Increasing Value for Money in the Canadian Healthcare System: New Findings on the Contribution of Primary Care Services

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Abstract

This article presents a major new finding in regard to the value for money of primary care services. It was found that the more higher-care-needs patients were attached to a primary care practice, the lower the costs were for the overall healthcare system (for the total of medical services, hospital services and drugs). The majority of the cost reductions stemmed from decreases in the costs of hospital services. Thus, for higher-care-needs patients, it appears that the nature of the physician-patient relationship is related to reductions in hospital costs. For example, for very-high-care-needs diabetic patients, the average annual hospital cost in fiscal 2007–2008 for those in the lowest attachment group was $16,988, whereas the hospital costs for those in the highest attachment group was $5,909. The results obtained were even more striking for patients with congestive heart failure. A series of multiple regression analyses were conducted, and the results were very consistent: attachment to practice was the best predictor in regard to cost and was a more significant predictor than other variables that were related to healthcare costs, such as age. These findings support the general literature on the benefits of primary care and the continuity of care.

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Family practice in British Columbia was in decline in the 1990s. In order to reverse this trend, the British Columbia Ministry of Health Services and the British Columbia Medical Association agreed to collaborate to support family physicians in the province. One of the main initiatives in this regard was the establishment of the General Practice Services Committee (GPSC) in 2002. GPSC was given the mandate "of finding solutions to support and sustain full service family practice in British Columbia" (GPSC 2008: 1). GPSC is a joint committee of the BC Ministry of Health Services, the BC Medical Association and the Society of General Practitioners of BC. Members of the BC Primary Health Care Council (i.e., representatives of BC's health authorities) also attend as guests. GPSC engages in a number of activities to support general practitioners. (For an overview of GPSC activities, see the 2007–2008 annual report [GPSC 2008].) GPSC's operational funding and mandate are based on a formal working agreement between the BC government and the British Columbia Medical Association. One of the stipulations in the working agreement is that GPSC's activities be evaluated.

Given that GPSC was established to support family practice, a basic evaluation question was whether or not full-service family practice constitutes a wise investment of funds in British Columbia. While there is a general literature on the benefits of primary care, an analysis of this specific question was undertaken as part of the broader evaluation of GPSC activities. The overall finding of this evaluation was that there is a clear inverse relationship between the level of attachment to a primary care practice and costs, for higher-care-needs patients. Thus, the more patients go to the same practice, the lower the overall annual costs are to the healthcare system. This is a significant finding and is discussed in more detail in this article.

Literature Scan

The benefits of primary care have been well documented. For example, Barbara Starfield, in her book titled *Primary Care: Balancing Health Needs, Services and Technology* (Starfield 1998) discussed primary care in regard to morbidity, quality, population health, health systems and international health. She and her colleagues have noted that primary care is an international phenomenon and that the countries with poor primary care services, on average, have poorer health outcomes (Starfield 2000). Macinko, Starfield and Erinosho (2009) assessed 36 peer-reviewed studies on the impact of primary care on health outcomes in low- and middle-income countries. The authors found that much of the evidence on the effectiveness of primary care is focused on infant and child health. They also found that there is evidence from the international literature that primary care has a positive impact on population health (Macinko et al. 2009). In an editorial, Phillips and Starfield (2004) summarized the literature on primary care and noted that there are more than two decades of evidence around the effectiveness, efficiency and equity of primary care.

The benefits of primary care have also been noted by other authors. Atun (2004), in a World Health Organization monograph, stated, "The available evidence confirms improved population health outcomes and equity, more appropriate utilization of services, user satisfaction and lower costs in health systems with a strong primary care orientation." (Atun 2004: 10). Other writers, in the United States, have noted that primary care physicians deliver a "disproportionate share of ambulatory care services to disadvantaged populations" (Ferrer 2007: 492) and that increased proportions of primary care physicians were associated with decreased health services use in the 1990s (Kravet et al. 2008). Ferrer and colleagues outlined the mechanisms that make primary care successful when they state that "primary care improves healthcare system functioning through such services as managing and triaging undifferentiated symptoms, matching patient needs to healthcare resources, and enhancing the systems ability to adapt to new circumstances" (Ferrer et al. 2005: 691).

Recently, Starfield discussed the importance of continuity of care across different levels of care, such as general practitioners (GPs) and specialists (Starfield 2003; Starfield et al. 2009), and

she and her colleagues pointed out that if there is a discontinuity of primary care, patients may see more specialists, which increases costs (Starfield et al. 2009). The issue of primary care patients and specialists has also been noted by Atun (2004), who stated that systems that rely more on primary care doctors than on specialists as the main source of physician care have better health outcomes; improved equity, access and continuity; and lower costs.

Starfield has also discussed the concept of the continuity, or longitudinality, of the care relationship between care providers and patients, and provided examples of studies that indicate that improved satisfaction, and reduced costs, are related to the longitudinality of the practitioner-patient relationship. Starfield, Shi and Macinko (2005) noted the benefits of an ongoing relationship between a patient and a particular provider, rather than with a particular place such as a hospital walk-in clinic.

In addition to the literature on primary care, the importance of the continuity of care between a care provider and his or her patients has also been noted. As discussed above, this is an important theme in the writings of Starfield (who refers to this concept as longitudinality). Haggerty and colleagues (2003) referred to three types of continuity: informational, management and relational continuity. Relational continuity is similar to the continuity of provider and longitudinality. All three terms refer to the ongoing relationship between care providers and their patients (Haggerty et al. 2008). Atlas and colleagues (2009) noted that patients who have an ongoing relationship with their care provider are more likely to consistently receive guidelines-based care. Guthrie and colleagues (2008) stressed the importance of continuity of care and noted that patients are more satisfied when they regularly see the same doctor.

Thus, the literature seems to support the benefits of primary care and a continuous relationship with one's provider. Nevertheless, there is a relatively modest literature on the economic consequences of the continuity of care, particularly in regard to adults with chronic conditions. Perhaps the closest analysis to that presented in this article is provided by Raddish, Horn and Sharkey (1999). These authors examined the association between provider continuity and costs. While they only included hospital visits, instead of hospital costs, the authors concluded that continuity of care "was associated with a reduction in resource utilization and costs" (Raddish et al. 1999: 727). Sans-Corrales and colleagues (2006) conducted a systematic review on the relationship between family medicine attributes and satisfaction, health and costs. They found that continuity of care was related to lower costs. Kronman and colleagues (2008), in an end of life study, found that having more primary care visits at the end of life was associated with fewer hospital days. Forrest and Starfield (1996) conducted a study of "first contact care." They found that care episodes that began with a visit to an individual's family doctor were associated with a 50% reduction in ambulatory episode-of-care expenditures.

There are also two Canadian studies on this topic. Menec and colleagues (2006) found that greater continuity of care with a family physician was associated with reduced "ambulatory care-sensitive hospitalizations" (Menec at al. 2006: 196). Finally, Ionescu-Ittu and colleagues (2007) found that "after adjusting for age, sex and co-morbidity … an increased rate of emergency department use was associated with a lack of a primary physician." (Ionescu-Ittu et al. 2007: 1362).

In this study, attachment to practice is consistently inversely related to the total cost of care for both diabetes and CHF for higher-care-needs patients.

Methods

In order to evaluate the question of the value for money of primary care, several steps and a wide range of analyses were undertaken. The first issue was to consider the nature of the attachment. Barbara Starfield has noted the distinction between attachment to a particular provider versus attachment to the place where care is provided. We conducted analyses based on attachment to a provider, based on the unique provider number of the GP, and attachment to a practice, defined as a payee number. The payee number denotes the organization to which funds are sent to reimburse GPs. Thus, in a solo practice, the GP would have one practitioner number and one payee number. In a group practice or drop-in clinic, each GP would have his or her own practitioner number, but the overall clinic may have one payee number. In such a case, funds would be sent to the provider organization (the payee) and would be disbursed to the individual practitioners, as appropriate.

For purposes of this article, the percentage of attachment is the percentage of GP services provided by the *practice* that provides the most services in one year. For example, if a patient receives four services from the same GP (in a solo practice) in one year and goes to four other "practices" once each (e.g., four separate drop-in clinics) receiving one service each time, the attachment to the main practice (i.e., the practice of the solo GP) would be 50% (four out of eight GP services).

It was found in the BC context that primary care services are mainly provided by solo GPs or through small to medium-sized group practices. The consequence of this was that using attachment to a particular GP would underestimate the level of attachment that a patient had to his or her physician. For example, if a patient received five services in one year from the same GP, the attachment would be 100%. However, if one service in the spring and one service in the fall were covered by locums filling in for the main GP, the main GP would have an attachment of

60% (three of five services), but the attachment to the practice would be 100% as the practice would be considered as having three practitioners, the main GP and the two locums. Given the fact that the large majority of GPs operate in practices of nine or fewer GPs (including locums), it seemed that the appropriate analysis should be on the primary care practice rather than the provider per se. For example, with regard to patients at RUBs 3–5 (see the explanation of RUBs below) who had diabetes, 95% of the GPs who saw these patients worked in practices with nine or fewer practitioners, and they saw some 88% of the patients. Thus, our resolution of the practitioner versus place dichotomy was to consider "attachment" as attachment to a practitioner "in the context of his or her practice."

Given that our analyses indicated that the relationships between attachment to practice and costs primarily applied to higher-care-needs individuals, we needed a validated measure of co-morbidities or care need. The BC Ministry of Health Services uses version seven of the classification system developed by Johns Hopkins University. The main groupings in this system are adjusted clinical groups (ACGs), which can be rolled up into broader groupings called resource utilization bands (RUBs). The ACGs are clinical groupings that incorporate age, gender and the number and type of different diagnostic conditions the patient has. Starfield has stated that the ACG system "takes all diagnoses made on each individual in a year and combines them in such a way as to provide a 'burden of morbidity' pattern unique to each individual" (Starfield 2001: 308). The RUBs are broader aggregates of ACGs and range from non-users (RUB 0) to a category of very high resource users (RUB 5). (The interested reader is referred to the John Hopkins website at http://www.acg.jhsph.edu/html/AboutACGs.htm for a more detailed explanation of this system.) This system is in wide use not only in the United States but also internationally (Halling et al. 2006; Lee 2008; Reid et al. 1999; Sicras-Mainar et al. 2007, 2009).

Our analyses indicated that the inverse relationship between attachment to practice and cost did not hold for RUBs 0, 1 and 2. There was a relatively modest relationship at RUB 3 (the moderate resource use category) and a strong relationship for RUBs 4 and 5 (the high and very high resource use groups). In conducting more in-depth analyses, it was found that most of the cost reductions for highly attached individuals related to hospital use. Thus, seeing a primary care practitioner on a regular basis seemed to be related to lower hospital use and, thus, lower costs. There was also a modest reduction in the use, and costs, of medical services (i.e., all medical claims paid by the BC Medical Services Plan) for people in RUBs 4 and 5 who had a higher level of attachment to practice.

In this article, we present data on attachment to practice and costs for persons in RUBs 4 and 5 with diabetes. To further validate the results, we also conducted parallel analyses on another health condition, congestive heart failure (CHF). British Columbia has registries for people who are believed to have diabetes and CHF. Thus, the registries served as our original universe of people whom we considered for our analysis. For both sets of analyses, we present data on RUBs 4 and 5 patients separately. This controls for co-morbidities as each RUB group has people with similar levels of care need. We also analyzed the data by the most frequent ACG groups, which have less internal variability than the RUB groupings.

As we were conducting an analysis of community-based primary care services, we used a number of selection criteria in regard to who would and would not be included in the analysis. The selection criteria and their rationales were as follows:

1. **RUBs 4 and 5:** Given our previous analysis, we only included patients on the registries who were classified as RUBs 4 and 5.
2. **Residential long-term care:** As this was an analysis of community-based primary care, we excluded patients who were residential long-term care patients at the end of the 2006–2007 fiscal year.
3. **A minimum of five GP services:** Given that people are generally not removed from registries and that their health condition may vary over time (e.g., type 2 diabetics who are able to control their diabetes with diet and exercise), we wanted to include people who were active patients. Thus, we only included patients who received five or more GP *services* in one year. Patients could have more than one service during one visit with their GP. Thus, in one visit, a patient could have a GP deal with two different kinds of problems, such as an examination of his or her sore foot (one service) and the suture of a hand laceration (the second service). In addition, we did not wish to classify a person with one visit as having a 100% level of attachment. Thus, some degree of differentiation was required. This criterion excluded a relatively small percentage of people with diabetes or CHF at RUB 4 (10% and 9%, respectively) and RUB 5 (5% and 3%, respectively).
4. **People who died:** We excluded people who died in fiscal 2007–2008 (the year for which data were analyzed) as patients who die typically have high healthcare costs during the last three to six months of life, and this could distort the findings.
5. **Hospital costs greater than $100,000:** As this was an analysis of community-dwelling patients, we excluded people who were in hospital for significant portions of the year. The $100,000 cut-off would exclude most people who spent more than 100–120 days per year in hospital. At the same time, we also wished to recognize that some high-care-needs patients may have multiple hospital visits during a year and should be included in the analysis.
6. **Patients with visits to more than 25 payees:** There were some patients who saw a large number of GPs. We inspected the distribution of payee numbers per patient and found that

the distribution began to tail off at the 25 payees per year mark. Thus, these outliers were excluded. Nevertheless, we did want to recognize that patients with high care needs may well see a large number of GPs, particularly if they do not have a family doctor, as they may go to a range of drop-in clinics, see GPs working in emergency departments or see GPs working as hospitalists if they have one or more hospital admissions during the year.

With regard to costing and data analysis, the costs of medical services were primarily based on fee-for-service billings for GPs, specialists and diagnostic services (using the billing claims database). For claims submitted to the Medical Services Plan from GPs with a method of payment other than fee-for-service, an estimated cost *per service* was calculated based on the average cost for fee-for-service GPs. Drug data were obtained from the Pharmacare database and reflect the costs to government. Given that medical costs and drug costs are derived from actual payments by government to providers, it is believed that these data are quite accurate. With regard to hospital costs, the BC Ministry of Health Services uses a cost per resource intensity weight (RIW; an estimate of resource use for a given hospital stay) of $4,550. Thus, RIWs were multiplied by $4,550 to obtain the estimated annual hospital cost per year. For hospital stays that started in one year and ended in a subsequent year, the costs in fiscal 2007–2008 were pro-rated. Thus, if a patient started a stay of 10 days in fiscal 2006–2007 and concluded the stay in fiscal 2007–2008, and if the patient was in hospital for five days each year, half of the cost of the stay was attributed to fiscal 2007–2008. Similarly, if a patient started a hospital stay in 2007–2008 and finished in 2008–2009, and was in hospital for five days each year, half of the hospital cost for that stay would be attributed to fiscal 2007–2008.

While the inverse relationship between attachment and costs was clearly significant, it could nevertheless be the case that this was a spurious relationship. For example, it may be that age is a more significant predictor of cost than attachment. Thus, a more complex set of multivariate analyses were undertaken to look at the impact of attachment to practice on costs, in conjunction with a number of other variables that could also have an impact on costs. Stepwise or sequential multiple regression analyses were conducted to more clearly determine which independent variables are related to total costs (defined as the sum of medical costs, drug costs and hospital costs).

The independent variables included in the analyses were as follows:

- Percentage attachment to practice (continuous variable)
- Age of patient (continuous variable); there were three patients with an unspecified age, and they were excluded from the analyses
- Gender of patient (a dichotomous variable of male or female)
- Location of patient (a dichotomous variable of urban or rural)
- Patient's 2006 median after-tax family income based on the average for the local community, that is, the Canada Post forward sortation area (a continuous variable)
- Practice span (the length of time the GP had been in practice up to and including the 2007–2008 fiscal year)
- Gender of the practitioner (a dichotomous variable of male or female); there were 26 GPs in the RUB 4 analysis and 18 GPs in the RUB 5 analysis with an unspecified gender – these GPs and their patients were excluded from the analyses
- Number of payee numbers a GP has (a continuous variable)
- Place of graduation of a GP (a dichotomous variable of Canada or outside Canada)
- Full-time equivalent (FTE) factor (this is calculated based on annual income and can include part-time GPs [FTE factor <1] and GPs who work more than the average [FTE factor >1], a continuous variable).

With regard to the physician-related variables noted above, we identified the GP who provided the most services to the patient, in the practice with the most overall services, and used the characteristics of that GP in our analyses. The GP characteristics were obtained from the Practitioner Profiles database.

Findings

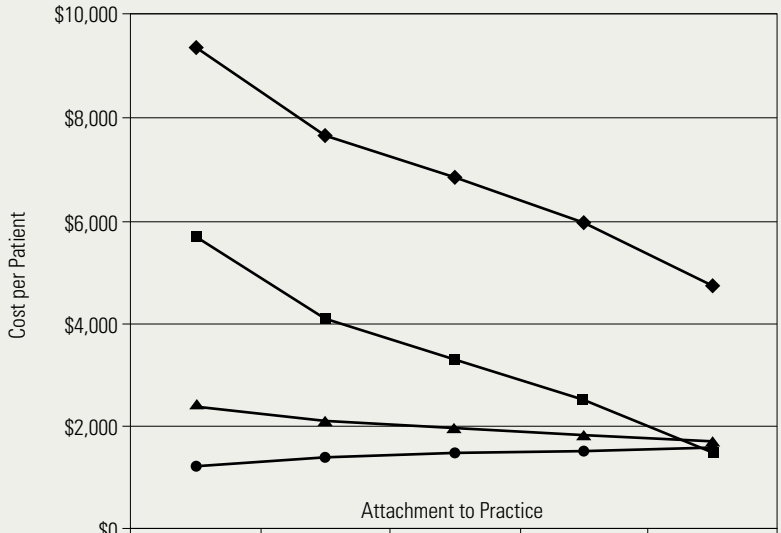
Our major overall finding, as we report below, is that as attachment to practice increases, the total cost of care decreases. We examined this relationship for both patients with diabetes and those with CHF and report the findings separately for both RUBs 4 and 5 for each type of illness. Because RUBs are fairly broad aggregates, we also conducted parallel analyses on the most common ACGs. The statistical analyses were done in two ways. First, we examined the relationship between attachment to practice and the total costs of care using (bivariate) correlation coefficients. However, because other patient and physician variables are likely to be related to cost as well, we then tested the relationship between attachment to practice and total cost in the context of these other variables using multiple regression analyses.

Cost of Diabetes

The various types of costs per diabetic patient across increasing levels of attachment to practice are shown in Figure 1. The total cost per patient decreases with the patient's increasing attachment to practice, in both RUBs 4 and 5. This decrease seems to be primarily due to the decrease in hospital costs and, to a more modest degree, medical costs (GPs, specialists and diagnostic services). Pharmacare costs per patient are considerably smaller and do not seem to be related to the patient's attachment to practice. With regard to the literature on the continuity of

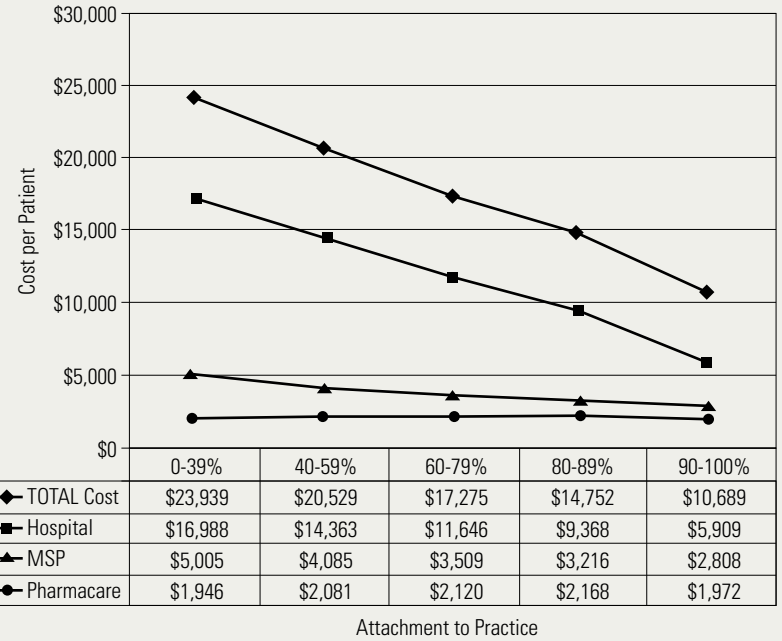
Figure 1. Various costs per patient as a function of attachment to practice, for diabetes RUBs 4 and 5: fiscal 2007–2008

Diabetes, RUB 4



	0-39%	40-59%	60-79%	80-89%	90-100%
TOTAL Cost	$9,380	$7,689	$6,863	$5,981	$4,754
Hospital	$5,702	$4,127	$3,333	$2,556	$1,513
MSP	$2,426	$2,154	$2,026	$1,888	$1,702
Pharmacare	$1,252	$1,408	$1,504	$1,537	$1,538

Diabetes, RUB 5



	0-39%	40-59%	60-79%	80-89%	90-100%
TOTAL Cost	$23,939	$20,529	$17,275	$14,752	$10,689
Hospital	$16,988	$14,363	$11,646	$9,368	$5,909
MSP	$5,005	$4,085	$3,509	$3,216	$2,808
Pharmacare	$1,946	$2,081	$2,120	$2,168	$1,972

MSP = Medical Services Plan; RUB = resource utilization band.

Source: British Columbia Ministry of Health Services, Primary Care Data Repository, June 2009.

care between GPs and specialists noted above, we found, in a separate analysis not shown here, that the higher the attachment was to a primary care practice, the lower the costs were for GPs and specialists. Thus, lower attachment to practice was related to higher specialist costs. This is consistent with the findings in the literature. However, there was not an inverse relationship between attachment to practice and the costs of diagnostic services.

Table 1 presents the results from our statistical analyses. For each RUB and specific ACG subsample, the relationship between the total cost of care and each diabetic patient and physician variable alone is given by the correlation coefficient ("*r* with Total Cost") in the first column. The results of the regression analyses where the influences on the total cost of all variables are considered together are presented in the second column ("B Estimate"). The footnotes in Table 1 also contain additional information from the regression analyses and provide the best predictors of the total cost of care and model fit statistics.

A correlation coefficient gives the strength and direction of a relationship between two variables; a correlation of zero indicates no relationship. The closer the coefficient is to 1.0 or –1.0, the stronger the relationship is (a negative correlation indicates an inverse relationship where higher values on one variable are associated with lower values on the second variable). In all five RUB and ACG cases summarized in Table 1, we can see that attachment to practice has the largest correlation with total cost (ranging from –.179 for RUB 4 to –.282 for RUB 5), indicating an inverse relationship,

Table 1. Diabetes: correlations (*r*) and regression coefficients (B estimates) between total cost and cost-related variables: fiscal 2007–2008

	RUB 4[1] (*n* = 40,483)		RUB 4, ACG 4920[2] (*n* = 20,842)		RUB 5[3] (*n* = 22,557)		RUB 5, ACG 4930[4] (*n* = 7,892)		RUB 5, ACG 5070[5] (*n* = 6,809)	
Variable	***r* with Total Cost**	**B Estimate (*SE*)[6]**	***r* with Total Cost**	**B Estimate (*SE*)**	***r* with Total Cost**	**B Estimate (*SE*)**	***r* with Total Cost**	**B Estimate (*SE*)**	***r* with Total Cost**	**B Estimate (*SE*)**
Attachment to practice	–.179**	–81.6** (2.06)	–.178**	–79.7** (2.93)	–.282**	–268.1** (6.13)	–.275**	–173.4** (6.70)	–.217**	–255.9** (14.14)
Patient age	.054**	50.9** (2.61)	.067**	56.3** (4.34)	.004	47.5** (9.44)	.017	42.3** (10.7)	–.036	–
Patient gender	–.040**	–513.5** (77.91)	–.037**	–423.8** (108.37)	–.021**	–	–.023*	–	–.006	–
Patient location	–.035**	–	–.034**	–	–.013*	–	–.034**	–	–.008	–
Patient income	–.041**	–0.032** (0.004)	–.048**	–.035** (0.006)	–.016*	–.033* (0.013)	–.008	–	–.018	–
Physician FTE factor	–.024**	–	–.034**	–395.8* (149.2)	–.036**	–	–.037**	–	–.037**	–
Physician gender	.004	261.4* (99.60)	.008	511.1** (147.2)	.010	–	–.022*	–	–.005	–
Physician practice span	–.014*	–	–.005	–	–.029**	–	–.020*	–	–.026*	–
Number of physician payee numbers	.018**	–	.013*	–	.068**	251.7** (41.8)	–.017	–	.063**	336.4** (88.5)
Physician place of graduation	.010*	344.72** (80.14)	.007	226.0* (112.5)	.016*	1193.5** (255.3)	.023*	913.4** (268.7)	.020	1483.1* (592.1)

ACG = adjusted clinical group; FTE = full-time equivalent; RUB = resource utilization band; *SE* = standard error.

*$p < .05$; **$p < .001$.

[1] The predictors, in order of importance, were attachment to practice, patient age, patient median income, patient gender, physician place of graduation and physician gender. For this model, $R^2 = .044$, $F(6, 40,476) = 309.99$, $p < .001$.

[2] The predictors, in order of importance, were attachment to practice, patient age, patient median income, patient gender, physician gender, physician FTE factor and physician place of graduation. For this model, $R^2 = .043$, $F(7, 20,834) = 134.74$, $p < .001$.

[3] The predictors, in order of importance, were attachment to practice, number of physician payee numbers, patient age, physician place of graduation and patient median income. For this model, $R^2 = .083$, $F(5, 22,551) = 409.75$, $p < .001$.

[4] The predictors, in order of importance, were attachment to practice, patient age and physician place of graduation. For this model, $R^2 = .079$, $F(3, 7,888) = 225.27$, $p < .001$.

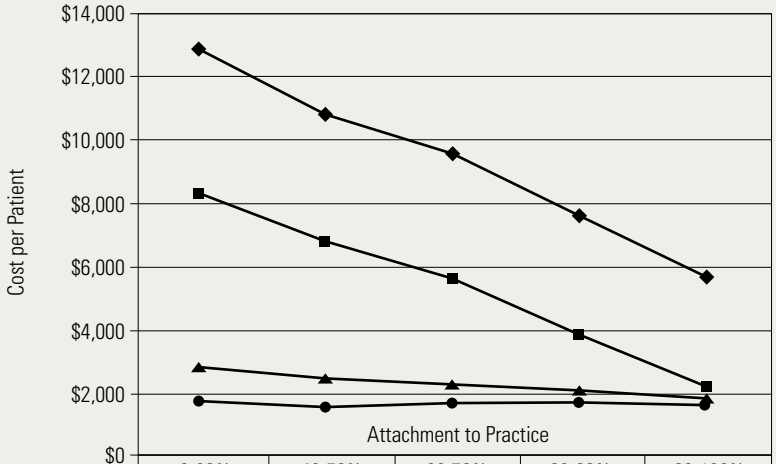
[5] The predictors, in order of importance, were attachment to practice, number of physician payee numbers and physician place of graduation. For this model, $R^2 = .050$, $F(3, 6,805) = 119.65$, $p < .001$.

[6] These regression coefficients B, and their standard errors of estimate (*SE*s), were obtained from a sequential multiple regression analysis, and a dash in this column indicates a non-contributing predictor variable in the final best-fitting regression model.

Source: British Columbia Ministry of Health Services, Primary Care Data Repository, June 2009.

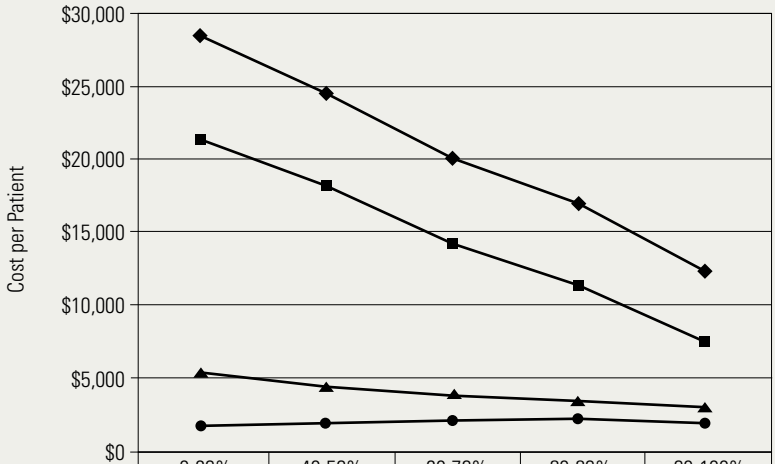
Figure 2. Various costs per patient as a function of attachment to practice, for congestive heart failure RUBs 4 and 5: fiscal 2007–2008

CHF, RUB 4



	0-39%	40-59%	60-79%	80-89%	90-100%
TOTAL Cost	$12,894	$10,842	$9,578	$7,625	$5,682
Hospital	$8,320	$6,794	$5,633	$3,859	$2,204
MSP	$2,828	$2,485	$2,284	$2,058	$1,852
Pharmacare	$1,747	$1,562	$1,660	$1,708	$1,625

CHF, RUB 5



	0-39%	40-59%	60-79%	80-89%	90-100%
TOTAL Cost	$28,423	$24,471	$19,990	$16,888	$12,309
Hospital	$21,293	$18,149	$14,162	$11,319	$7,507
MSP	$5,403	$4,417	$3,777	$3,405	$2,948
Pharmacare	$1,727	$1,906	$2,050	$2,164	$1,854

CHF = congestive heart failure; MSP = Medical Services Plan; RUB = resource utilization band.
Source: British Columbia Ministry of Health Services, Primary Care Data Repository, June 2009.

such that an increase in a patient's attachment to practice is associated with a decrease in his or her total cost of care.

In Table 1, we can see the negative, albeit small, correlations of total cost with patient gender, location and median annual income, which indicate that the costs are lower for (1) women, (2) urban patients and (3) patients with higher median incomes. There was a positive correlation between patient age and total cost for RUB 4 but not RUB 5. For the physician variables, lower total costs per patient are related to (1) physicians with a higher FTE factor, (2) a greater practice span (negative correlation), (3) lower number of payees numbers and (4) in some samples, GPs trained in Canada.

Next, to examine whether the relationship of attachment to practice with the total cost of care holds when all the cost-related variables are considered together, we report results from sequential regression analyses. In this type of analysis, the variables are entered into the regression model one at a time (based on the statistical strength of the relationship between the predictor variables and the dependent variable, which is total cost in our case). The first predictor variable chosen is the one that is most strongly related to the dependent variable. Predictor variables continue to be added to the model, in descending order of their strength of relationship with total cost, until the ones remaining (if any) no longer contribute significantly over and above those variables already in the model. Therefore, the order in which a predictor is selected to be in the model indicates the relative importance of that variable to the predic-

Table 2. Congestive heart failure: correlations (*r*) and regression coefficients (B estimates) between total cost and cost-related variables: fiscal 2007–2008

Variable	RUB 4[1] (*n* = 18,697)		RUB 4, ACG 4920[2] (*n* = 10,593)		RUB 5[3] (*n* = 16,299)		RUB 5, ACG 4930[4] (*n* = 5,166)		RUB 5, ACG 5070[5] (*n* = 5,670)	
	r with Total Cost	B Estimate (*SE*)	*r* with Total Cost	B Estimate (*SE*)	*r* with Total Cost	B Estimate (*SE*)	*r* with Total Cost	B Estimate (*SE*)	*r* with Total Cost	B Estimate (*SE*)
Attachment to practice	–.238**	–124.0** (3.80)	–.222**	–112.3** (4.82)	–.316**	–323.4** (7.80)	–.299**	–208.0** (9.32)	–.255**	–302.2** (15.72)
Patient age	–.022**	–	–.016	–	–.093**	–141.9** (13.1)	–.070**	–60.5** (15.38)	–.142**	–274.5** (26.5)
Patient gender	–.051**	–779.8** (136.4)	–.026*	–348.8* (108.4)	–.012	–	–.007	–	.003	–
Patient location	–.023**	–	–.029**	–	–.023	1140.8* (400.0)	–.017	–	.007	–
Patient income	–.038**	–.033** (0.007)	–.052**	–.044** (0.009)	–.021*	–.039* (0.016)	–.024*	–	–.033*	–
Physician FTE factor	–.018*	388.8* (194.4)	–.013	–	–.035**	–	–.033*	–	–.035*	–
Physician gender	–.016*	–	.002	–	–.017*	–	–.003	–	–.006	–
Physician practice span	–.025**	–	–.018*	–	–.024**	–	–.023*	–	–.010	–
Number of physician payee numbers	.048**	68.4* (25.6)	.038**	–	.070**	232.0** (52.0)	.047**	–	.066**	371.1** (99.8)
Physician place of graduation	.003	352.2* (145.1)	–.005	–	.025**	1556.9* (324.8)	.001	–	.035*	2484.2** (648.3)

ACG = adjusted clinical group; FTE = full-time equivalent; RUB = resource utilization band; *SE* = standard error.

*$p < .05$;**$p < .001$.

[1] The predictors, in order of importance, were attachment to practice, patient gender, patient median income, number of physician payee numbers, physician place of graduation and physician FTE factor. For this model, $R^2 = .060$, $F(6, 18{,}690) = 199.10$, $p < .001$.

[2] The predictors, in order of importance, were attachment to practice, patient median income and patient gender. For this model, $R^2 = .052$, $F(3, 10{,}589) = 193.37$, $p < .001$.

[3] The predictors, in order of importance, were attachment to practice, patient age, physician place of graduation, number of physician payee numbers, patient location and patient median income. For this model, $R^2 = .109$, $F(6, 16{,}292) = 332.15$, $p < .001$.

[4] The predictors, in order of importance, were attachment to practice and patient age. For this model, $R^2 = .092$, $F(2, 5{,}163) = 262.83$, $p < .001$.

[5] The predictors, in order of importance, were attachment to practice, patient age, physician place of graduation and number of physician payee numbers. For this model, $R^2 = .086$, $F(4, 5{,}665) = 133.34$, $p < .001$).

[6] These regression coefficients B, and their standard errors of estimate (*SE*s), were obtained from a sequential multiple regression analysis, and a dash in this column indicates a non-contributing predictor variable in the final best-fitting regression model.

Source: British Columbia Ministry of Health Services, Primary Care Data Repository, June 2009.

tion of the total cost of care.

The main results of interest obtained from the multiple regression analyses are the regression coefficients (B estimates) for each predictor in the best-fitting regression model. Technically, these regression coefficients are the slopes of the best-fitting lines for predicting the total cost from each of the predictor variables. Thus, for example in Table 1, the B estimate for attachment to practice for RUB 4 of –81.6 means that for a one-unit change in attachment to practice (which is 1%), the change in total cost is –81.6, or a decrease of $81.60. It is also important to note the small standard errors (SEs) of these B estimates for attachment to practice, which indicate that these "averages" are quite precise (i.e., the confidence intervals around these estimates are narrow). For dichotomous variables, the interpretation of the regression coefficients is similar, and it is simply the difference in total cost between the two values of the dichotomous variable; for example, B for patient's gender in RUB 4 is –513.5, which means that the total cost for diabetic RUB 4 women (coded as 1) is $513.50 lower than that for men (coded as 0).

Regression results reported in Table 1 show that attachment to practice is consistently the strongest predictor of total costs across all RUB and ACG groups, with the total costs of care decreasing by approximately $82 in RUB 4 and by about $268 in RUB 5 per a 1% increase in attachment to practice. Of the other statistically significant predictor variables, the B estimates for the patient's age indicate that for each additional year of age, the cost of care is increased by an average of about $51 for RUB 4 and $48 for RUB 5 (after attachment to practice has been accounted for). Men and women patients have different total costs, but only in RUB 4, with women costing about $514 less than men on average. The patient's location is not a factor in total cost, and an increase in a patient's median family income after taxes is associated with an average cost decrease of about $32 (because the units in the analysis were in $1,000) in RUB 4 and $33 in RUB 5 (but not in the RUB 5 ACG subsamples). Of the physician variables, the only consistently significant predictor was the physician's place of graduation, with physicians graduating outside of Canada being associated with an average increase of about $345 in RUB 4 and $1,194 in RUB 5.

Table 3. Correlation coefficients (*r*) for the relationship between attachment to practice and costs for the main analysis and the economic sensitivity analyses for diabetics at RUB 4: fiscal 2007–2008*

	Attachment to Practice	Age	Patient Gender	Median after Tax Family Income
Main analysis (*n* = 40,483)	–.179	.054	–.040	–.041
Analysis based on a minimum of 3 services instead of 5 services (*n* = 41,440)	–.177	.053	–.042	–.042
Analysis based on patient seeing 12 or fewer payees instead of 25 or fewer payees (*n* = 40,376)	–.173	.056	–.042	–.042
Patient analysis based on patient seeing 6 or fewer payees (*n* = 37,383)	–.143	.058	–.034	–.036
Hospital costs of $50,000 or less (*n* = 40,375)	–.185	.059	–.041	–.046
Hospital costs of $25,000 or less (*n* = 39,882)	–.171	.056	–.046	–.047
Hospital costs of $10,000 or less (*n* = 37,556)	–.090	.052	.077	–.051

RUB = resource utilization band.

*The data for the main analysis are the same as those presented in Table 1. For each of the analyses performed in the sensitivity analysis, all selection criteria are the same except for the change that is noted (e.g., including people with 3 or more services rather than 5 or more services, which was used in the main analysis). Diabetics at RUB 4 had the weakest relationship between attachment to practice and costs. Thus, our sensitivity analysis was performed on the group with the weakest relationship and shows that even by reducing the cut-off point for hospital costs, the number of payees seen by a client and the minimum number of services per year, attachment still had the highest correlation with cost. This indicates that the finding of the inverse relationship between attachment and cost is very robust.

Source: British Columbia Ministry of Health Services, Primary Care Data Repository, June 2009.

Table 4. Average cost ($) for levels of attachment to practice and age: Fiscal 2007-2008

	Age	Cost ($) of Attachment to Practice				
		0–39%	40–59%	60–79%	80–89%	90–100%
Diabetes, RUB 4	0–44	7,666	6,419	5,737	5,150	5,062
	45–59	8,043	7,234	6,503	5,473	4,888
	60–69	11,104	8,077	7,395	6,450	5,090
	70–79	14,867	9,915	8,115	6,687	5,369
	80+	12,066	9,595	8,553	6,995	5,120
Diabetes, RUB 5	0–44	19,386	19,604	18,507	17,663	14,216
	45–59	23,644	22,370	18,351	15,992	11,311
	60–69	30,623	24,711	18,724	16,858	12,219
	70–79	32,575	25,633	20,483	16,343	11,846
	80+	30,030	24,968	20,369	16,814	10,796
CHF, RUB 4	0–44	17,703	10,836	10,822	8,486	7,669
	45–59	10,934	11,616	8,414	8,678	6,815
	60–69	12,627	10,026	9,924	8,082	6,557
	70–79	15,847	12,362	9,875	8,017	6,145
	80+	12,007	11,963	10,691	8,241	5,721
CHF, RUB 5	0–44	33,048	31,288	26,580	25,852	18,444
	45–59	31,412	29,054	25,034	18,954	15,412
	60–69	37,501	31,893	24,536	20,649	16,378
	70–79	36,739	29,927	24,314	19,892	14,343
	80+	33,307	26,772	22,349	18,907	11,918

CHF = congestive heart failure; RUB = resource utilization band.

Source: British Columbia Ministry of Health Services, Primary Care Data Repository, June 2009.

The best-fitting models resulting from the sequential regression analyses, given in the footnotes in Table 1, indicate that, due to its strong relationship with total cost, attachment to practice entered each sequential regression model first in each RUB/ACG case. Furthermore, as other significantly related variables were added to the model, attachment to practice always retained its strong relationship with total cost.

Cost of CHF

Figure 2 shows the various types of costs of care per patient with CHF for RUBs 4 and 5. As we saw with diabetes, the total cost per patient decreases with the patient's increasing attachment to practice. The same patterns appear, with hospital costs showing the greatest reduction as the level of attachment increases.

The correlation and regression results for the total cost of care of CHF are presented in Table 2. The results show that, again, of all the patient and physician variables tested, attachment to practice is the strongest predictor of total cost (r = –.238 for RUB 4 and –.316 for RUB 5). The other variables, many of which are also statistically significant, are an order of magnitude smaller.

In RUB 4, a 1% increase in a patient's attachment to practice is related to a decrease of $124 in total cost; in RUB 5, this figure rises to $323. Of the other patient variables, a patient's age was not related to total cost in RUB 4; however, gender was, with women costing, on average, about $780 less than men. Age was related to cost in RUB 5, with an associated average decrease in cost of about $142 per year. Patient income was associated with total cost in RUB 4 samples and in the overall RUB 5 analysis, but patient location was not consistently associated with total cost. The physician's FTE factor was related to total cost in RUB 4, with $389 increase per a full 1.0 FTE increase. The number of physician payee numbers was positively related to total cost per patient, with a $68 increase in total cost per physician payee number in RUB 4 patients and $232 in RUB 5 patients. Where the physician graduated was also related to the total cost per patient: physicians graduating outside of Canada were associated with a $352 increase in total cost per patient in RUB 4 and a $1,557 increase in RUB 5.

Economic Sensitivity Analysis and the Relationship between Attachment to Practice and Age

Clearly, a number of decisions were made about our selection criteria, such as the $100,000 cut-off for hospital costs. It is our view that the way the sample was selected for analysis, and the way outliers were excluded, was reasonable. Nevertheless, the choices made could have affected the results. Thus, we decided to conduct a sensitivity analysis. In economic evaluation, a sensitivity analysis is one in which one makes changes to basic assumptions, or selection criteria, to see if the results of the main analyses still hold when different assumptions or selection criteria are used (Canadian Coordinating Office for Health Technology Assessment 1997; Drummond et al. 1987). For example, because most of the decrease in costs is related to hospital costs, using a different cut-off for hospital costs could affect the results. Thus, we conducted a sensitivity analysis in regard to the key variables that could have an impact on costs. We reduced the hospital cost cut-off and reduced the cut-off for the number of payees seen by a patient to exclude patients who had had services from more than 12 payee organizations. We also reduced the minimum number of GP services from five to three. Based on this sensitivity analysis, it appears that the findings from our analysis are quite robust. Table 3 presents the comparative correlation coefficients for the main analysis and the sensitivity analysis. As can be seen, using different selection criteria had a minimal effect on the results.

Because in some cases the patient's age was a relatively strong predictor of total cost and was also related to attachment to practice, we wanted to examine whether the decreasing relationship of total cost with increasing attachment to practice held within different age groups of patients. An analysis of variance (ANOVA) confirmed that the relationship was maintained. We conducted a two-way between-subjects ANOVA, with both age and attachment to practice categorized into five levels (see Figure 1 for the group intervals used). The interaction effects of age and attachment to practice on total cost for diabetes were significant for both RUB 4 (F[16, 40,613] = 11.938, $p < .001$, mean square error [MSE] = 5.912×10^7, $\eta^2 = .003$) and RUB 5 (F[16, 22,633] = 5.458, $p < .001$, $\eta^2 = .002$). In both ANOVAs, the main effects of attachment to practice and age were also significant, with attachment to practice having the strongest effect on total cost: in RUB 4, main effect of attachment to practice (F[4, 40,613] = 270.016, $p < .001$, $\eta^2 = .015$) and main effect of age (F[4, 40,613] = 93.438, $p < .001$, $\eta^2 = .005$); in RUB 5, main effect of attachment to practice (F[4, 22,633] = 210.502, $p < .001$, $\eta^2 = .018$) and main effect of age (F[4, 22,633] =15.795, $p < .001$, $\eta^2 = .001$). The total cost of care decreased with attachment to practice within each age group, although the relationship tended to be stronger for older patients.

As was the case for diabetes, the total cost of care for patients with CHF decreased with an increasing attachment to practice within each age group. The two-way ANOVA results for CHF were as follows: for RUB 4, interaction effect (F[16, 18,747] = 4.573, $p < .001$, MSE = 8.69×10^7, $\eta^2 = .001$), main effect of age (F[4, 18,747] = 4.874, $p = .001$, $\eta^2 = .0006$) and main effect of attachment to practice (F[4, 18,747] = 85.585, $p < .001$, $\eta^2 = .010$); for RUB 5, interaction effect (F[16, 16,352] = 1.057, $p = .391$, $MSE = 3.85 \times 10^8$), main effect of age (F[4, 16,452] = 17.097, $p < .001$, $\eta^2 = .002$) and main effect of attachment to practice (F[4, 16,452] = 89.525, $p < .001$, $\eta^2 = .009$). Group means are shown in Table 4 for RUBs 4 and 5, for patients with diabetes and those with CHF.

Summary

The key finding from this study is loud and clear – attachment to practice is consistently *inversely* related to the total cost of care for both diabetes and CHF for higher-care-needs patients. Across both types of illnesses and across both RUBs examined here, a 1% increase in attachment to practice is associated with an average decrease in the total cost of care of $80–$323. No other variables we tested came close in terms of being so strongly related to the total cost of care. The second most strongly related variable is the patient's age. For diabetes, age is positively related to the total cost of care, with increasing age incurring increasing total costs. Other variables that are somewhat related to the total cost of care included the patient's median annual family income after taxes, which is negatively related to total costs but is much weaker and smaller than attachment to practice. Of the physician variables, the only one that seems to contribute to the total cost of care somewhat consistently across RUBs and ACGs is whether or not the physician was trained in Canada, with those having been trained outside of Canada being associated with slightly higher average costs (ranging from $345 in diabetes RUB 4 to $2,484 in CHF RUB 5, ACG 5070).

Finally, these findings need to be replicated and refined in future research. In addition, it may be appropriate to move in the direction Starfield has indicated with regard to issues of continuity of care between GPs and specialists. HQ

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