). Compared to hospitalist care, FP care was associated with higher readmission (OR, 1.27; 95% CI, 1.22-1.33), while IM care showed lower odds of readmission (OR, 0.83; 95% CI, 0.79-0.87). Patients admitted to the IM group had significantly lower total LOS (mean, 5.13 days; 95% CI, 5.04-5.21) compared to patients admitted to hospitalists (mean, 7.37 days; CI, 7.26-7.49) and FPs (mean, 7.30 days; 95% CI, 7.19-7.41). In a subgroup analysis of patients presenting with congestive heart failure, chronic obstructive pulmonary disease, and pneumonia, these general tendencies broadly persisted for mortality and LOS comparisons between FPs and hospitalists, but results were mixed for hospital readmissions.

Conclusion: Care provided by hospitalists was associated with lower mortality and readmission rates compared with care provided by FPs, despite similar LOS. These findings may reflect differences in volume of services delivered by individual physicians, on-site availability to address urgent medical issues, and evolving specialization of clinical and nonclinical care processes in the acute care setting.

Keywords: hospital medicine; length of stay; readmission; mortality.

The hospitalist model of care has undergone rapid growth globally in recent years.[1] The first hospitalist programs in Canada began around the same time as those in the United States and share many similarities in design and operations with their counterparts.[2-4] However, unlike in the United States, where the hospitalist model has successfully established itself as an emerging specialty, debates about the merits of the model and its value proposition continue among Canadian observers.[5-9]

Historically, the type of physicians who acted as the most responsible provider (MRP) in Canadian hospitals depended on setting and geography.[10] In large urban areas, groups of general internists or specialists have historically looked after general medicine patients as part of university-affiliated teaching services.[11,12] Patients admitted to community hospitals have traditionally been cared for by their own primary care providers, typically

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general practitioners or family physicians (FPs). In the mid-1990s, many primary care providers in urban centers began to withdraw from inpatient care and primarily focused their practices in the outpatient setting.[13-15] Hospitalist programs emerged as health care administrators sought to fill the resulting gap in MRP coverage.[2,10]

To date, attempts to understand the impact of hospitalist programs in Canada have been limited. A number of early studies aimed to describe[16] the role of hospitalists in Canada and suggested improvements in length of stay (LOS) and staff satisfaction.[17] However, these studies relied on unadjusted before-after comparisons and lacked methodological rigor to draw robust conclusions. More recently, a few studies have evaluated care outcomes associated with hospitalists using administrative databases, which attempted to control for potential confounding factors.[18-21]

While these studies are beginning to shed some light on the impact of hospital medicine programs in Canada, there are a number of issues that limit their generalizability. For example, the majority of studies to date focus on hospital medicine programs in Canada's largest province (Ontario), and most describe experiences from single institutions. Since each of the 13 provincial and territorial governments organizes its health care system differently,[22] results from 1 province may not be generalizable to other parts of the country. Moreover, hospitalists in Ontario are more diverse in their training backgrounds, with a larger percentage having trained in general internal medicine (IM), as compared to other parts of Canada, where the majority of hospitalists are overwhelmingly trained as FPs.[3]

We aimed to study care outcomes associated with a network of hospitalist services compared to "traditional" providers (community-based FPs and IM specialists) in a large integrated health care system in the province of British Columbia in western Canada. The hospital medicine services in this network span a range of community and academic hospitals, and collectively constitute 1 of the largest regional programs in the country. This provides a unique opportunity to understand the impact of hospitalists on outcome measures across a range of acute care institutions.

Methods

Setting and Population

Fraser Health Authority is 1 of 5 regional health authorities in British Columbia that emerged in 2001.[23,24] It operates a network of hospitalist programs in 10 of its 12 acute care hospitals. In addition to hospitalists, there are a variable number of "traditional" physician providers who continue to act as MRPs. These include community-based FPs who continue to see their own patients in the hospital, either as part of a solo-practice model or a clinic-based call group. There are also a number of general internists and other subspecialists who accept MRP roles for general medicine patients who may present with higher-acuity conditions. As a result, patients requiring hospitalization due to nonsurgical or noncritical care conditions at each Fraser Health hospital may be cared for by a physician belonging to 1 of 3 groups, depending on local circumstances: an FP, a hospitalist, or an internist.

Inclusion and Exclusion Criteria

In order to evaluate comparative outcomes associated with hospitalist care, we included all patients admitted to a physician in each of the 3 provider groups between April 1, 2012, and March 31, 2018. We chose this time period for 2 reasons: first, we wanted to ensure comparability over an extended period of time, given the methodological changes implemented in 2009 by the Canadian Institute for Health Information (CIHI), the federal organization in the country responsible for setting standards for health care measures.[25] Second, previous internal reviews had suggested that data quality prior to this year was inconsistent. We only considered hospitalizations where patients were admitted to and discharged by the same service, and excluded 2 acute care facilities and 1 free-standing rehabilitation facility without a hospitalist service during this period. We also excluded patients who resided in a location beyond the geographic catchment area of Fraser Health. Further details about data collection are outlined in the **Appendix** (The Appendix is available at www.mdedge.com/jcomjournal.).

Measures

We used the framework developed by White and Glazier[26] to inform the selection of our outcome measures, as well as relevant variables that may impact them. This frame-

Table 1. **Demographic and Clinical Characteristics by Provider Group (n = 224,214)**

	Family Physician (n = 61,604)	Internal Medicine (n = 35,200)	Hospitalist (n = 127,410)	*P* Value
Sex, No. (%)				
Male	27,824 (45.2)	20,669 (58.7)	60,028 (47.1)	< 0.001
Female	33,776 (54.8)	14,531 (41.3)	67,381 (52.9)	
Discharge disposition, No. (%)				
Died	454 (7.4)	2105 (6.0)	7489 (5.9)	< 0.001
Discharged home	44,303 (71.9)	27,549 (78.3)	92,964 (73.0)	
Transferred	11,652 (18.5)	4572 (13.0)	23,486 (18.4)	
Signed out/other	1101 (1.8)	974 (2.8)	3471 (2.7)	
Facility peer group, No. (%)				
Teaching	5287 (8.6)	15,838 (45.0)	36,816 (28.9)	
Community, small	7153 (11.6)	0 (0)	1043 (0.8)	
Community, medium	3207 (5.2)	6411 (18.2)	41,941 (32.9)	
Community, large	45,957 (74.6)	12,951 (36.8)	47,610 (37.4)	
Fiscal year, No. (%)				
2012-2013	12,958 (21)	6952 (19.8)	20,475 (16.1)	< 0.001
2013-2014	12,861 (20.9)	6970 (19.8)	22,151 (17.4)	
2014-2015	12,550 (20.4)	5771 (16.4)	20,355 (16.0)	
2015-2016	11,967 (19.4)	5269 (15.0)	17,879 (14.0)	
2016-2017	6734 (10.9)	5200 (14.8)	21,233 (16.7)	
2017-2018	4534 (7.4)	5038 (14.3)	25,317 (19.9)	
HSDA, No. (%)				
East	28,441 (46.2)	4675 (13.3)	7841 (6.2)	< 0.001
North	5553 (9.0)	20,504 (58.3)	64,455 (50.6)	
South	27,610 (44.8)	10,021 (28.5)	55,114 (43.3)	
SCU, No. (%)				
0 days	59,994 (97.4)	26,458 (75.2)	124,703 (97.9)	< 0.001
≥ 1 day	1610 (2.6)	8742 (24.8)	2707 (2.1)	
Palliative care status, No. (%)				
No	26,902 (92.4)	34,808 (98.9)	122,621 (96.2)	< 0.001
Yes	4702 (7.6)	388 (1.1)	4789 (3.8)	
Age, mean (SD), yr	70.86 (18.73)	61.00 (17.99)	71.22 (17.56)	< 0.005
No. of comorbidities, mean (SD)	0.74 (1.10)	0.78 (1.64)	1.03 (1.26)	
Conservable days, mean (SD)	2.876 (7.19)	1.254 (4.41)	3.954 (9.30)	
RIW, mean (SD)	1.48 (2.35)	1.44 (2.61)	1.74 (2.71)	
LOS, mean (SD), days	9.94 (16.14)	5.56 (8.41)	12.07 (18.87)	

Note. Comparisons were made using independent ANOVA or chi-square tests. Results were consistent between parametric and nonparametric tests. Fiscal year starts April 1 and ends on March 31.

GHSDA, health service delivery area (geography); LOS, length of stay (total); RIW, resource intensity weight; SCU, special care unit.

work proposes that the design of the inpatient care model (structures and processes of care) directly affects care outcomes. The model also proposes that patient and provider attributes can modulate this relationship, and suggests that a comprehensive evaluation of hospitalist performance needs to take these factors into account. We identified average total LOS, 30-day readmission rate, in-hospital mortality, and hospital standardized mortality ratio (HSMR)[27] as primary outcome measures. HSMR is defined as actual over expected mortality and is measured by CIHI through a formula that takes into account patient illness attributes (eg, the most responsible diagnosis, comorbidity levels) and

Table 2. **Top 10 Case-Mix Groups by Provider Type (n = 195)**

	Family Physician (n = 54,402)	Internal Medicine (n = 30,216)	Hospitalist (n = 111,324)
1.	COPD (6%)	Arrhythmia without coronary angiogram (7%)	COPD (7%)
2.	Viral/unspecified pneumonia (5%)	Percutaneous coronary intervention with MI/shock/arrest/HF (6%)	Viral/unspecified pneumonia (5%)
3.	Lower urinary tract infection (5%)	HF without coronary angiogram (4%)	HF without coronary angiogram (4%)
4.	HF without coronary angiogram (4%)	Angina (except unstable)/chest pain without coronary angiogram (3%)	Lower urinary tract infection (4%)
5.	Symptom/sign of digestive system (4%)	Syncope (3%)	General symptom/sign (4%)
6.	General symptom/sign (4%)	Diabetes (3%)	Symptom/sign of digestive system (3%)
7.	Palliative care (4%)	COPD (3%)	Nonsevere enteritis (3%)
8.	Nonsevere enteritis (3%)	Viral/unspecified pneumonia (2%)	Ischemic event of central nervous system (2%)
9.	Diagnosis not generally hospitalized (3%)	Other/miscellaneous cardiac disorder (2%)	GI hemorrhage (2%)
10.	GI hemorrhage (2%)	Poisoning/toxic effect of drug (2%)	Disorder of pancreas except malignancy (2%)

Note: All transfers were excluded.
COPD, chronic obstructive pulmonary disease; GI, gastrointestinal; HF, heart failure; MI, myocardial infarction.

baseline population mortality rates.[27] We chose these measures because they are clinically relevant and easy to obtain and have been utilized in previous similar studies in Canada and the United States.[18-21,26]

Statistical Analysis

Baseline demographic and clinical differences in patient outcomes were examined using independent t-tests or chi-square tests. Furthermore, baseline differences based on provider groups were explored using analysis of variance or chi-square tests. Multiple logistic regression analyses were completed to determine the relationship between provider groups and readmission and mortality, while the relationship between provider groups and hospital LOS was determined with generalized linear regression (using gamma distribution and a log link). Gamma distribution with a log link analysis is appropriate with outcome measures that are positively skewed (eg, hospital LOS). It assumes that data are sampled from an exponential family of distributions, thus mimicking a log-normal distribution, and minimizes estimation bias and standard errors. These analyses were completed while controlling for the effects of age, gender, and other potential confounding factors.

We initially attempted to control for case mix by incorporating case-mix groups (CMGs) in our multivariate analysis. However, we identified 475 CMGs with at least 1 patient in our study population. We then explored the inclusion of major clinical categories (MCCs) that broadly group CMGs into various higher order/organ-system level categories (eg, diseases of the respiratory system); however, we could not aggregate them into sufficiently homogenous groups to be entered into regression models. Instead, we conducted subgroup analyses on patients in our study population who were hospitalized with 1 of the following 3 CMGs: chronic obstructive pulmonary disease (COPD, n = 11,404 patients), congestive heart failure without coronary angiography (CHF, n = 7680), and pneumonia (itself an aggregate of 3 separate CMGs: aspiration pneumonia, bacterial pneumonia, viral/unspecified pneumonia, n = 11,155). We chose these CMGs as they are among the top 8 presentations for all 3 provider groups.

For all outcome measures, we excluded atypical patients (defined by CIHI as those with atypically long stays) and patients who had been transferred between facilities. For the readmission analysis, we also excluded patients who died in the hospital (Appendix A). Data

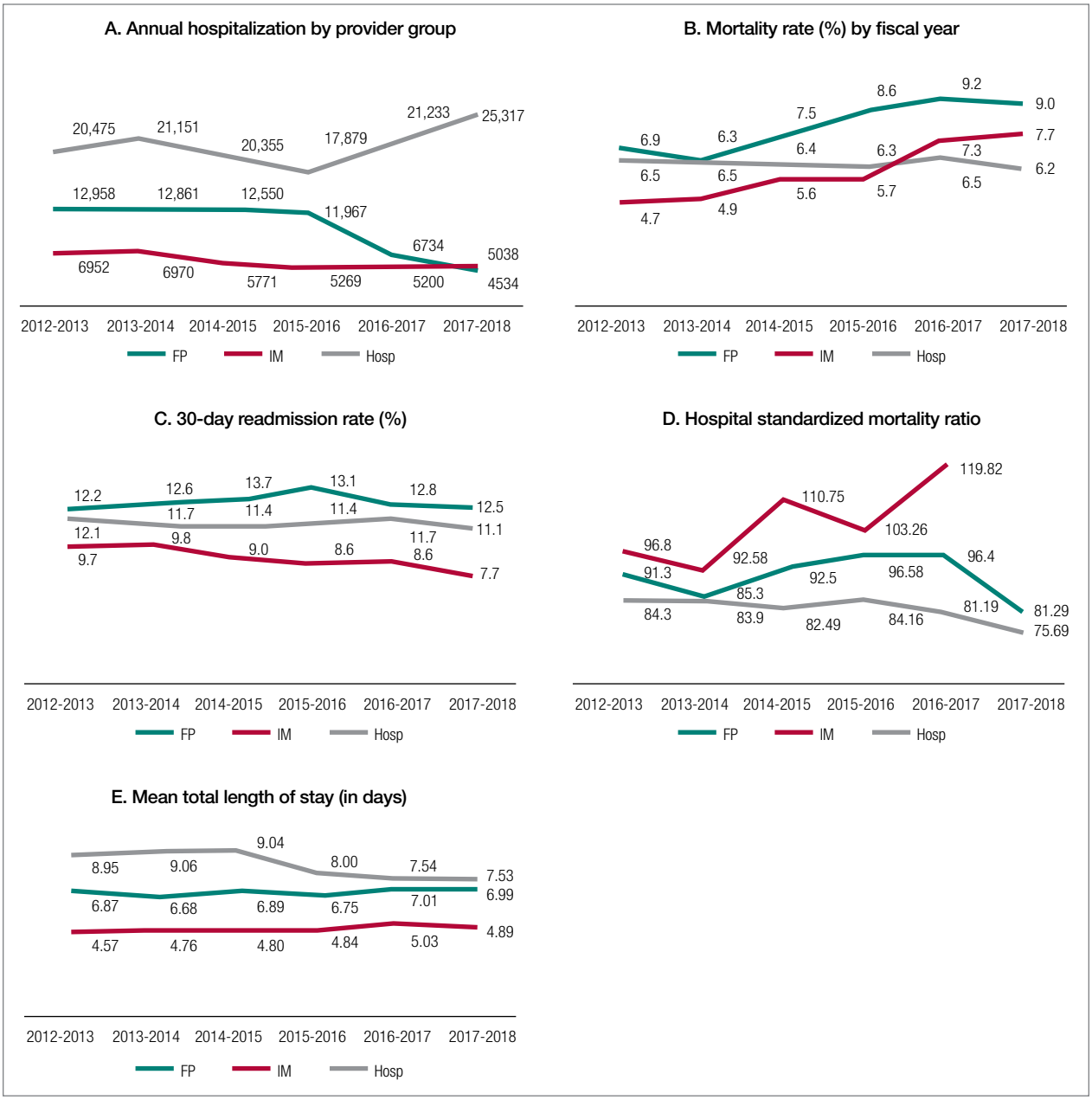

Figure. Trends in (**A**) annual hospitalization, (**B**) mortality rate, (**C**) 30-day readmission rates, (**D**) hospital standardized mortality ratio, and (**E**) mean total length of stay by provider group over time. FP, family physicians; Hosp, hospitalists; IM, internal medicine physicians.

analyses were completed in IBM SPSS, version 21. For all analyses, significance was determined using 2-tailed test and alpha < 0.05.

Ethics

The Fraser Health Department of Research and Evaluation reviewed this project to determine need for formal Ethics Review Board review, and granted an exemption based on institutional guidelines for program evaluations.

Results

A total of 132,178 patients were admitted to and discharged by 1 of the 3 study provider groups during the study period, accounting for a total of 248,412 hospitaliza-

Table 3. **Results of Logistic Regression for Primary Outcomes: Mortality (n = 183,779)**

Parameter	B	SE	Wald $\chi 2$	*df*	*P* Value	OR (95% CI)
Group provider (ref. Hospitalist)			84.831	2	< 0.001	
Family physician	0.255	0.031	67.498	1	< 0.001	1.290 (1.214-1.371)
Internal medicine	0.214	0.037	32.493	1	< 0.001	1.238 (1.150-1.332)
Age	0.038	0.001	1932.514	1	< 0.001	1.039 (1.037-1.041)
Females	–0.272	0.022	150.078	1	< 0.001	0.762 (0.729-0.795)
Comorbidity level	0.712	0.010	5450.543	1	< 0.001	2.038 (2.000-2.077)
LOS in days	–0.068	0.003	716.323	1	< 0.001	0.934 (0.930-0.939)
No. of secondary diagnoses	0.070	0.008	80.643	1	< 0.001	1.072 (1.056-1.089)
Conservable days	0.056	0.004	222.757	1	< 0.001	1.058 (1.050-1.066)
RIW	0.146	0.008	323.281	1	< 0.001	1.157 (1.139-1.176)
Hospital type (ref. Teaching)			6.281	3	0.099	
Community, small	–0.142	0.083	2.935	1	0.087	0.867 (0.737-1.021)
Community, medium	–0.070	0.034	4.281	1	0.039	0.933 (0.873-0.996)
Community, large	–0.044	0.029	2.270	1	0.132	0.957 (0.903-1.013)
HSDA (ref. Fraser East)			25.899	2	< 0.001	
Fraser North	0.124	0.041	9.180	1	0.002	1.132 (1.045-1.227)
Fraser South	0.181	0.037	24.483	1	< 0.001	1.199 (1.116-1.288)
Palliative care	2.923	0.030	9579.961	1	< 0.001	18.592 (17.535-19.713)
SCU care	1.065	0.041	675.843	1	< 0.001	2.901 (2.677-3.144)
Year of program (ref. 2012/13)			46.327	5	< 0.001	
2013-2014	–0.116	0.037	9.689	1	0.002	0.891 (0.828-0.958)
2014-2015	–0.101	0.037	7.237	1	0.007	0.904 (0.840-0.973)
2015-2016	–0.227	0.038	34.759	1	< 0.001	0.797 (0.739-0.859)
2016-2017	–0.173	0.039	19.701	1	< 0.001	0.841 (0.079-0.908)
2017-2018	–0.209	0.039	28.456	1	< 0.001	0.812 (0.752-0.876)

Notes: Reference groups are identified in parentheses. Fiscal year starts April 1 and ends on March 31. Parameters were estimated using maximum likelihood. HSDA, health service delivery area; LOS, length of stay; OR, odds ratio; RIW, resource intensity weight; SCU, special care unit.

tions. After excluding patients cared for in Fraser Health facilities without a hospitalist service and those who resided in a geographic area beyond Fraser Health, a total of 224,214 admissions were included in the final analysis.

Patient Characteristics

The demographic and clinical characteristics of patients by provider group are summarized in **Table 1** (page 61). Patients admitted to IM providers were substantially younger than those admitted to either FPs or hospitalists (61.00 vs 70.86 and 71.22 years, respectively; $P < 0.005$). However, patients admitted to hospitalists had higher degrees of complexity (as measured by higher comorbidity levels, number of secondary diagnoses, and higher resource intensity weights [RIWs]; $P < 000.1$ for all comparisons). Overall, the most common CMGs seen by FPs and hospitalists were similar, while IM providers primarily saw patients with cardiac conditions (**Table 2**, page 62).

Trends Over Time

During the study period, the number of patients admitted to the hospitalist services increased by 24%, while admissions to FPs and IM providers declined steadily (**Figure**, page 63). During this time, LOS for hospitalists

Table 4. **Results of Logistic Regression for Primary Outcomes by Case-Mix Group: Mortality**

	COPD (n = 11,404)		Heart Failure (n = 7680)		Pneumonia (n = 11,155)	
Parameter	**B**	**OR (95% CI)**	**B**	**OR (95% CI)**	**B**	**OR (95% CI)**
Provider group (ref. Hospitalist)						
Family physician	0.258	1.294 (0.985-1.700)	0.570	1.768 (1.377-2.271)	0.425	1.529 (1.246-1.876)
Internal medicine	0.999	2.715 (1.941-3.798)	0.163	1.177 (0.842-1.646)	–0.074	0.929 (0.689-1.252)
Age	0.050	1.051 (1.040-1.062)	0.065	1.067 (1.055-1.080)	0.043	1.044 (1.037-1.050)
Female	–0.254	0.776 (0.645-0.933)	–0.212	0.809 (0.676-0.969)	–0.285	0.752 (0.656-0.862)
Comorbidity level	1.264	3.541 (3.193-3.927)	0.959	2.610 (2.385-2.856)	0.901	2.462 (2.300-2.636)
Length of stay	–0.137	0.872 (0.844-0.900)	–0.113	0.893 (0.870-0.917)	–0.142	0.868 (0.847-0.888)
No. of secondary diagnoses	–0.113	0.893 (0.823-0.969)	0.011	1.011 (0.955-1.070)	0.086	1.090 (1.034-1.148)
Conservable days	0.163	1.177 (1.078-1.284)	0.107	1.113 (1.075-1.152)	0.123	1.131 (1.094-1.169)
RIW	0.123	1.131 (1.082-1.183)	0.417	1.517 (1.352-1.703)	0.193	1.213 (1.144-1.287)
Hospital type (ref. Teaching)						
Community, small	0.719	2.052 (1.111-3.793)	1.073	2.923 (1.612-5.303)	0.218	1.244 (0.795-1.946)
Community, medium	0.715	2.044 (1.520-2.747)	0.115	1.122 (0.844-1.491)	0.285	1.330 (1.083-1.633)
Community, large	0.659	1.933 (1.480-2.523)	0.524	1.690 (1.330-2.146)	0.301	1.351 (1.124-1.623)
HSDA (ref. Fraser East)						
Fraser North	0.287	1.332 (0.906-1.958)	0.754	2.126 (1.480-3.055)	0.598	1.818 (1.387-2.384)
Fraser South	0.529	1.697 (1.217-2.366)	0.659	1.934 (1.413-2.647)	0.512	1.668 (1.308-2.126)
Palliative care	2.598	13.436 (9.285-19.444)	1.953	7.046 (5.004-9.922)	2.212	9.132 (7.042-11.844)
SCU care	0.414	1.513 (1.079-2.120)	0.545	1.724 (1.212-2.453)	0.416	1.516 (1.093-2.103)
Year of program (ref. 2012/13)						
2013-2014	–0.580	0.560 (0.406-0.773)	–0.411	0.663 (0.488-0.901)	–0.563	0.570 (0.449-0.724)
2014-2015	–0.736	0.479 (0.343-0.668)	–0.187	0.830 (0.610-1.128)	–0.402	0.669 (0.529-0.847)
2015-2016	–0.328	0.720 (0.529-0.981)	–0.322	0.725 (0.533-0.985)	–0.572	0.565 (0.444-0.718)
2016-2017	–0.152	0.859 (0.634-1.164)	–0.112	0.894 (0.667-1.198)	–0.330	0.719 (0.572-0.904)
2017-2018	–0.407	0.665 (0.4870-0.910)	0.011	1.011 (0.759-1.346)	–0.293	0.746 (0.593-0.937)

Notes: Reference groups are identified in parentheses. Fiscal year starts April 1 and ends on March 31. Parameters estimated using maximum likelihood.
COPD, chronic obstructive pulmonary disease; HSDA, health service delivery area (geography); RIW, resource intensity weight; SCU, special care unit.

progressively declined, while LOS for FPs and IM providers increased. Similar trends were observed for measures of mortality, while readmission rates remained constant for FPs, despite a decline observed for other providers.

Mortality

Table 3 summarizes the relationship between provider groups and in-hospital mortality (n = 183,779). Controlling for other variables, patients admitted to FP and IM providers had higher odds of mortality when compared to hospitalists (odds ratio [OR] for FPs, 1.29; 95% confidence interval [CI], 1.21-1.37; OR for IM, 1.24; 95% CI, 1.15-1.33). Older age, higher comorbidity level, higher number of secondary diagnoses, higher use of hospital resources (as measured by RIWs), longer than expected hospital stay (as measured by conservable days), and male gender were also associated with higher mortality. Similarly, patients receiving palliative care and those who spent at least 1 day in a special care unit (critical care, observation, and monitored care units) also had higher odds of mortality. On the other hand, admission to nonteaching medium facilities and longer hospital stay were associated with lower mortality. Compared to the first year of this analysis, lower mortality rates were observed in subsequent fiscal

Table 5. **Results of Logistic Regression for Primary Outcomes: 30-Day Hospital Readmission (n = 166,042)**

Parameter	B	SE	Wald $\chi 2$	*df*	*P* Value	OR (95% CI)
Provider group (ref. Hospitalist)			201.812	2	< 0.001	
Family physician	0.245	0.023	114.947	1	< 0.001	1.277 (1.221-1.336)
Internal medicine	–0.184	0.026	51.867	1	< 0.001	0.832 (0.792-0.874)
Age	0.013	0.001	674.171	1	< 0.001	1.013 (1.012-1.014)
Females	–0.004	0.016	0.068	1	0.794	0.996 (0.965-1.027)
Comorbidity level	0.154	0.009	326.483	1	< 0.001	1.167 (1.148-1.187)
LOS in days	–0.011	0.002	37.440	1	< 0.001	0.989 (0.985-0.992)
No. of secondary diagnoses	0.143	0.006	494.398	1	< 0.001	1.153 (1.139-1.168)
Conservable days	0.030	0.003	106.037	1	< 0.001	1.031 (1.205-1.037)
RIW	–0.016	0.011	2.417	1	0.120	0.984 (0.963-1.004)
Discharge disposition (ref. Home)			631.098	2	< 0.001	
Transferred	–0.852	0.034	631.097	1	< 0.001	0.427 (0.399-0.456)
Signed-out	–18.995	556.881	.001	1	0.973	0.000
Hospital type (ref. Teaching)			5.501	2	0.064	
Community, medium	–0.018	0.023	.573	1	0.449	0.982 (0.938-1.029)
Community, large	–0.051	0.022	5.378	1	0.020	0.951 (0.911-0.992)
HSDA (ref. Fraser East)			58.147	2	< 0.001	
Fraser North	0.064	0.029	4.788	1	0.029	1.066 (1.007-1.129)
Fraser South	–0.081	0.025	10.402	1	0.001	0.922 (0.878-0.969)
Palliative care	–1.348	0.084	254.484	1	< 0.001	0.260 (0.220-0.307)
SCU care	–0.081	0.041	3.950	1	0.047	0.922 (0.851-0.999)
Year of program (ref. 2012/13)			59.808	5	< 0.001	
2013-2014	–0.023	0.025	.804	1	0.370	0.977 (0.930-1.027)
2014-2015	–0.092	0.026	12.149	1	< 0.001	0.913 (0.867-0.961)
2015-2016	–0.116	0.027	18.337	1	< 0.001	0.890 (0.844-0.939)
2016-2017	–0.133	0.028	22.355	1	< 0.001	0.876 (0.829-0.925)
2017-2018	–0.183	0.028	41.728	1	< 0.001	0.833 (0.788-0.880)

Notes: No data for Small Community hospital category. Reference groups are identified in parentheses. Fiscal year starts April 1 and ends on March 31. Parameters were estimated using maximum likelihood.

HSDA, health service delivery area; LOS, length of stay; OR, odds ratio; RIW, resource intensity weight; SCU, special care unit.

years. Finally, there appear to be geographic variations in mortality within Fraser Health.

Our analysis of patients with COPD, CHF, and pneumonia showed mixed results (**Table 4**). Patients admitted to the FP provider group with CHF and pneumonia had higher mortality compared to hospitalists (OR for CHF, 1.77; 95% CI, 1.38-2.27; OR for pneumonia, 1.53; 95% CI, 1.25-1.88), with a similar but nonstatistically significant trend observed for patients with COPD (OR, 1.29; 95% CI, 0.99-1.70). On the other hand, the higher observed mortality associated with the IM provider group in the overall study population only persisted for patients with COPD (OR, 2.71; 95% CI, 1.94-3.80), with no statistically significant differences for patients with CHF (OR, 1.18; 95% CI, 0.84-1.65) and pneumonia (OR, 0.93; 95% CI, 0.69-1.25).

We also studied adjusted mortality as measured by HSMRs. Currently, our Health Information Management system calculates an HSMR value for each patient admitted to our acute care facilities using the methodology developed by CIHI. Prior internal audits demonstrated that

Table 6. **Results of Logistic Regression for Primary Outcomes Case-Mix Group: Readmission**

	COPD (n = 10,222)		Heart Failure (n = 6665)		Pneumonia (n = 9367)	
Parameter	**B**	**OR (95% CI)**	**B**	**OR (95% CI)**	**B**	**OR (95% CI)**
Provider group (ref. Hospitalist)						
Family physician	0.101	1.107 (0.955-1.282)	–0.006	0.994 (0.836-1.182)	0.240	1.271 (1.049-1.541)
Internal medicine	–0.223	0.800 (0.633-1.012)	–0.285	0.752 (0.615-0.921)	0.130	1.139 (0.879-1.477)
Age	0.002	1.002 (0.997-1.006)	0.013	1.013 (1.007-1.019)	0.014	1.014 (1.010-1.019)
Female	–0.035	0.965 (0.872-1.068)	–0.060	0.942 (0.832-1.065)	–0.030	0.970(0.854-1.102)
Comorbidity level	0.088	1.092 (1.018-1.171)	0.067	1.069 (0.981-1.165)	0.051	1.053 (0.978-1.133)
Length of stay	–0.002	0.998 (0.977-1.020)	–0.011	0.989 (0.965-1.013)	0.005	1.005 (0.984-1.027)
Conservable days	0.028	1.029 (0.998-1.061)	0.027	1.027 (0.992-1.063)	0.020	1.020 (0.990-1.052)
RIW	–0.051	0.950 (0.859-1.051)	0.039	1.039 (0.894-1.209)	–0.001	0.999 (0.929-1.075)
Discharge disposition						
Transferred	–0.412	0.662 (0.524-0.837)	–0.905	0.405 (0.307-0.533)	–0.252	0.777 (0.646-0.935)
Signed out	–19.70	0.000 (0.000)	–19.76	0.000 (0.000)	–18.87	0.000 (0.000)
No. of secondary diagnoses	0.113	1.120 (1.064-1.179)	0.099	1.104 (1.059-1.150)	0.154	1.166 (1.104-1.232)
Hospital type (ref. Teaching)						
Community, medium	0.024	1.024 (0.878-1.195)	0.194	1.214 (1.007-1.464)	–0.048	0.953 (0.783-1.161)
Community, large	0.030	1.030 (0.897-1.183)	0.291	1.338 (1.140-1.569)	–0.014	0.986 (0.828-1.174)
HSDA (ref. Fraser East)						
Fraser North	–0.020	0.980 (0.804-1.195)	0.179	1.196 (0.953-1.502)	–0.015	0.985 (0.772-1.257)
Fraser South	–0.060	0.941 (0.795-1.115)	0.067	1.069 (0.877-1.304)	–0.117	0.890 (0.723-1.096)
Palliative care	0.038	1.038 (0.795-1.356)	–1.528	0.217 (0.067-0.705)	–1.153	0.316 (0.136-0.730)
SCU care	0.028	1.029 (0.998-1.061)	0.071	1.073 (0.805-1.432)	0.071	1.073 (0.758-1.520)
Year of program (ref. 2012/13)						
2013-2014	–0.229	0.796 (0.662-0.956)	–0.208	0.812 (0.655-1.007)	–0.365	0.694 (0.556-0.867)
2014-2015	–0.086	0.918 (0.769-1.094)	–0.134	0.874 (0.703-1.086)	–0.458	0.633 (0.503-0.796)
2015-2016	–0.126	0.882 (0.737-1.054)	–0.122	0.885 (0.716-1.095)	–0.357	0.700 (0.562-0.872)
2016-2017	–0.035	0.966 (0.815-1.144)	–0.152	0.859 (0.698-1.058)	–0.222	0.801 (0.653-0.981)
2017-2018	–0.022	0.979 (0.830-1.154)	–0.059	0.943 (0.770-1.155)	–0.377	0.686 (0.557-0.845)

Notes: No data for Small Community hospital category. Reference groups are identified in parentheses. Fiscal year starts April 1 and ends on March 31. Parameters estimated using maximum likelihood.

COPD, chronic obstructive pulmonary disease; HSDA, health service delivery area (geography); RIW, resource intensity weight; SCU, special care unit.

our internal calculations closely approximate those reported nationally. Our analysis suggests that over time, HSMR rates for the 3 provider groups have diverged, with patients admitted to IM providers having a higher mortality rate than what would be expected based on the presenting clinical conditions and comorbidity levels (Figure, part D).

Readmission

The results of our multiple logistic regression for readmission are summarized in **Table 5** (n = 166,042). The impact of provider group on 30-day readmission is mixed, with higher odds associated with FPs compared to hospitalists (OR, 1.27; 95% CI, 1.22-1.34) and lower odds associated with IM physicians (OR, 0.83; 95% CI, 0.79-0.87). Gender and RIW did not show any significant associations, but increasing age, higher number of secondary diagnoses, higher comorbidity levels, and longer than expected LOS (as measure by conservable days) were associated with higher odds of readmission. Conversely, longer hospitalization, admission to a large

community hospital, palliative status, admission to a special care unit, geography, and fiscal year were associated with lower odds of readmission.

The above differences between provider groups were no longer consistently present when we analyzed patients presenting with COPD, CHF, and pneumonias (**Table 6**). Only patients admitted to the FP provider group with pneumonia had higher odds of readmission compared to hospitalists (OR, 1.27; 95% CI, 1.05-1.54). Conversely, only patients admitted to the IM provider group with CHF showed lower readmission (OR, 0.75; 95% CI, 0.62-0.92).

Total LOS

Results using generalized linear regressions for total LOS are presented in **Table 7** (n = 183,779). Patients admitted to the IM provider group had significantly lower total LOS (mean, 5.13 days; 95% CI, 5.04-5.21) compared to the hospitalist (mean, 7.37 days; 95% CI, 7.26-7.49) and FP (mean, 7.30 days; 95% CI, 7.19-7.41) groups, with no significant differences between the latter 2 groups. Older patients, females, patients with higher comorbidity levels or number of secondary diagnoses, higher RIW, palliative patients, and discharge to a facility other than the patient's home were associated with a significantly longer LOS. On the other hand, admission to nonteaching hospitals and admission to a special care unit was associated with lower LOS.

When we compared total LOS for patients admitted with COPD, CHF, and pneumonias, the same differences observed for the broader comparisons persisted: IM patients consistently showed shorter LOS compared to hospitalist patients, while LOS associated with FP patients was similar (**Table 8**).

Discussion

To our knowledge, our evaluation is the largest study to date designed to understand outcomes associated with hospitalist care in Canada. Our analyses suggest that patients admitted to our large network of hospitalist services present with clinical conditions that are very similar to those of general medicine patients in other Canadian provinces.[28,29] They also show that patients cared for by hospitalists experience lower mortality rates compared to those cared for by FPs. Our findings are similar to previous studies, which have suggested a 12% to 75% reduction in odds of mortality associated with hospitalist care.[18,19] These differences persisted even when we focused on patients presenting with specific clinical conditions (CHF, COPD, and pneumonias).

White and colleagues have previously demonstrated that generalist physicians who had higher volumes of inpatient care activity also had lower mortality rates compared to those who cared for hospitalized patients less frequently.[19] An association between higher physician caseloads and better outcomes has been established for many surgical and medical conditions.[30-32] Given that 85% of hospitalists in our program have post-graduate medical training in family medicine (internal department surveys, data not shown), it is less likely that training background can explain differences in outcomes. Instead, differences in patient volumes and the dedicated focus of hospitalists on acute care are likely more important contributors to lower mortality. In our program, a full-time hospitalist spends an average of 2000 hours annually providing services in the hospital setting. The continuous on-site presence of hospitalists enhances their clinical experience with regards to the management of common medical conditions, and increases their exposure to less common presentations of illnesses. The ability to respond to deteriorating patients in a timely manner may be another factor in explaining the differences in mortality rates between dedicated hospital-based generalist providers and similarly trained physicians with a primarily community-based focus.

In our study, hospitalist care was also broadly associated with lower mortality compared to the IM providers, although these differences were not consistently present when patients with specific diagnoses were compared. This may be partly explained by the relationship between caseload and outcomes, but other factors may also be important. For example, patients admitted by IM providers spend significantly more time in specialized units. They also predominantly present with cardiac conditions, and as such may have higher acuity levels and require more invasive interventions. While this may explain the higher observed mortality, a within-group comparison still suggests higher than

Table 7. **Results of Generalized Linear Regression for Primary Outcomes: Total Hospital Length of Stay (n = 183,779)**

			95% Wald CI		Hypothesis Test		
Parameter*	**B**	**SE**	**Lower**	**Upper**	**Wald χ2**	***df***	***P* Value**
Intercept	0.555	0.0086	0.538	0.572	4211.175	1	< 0.001
Provider group (ref. Hospitalist)							
Family physician	0.001	0.0042	–0.007	0.009	0.067	1	0.796
Internal medicine	–0.184	0.0045	–0.193	–0.175	1640.539	1	< 0.001
Age	0.007	0.000	0.006	0.007	5707.514	1	< 0.001
Female	0.021	0.0029	0.016	0.027	53.556	1	< 0.001
Comorbidity level	0.098	0.0016	0.095	0.101	3641.639	1	< 0.001
No. of secondary diagnoses	0.032	0.0013	0.030	0.035	623.489	1	< 0.001
Conservable days	0.113	0.0005	0.112	0.114	56,927.383	1	< 0.001
RIW	0.324	0.0020	0.321	0.328	27,095.939	1	< 0.001
Discharge disposition (ref. Home)							
Transferred	0.244	0.0053	0.234	0.255	2164.377	1	< 0.001
Died	–0.263	0.0068	–0.276	–0.250	1510.347	1	< 0.001
Signed-out	–0.316	0.0087	–0.333	–0.299	1315.030	1	< 0.001
Hospital type (ref. Teaching)							
Community, small	–0.032	0.0098	–0.051	–0.013	10.761	1	0.001
Community, medium	–0.080	0.0044	–0.089	–0.072	327.767	1	< 0.001
Community, large	–0.065	0.0040	–0.073	–0.057	267.831	1	< 0.001
HSDA (ref. Fraser East)							
Fraser North	0.031	0.0047	0.022	0.040	43.876	1	< 0.001
Fraser South	0.051	0.0054	0.041	0.062	90.981	1	< 0.001
Palliative care	0.100	0.0079	0.085	0.116	163.075	1	< 0.001
SCU care	–0.041	0.0069	–0.055	–0.028	36.055	1	< 0.001
Year of program (ref. 2012/13)							
2017-2018	–0.017	0.0051	–0.028	–0.007	11.567	1	0.001
2016-2017	–0.033	0.0051	–0.043	–0.023	41.967	1	< 0.001
2015-2016	–0.048	0.0050	–0.058	–0.038	90.319	1	< 0.001
2014-2015	–0.016	0.0049	–0.025	–0.006	10.461	1	0.001
2013-2014	–0.007	0.0047	–0.017	0.002	2.318	1	0.128

Notes: Reference groups are identified in parentheses. Fiscal year starts April 1 and ends on March 31. Parameters were estimated using maximum likelihood. HSDA, health service delivery area; LOS, length of stay; OR, odds ratio; RIW, resource intensity weight; SCU, specialty care unit.
*Model used with gamma distribution and a log link.

expected mortality for IM patients. The HSMR methodology measures actual mortality rates compared to what would be expected based on clinical presentation and baseline population characteristics. Calculating HSMR is highly dependent on proper documentation and chart abstraction,[33,34] and it is possible that some of the differences observed are due to incomplete physician documentation. However, a more in-depth analysis of care processes will be required to clarify the observed trends.

Table 8. **Results of Generalized Linear Regression for Primary Outcomes by Case-Mix Group: Total Hospital Length of Stay**

	COPD (n = 11,404)			Heart Failure (n = 7680)			Pneumonia (n = 11,155)		
Parameter*	**B**	**SE**	**95% CI**	**B**	**SE**	**95% CI**	**B**	**SE**	**95% CI**
Intercept	0.774	0.372	0.701-0.847	0.839	0.573	0.727-0.951	1.028	0.314	0.966-1.089
Provider group (ref. Hospitalist)									
Family physician	–0.013	0.0137	–0.040 to 0.014	0.018	0.0176	–0.017 to 0.052	–0.029	0.0144	–0.057 to 0.000
Internal medicine	–0.111	0.0204	–0.151 to –0.071	–0.103	0.0203	–0.143 to –0.063	–0.168	0.0199	–0.207 to –0.129
Age	0.006	0.0004	0.005-0.006	0.005	0.0006	0.003-0.006	0.004	0.0003	0.003-0.005
Female	0.025	0.0094	0.006-0.043	0.020	0.0126	–0.005 to 0.045	0.022	0.0096	0.003-0.040
Comorbidity level	0.163	0.0062	0.150-0.175	0.172	0.0078	0.156-0.187	0.148	0.0057	0.137-0.159
Number of secondary diagnosis	0.015	0.0050	0.005-0.025	0.019	0.0043	0.010-0.027	0.023	0.0045	0.015-0.032
Conservable days	0.132	0.0016	0.129-0.135	0.110	0.0019	0.106-0.114	0.120	0.0016	0.117-0.123
RIW	0.166	0.0083	0.150-0.182	0.193	0.0112	0.171-0.215	0.149	0.0064	0.137-0.162
Discharge disposition (ref. Home)									
Transferred	–0.010	0.0203	–0.050 to 0.030	0.071	0.0238	0.025-0.118	0.035	0.0147	0.006-0.064
Died	–0.321	0.0227	–0.365 to –0.276	–0.258	0.0238	–0.305 to –0.211	–0.276	0.0174	–0.310 to –0.241
Signed-out	–0.534	0.0303	–0.593 to –0.475	–0.350	0.0510	–0.450 to –0.250	–0.343	0.0370	–0.416 to –0.271
Hospital type (ref. Teaching)									
Community, small	–0.026	0.0281	–0.081 to 0.029	0.026	0.0418	–0.056 to 0.108	–0.035	0.0289	–0.091 to 0.022
Community, medium	–0.051	0.0146	–0.079 to –0.022	–0.088	0.0196	–0.126 to –0.050	–0.072	0.0152	–0.101 to –0.042
Community, large	–0.027	0.0129	–0.052/ to 0.002	–0.022	0.0163	–0.054 to 0.010	–0.032	0.0134	–0.058 to –0.006
HSDA (ref. Fraser East)									
Fraser North	0.058	0.0160	0.027-0.090	0.003	0.0208	–0.038 to 0.044	0.050	0.0165	0.017-0.082
Fraser South	0.046	0.0186	0.009-0.082	0.018	0.0234	–0.028 to 0.064	0.042	0.0189	0.004-0.079
Palliative care	0.131	0.0397	0.054-0.209	0.095	0.0395	0.018-0.173	0.113	0.0291	0.056-0.170
SCU care	0.091	0.0239	0.044-0.138	0.039	0.0283	–0.017 to 0.094	0.044	0.0261	–0.007 to 0.096
Year of program (ref. 2012/13)									
2017-2018	–0.131	0.0166	–0.163 to –0.098	–0.070	0.0217	–0.113 to –0.027	–0.118	0.0172	0.117-0.123
2016-2017	–0.104	0.0163	–0.136 to –0.072	–0.028	0.0221	–0.071 to 0.015	–0.126	0.0172	–0.152 to –0.084
2015-2016	–0.122	0.0164	–0.154 to –0.090	–0.043	0.0218	–0.086 to 0.000	–0.118	0.0172	–0.159 to –0.092
2014-2015	–0.034	0.0158	–0.065 to –0.003	–0.018	0.0210	–0.059 to 0.023	–0.069	0.0164	–0.151 to –0.084
2013-2014	–0.005	0.0154	–0.035 to 0.025	0.022	0.0206	–0.019 to 0.062	–0.066	0.0162	–0.097 to –0.034

Note: Reference groups are identified in parentheses. Fiscal year starts April 1 and ends on March 31. Parameters estimated using maximum likelihood.
COPD, chronic obstructive pulmonary disease; HSDA, health service delivery area (geography); RIW, resource intensity weight; SCU, special care unit.
*Model used with gamma distribution and a log link.

Compared to hospitalists, patients cared for by FPs also had higher odds of readmission within 30 days, which is consistent with prior studies.[18,19] One of the criticisms of the hospitalist model has been the inherent discontinuity of care that is built into the model, which can contribute to suboptimal transitions of care between the acute and community settings.[35] The expectation is that FPs who admit their own patients do not face this challenge, and as a result their patients should be readmitted less frequently after discharge. Our data and those from previous studies do not support this hypothesis. At the same time, when we studied patients with specific clinical diagnoses, only those hospitalized for pneumonias continued to demonstrate higher readmission odds. This suggests that hospital readmission rate is a complex measure that may be influenced by a multitude of hospital and community

factors, and may be different for patients who present with different clinical diagnoses. Further research is required to better understand the relationship between provider type and experience with hospital readmission for patients with various clinical presentations.

Unlike the United States, where hospitalist care has been associated with reductions in LOS,[26,36] studies in the Canadian health care setting have shown mixed results.[17-21] In our evaluation, hospitalist care is not associated with reductions in total LOS compared to care provided by FPs or IM physicians. This could be due to a number of factors. First, unlike FPs, who know their patients, hospitalists may have a more conservative risk tolerance in discharging patients with whom they are not familiar. Similarly, physicians who have trained in IM may have a lower threshold for discharging patients than hospitalists, whose training background is mainly rooted in family medicine.[3] Second, discontinuity of care has been associated with longer LOS for hospitalized patients.[37,38] Hospitalists generally work for 7- to 10-day rotations. As a result, a patient may see a number of different hospitalists during the same hospital stay, which could nullify any gains in LOS that may be expected from better familiarity with hospital processes. Third, whereas a FP or an internist may only have a few inpatients under their care at any given time, each hospitalist typically cares for 17 to 22 patients every day. Increasing hospitalist workload has been shown to negatively impact LOS and may result in lower efficiency.[39] Finally, many patients in our health system who require more time to recuperate or need complex discharge planning are usually transferred to the care of the hospitalist service from other services, or are preferentially admitted to hospitalists from the emergency department. As a result, hospitalists may look after a disproportionately higher number of long-stay patients. Despite all this, hospitalists in our population perform similarly to FPs, regardless of the clinical diagnoses of hospitalized patients.

Our study has a number of notable limitations. First, we used administrative data to conduct our evaluation and could only control for factors that are available in our data systems. As a result, some potential confounders may not have been taken into consideration. For example, our databases do not contain provider characteristics (eg, age, years of clinical experience) that have been deemed to be relevant by White and Glazier.[26] Similarly, we did not have all the necessary information about the characteristics of the various MRP programs (eg, number of physicians involved in group practices, the schedule model of community FP call groups) and were not able to account for the potential impact of these on observed outcomes. Second, although our findings mirror prior studies from other parts of Canada, they may not be applicable to hospitalist programs in other jurisdictions or in health systems that are not regionalized or integrated. Third, our IM provider group is heterogeneous, with a number of different IM subspecialties (cardiologists, gastroenterologists, general internists) grouped under the IM category in our database. As a result, comparisons between the IM provider group and the other 2 provider groups, which are more homogenous, should be interpreted with caution.

Finally, we included only patients admitted to facilities in which a hospitalist service existed during the study period. As a result, a medium-size community hospital without a hospitalist service where patients are cared for exclusively by FPs and IM physicians was not included in the comparisons, and in 4 of the 10 facilities included, the number of FP patients was less than 10% of total hospitalized patients at the site (Appendix A). This may have resulted in an under-representation of FP patients.

Conclusion

Debates about the merits of the hospitalist model in Canada continue, and are in part fueled by a paucity of robust evidence about its impact on care outcomes compared to more traditional ways of providing inpatient care. In our evaluation, care provided by hospitalists is associated with lower mortality and readmission rates, despite similar LOS compared with FPs. Hospitalist care is also associated with lower mortality compared to IM providers. Hospitalists also demonstrated progressive improvement over time, with decreasing LOS and mortality rates and a stable readmission rate. Our results suggest that physicians with a focus on inpatient care can have positive contributions to quality and efficiency of care in Canada.

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Appendix. Methodological Notes

Fraser Health

Fraser Health (FH) is the largest Health Authority in British Columbia. It provides a range of services to a population of 1.8 million people, spanning public health, community services, mental health and addictions services, long-term care, primary care, and acute care.

FH Hospitalist Program Operational Attributes

Each local hospitalist service is largely autonomous operationally, with a Local Department Head (LDH) who is responsible for recruitment of staff, participation in local site committees, and collaborating with the local hospital administration and other physician departments to ensure service delivery to unattached patients. The LDH reports to the Regional Department Head of Hospital Medicine. The LDH also ensures 24-7 coverage of all available shifts by hospitalists, scheduling of physicians working at the site, quality assurance activities (such as Morbidity and Mortality rounds, maintenance of competencies) and credentialing of medical staff. In most sites, many of these responsibilities are delegated to other department members, with a distributed leadership model that aims to promote group cohesiveness and teamwork among hospitalists. Since each of these acute care facilities is unique in terms of availability of clinical and support services and the population it serves, the scope of clinical conditions that hospitalists are responsible for can vary from site to site. Generally, however, hospitalists act as the most responsible physician (MRP) for unattached patients presenting with general medical conditions (eg, pneumonia, congestive heart failure), patients with nonoperative surgical diagnoses (eg, nonoperative bowel obstruction, pelvic fractures) and patients requiring inpatient rehabilitation (eg, stroke). In some facilities, hospitalists also provide supportive care to other physician groups (eg, orthopedics, psychiatry) in a co-management model.

Additionally, all hospitalists working in FH are members of the Regional Department of Hospital Medicine, with uniform credentialing requirements, expectations around competencies and quality of care, and adherence to the Medical Staff Rules. The Regional Department Head is ultimately responsible to ensure adequate staffing at all the sites, privileging of physicians, quality assurance and performance reviews, responding to complaints and investigating quality of care concerns, appropriate disciplinary actions when necessary, and a coordinated approach to quality improvement (QI) and delivery of standards of care. While department members at each site are involved in various local QI and system redesign projects, many are also involved in regional initiatives coordinated by the Regional Department staff and supported by the central program management team.

At the same time, all FH hospitalist services are operated centrally by a dedicated management team as part of a regional program. This team provides support to the local site-based services (eg, administrative support, billing submissions, staff orientation) as well as oversight of

Type of Hospital	No. of Funded Acute Beds*	HM Program Inception Date	Average Daily Hospitalist Census*	No. of Full-Time Equivalents**
Teaching	624	January 2001	352	62.14
Teaching	402	November 2001	136	22.81
Large community	257	July 2016	126	21.07
Large community	259	January 2001	150	28.24
Large community	188	April 2005***	116	18.90
Large community	171	September 2012	88	13.69
Medium community	173	October 2001	170	26.29
Medium community	157	November 2002	122	16.73
Medium community	58	November 2002	64	7.81
Small community	45	December 2016	28	4.13

* As of December 9, 2018.

** As of March 1, 2018, defined as 1680 hours of work annually.

*** Program underwent a 6-month hiatus between June 6, 2016 to January 2, 2017, during which time it was replaced by an FP model.

Number of Hospitalization Episodes Included in Stages of Data Analysis

Inclusions/Exclusions	Outcome Measure	n
Original data		248,412
Inclusion: • Patients admitted and discharged by the same physician type in the following list: Hospitalist, FP, or IM • Patients visits to a hospital with a hospitalist program • Patients with a visit between FY2012/13 to FY2017/18 (April 1, 2012 - March 31, 2018)		
Exclusion: • Patients aged < 18 yr • Patients admitted for pregnancy or childbirth reasons • Patients with a transfer in or out of a hospital • Patients who did not return from pass		
Excluding 3 facilities without hospitalist services		240,158 (96.7%)
Excluding 3 facilities without hospitalist services Excluding patients with home address outside of FH	All	224,214 (90.3%)
Excluding 3 facilities without hospitalist services Excluding patients with home address outside of FH	LOS	183,779 (73.9%)
Excluding long-stay patients and transfers	Mortality	
Excluding 3 facilities without hospitalist services Excluding patients with home address outside of FH Excluding long-stay patients and transfers Excluding patients who died in hospital	Readmission	166,042 (66.8%)

Demographic and Clinical Characteristics by Provider Group and Hospital Site/Facility (n = 224,214)

	FP		IM		Hosp	
	n = 61604		n = 35200		n = 127410	
	n	%	n	%	n	%
Facility/Hospital Type						
Teaching	3410	5.50	1078	3.10	19326	15.20
Teaching	1877	3.00	14760	41.90	17490	13.70
Large Community	23630	38.40	4425	12.60	6364	5.00
Large Community	1877	3.00	4149	11.80	15917	12.50
Large Community	9189	14.90	3494	9.90	12012	9.40
Large Community	11261	18.30	883	2.50	13317	10.50
Medium Community	368	0.60	2845	8.10	19158	15.00
Medium Community	1042	1.70	2367	6.70	14475	11.40
Medium Community	1797	2.90	1199	3.40	8308	6.50
Small Community	7153	11.60	0	0	1043	0.80

a uniform contract between the health authority and the contracted physicians. The program management team monitors workload at each site, using a workload model that aims to quantify the hours of physician time needed to provide services to an average number of patients. The management team adjusts funding accordingly in response to sustained trends in workload.

Data Source and Linkage

Data were extracted and cross-referenced from 2 databases that collectively contain a large number of clinical and provider attributes for each hospitalization episode. The Med2020 WinRecs database (Ottawa, Ontario) is a Health Information Management system used by FH for abstracting and coding of medical charts for acute care

Data Points Available in Our Data Systems

We developed a list of variables identified by White and Glazier and cross-referenced their availability through our various data systems. The following table summarizes the variables that we could extract from our databases.

Patient Need & Demographics	Inpatient Care Model		Outcomes of Care		Physician Characteristics
	Institutional Characteristics	Clinical Processes	Operating Efficiency	Clinical Outcomes of Treatment	
Age	Hospital type/size/location	ICU days	Length of stay	Mortality	Medical Specialization
Gender		Palliative care	ALOS:ELOS	Readmissions/return to ED	
Insurance status			Conservable bed days	Discharge disposition	
Geography of residence			Resource intensity weight		
Major clinical category					
Number of secondary diagnoses					

hospitalizations. It includes a wide array of clinical information, such as diagnoses, patient demographics, comorbidity levels and resource-intensity weight. This database feeds into the Discharge Abstract Database maintained by the Canadian Institute for Health Information (CIHI) that collects standardized data from across Canada. FH also utilizes the Meditech electronic medical record system (Westwood, Massachusetts) to manage day-to-day medical records keeping and clinical documentation.

Attending physicians are identified by a distinct code in the Meditech provider dictionary based on their specialty and work characteristics. This information is kept updated by the health informatics department through cross-referencing of a number of data sources, including credentialing information from the Medical Affairs department and data from the College of Physicians and Surgeons of British Columbia (the licensing authority for physicians in the province). Patients admitted to the hospitalist service have their attending physician coded as HOSP. Similarly, the MRP service is tagged as GENP in Meditech if a patient is admitted to their own family physician (or the GP's call group), while patients admitted under the care of an internal medicine provider are coded as INTM. The latter provider group is heterogenous and includes both general internists (GIM) as well as other internal medicine subspecialists (such as cardiologists). In order to assign a patient to each of the study groups, we cross-referenced data between the 2 databases using the patient's unique Personal Health Number. Each hospitalization episode in the Med2020 WinRecs database was linked to the corresponding episode in Meditech, allowing us to assign that hospital stay to 1 of the 3 provider groups.