CORVINUS ECONOMICS WORKING PAPERS

CORVINUS UNIVERSITY of BUDAPEST

Faculty of Economics

Lower fragmentation of coordination in primary care is associated with lower prescribing drug costs-lessons from chronic illness care in Hungary

by
Ágnes Lublóy, Judit Lilla Keresztúri, Gábor Benedek

LOWER FRAGMENTATION OF COORDINATION IN PRIMARY CARE IS ASSOCIATED WITH LOWER PRESCRIBING DRUG COSTS−LESSONS FROM CHRONIC ILLNESS CARE IN HUNGARY

Ágnes Lublóy[1]
Department of Finance and Accounting, Stockholm School of Economics in Riga

Judit Lilla Keresztúri[2]
Department of Finance, Corvinus University of Budapest

Gábor Benedek[3]
Department of Mathematical Economics and Economic Analyses, Corvinus University of Budapest and
Thesys SEA Pte Ltd.

May 15, 2017.

1 Strēlnieku iela 4a, Riga LV1010, Latvia, +371 67015841 (tel), +371 67830249 (fax), agnes.lubloy@sseriga.edu (email)

2 Fővám tér 8, Budapest 1093, Hungary, lilla.kereszturi@uni-corvinus.hu (email)

3 Neil Road, Singapore 088849, Singapore, gabor.benedek@thesys.com (email)

Abstract

Improved patient care coordination is critical for achieving better health outcome measures at reduced cost. Better integration of primary and secondary care in chronic illness care and utilizing the advantages of better collaboration between general practitioners and specialists may support these conflicting goals. Assessing patient care coordination at system level is, however, as challenging as achieving it. Based on prescription data from a private data vendor company, we develop a provider-level care coordination measure to assess the function of primary care at system level. We aim to provide empirical evidence for the possible impact of patient care coordination in chronic illness care—we investigate whether the type of collaborative relationship general practitioners have built up with specialists is associated with prescription drug costs. To our knowledge, no large-scale quantitative study has ever investigated this association. We find that prescription drug costs for patients treated by general practitioners who build up strong collaborative relationships with specialists are significantly lower than for patients treated by general practitioners characterized by fragmented collaborative structures. If future system-level studies in other settings confirm that total healthcare costs are indeed lower for patients treated in strong collaborative structures, then healthcare strategists need to advocate a healthcare system with lower care fragmentation on the interface of primary and secondary care. Regulating access to secondary care might result in significant cost savings through improved care coordination.

JEL codes: C12, H51, I18

Keywords: chronic illness care, care coordination, primary care, secondary care, administrative data, prescription drug costs

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 in chronic illness 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).

Professional collaboration between general practitioners and specialists is one critical element of this integration. Professional collaboration reflects the extent to which general practitioners and specialists work together to achieve optimal outcomes for a given patient. Collaborative relationships in chronic illness care create opportunities for direct communication and information sharing that may lower barriers to care coordination.

Empirical evidence suggests that the level of care coordination is positively related to clinical performance and outcomes (Bosch et al. 2009, Lemieux-Charles and McGuire 2006). Previous care coordination measures are, however, limited in their practical utility nowadays, because they involve time and cost intensive surveys that does not allow assessing the efficiency of health care systems on a large scale (Bynum and Ross 2013, Schulz et al. 2013). In the past, system-level care coordination has been impossible to measure. Recent availability of administrative data enabled researchers to develop new measures of care coordination applicable to system-level (Barnett et al. 2012, 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. The measure has been validated for predicting the existence of collaborative relationships among doctors by Barnett et al. (2011). This novel measure focuses on ties in which the number of shared patients are high—provider-level care coordination measure has not been developed yet. This study fills this gap—the care coordination measure developed here has the general practitioners as providers in its focus acknowledging their role as gatekeepers and patient care coordinators.

Assessing system level patient care coordination is as challenging as achieving it. This paper takes a leap forward in providing empirical evidence for the possible impact of patient care coordination—we investigate whether the type of collaborative relationship general practitioners have built up with specialists is associated with prescription drug costs. 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 (Barnett et al. 2012, Pollack et al. 2013, Uddin et al. 2011). Moreover, to the authors' knowledge, this analysis shall be considered as the first attempt to measure system-level care coordination in Europe, and the second one to assess a healthcare system with universal coverage (Uddin et al. 2011).

Methods

The Hungarian healthcare system is primarily publicly funded, through taxation. Its universal health coverage sets minimum standards and aims to extend access as widely as possible. Patients are free to choose their general practitioners, who act as gatekeepers for the secondary and tertiary care provided by specialists. The care of patients with chronic conditions is shared between general practitioners and specialists. In shared care, general practitioners act as first points of contact, for patients, and as gatekeepers, for secondary care, whereas specialists test, diagnose, and treat patients. When specialists initiate therapies with specialist medication, usually of high cost, general practitioners have to prescribe that medication for a time, usually for one year. To obtain prescribed medication, patients have to visit their general practitioners monthly, allowing general practitioners to filter out—and refer back to specialists—cases where the health status had worsened under treatment. General practitioners channel patients to healthcare providers designated by National Health Insurance Fund of Hungary as nearest to either patient or general practitioner. However, general practitioners can refer patients to any outpatient services in Hungary, provided that patients make such requests on referral.

We use prescription data for the years 2010-11 available from Doktorinfo Ltd, a health data collection and information services company based in Hungary. Twenty per cent of general practitioners practicing in Hungary feeds real-time prescription data into this database voluntarily—they are representative of the entire Hungarian general practitioner population in both age and location (defined by region and population size). General practitioners are compensated for providing information such as general practitioner identification number; prescription date; prescribed drug characteristics; International Classification of Diseases (ICD) codes; prescribed drug subsidy; patient characteristics (age and gender); and, since January 2009, for patients whose care is shared, identification number of the therapy-initiating specialist. The identification numbers of general practitioners and specialists enable the detection of collaborative relationships between prescribing general practitioners and therapy-initiating specialists.

In this study, we focus on diabetic patients aged over 40 whose care is shared between general practitioners and specialists. Diabetic patients are defined as patients who received at least one specialist drug from the A10 'drugs used in diabetes' subgroup of the Anatomical Therapeutic Chemical (ATC) Classification System—for example, insulin or an oral antidiabetic agent.
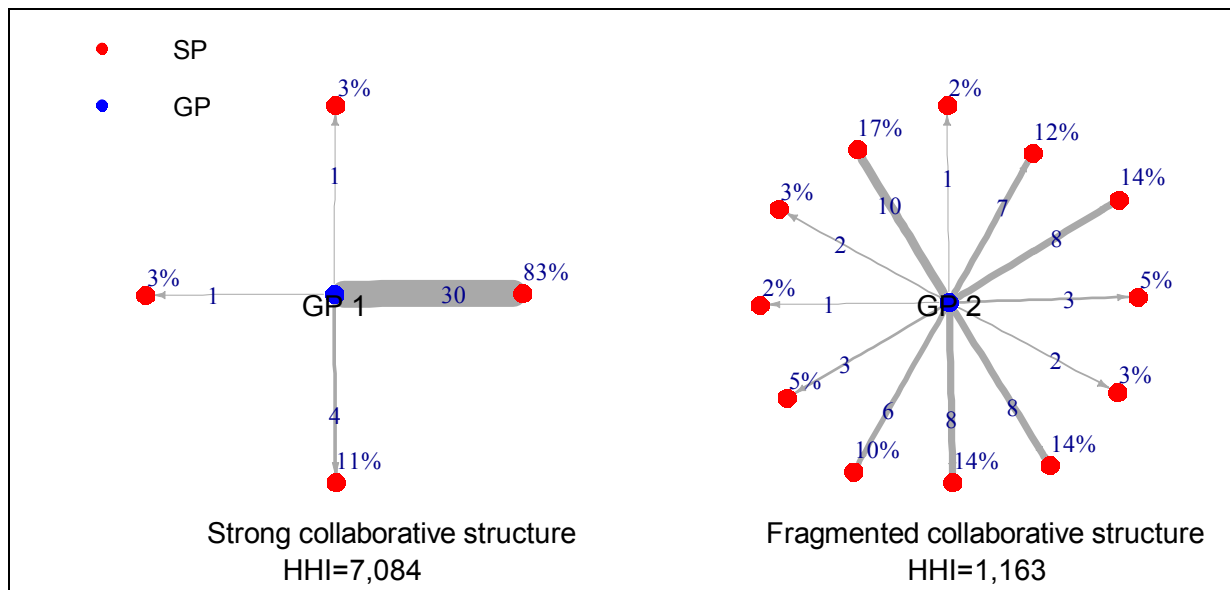
The formal collaboration between general practitioners and specialists is materialized in referral and prescribing of special medications. Similar to the recent studies (Landon et al. 2012; Pham et al. 2009; Pollack et al. 2013; Uddin et al. 2011), collaborative relationship between two doctors exists if they care for at least one patient together. This information is readily and unambiguously available from the prescription data, where the identification numbers of prescribing general practitioners and therapy-initiating specialists both appear on prescriptions.

The structure of collaborative relationships between general practitioners and specialists depends on both the number of specialists with whom general practitioners coordinate care and patient distribution across specialists. General practitioners channeling the majority of their patients to a few specialists build up strong, collaborative relationship with specialists, whereas general

4

practitioners channeling their patients to many specialists build up weak, fragmented collaborative ties.

The structure of collaborative relationships between general practitioners and specialists 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 general practitioner's patients shared with specialists (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 general practitioners, which implies stronger collaborative relationships among doctors. Figure 1, based on the sample data, shows examples for general practitioner–specialist collaborative structures. The number assigned to each link indicates the number of patients treated in that general practitioner–specialist connection, whereas the percentages indicate the proportion of general practitioner's patients treated in that general practitioner–specialist connection.

Figure 1 Strong vs fragmented collaborative structures

Strong collaborative structure
HHI=7,084

Fragmented collaborative structure
HHI=1,163

General practitioners build up strong collaborative relationship with specialists, if the HHI is in the uppermost decile; if HHI is in the lowest decile then general practitioners have weak, fragmented ties with specialists. General practitioners with strong collaborative ties may be strongly tied to more than one specialist. In this particular sample, general practitioners with a HHI higher than 6,258 qualify for strong collaborative relationship with specialists; whereas general practitioners with a HHI smaller than 1,743 qualify for weak, fragmented relationships. In additional sensitivity analyses we carried out, general practitioners with strong collaborative relationships were defined as general practitioners with a HHI in the top quintile/tertile, and general practitioners with weak, fragmented relationships as general practitioners with a HHI in the bottom quintile/tertile.

In a bivariate analysis, we first test whether the type of collaborative structure (strong versus fragmented) is associated with prescription drug costs. The skewed distribution of the collaborative relationship measure suggests a decile-based categorization. Prescription drug costs are measured as the sum of the retail prices for drugs prescribed by general practitioners—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. The cost implications of strong versus fragmented collaborative structures are evaluated using t-tests, considered significant if the p-value is less than 0.05. Sensitivity analyses are also carried out for the alternative definitions of strong and fragmented collaborative structures.

In a multivariate regression analysis, potentially confounding variables are controlled for—the variation in prescription drug costs across the patient lists of general practitioners is explained by the type of collaborative structure and potentially important patient characteristics such as age, diagnosis-based comorbidity index and type of treatment. Diagnosis-based comorbidity indices can be considered as proxies for patient health status—evidently, the higher the index, the poorer the health status. Vast empirical evidence shows that these indices are good predictors of mortality and of adverse events, such as amputation, hospitalisation, longer inpatient stay, and re-admission to hospital (Charlson et al. 1987, Lix et al. 2013, Quail et al. 2011, Quan 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. ICD-10 codes are employed to identify which of the comorbid conditions apply to the patients in the sample. To control for potential bias in ICD-10 coding, this study also measures comorbidity by counting the number of third-level ATC codes[4] on which the patient received at least one prescription semi-annually.

Results

The final sample includes 794 general practitioners and 318 specialists in endocrinology who shared care for 31,070 diabetic patients. Over the two-year sample period general practitioners issued 509,281 specialist medication prescriptions for antidiabetic agents and wrote an additional 3,575,726 prescriptions. A typical general practitioner treated 39 diabetic patients and wrote 1060 prescriptions for antidiabetic agents—14 prescriptions per patient per year. On average, a general practitioner coordinated care with eight specialists.

Table 1 compares characteristics of patients treated by general practitioners who built up strong collaborative relationships with specialists with those of patients treated by general practitioners who are connected to specialists with weak, fragmented ties. Table 1 shows mean values or proportions, as appropriate. Patients treated in strong collaborative relationships have more diabetes-related complications, receive less prescription for antidiabetic agents, and consult more frequently with their general practitioners. The two cohorts do not differ significantly in age,

---

4 The third level of an ATC code includes the main anatomical group (first level, one letter), the main therapeutic group (second level, two digits), and the therapeutic/pharmacological subgroup (third level, one letter), but excludes the chemical/therapeutic/pharmacological subgroup (fourth level, one letter) and the chemical substance (fifth level, two digits) (WHO 2003).

gender mix, type of therapy, number of prescriptions in total, or frequency of consultations with specialists. Two comorbidity measures (Quan-modified Charlson comorbidity index and ATC-based comorbidity count) indicate that patients in both cohorts have the same number of comorbidities. The other two comorbidity measures (Charlson comorbidity index and Elixhhauser measure) signal that strong, collaborative structures is coupled with less comorbidities diagnosed and treated.

Table 1 General practitioners (GPs) with strong collaborative structures vs weak, fragmented structure: patient characteristics

Patient characteristics	GPs with strong collaborative ties (uppermost decile)	GPs with weak, fragmented ties (lowest decile)	p-value
Gender (%)			
male	52.59	52.89	0.8140
female	47.41	47.11	
Average age	65.48	65.68	0.3293
Diabetes (%, based on ICD-10 codes)			
with complications	61.24	56.33	0.0000
without complications	38.76	43.67	
Treatment (%, based on third-level ATC codes)			
insulin based	71.18	71.26	0.9409
non-insulin based	28.82	28.74	
Comorbidity indices			
Charlson comorbidity index	0.88	0.94	0.0264
Quan-modified Charlson comorbidity index	0.59	0.58	0.5183
Elixhauser measure	1.92	2.01	0.0058
ATC-based comorbidity count	7.86	8.02	0.1749
Prescriptions per patient			
for all agents	127.41	130.05	0.2679
for antidiabetic agents	25.28	27.27	0.0000
Consultations per patient			
with the general practitioner, for all prescriptions	22.55	21.53	0.0023
with the specialist, for therapy-initiating prescriptions	2.33	2.471	0.0187

The bivariate analysis shows that the type of collaborative structure is associated with prescription drug costs—they are 5.88% lower for patients treated by general practitioners who build up strong collaborative relationships with specialists than for patients treated by general practitioners who are connected to specialists with weak, fragmented ties (Table 2).

Table 2 Bivariate analysis for general practitioners with strong collaborative structures vs weak, fragmented structure

Outcome measure	GPs with strong collaborative ties (uppermost decile, mean value)	GPs with weak, fragmented ties (lowest decile, mean value)	p-value
Prescription drug costs (based on retail prices as of January 2010; thousand Hungarian Forint)	586.58	623.22	0.0000

In Hungary, access to secondary care is regulated, free provider choice is restricted to the primary care level. One might argue that in small settlements, where the supply of specialists is smaller, general practitioners naturally build up strong collaborative relationships. Using settlement size as moderator variable, our results remained practically unchanged—prescription drug costs were lower in the three subsamples split by settlement size.

The finding that general practitioners 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 (Table 3).

Table 3 Determinants of prescription drug costs: multivariate regression analysis on type of collaborative structures and patient characteristics*

Independent variables		Standardized Coefficients	Sig.
		Beta	
General practitioner's collaboration with specialists	Strong, collaborative structure (0/1)	-0.020	0.001
	Weak, fragmented structure (0/1)	0.014	0.001
Quan-modified Charlson comorbidity index		-0.011	0.013
Patients' age		0.164	0.000
Patients' age squared		-0.261	0.000
Patients' gender (0-female, 1-male)		-0.024	0.000
Diabetes without complications/ with complications (0/1, based on ICD-10 codes)		0.015	0.001
Treatment method (0 - non-insulin based, 1-insulin based)		0.196	0.000
Prescriptions per patient for all agents		0.581	0.000
Consultations per patient (with the specialist for therapy-initiating prescriptions)		0.062	0.000

R^2=.408

* Variables excluded from the multivariate regression analysis due to high correlation (<0.6): Charlson comorbidity index, Elixhauser measure, ATC-based comorbidity count, Prescriptions per patient for antidiabetic agents, Consultations per patient with the general practitioner.

Most importantly, the multivariate analysis confirms that the type of collaborative structure is a statistically significant determinant of prescription drug costs. In addition to the type of collaborative structures, both the treatment method and the presence of diabetes complications is an important determinant of prescription drug costs—patients treated by the generally more expensive insulin and patients who have diabetes complications involve significantly higher prescription drug costs.

Discussion

Both bivariate and multivariate analysis confirm that prescription drug costs for patients treated by general practitioners who build up strong collaborative relationships with specialists are significantly lower than for patients treated by general practitioners characterized by fragmented collaborative structures, a major benefit for the society as a whole.

The significant difference in prescription drug costs is neither related to the total number of prescriptions patients receive, nor to the number of comorbidities diagnosed and treated, as measured by the Quan-modified Charlson comorbidity index or the ATC-based comorbidity count (Table 1). The difference cannot be explained by the severity of the diabetes as well, as our data suggests that patients treated in strong collaborative relationships tend to have more diabetes-related complications (Table 1).

The finding that collaborative structures affect prescription drug cost 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, Uddin et al. 2011). 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). This article finds empirical evidence for this association on system-level for primary care providers—association never tested in the literature before. Previous studies either assessed the results of patient care coordination on a small scale (Bosch et al. 2009, Lemieux-Charles and McGuire 2006), or did not focus on primary care providers (Barnett et al. 2012, Pollack et al. 2013, Uddin et al. 2011).

This study might bear important policy implications with regards to care fragmentation—general practitioners may struggle to coordinate care, if they should collaborate with more specialists as a result, and prescription drug costs would be higher. If future research shows that total healthcare costs are indeed lower for patients treated in strong collaborative structures when numerous other specialties are considered as well, then healthcare strategists need to advocate a healthcare system with lower care fragmentation. Offering completely free choice to secondary care providers, advocated in several developed countries, such as the United Kingdom and the Netherlands (Bevan and Van De Ven 2010), may increase care fragmentation by forcing general practitioners to collaborate with more providers. In counties with universal health coverage, lower care fragmentation might be achieved through offering patients limited rather than unrestricted choice.

In countries without universal health coverage, such as the US, healthcare insures should follow a narrow provider network strategy which would allow them to offer lower premiums. 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.

This study has a number of *limitations* worth future further exploration. First, sampling bias might be present due to general practitioners supplying prescription data voluntarily and excluding remote or recently opened/closed practices during data cleaning. Second, prescription drug costs are just one element of the total patient care costs—additional analyses are necessary to examine other elements, such as outpatient and inpatient costs, as main outcome measures. Third, the specialists analyzed in this article were all endocrinologists practicing in Hungary—future research needs to investigate results for validity with other specialties and countries. Fourth, diagnoses data entering into the comorbidity scoring is incomplete. If a diagnosis made by a specialist did not imply a further need for prescription by general practitioners, then the diagnosis was not listed among the patients' comorbid conditions. Fifth, lower prescription drug cost is only one aspects when the functioning of shared-care schemes is to be evaluated. Several other factors to be considered include, for example, potential improvement in clinical outcomes; the degree of participation by patients and healthcare teams; the long-term continuity of care; therapeutic adherence; and the level and ease of communication between specialists and general practitioners. Finally, we were unable to assess whether patients treated in stronger general practitioner–specialist connections perceived better care—or were more satisfied—than others.

Summary

In chronic illness care, many patient outcomes may only be achieved if the clinical activities of different health professionals—such as general practitioners and specialists—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 assessing the function of primary care at system level. In particular, a provider-level care coordination measure was developed, and the possible impact of different kinds of collaborative structures on prescription drug costs was measured. We found that prescription drug costs for patients treated by general practitioners who build up strong collaborative relationships with specialists are significantly lower than for patients treated by general practitioners characterized by fragmented collaborative structures. Overall drug expenditure may thus be reduced by lowering patient care fragmentation through channeling a general practitioner's patients to a small number of specialists. If future system-level studies in other settings confirm that total healthcare costs are indeed lower for patients treated in strong collaborative structures, then healthcare policy strategists need to advocate a healthcare system with lower care fragmentation on the interface of primary and secondary care. Regulating access to secondary care might result in significant cost savings.

Acknowledgements

References

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.

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.

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.

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

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.

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.

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.

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 (1), 146.

Quan H, Li B, Couris CM, Fushimi K, Graham P, Hider P, Januel JM, Sundararajan V. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. Am J Epidemiol. 2011;173(6):676–82.

Rhoades, S. A. 1993. Herfindahl-Hirschman Index, Federal Reserve Bulletin, 79, 188.

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.

Schultz, E. M., Pineda, N., Lonhart, J., Davies, S. M., & McDonald, K. M. 2013. A systematic review of the care coordination measurement landscape. *BMC Health Services Research*, *13*(1), 119.

Uddin, S., Hossain, L., Kelaher, M. 2011. Effect of physician collaboration network on hospitalization cost and readmission rate. *The European Journal of Public Health*, ckr153.

WHO. 2003. Introduction to drug utilization research. In: Essential medicines and health products information portal: a World Health Organization resource. WHO. Available at http://apps.who.int/medicinedocs/pdf/s4876e/s4876e.pdf (accessed date December 11, 2015).