Care to share:
Impact of general practitioner-specialist collaborative structures on health care outcomes

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Abstract
Professional interactions among health providers are critical to an efficient shared-care model. This research investigates whether the collaborative structure between general practitioners and specialists affects either the health status of patients or their pharmacy costs. The more concentrated collaborative structure results in lower pharmacy costs, but not in higher patient.

Keywords: patient care coordination, general practitioner-specialist collaboration, health care outcomes

INTRODUCTION

All over the world, governments face pressures of health care budget reductions while aiming at maintaining or even improving the level of service. One way to achieve these conflicting goals may be through better integration of primary and secondary care and utilizing the advantages of better collaboration between general practitioners and specialists. This integration is most frequently equated with shared care in the UK, managed care in the US, transmural care in the Netherlands, and other widely recognized formulations such as collaborative care, comprehensive care and disease management (Kodner 2002). Although both shared care and managed care is based on inter-professional practice, the shared-care model in the UK advances communication and co-operation between care providers, whereas the managed care provided by the Health Maintenance Organizations (HMO) in the US rather focuses on the provision of healthcare through service utilization monitoring and cost containment (White 2010). However, many current health care reforms in the US seek to improve coordination of care through building integrated networks of providers offering complex care to overcome issues of lost patients, late

service deliveries, declining quality and patient satisfaction measures and diminished cost-effectiveness—characteristics of disintegrated professional practices and fragmented patient care (Fisher et al. 2011).

Professional collaboration between general practitioners (GPs) and specialists (SPs) is one critical element of this integration. Professional collaboration reflects the extent to which GPs and SPs work together to achieve optimal outcomes for a given patient and may result from better interpersonal information exchange and reflect longstanding relationship between doctors. GPs have developed guiding principles worldwide to advance comprehensiveness and forms of integration as key professional goals. (U.S. Institute of Medicine, 1996; WONCA Europe, 2002).

Parallel to primary and secondary care integration, some degree of freedom in choosing healthcare providers is advocated in several developed countries including the United States (Bevan and Van De Ven, 2010; Corlette et al. 2014). Theory assumes and available data confirm that some portion of patients who are offered a choice will exercise it in order to access perceived higher-quality services (Dixon et al. 2010). In the UK, when offered a choice, an additional 5-14 per cent of patients travel beyond their local or nearest provider (Dixon et al. 2010). In the US, several states enacted laws to restrict the ability of managed care insurers to selectively contract with providers (Corlette et al. 2014; Hellinger 1995). In response to the continuous pressure on managed care insurers to offer patients wider access to providers, they shifted to broader networks in the late 1990s and early 2000s (Corlette et al. 2014). However, offering completely free choice or wide access to providers to patients may increase care fragmentation by forcing GPs to collaborate with more providers.

This study investigates the characteristics of formal collaborative structures between GPs and SPs in shared care—outcome measures of patients treated by GPs with strong collaborative relationships are compared with those characterized by fragmented collaborative structures. In particular, this study examines possible associations between collaborative structures and patient health status, proxied by the number of comorbidities diagnosed and treated, as well as between collaborative structures and pharmacy costs. The direction of causality is unknown—higher patient health status and lower pharmacy costs might be prerequisites to strong collaborative structures, or might be consequences thereof. In line with intuition and empirical evidence, this study favors the latter—building up strong collaborative relationships with a few SPs enable GPs better and smoother care coordination.

In this study we develop a novel measure for coordination of patient care activities between GPs and SPs. Care coordination measures are limited in their practical utility today, because they involve time and cost intensive survey that cannot be used to assess the function of health care systems on a large scale (Bynum and Ross, 2013). Recent availability of administrative data enabled researchers to develop a new measure of care coordination applicable to system-level (Barnett et al. 2011; Pham et al. 2009; Pollack et al. 2013; Uddin et al. 2011). This new measure of care coordination relies on the number of shared patients, and assumes that the higher the number of shared patients, the higher the probability of developing collaborative relationships is. Collaborative relationships create opportunities for direct communication and information sharing that may lower barriers to care coordination and ultimately lower costs. Previous research focused on ties in which the number of shared patients were high—provider-level care coordination measure has not been developed yet. This study fills this gap—our novel care coordination measure has the GPs in its focus acknowledging the GPs' role as gatekeepers and the most important patient care coordinators.

This paper contributes to the literature by assessing whether the type of collaborative relationship GPs have built up with SPs is associated with patient health status and pharmacy

costs. To the authors' knowledge, no large-scale quantitative study has ever investigated this association. Previous research either did not develop a system-level care coordination measure (Bosch et al. 2009; Lemieux-Charles and McGuire, 2006), or did not perform a provider-level analysis. We find no clear evidence that a strong collaborative relationship results in enhanced health statuses. However, the efficiency of care coordination is reflected in cost savings—patients treated in strong collaborative structures by their GPs involve significantly lower pharmacy costs than those treated in fragmented collaborative structures. This study also bears important policy implications with regards to care fragmentation—healthcare strategists need to advocate a healthcare system with lower care fragmentation at the level of primary care providers by offering patients limited rather than unrestricted choice.

DATA AND METHODS

One key element of the shared-care models introduced in many European countries and the managed care programs in the US is better care coordination, especially for people with chronic illness. Better care coordination implies collaboration among health professionals—sharing of planning and goal setting, making decisions, solving problems, assuming responsibilities, working together cooperatively, and communicating and coordinating openly (Mattesich and Monsey, 1992; Uddin et al. 2011).

Recently, a *new measure of care coordination* has been developed to assess the function of health care system on a large scale—impossible to measure in the past (Barnett et al. 2011; Pham et al. 2009; Pollack et al. 2013; Uddin et al. 2011). Collaborative relationship between two doctors exists if they care for at least one patient together. The higher the number of shared patients, the higher the probability of advice seeking and referral relationship between doctors is. This new measure of care coordination has been validated for predicting the existence of collaborative relationships among doctors by Barnett et al. (2011). The authors show that the probability of two doctors having a recognized professional relationship increases with the number of patients shared—for example, doctors sharing nine or more patients have an 82 per cent probability.

In the literature on shared care, there is mixed evidence as to whether or not the level of care coordination is positively related to *health outcomes*. On the one hand, Lemieux-Charles and McGuire (2006) and Bosch et al. (2009) report in their systematic literature reviews that good teamwork among medical professionals improves clinical performance and outcomes. On the other hand, several other systematic reviews on shared care suggest that the degree of collaboration does not predict clinical outcomes (Craven and Bland, 2006; Greenhalgh 1994; Smith et al. 2007). Craven and Bland (2006), for example, report that although there is a trend toward positive outcomes occurring more often in studies with moderate or high levels of collaboration, some studies with lower levels of collaboration also have positive outcomes. Similarly, the systematic review of Smith et al. (2007) on the effectiveness of shared care concludes that overall there are no consistent improvements in any of the health outcome measures (physical, mental, psychosocial) reviewed.

The recent literature using the newly developed measure of care coordination finds evidence for the positive association between the level of care coordination and health outcomes (Barnett et al. 2012; Hussain et al. 2015; Pollack et al. 2013, 2014; Uddin et al. 2011). The higher the number of patients shared, the better patient health status is, most probably due to the consolidation of clinical information and the management of patient care.

Although the literature on patient-sharing unambiguously suggest improvements in health outcomes when high number of patients are shared, previous systematic reviews on shared care suggest that the degree of collaboration does not predict clinical outcomes. Thus, it is reasonable to hypothesize that patient health status should be at least the same, when GPs develop strong collaborative relationship with SPs.

In addition to improved quality of care, with shared-care programs policy makers and payers in both public and private sectors aim to lower *cost of care*, or at the very least to ensure that health care resources are used more wisely (Kodner and Spreeuwenberg, 2002). Empirical evidence shows that this aim is better served. For example, the systematic review of van Walraven et al. (2010) finds that better care coordination is associated with lower health utilization, including lower hospitalization and fewer emergency visits. The recent literature using the newly developed measure of care coordination finds evidence for the significant association between the level of care coordination and cost of care as well (Barnett et al. 2012; Pollack et al. 2013, 2014; Uddin et al. 2011). Thus, it is reasonable to hypothesize that healthcare delivery is more cost-efficient when the numbers of shared patients are higher, most probably due to the consolidation of clinical information and the management of patient care.

Sample

This study uses prescription data for the years 2010–2011 available from DoktorInfo Ltd, a health data collection and information services company based in Hungary. Twenty per cent of the GPs practicing in Hungary feed real-time prescription data into this database voluntarily—they are representative of the entire Hungarian GP population in both age and location. GPs are compensated for providing information such as GP identification number; prescription date; prescribed drug characteristics; International Classification of Diseases (ICD) codes; patient characteristics (age and gender); and, since January 2009, for patients whose care is shared, identification number of the therapy-initiating SP.

This study concentrates on shared diabetic patients, defined as patients who receive at least one specialist drug from the A10 Anatomical Therapeutic Chemical (ATC) group as listed by the WHO—for example, insulin or an oral antidiabetic agent. Following data cleaning, GPs who treated fewer than 20 diabetic patients were excluded from analysis. The final sample thus includes 794 GPs and 318 SPs in endocrinology who shared care for 31,070 diabetic patients. During the observation period 2010–2011, GPs issued 509,281 specialist medication prescriptions for antidiabetic agents, initiated additional 332,635 antidiabetic therapies for which they did not require prior SP approval, and wrote an additional 3,243,191 prescriptions for other agents. A typical GP treated 39 diabetic patients.

Identifying collaborative relationships among doctors

GPs and SPs enter in informal collaborative relationships when they email, call, or curbside one another with specific clinical matters. For example, GPs may seek information or advice from SPs prior to referring patients for care (Keating et al. 1998). GPs and SPs enter in formal collaborative relationships when GPs refer patients to SPs and subsequent requests for information are formalized (Barnett el al. 2011). This study investigates the characteristics of formal collaborative structures between GPs and SPs in shared care—the formal collaboration is materialized in referral and prescribing of specialist medications.

In this study, similar to the patient-sharing networks constructed recently by Barnett et al. (2011), Pham et al. (2009), Landon et al. (2012), and Pollack et al. (2013), a collaborative relationship between two doctors exists if they care for at least one patient together— information readily and unambiguously available from prescription data, where the identification numbers of prescribing GPs and therapy-initiating SPs both appear on prescriptions. In our sample, there were 6,723 GP–SP connections identified, representing 5.33 % of all potential ties between GPs and SPs. On average, a GP coordinated care with eight SPs.

General practitioners with strong versus fragmented collaborative ties

The structure of collaborative relationships between GPs and SPs depends on both the number of SPs with whom GPs coordinate care and patient distribution across SPs. GPs channeling the majority of their patients to a few SPs build up strong, collaborative relationship with SPs, whereas GPs channeling their patients to many SPs build up weak, fragmented collaborative ties.

The structure of collaborative relationships between GPs and SPs is measured by the Herfindahl-Hirschman Index (HHI), a widely used concentration measure in industrial organization—the sum of the squares of the proportion of GP's patients shared with SPs (Rhoades 1993). The higher the index (it ranges from a very small number close to zero to 10,000 in case of a monopoly or 100% share), the more concentrated the collaborative structure of GPs, which implies stronger collaborative relationships among doctors. GPs build up strong collaborative relationship with SPs, if the HHI is in the uppermost decile; if HHI is in the lowest decile then GPs have weak, fragmented ties with SPs. GPs with strong collaborative ties may be strongly tied to more than one SP. In this particular sample, GPs with a HHI higher than 6,258 qualify for strong collaborative relationship with SPs; whereas GPs with a HHI smaller than 1,743 qualify for weak, fragmented relationships.

Outcome measures

In this study patient health status is proxied by the *number of comorbidities diagnosed and treated*—evidently, the higher the number, the poorer the health status. Although comorbidity indices only capture one particular dimension of health status, vast empirical evidence shows that they are good predictors of mortality, which is a health status indicator that is widely used for populations (Charlson et al. 1987; Li et al. 2008; Lix et al. 2013; Sharabiani et al. 2012; Quail et al. 2011; Quan et al. 2011). Thus, significant differences in the number of comorbidities between patients treated by GPs characterized by strong collaborative relationships and by weak, fragmented ties would signal significant differences in mortality which, in turn, highlights inequalities in health status between these two patient populations. In addition, comorbidity indices are also good predictors of adverse events (amputation, hospitalisation, longer inpatient stay, re-admission to hospital), another important dimension of health status (de Groot et al. 2003; Lix et al. 2013; Quail et al. 2011; Rochon et al. 1996).

This study uses three diagnosis-based comorbidity measures, including the Charlson comorbidity index (Charlson et al. 1987), the Quan-modified Charlson comorbidity index (Quan et al. 2011), and the Elixhauser measure (Elixhauser et al. 1998) identified by Sharabiani et al (2012) as the most common. As suggested by Quan et al. (2005), ICD-10 codes are employed to identify which of the comorbid conditions apply to the patients in the sample. The Charlson

comorbidity index predicts mortality for a range of 19 diseases selected and weighted based on the strength of association with mortality. However, since mortality is likely to have changed since the development of the original index in 1984, the Quan-modified Charlson comorbidity index uses updated weights. The Elixhauser measure contains 30 carefully selected comorbid conditions. To control for potential bias in ICD-10 coding, this study also measures comorbidity by counting the number of third-level ATC codes on which the patient received at least one prescription semi-annually. All four comorbidity measures are applied to the prescriptions written by GPs in addition to prescriptions for antidiabetic agents.

Pharmacy costs are measured at GPs' patient panel level as the sum total of the retail prices for drugs, including all agents, prescribed by GPs in 2010–2011—they include the amount paid by patient as well as any drug subsidy. Private and public pharmaceutical expenditure are thus considered jointly to assess the total cost to society.

Statistical analysis

GPs are classified based on the strength of their collaborative relationships with the SPs. The means of the outcome measures are then calculated for patient panels of GPs with different kinds of collaborative structures, and compared. The skewed distribution of the collaborative relationship measures (HHI)—as well as the associations with patient health status and pharmacy costs, assumed nonlinear, similarly to Pollack et al. (2013), suggest a decile-based categorization. GPs characterized by strong collaborative structures form the uppermost decile, whereas GPs characterized by fragmented structures belong to the lowest decile. The health and cost implications of strong versus fragmented collaborative structures are therefore evaluated using t-tests, considered significant if the p-value is less than 0.05.

RESULTS

In Table 1, two comorbidity measures indicate that collaboration structure does not affect patient health status, whereas two comorbidity measures indicate that strong, collaborative structures improve patient health status.

Table 1 - Strong ties versus weak ties between GPs and SPs: outcome measures

Outcome measures	GPs with strong collaborative ties (uppermost decile, mean value)	GPs with weak, fragmented ties (lowest decile, mean value)	p-value
Patient health status (excluding diabetes)			
Charlson comorbidity index	0.88	0.94	0.0264
Quan-modified Charlson comorbidity index	0.59	0.58	0.5183
Elixhauser measure (based on ICD-10 codes)	1.92	2.01	0.0058
ATC-based comorbidity count (based on third-level ATC codes)	7.86	8.02	0.1749
Pharmacy costs (based on retail prices as of January 2010; thousand HUF - Hungarian Forint)	586.58	623.22	0.0000

For GPs with strong collaborative structures the patient health status is thus at least the same than for GPs with fragmented collaborative structures. At the same time, the collaborative structure does affect pharmacy costs, which are 5.88% lower for patients treated in strong GP–SP collaborative structures than for those treated in fragmented collaborative structures.

DISCUSSION

The health status of patients treated by GPs who build up strong collaborative relationships with SPs is at least the same than the health status of patients treated by GPs characterized by fragmented collaborative structures. Collaborative structure is thus not clearly associated with variation in patient health status. If strong collaborative structures are characterized by efficient care coordination, then this efficiency does not reflect in enhanced patient health status in all health status proxies.

This mixed evidence is in line with previous literature. Based on small-scale care coordination measures some authors report that good teamwork among medical professionals improves clinical performance and outcomes (Bosch et al. 2009; Lemieux-Charles and McGuire, 2006), whereas others conclude that the degree of collaboration does not predict clinical outcomes (Craven and Bland, 2006; Greenhalgh 1994; Smith et al. 2007). Authors using system-level care coordination measures tend to find evidence for the positive association between the level of care coordination and health outcomes (Barnett et al. 2012; Hussain et al. 2015; Pollack et al. 2013, 2014; Uddin et al. 2011). These latter studies, however, did not perform an analysis on the level of primary care providers.

This study finds that pharmacy costs for patients treated by GPs who build up strong collaborative relationships with SPs are significantly lower than for patients treated by GPs characterized by fragmented collaborative structures, a major benefit for the society as a whole. The significant difference in pharmacy costs is not related to the total number of prescriptions patients receive.

The finding that GPs with strong collaborative structure involve lower pharmacy costs is based on a bivariate analysis that does not account for confounding variables. To address the issue of confounding, a multivariate regression analysis is performed—the variation in pharmacy costs is explained by the type of collaborative structure, the Quan-modified Charlson comorbidity index, and potentially important patient characteristics. Most importantly, the multivariate analysis confirms that the type of collaborative structure is a statistically significant determinant of pharmacy costs (results not shown). In addition to the type of collaborative structures, both the treatment method and the presence of diabetes complications is an important determinant of pharmacy costs—patients treated by the generally more expensive insulin and patients who have diabetes complications involve significantly higher pharmacy costs.

The finding that collaborative structures affects pharmacy costs is in line with previous literature reporting that better care coordination is associated with lower health utilization, including lower hospitalization and fewer emergency visits (Barnett et al. 2012; Pollack et al. 2013, 2014; Uddin et al. 2011; van Walraven et al. 2010). This study finds empirical evidence for this association on system-level for primary care providers—association never tested in the literature before. Moreover, the care coordination measure developed in this study overcomes the counterintuitive nature of the care coordination measure used by Pollack et al. (2013). When the authors split the overall costs into components such as outpatient, inpatient, and pharmacy costs,

they counterintuitively find higher pharmacy costs for diabetic patients with higher care density (a patient-based quantifier of patient sharing).

This study might bear important policy implications with regards to care fragmentation—GPs may struggle to coordinate care, if they have to share patients with more SPs as a result, and the pharmacy costs would be higher. If future research shows that total costs are indeed lower for patients treated in strong collaborative structures when numerous other specialties (cardiology, neurology, ophthalmology) are considered as well, then healthcare strategists need to advocate a healthcare system with lower care fragmentation. Lower care fragmentation, coupled with enhanced medical education and technical infrastructure might benefit patients, by savings on travel times and costs, and the wider society, by savings on healthcare costs. In Europe, this might be achieved through offering patients limited rather than unrestricted choice—patients need excellent providers, in small numbers and close geographic proximity. In the US, healthcare insures should follow a narrow provider network strategy. In response to recent healthcare reforms many qualified health plans inside the exchange have already started to follows this strategy because narrow networks allow them to offer lower premiums (Corlette et al. 2014).

SUMMARY

In chronic illness care, many patient outcomes may only be achieved if the clinical activities of different health professionals—such as GPs and SPs—are intentionally coordinated. Improving patient care coordination has become a key focus in healthcare reform and a national priority in numerous countries. However, assessing patient care coordination is as challenging as achieving it. This study took a leap forward in measuring the possible impact of different kinds of collaborative structures on patient health and the cost of patient care. In particular, it investigated whether the structure of collaborative relationships between GPs and SPs is associated with the number of comorbidities diagnosed and treated, but found no clear evidence that a collaborative relationship through many shared patients results in enhanced health statuses. However, the efficiency of care coordination was reflected in cost savings—patients treated in strong collaborative structures involve significantly lower pharmacy costs than those treated in fragmented collaborative structures. This paper is the first to present evidence that the more socially embedded patients in the GP-SP diad may lead to more cost efficient health care. Overall drug expenditure may thus be reduced by lowering patient care fragmentation through channeling a GP's patients to a small number of SPs. To harvest the financial benefits stemming from efficient patient care coordination, healthcare policy strategists need to advocate limited patient choice rather than complete freedom of choice.

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BIBLIOGRAPHY

Barnett, M. L., B. E. Landon, A. J. O'Malley, N. L. Keating, N. A. Christakis. 2011. Mapping physician networks with self-reported and administrative data. *Health Services Research* **46**(5): 1592–1609.

Barnett, M. L., N. A. Christakis, A. J. O'Malley, J. P. Onnela, N. L. Keating, B. E. Landon. 2012. Physician patient-sharing networks and the cost and intensity of care in US hospitals. *Medical Care* **50**(2): 152–160.

Bevan, G., W. P. Van De Ven. 2010. Choice of providers and mutual healthcare purchasers: can the English National Health Service learn from the Dutch reforms? *Health Economics, Policy and Law* **5**(3): 343–363.

Bosch, M., M. J. Fabe, J. Cruijsberg, G. E. Voerman, S. Leatherman, R. P. T. M. Grol, M. Hulscher, M. Wensing. 2009. Review article: effectiveness of patient care teams and the role of clinical expertise and coordination: a literature review. *Medical Care Research and Review* **66**(6 Suppl): 5S–35S.

Bynum, J. P., J. S. Ross. 2013. A measure of care coordination? *Journal of General Internal Medicine* **28**(3): 336–338.

Charlson, M. E., P. Pompei, K. L. Ales, C. R. MacKenzie. 1987. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of Chronic Diseases* **40**(5): 373–383.

Corlette, S., J. Volk, R. Berenson, J. Feder. 2014. *Narrow provider networks in new health plans: balancing affordability with access to care.* Center on Health Insurance Reforms, Health Policy Institute, Georgetown University, Georgetown.

Craven, M. A., R. Bland. 2006. Better practices in collaborative mental health care: an analysis of the evidence base. *Canadian Journal of Psychiatry* **51**(6 Suppl 1): 7S–72S.

Dixon, A., R. Robertson, J. Appleby, P. Burge, N. Delvin, H. Magee. 2010. Patient Choice. London, King's Fund.

Elixhauser, A., C. Steiner, D. R. Harris, R. M. Coffey. 1998. Comorbidity measures for use with administrative data. *Medical Care* **36**(1): 8–27.

Fisher, E. S., M. B. McClellan, D. G. Safran. 2011. Building the path to accountable care. *New England Journal of Medicine* **365**(26): 2445–2447.

Greenhalgh P. M. 1994. Shared care for diabetes. A systematic review. *Occasional paper (Royal College of General Practitioners)* (67):i-viii,1–35.

de Groot, V., H. Beckerman, G. J. Lankhorst, L. M. Bouter. 2003. How to measure comorbidity: a critical review of available methods. *Journal of Clinical Epidemiology* **56**(3): 221–229.

Hellinger, F. J. 1995. Any-willing-provider and freedom-of-choice laws: an economic assessment. *Health Affairs* **14**(4): 297–302

Hussain, T., H-Y. Chang, C. M. Veenstra, C. E. Pollack. 2015. Collaboration Between Surgeons and Medical Oncologists and Outcomes for Patients With Stage III Colon Cancer. *Journal of Oncology Practice* **11**(3): e388–e397.

Institute of Medicine (1996). *Primary care: America's health in a new era.* National Academy Press, Washington DC.

Keating, N. L., A. M. Zaslavsky, J. Z. Ayanian. 1998. Physicians' experiences and beliefs regarding informal consultation. *The Journal of the American Medical Association*, **280**(10): 900–904.

Kodner, D. L., C. Spreeuwenberg. 2002. Integrated care: meaning, logic, applications, and implications–a discussion paper. *International Journal of Integrated Care* **2**(14): 1–6.

Landon, B. E., N. L. Keating, M. L. Barnett, J. P. Onnela, S. Paul, A. J. O'Malley, T. Keegan, N. A. Christakis. 2012. Variation in patient-sharing networks of physicians across the United States. *The Journal of the American Medical Association* **308**(3): 265–273.

Lemieux-Charles, L., W. L. McGuire. 2006. What do we know about health care team effectiveness? A review of the literature. *Medical Care Research and Review* **63**(3): 263–300.

Li, B., D. Evans, P. Faris, S. Dean, H. Quan. 2008. Risk adjustment performance of Charlson and Elixhauser comorbidities in ICD-9 and ICD-10 administrative databases. *BMC Health Services Research* **8**: 12.

Lix, L. M., J. Quail, O. Fadahunsi, G. F. Teare. 2013. Predictive performance of comorbidity measures in administrative databases for diabetes cohorts. *BMC Health Services Research*, **13**: 340.

Mattesich, P. W., B. Monsey. 1992. *Collaboration: what makes it work. A review of research literature on factors influencing successful collaboration. 2nd ed.* Amherst H. Wilder Foundation, St. Paul, MN.

Pham, H. H., A. S. O'Malley, P. B. Bach, C. Saiontz-Martinez, D. Schrag. 2009. Primary care physicians' links to other physicians through Medicare patients: the scope of care coordination. *Annals of Internal Medicine*, **150**(4): 236–242.

Pollack, C. E., G. E. Weissman, K. W. Lemke, P. S. Hussey, J. P. Weiner. 2013. Patient sharing among physicians and costs of care: a network analytic approach to care coordination using claims data. *Journal of General Internal Medicine* **28**(3): 459–465.

Pollack, C. E., K. D. Frick, R. J. Herbert, A. L. Blackford, B. A. Neville, A. C. Wolff, M. A. Carducci, C.C. Earle, C. F. Snyder. 2014. It's who you know: patient-sharing, quality, and costs of cancer survivorship care. *Journal of Cancer Survivorship* **8**(2): 156–166.

Quail, J. M., L. M. Lix, B. A. Osman, G. F. Teare. 2011. Comparing comorbidity measures for predicting mortality and hospitalization in three population-based cohorts. *BMC Health Services Research* **11**: 146.

Quan, H., V. Sundararajan, P. Halfon, A. Fong, B. Burnand, J. C. Luthi, L. D. Saunders, C. A. Beck, T. E. Feasby, W. A. Ghali. 2005. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Medical Care* **43**(11): 1130–1139.

Quan, H., B. Li, C. M. Couris, K. Fushimi, P. Graham, P. Hider, J. M. Januel, V. Sundararajan. 2011. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *American Journal of Epidemiology*, **173**(6): 676–678.

Rhoades, S. A. 1993. Herfindahl-Hirschman Index, *Federal Reserve Bulletin*, **79**: 188–189.

Rochon, P. A., J. N. Katz, L. A. Morrow, R. McGlinchey-Berroth, M. M. Ahlquist, M. Sarkarati, K. L. Minaker. 1996. Comorbid illness is associated with survival and length of hospital stay in patients with chronic disability. A prospective comparison of three comorbidity indices. *Medical Care* **34**(11): 1093–1101.

Sharabiani, M. T. A., P. Aylin, A. Bottle. 2012. Systematic review of comorbidity indices for administrative data. *Medical Care* **50**(12): 1109–1118.

Smith, S. M., S. Allwright, T. O'Dowd. 2007. Effectiveness of shared care across the interface between primary and specialty care in chronic disease management. *Cochrane Database of Systematic Reviews* (3):CD004910.

Uddin, S., L. Hossain, M. Kelaher. 2011. Effect of physician collaboration network on hospitalization cost and readmission rate. *European Journal of Public Health* **22**(5): 629–633.

van Walraven, C., N. Oake, A. Jennings, A. J. Forster. 2010. The association between continuity of care and outcomes: a systematic and critical review. *Journal of Evaluation in Clinical Practice* **16**(5), 947–956.

White, T. (2010). *The Doctors' Handbook. Part 2. Understanding the NHS (4th edition).* Radcliffe Publishing, Oxford.

Wonca Europe (2002). *The European definition of general practice/family medicine.* Barcelona, WHO Europe Office.