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NETWORKS IN HEALTH CARE

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Introduction

'People are interconnected,
and so their health is interconnected.'
(Smith – Christakis [2008], pp. 405.)

Our world is composed of a system of intricate networks, which can be equally detected within the elementary cells of the human body as well as in the universe created by ourselves. There are theories which interpret the relationships within human beings as segments of a large social network. Therefore, we are all participants in social networks around our private and professional lives. The initial realization of the fact that with our efforts combined we are better able to reach our common goals and objectives has lead to the creation of collaborative institutions which, in turn, has inevitably resulted in the proliferation of inter-personal networks. Therefore, the system of social networks is recognizable in the entirety of public administration as well as in its particular institutional entities, and similarly, in the relationship between business organizations and their employees. Likewise, networks play an essential part in the collaborative activities conducted by health care professionals and govern their relationship with patients and their relatives. This dissertation addresses systems of relationships which are characteristic for networks evolving among physicians.

The system of relationships in health care constitutes an exceptionally complex and extensive network. The system of relations among health care professionals, patients and medical institutions represent a network of ties providing for its integrity and depth. In order to provide a sufficiently informed and thorough view of the network studied, the scope of my dissertation, by necessity, had to be narrowed down to one selected area. Since a comprehensive study of the system as a whole would have extended the space available for the present dissertation.

In my thesis I analyse and describe the nature and functioning of the professional networks developed among general practitioners and specialist as a result of ties established between doctors and patient while provisioning medical services. The subject of my research is the impact of this network on the patient health on the one hand and pharmacy costs on the other.

The weight of the issue studied depends on the data utilized. In attempting to obtain a view on the merits of shared care, I first set out to identify the forms of collaboration between general practitioners and specialists which are required in referring the patient to a specialist and in the post-prescription[1] of medication. I defined the strength of ties between doctors in accordance with the number of patients receiving care by the same two doctors. These professional ties were analysed with reliance on prescription data recorded. Thanks to the database, all ties between physicians figuring in the database can be mapped with great accuracy.

Relying on prescription data recorded by general practitioners, it becomes possible to map up and analyse the formal networks connecting general practitioners and specialists. In the research presented, I endeavour to resolve the question whether or not the quality of the ties among general practitioners and specialists - depending on the effectiveness of communication and collaboration between them - has a significant impact on the delivery of medical care.

In my empirical research I first address the question whether general practitioners and specialists maintaining close professional ties with each other - at comparable patient health levels as a minimum - are successful in reducing pharmacy costs. Should it be concluded that the pharmacy costs - at least when assuming comparable levels of patient health status - are significantly lower in strong general practitioner-specialist ties; then obviously the creation and maintenance of such ties serve the best interests

[1]In a shared care system, the general practitioner refers the patient to the specialist who, in turn, identifies the medication required in the therapy of the patient, after which - on the recommendation of the specialist - the same pharmaceutical products will be regularly prescribed by the general practitioner. This part of the process is referred to with the technical term ‘post-prescription’.

of all parties concerned. In accordance with the foregoing deliberations, it appears that the simultaneous exploration of two hypotheses is required as presented below:

H1: The health status of patients treated in strong-ties general practitioner-specialist relationships tends to be better.

H2: The pharmacy costs carried by patients treated in strong-ties general practitioner-specialist relationships tend to be lower.

The novelty of my research is not only evidenced by the fact that no similar studies have been pursued and published in reliance on quantitative methods but also that no attempt has been made so far in the professional literature of the field to provide a simultaneous and interdependent presentation of the above two hypotheses.

As regards to the first hypothesis, certain research projects have been conducted on the field in the United States of America. In particular, Barnett et al. [2012] and Pollack et al. [2013] concluded that in an environment where one doctor provides treatment for a patient with the collaborative care of a small number of other doctors, such collaboration will result in an improved patient health status - probably on account of a more efficient exchange of professional information and the better management of the health care process. These findings are supported by the systematic literature reviews of Lemieux et al. [2006] and Bosch et al. [2009] where the authors conclude that close ties among doctors providing shared care result in enhanced clinical performance and a better health status for the patient. In summary, it can be stated that similar research projects have only been conducted outside Europe and even those have fell short of addressing the health care systems of other countries. The research performed by Pollack et al. [2013] stand closest to my thesis. It is important to note, that the results of research carried out outside Europe are not applicable or transferable to Hungary due to substantial differences between the health care systems. Nonetheless, the methodology employed in previous research projects may well provide a useful background for this research.

The second hypothesis relies on the assumption that in cases where doctors share the treatment of a large number of patients, pharmacy costs will be reduced. Examining the treatment of diabetes Walraven et al. [2010] have pointed out in their systematic literature review that improved coordination of medical care results in a decrease in

the usage of health care services; especially in the area of inpatient care and emergency care. Barnett et al. [2012] and Pollack et al. [2013] have shown that the cost of care provisioning for those patients whose doctors work with a number of other patients in a shared care environment are lower when compared to other settings, probably due to more efficient collaboration among the physicians involved. The reduction of pharmacy costs is an important objective considering the fact that within the expenditures laid out for medical services - in treating diabetes as an example - the share of pharmacy costs exceeds more than 20% of the total costs (Pollack et al. [2013]).

Should we find that the health status of patients treated in strong general practitioner-specialist relationships is better or at least equal to those treated in weak general practitioner-specialist relationship then it is important to understand the reasons of such improved performance. Such understanding may help developing strategic recommendations for healthcare strategists seeking to create and strengthen efficient ties between general practitioners and specialists.

In order to understand better the relationship among doctors participating in shared care arrangements, it is important to investigate whether such relationships are dominantly created between general practitioners and specialists of similar professional characteristics. In addition, it also appears necessary to evaluate the differences between the typical professional characteristics of general practitioners working in a concentrated referral environment as opposed to those working in a non-concentrated referral environment; and likewise: to assess the differences in the professional traits of specialist of preferred referrals as opposed to those providing care on non-preferential referrals. I expect of the described elaborations to obtain results showing substantial differences in the nature and quality of the various sets of relationships between general practitioners, on the one hand, and specialists on the other. Such recognized differences would enable drawing policy recommendations aiming at an enhanced level of collaboration between general practitioners and specialists assuming that enhanced collaboration results in lower pharmacy costs. Following this argumentation, the following hypotheses have to be tested:

H3: Doctors having strong ties to one another share many similarities (homophyly).

H4a: Based on their characteristics, general practitioners maintaining a concentrated referral structure can be differentiated from those maintaining a dispersed referral structure.

H4b: Based on their characteristics, preferred specialists can be differentiated from those defined as non-preferred.

My research focuses on the impact of the strength of ties between general practitioners and specialists developed in the practice of shared care on the health status of the patient and the costs of medication. My research focuses on the impact of the strength of ties between general practitioners and specialists developed in the practice of shared care on the health status of the patient and the costs of medication. The significance of the present thesis may lie in investigating the way general practitioner-specialist professional networks actually operate and its economic policy implications. By understanding these networks, healthcare economists and politicians might be able to strengthen those relationships which enhance the probability of providing for lower pharmacy costs at comparable or improved health care quality standards. Therefore, understanding these relationships ought to be seen as serving important social objectives.

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1. Literature Review

My objective in the following chapter is to explore the relation of the present study with findings presented in earlier publications on the subject. The chapter is divided into two parts: in the first, I discuss the various types of networks as they occur in health care, thereby also marking the principal directions of the scrutiny undertaken in this area. Secondly, I attempt to provide an overview of the networks operating in health care systems with a special focus on networks created in shared care practices. In the following, I am not going to offer a systematic literature review analytical overview of the scientific papers and studies published on my subject; rather: I attempt to review references provided in the bibliographies or relevant research publications which then formed the core of the literature used for my own research.

1.1. Types of networks operated in health care

Health care networks belong to a variety of categories. With such participants as doctors, patients, relatives, health care institutions, government agencies, medical equipment producers and the exponents of the pharmaceutical industry, virtually any number of networks could be conceptualized. My objective in this sub-chapter is to review the relevant literature on health care networks to define network categories as applicable to health care services, as well as to identify recognizable network types within the same categories.

1.1.1. Economic theory background

The theoretical background for my dissertation is provided by the theory of inter-organizational relations on the one hand, and networking theory on the other. The main purpose of publications focusing on inter-organizational relations is to describe and analyse patterns of cooperation among the actors of the economy defining the origins, the objectives and characteristic features of the studied relationships (Cropper et al. [2008]). The collaboration is a process in which the participants work jointly towards achieving common goals and objectives (Mattesich – Monsey [1992]). As a result of the collaborative process, the parties obtain rewards which they would not have been able to achieve relying solely on their own individual efforts. A number of research

papers present findings in support of the cited conclusion (for example: Balakrishnan – Geunes [2004], Cropper et al. [2008], Peng et al. [2014], San Martín-Rodríguez et al. [2005]). In my dissertation, I concentrate on institutions providing general practice medical services on the one hand, and specialized medical services on the other, as examples of participating organizations, while presenting general practitioners and specialists as collaborating parties working jointly for the objective of providing improved health care services for their patients.

Networking theory has long played an important role in the research of organizations. Borgatti and Foster [2003] provide a detailed analysis on the scope and focus of projects related to organizational research using the methodology of networking relations analysis: of which a short summary is included in Hungarian in the exhaustive study published by Csizmadia and Grosz [2011]. Borgatti and Foster [2003] identify eight areas of organizational research where the network paradigm demonstrably applies: social capital, embeddedness, network organizations, board interlocks, joint ventures and inter-firm alliances, knowledge management, social cognition, and a catch-all category. The broader context of this research - possessing a narrower orientation - is offered in the subjects of relational approval (embeddedness) and social capital since the object of my scrutiny is the impact of the closeness (strength) of ties among the exponents of the medical profession (general practitioners on the one hand, and specialists on the other) upon patient health status and pharmacy costs (social capital expressed in enhanced performance). Economic sociologists have addressed, for some time, the influence of relational approval on economic performance, including the effectiveness of operations. The systematic literature review compiled by Smith-Doerr and Powell [2005] has shown that interconnections between organizations exert a simultaneous influence on economic performance and on the effectiveness of distribution mechanisms as well as on the propagation of information. Following the typology of Smith-Doerr and Powell [2005], in this dissertation I investigate the issue of interconnections as a determinant of performance levels. Csizmadia and Grosz [2011] make a point of demonstrating that the majority of empirical studies are dedicated to the issue of relationships as exercising either a positive or a negative influence on performance levels.

1.1.2. Investigation health networks

Network analysis is an approach to research that is uniquely suited to describing, exploring, and understanding structural and relational aspects of health (Luke – Harris [2007]).

Varda et al. [2012], in their systematic literature review, came to the conclusion, that a decisive majority of research papers describing the functioning of networks operating in health care systems are focusing on the analysis of collaborative structures by mapping the interconnection of networks. The authors of such studies were usually successful in converting their findings on collaborative partnerships into strategic recommendations for health care policies serving eminent social objectives.

Luke and Harris [2007] define the four elementary components of network analysis as follows:

1. Network analysis is a structural approach that focuses in part on patterns of linkages between actors;
2. it is grounded in empirical data;
3. it makes frequent use of mathematical and computational models; and
4. it is highly graphical.

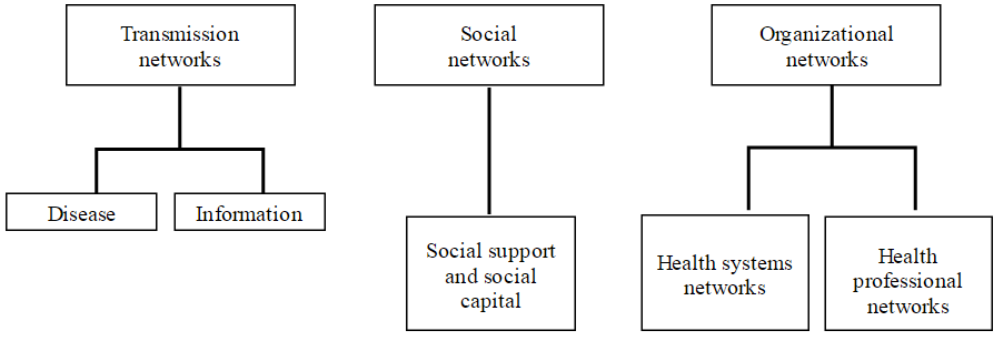
The novelty of exploring health care networks lies in the manner of approach, namely in the fact that it undertakes a scrutiny of interpersonal relationships. Thanks to this methodology, it becomes possible for us to understand and describe relationships the nature of which would remain undetectable when applying other means and methods. In some of the cases, the review of the mere topology of the network may provide new insights. This approach appears to be highly popular among researchers up to our days and - in my view - they will continue to be helpful in resolving a host of significant exploration issues.

In my dissertation, I intend to rely on Luke and Harris [2007] when setting out to provide a classification of heath care networks. According to the authors, three primary sub-networks can be distinguished: transmission networks, social networks built around patients, and organizational networks (Fig 1.).

Transmission networks can again be divided into two main parts: the propagation of diseases and the propagation of information. Social networks built around diseases assume that patients - in reliance on their social capital - receive assistance and support from their acquaintances and relatives. The organizational networks mean networks created by the system itself. The organizational networks can again be divided into two main components: health system networks, health professional networks (Luke – Harris [2007]) (Fig. 1).

The three network types can easily recognized from each other: on the basis of absorbed directives, on the one hand, and along the features of the relationships thus created, on the other. In the case of transmission networks the provider and the recipient can be clearly identified. Usually we talk about the transfer of a disease or a set of information items. The network is thus created as an outcome of one unique instance of a one-way transfer event. In the case of social networks built around patients the direction of the transfer and the role of the participants cannot be defined in such a simple manner. Such relationships constitute systems with an ambiguity of transfer directions and continuously changing frequencies of transfer events. In the same instance examined, one of the participants may function equally as a provider or as a recipient. Networks emerging in health care systems are usually characterized by relationships organized top-down. Relationships connecting individuals are rarely shaped by the choice of the persons involved.

Figure 1. Classification of networks occurring in health care



Source: Luke – Harris [2007] figure 5. (p. C-03.)

In the following subsections, I am going to present in some detail the sub-networks shown in figure 1. My objective is to identify the scope of my own research in the spread of networks detectable in health care services.

1.1.3. Transmission networks

As has already been discussed, transmission networks can be classified under two headings: networks of disease propagation, and networks of information propagation. Most studies in the field of health care economics address the topic of networks emerging in the propagation of diseases.

In the case of transmission explored with respect to the propagation of diseases the connection is provided by the pathogenic agent responsible for the infection being transferred from one person to another (Friedman – Aral [2001]). A considerable number of studies and systematic literature reviews have been published on exploring and predicting the propagation of infectious diseases (such as Klovdahl et al. [1994], Hufnagel et al. [2004]).

The 2007 World Health Survey Report of WHO [2007] also called attention to the global public health exposures of the 21st century. Due to the accelerated mobility of people, contagious diseases pose a threat of spreading across continents with extreme rapidity (WHO [2007]). Looking back on the past few years, we may recall the threats of ebola or avian influenza, while the threat posed by sexually transmitted disease was not less severe. The forecasting and the mapping up of the networks concerned serve fundamental social interests.

The scope of the present dissertation is not designed to include a discussion on the effects of transmission networks as related to the propagation of diseases nor that of information.

1.1.4. Social networks created around patients

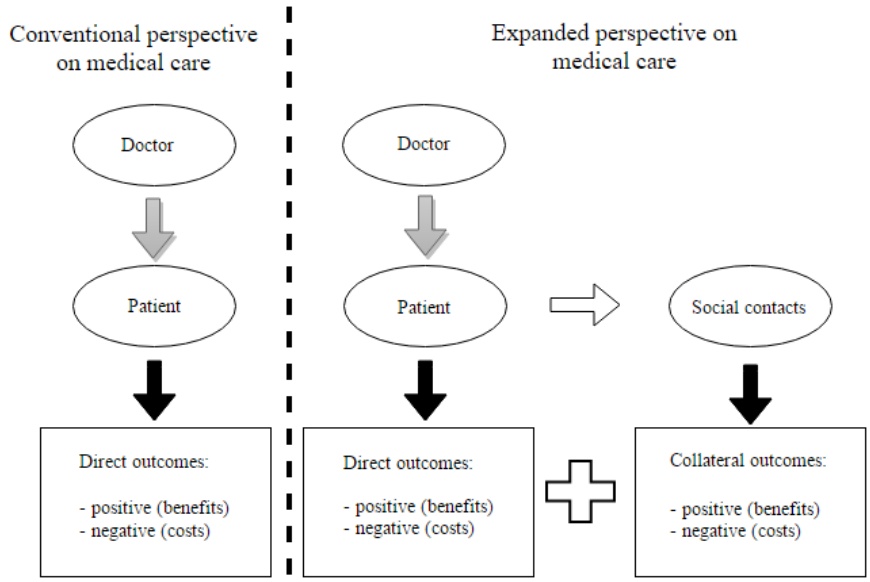
This subsection discusses the subject of social networks created around patients, in the absence of which, with regards to a significant number of patients, the health care

system could not function properly, or the delivery of its expected functions would be much costlier.

Christakis [2004] argues that while in the research work conducted by engineers, biologists and sociologists the network approach is broadly employed; it receives significantly less attention, as an applicable tool, from health care and medical researchers. It ought to be remembered, however, that it is not sufficient for health care systems to respond solely to the needs of individuals; it is equally important to address issues related to the system of social networks applying to those individuals (Smith – Christakis [2008]).

The social relations of individuals exert a positive influence on the health care system as well as on the health status of the patient (Fig. 2). As viewed from a traditional aspect, the physician is linked to the health care system through the patient. Through this relationship, the therapy provided may produce positive changes in the health status of the patient, while certain expenditures shall be inevitably incurred in the process. In the expanded model, the physician is not only connected to the patient but, indirectly, also to the system of relationships maintained by the patient, which adds the component of a social network created around the patient, complementing the narrower view and offering meaningful benefits (Christakis [2004]). It the circle of family and friends, people my provide help in the therapy by the procurement of medicines and supervising compliance with the prescription. Chattering with neighbours, taking a stroll with friends may contribute to the success of therapy. It ought to be pointed out that this junction, that what we have just said does not apply to senior persons only, suffering from chronic ailments, but the same can be true for young patients, wearing orthopaedic casts after a bone fracture. Friends and relatives may provide important help in performing daily routines.

Figure 2. Collateral health effects of medical care in social networks



Source: Christakis [2004] figure 1. (p. 184).

Cammack and Byrne [2012] provided further elaborations on the role played by social networks created around patients as applying to health care systems. They drew up a model for health care which largely relies on and reflects the latest technological innovations. Using the Christakis [2004] model as a point of departure, we regard the emergence of applications capitalizing on the social relations of patients in order to further health care objectives as carrying remarkable significance. Cammack and Byrne [2012] present a software product appearing to combine the functions of a community site, a file manager and an agenda organizer. The functions of the software include a feature within the organizer which emits a signal reminding granny to see the doctor the following day. Simultaneously, the software notifies relatives that grandma needs to be seen to the doctor the next day. As for the document manager of the program, it files the latest medical reports and it is capable of handling and storing test results. It also may allow access to the same readings and results to close relatives.

This dissertation will not discuss or analyse social networks created around health care patients.

1.1.5. Networks within the health care system

A number of networks have been created within the health care system among institutions mainly as a consequence of the centralized transfer of patients. In this dissertation, I do not focus on the nature of networks connecting institutions, much rather the relationship maintained among professionals working on the staff of particular institutions (Fig. 1.) My thesis intends to explore the characteristics of networks linking general practitioners and specialists as they develop in the process of providing care for patients jointly.

In the relevant literature we encounter a number of various classifications describing health care networks. Chambers et al. [2012], in their systematic literature review of research papers on the subject, apply a classification of such networks as functioning in primary care; outpatient care; and thirdly in other service areas. Exploring the subject, I concluded that social relations developing among medical doctors have generated a lesser degree of attention by researchers than other aspects informing their collaboration. Studies published to date are dominantly descriptive in nature when presenting the various types of networks connecting participants. In my assessment, the apparent lack of in-depth analyses and professional policy recommendations could be explained by the fact that in the preceding period researchers have not attributed notable significance to such networks.

Ranmuthugala et al. [2011], in their systematic literature review, explored the practice of interactive communication techniques applied by professionals representing different positions. The central issue they concentrated on concerned the mode of sharing knowledge between members of the professional staff, and how imparting such knowledge serves the objectives of the organization they work for. The authors came to the conclusion that the mode of communication among professionals show differing patterns depending the form of service they participate in. They emphatically propounded that for the benefit of health care it is important to get a good and reliable grasp on the functions and the internal procedures taking place within the described networks, and further: to support the expansion and continued development of networks displaying effectiveness in operation.

Cunningham et al. [2012] in their comprehensive review of professional literature on healthcare networks, presented three central conclusions: firstly, it is essential to acquire a thorough understanding of the parameters and structural properties of professional networks; secondly, to gain sufficient insight as to the mode of operations displayed by the same; and thirdly: it is well worth the while to invest time and effort into the nurturing of professional relations since such efforts will be lavishly recovered. The authors also made the point that a better understanding of the functioning of networks will be conducive of improved service levels.

The three systematic literature reviews referred to above show a number of similarities:

On the one hand, the authors conclude that - due to their complexity - health care systems typically breed a large number of networks sustained among professionals. However, in the various spheres of health care these networks show substantially different traits. On the other hand, researchers appear to share the view that such networks positively contribute to achieving health care objectives. Thirdly, the cited researchers equally asserted that the majority of scholarly papers and reviews published on the subject tended to provide a descriptive presentation of the networks studied as opposed to providing in-depth analyses. Fourth: they have similarly emphasized the belief that - relying on network theories and techniques - a more acute exploration and understanding of networks operating in the various segments of health care systems, is expected to offer meaningful advantages. The authors agree that the application of the techniques referred to would be supportive in developing professional policy recommendations thereby contributing to the emergence of enhanced effectiveness in health care systems.

With the objective of filling in a recognized gap in scholarly literature, as described above, this thesis undertakes to explore the functioning of networks created among medical doctors in Hungary. The present paper attempts to provide an analysis on relationships developing between general practitioners and specialists in shared care practices. My research focuses on the impact of the strength of ties between general practitioners and specialists, as participants in providing shared care, on the health status of the patients and on pharmacy costs. Beyond a descriptive presentation of related networks, my study also attempts to offer policy recommendations in reliance on the findings deduced.

1.2. Health professional networks

In this subsection, I intend to provide an introduction to the structural frames within which the relationship between general practitioners and specialists are studied and analysed for the purposes of the present paper, namely: the shared provisioning of health care services. It is worth noticing that the relationships forming the object of my scrutiny have developed as consequence of supplying shared care services. In the second half of the present subsection, I provide an overview of research projects addressing collaboration structures between general practitioners and specialists and therefore standing closest to my own field of studies.

1.2.1. Shared care

In the following section, I first propose a definition of the term of shared care (1.2.1.1.). Subsequently, under points 1.2.1.2. and 1.2.1.3., I discuss the various forms of shared care as practiced in Hungary, alongside with an analysis of the Hungarian health care system. In the concluding part of the chapter, I submit some comments on the advantages and challenges related to providing shared care for patients.

1.2.1.1. Definition

Among researchers contributing to the subject, Moorehead [1995] offered a broad definition of the term ‘shared care’.

‘Shared care has been defined as a service which uses both the skills of a general practitioner and another health professionals who share joint responsibility in relation to an individual’s care. This also implies monitoring and exchanging patient data and sharing skills and knowledge between disciplines’ (Moorehead [1995], p.1985.).

Hickman et al. [1994] offer another definition of a narrower angle focusing on patient care provided jointly by general practitioners and specialists:

‘Shared care, for the purposes of the survey, was defined as ’the joint participation of GPs and hospital consultants in the planned delivery of care for patients with a chronic condition, informed by an enhanced information exchange over and above routine discharge and referral letters’ (Hickman et al. [1994], 447-448. pp.). In the further part

of this dissertation, I am going to rely on the definition provided by Hickman et al. [1994].

The essential trait of shared care is that physicians representing different medical disciplines assume joint responsibility in the treatment of a patient, providing the best therapy available and employing the full capacity of their professional knowledge and experience; utilizing the synergies of the disciplines involved. It may be interesting to note that Hickman et al. [1994] make no references to the question of service quality in their definition.

Nor does this reference occur in the other definitions cited earlier. Yet, it is important to stress that, as a consequence of introducing shared care, the work load on specialists will be reduced since certain routines, such as regular reviews and raising prescriptions, will be taken over by general practitioners. Thereby also easing the load on both primary and secondary care. Reducing the load on these service areas, as indicated, will be instrumental in reducing the overall costs of health care (Greenhalgh [1994]).

1.2.1.2. Varieties of shared care

Shared care first occurred as a form of therapeutic practice in the early '70's in some English municipalities. Greenhalgh [1994] handled shared care research efforts as falling into two basic categories: those concerned with non-randomized- as opposed to those concentrating on randomized patient groups. Projects falling into the second group (randomized) were concluded in the 1980's. The introduction of shared care practices was rarely initiated by administrative superiors, rather, it happened the other way round. In the late '70's, for instance, general practitioners have started to participate in the isochronous treatment of diabetes patients, at the request of specialists taking over routine charges. In Chester, a pilot project was launched in 1985, providing shared care for 100% of patients. This project primarily addressed the health status of the patients: concentrating on the changes occurring as a result of shared treatment. The findings of the project have shown that the health status of patients had deteriorated in some cases (as in Cardiff and East Fife); remained unchanged in some other cases (such as Grampian, Wolverhampton), while in some further cases, a notable improvement was observed (Islington, Sydney) (Greenhalgh

[1994]). In summary, it can be established that, in the period studied, shared care systems still carried a number of deficiencies; while in certain townships, decisive improvements were recorded in the health status of patients thanks to the collaborative efforts of medical professionals.

The most common way of classifying shared care profiles is based on the respective employee statuses of the professionals involved. In this dissertation, I follow the classification method presented by White [2010] in discussing the various forms of shared care for patients:

- Shared care in primary care
- Shared care in secondary care
- Shared care based on communities

Shared care in primary care denotes a mode of cooperation between the general practitioner and the general assistant or the specialized assistant (Smith – Campbell [2004]), or respectively, with the specialized assistant and/or a multidisciplinary team (Vjrijhoef et al. [2002], or with an obstetrician or midwife (Lombardo – Golding [2003]). In Hungary, the assistant is employed by the general practitioner; therefore the notion of 'collaboration' is not really opportune. In this context, it should be appropriate to recall the observation of Orosz [2001], according to which: 'In Hungary, there is an obvious lack of collaboration between general practitioner services and the other primary care service branches (such as health visitors, school practitioners, paediatricians, etc.). Furthermore, the relationship between primary care and social care is also less than satisfactory' (Orosz [2001] p. 204). Some Hungarian projects are currently under way, serving the objective of developing a more fruitful set of interconnections among the exponents of primary care (TÁMOP, Swiss model[2]) (Horváth [2015]).

As to shared care practices within secondary care: here therapy is provided jointly by the general practitioner and either the specialist practitioner, or the hospital (or

[2] For a detailed discussion of the Swiss model, see the thesis: on the subject: Kiss [2016].

specialized clinic) (Hobbs – Wilson [2004], White [2001]). In this latter case, for instance, treatment starts in the hospital but further care is provided largely by the general practitioner playing an important role in follow-up monitoring and performing regular reviews of the patients' health status. Currently, this system embraces the whole of Hungary. Patients regularly see their general practitioner with their latest test results and medical reports, and also in order to obtain new prescriptions; and equally importantly: to receive paid-leave certificates.

In shared care practices based on communities, participation in providing care extends beyond the partnership of physicians and medical personnel to include family members (Lindsay et al. [1998]) and also organizations that typically provide assistance in hone care (Andrews – Hood [2003]).

The accepted classification of shared care practices also indicates that- while providing important support for specialists - general practitioners can also become recipients of meaningful assistance ensured in the framework of community care. The TÁMOP project and the Swiss Model place the primary health system in a new dimension. In this environment ‘the stress is placed on the risk management aspect of public health services’ (Horváth [2015]).

It ought to be emphasized that the function of general practitioners could not be effectively delivered without the participation of their colleagues working in other specializations. My dissertation intends to provide an analysis of the partnership of general practitioners and specialists as emerging with the practice of providing shared care for patients, therefore, in the following section, I propose to draw up a detailed view of the domestic system.

1.2.1.3. Shared care in Hungary

The Hungarian health care system is primarily financed from tax revenues and compulsory health insurance contributions. Access to health care services is universal

in the broadest sense. In Hungary, the National Health Insurance Fund of Hungary (NHIFH) provides pecuniary and in kind services for the insured (NHIFH [2015]).[3]

In Hungary, for patients with chronic ailments, health care is provided for in the form of shared care performed jointly by general practitioners and specialists. In an earlier period, up to the 1990's treatment for diabetes patients in Hungary was provided by hospitals, absorbing very considerable financial outlays especially in covering the costs related to multi-day hospitalizations required for adapting medication, and the stabilization of the patient's condition. Also, the specialist was expected to conduct regular medical checks upon each three months elapsed, and prescribe the pharmaceutical products as required.

In our days, 'intermittent or continuous outpatient care is provided by the specialist, either on the referral received from the general practitioner, or following up on the patient's personal and direct call, in cases of chronic ailments not requiring hospitalization' (NHIFH [2016]). The division of tasks between specialists and general practitioners reduces the workload placed on the specialists due to a lesser number of patient visits (once or twice a year as generally expected); at the same time the load is increased with regards to general practitioners since they will have additional patient encounters monthly or bimonthly, as required, for the prescription of pharmacy. General practitioners are well positioned to observe and monitor the health status of patients calling at their office once a month or once in every second month. In cases when a significant decline is observed in the patient's health status, and thus the inadequacy of the therapy applied becomes apparent, general practitioners have the option of returning the patient to the specialist handling the case.

The governing rule is that general practitioners are expected to refer their patients to the nearest medical institution (appointed by NHIFH) which provides outpatient care when the need arises. 'The patient is accorded the right to choose physicians, accordingly: the patient is entitled to request the replacement of the doctor appointed for his case in accordance with the internal regulations of the health care institution; to

[3]It is important to note that on the force of the Government Decision 1312/2016. (VI. 13.) Supplement 1., the National Health Insurance Fund of Hungary is to be dissolved and replaced by a merger into its legal successor the Ministry of Human Resources with the date of 31 December 2016.

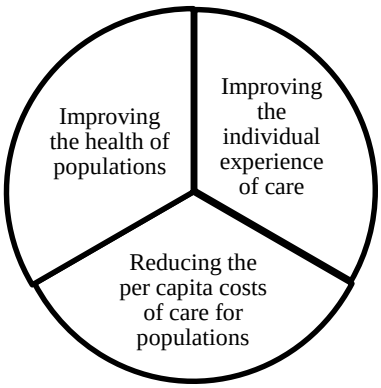
be replaced with another doctor of the patient's own choice - unless such a free choice be excluded by the physical condition of the patient, and/or the restricted availability of medical instruments and expertise. The choice of the physician must be confirmed in a written document signed by both the insured party and the doctor selected' (NHIFH [2016]).

1.2.1.4. The advantages and challenges of shared care

Berwick et al. [2008] unveiled a concept of three connected objectives (using the term 'triple aim' describing three conditions which, by necessity, must be met by any health care system (Fig. 3).

In the development and structuring of health care systems, three objectives must be kept in view: improving the health of populations; improving the individual experience of care; reducing the per capita costs of care for populations. It ought to be remembered that we must serve the three interconnected objectives simultaneously as we design and restructure our system. Unavoidably, we must provide for the continuous monitoring of the health status of patients alongside with the indices of service quality and the data reflecting the cost of services (Berwick et al. [2008]).

Figure 3. Triple aim



Source: Berwick et al. [2008].

Public health strategists are recently paying an increased amount of attention to the issue concerning the integration of primary and secondary care practices. They appear to believe that the desired integration will contribute to enhanced service quality levels

by eliminating a number of administrative encumbrances, improving communication among health professionals and helping to approach an optimal division of duties between general practitioners and specialists. In the final count, the effective integration of primary care and secondary care practices may contribute to a meaningful reduction of health care expenditures. A key element of the integration process is certainly offered by the introduction of shared care for patients suffering from chronic illnesses.

While offering a number of advantages, shared care also poses numerous challenges for health policy designers. Table 1. shows the relative advantages and challenges inherent in shared care as drawn up in the systematic literature review published by Millar and Drasic [2005].

Table 1. Advantages and challenges of shared care

Benefits	Challenges
- Reduced fragmentation of care; that is, a better integrated, more continuous system of care - More efficient use of scarce resources and related cost efficiencies - Strengthened links between primary, secondary and tertiary sectors - Improved working relationships between providers - Improved satisfaction among patients and providers - Increased patient access to care	- Power and status differences between health providers (e.g. between nurses and GP's, or GP's and medical specialists) - Professional territorialism and perceived threat to professional autonomy and/or scope of practice -Current funding arrangements that require the GP to see each patient in order to receive service payment/reimbursement -Dedicated time and personnel to implement and manage shared-care - Limited methods to measure shared care

Source: Millar – Drasic [2005] (p. 9).

Shared care exhibits a multitude of positive features but without appropriate incentives it may produce disappointing results. Among the advantages of shared care, I would emphasize the potential of this practice for improving the overall cost effectiveness of health care systems. A further advantage to mention in this context that - through a more intensive communication between professionals - it may strengthen the relationship among the various levels of health care. The implementation of shared care practices will bring welcome change for doctors and patients alike since this practice reduces the load on specialists while providing improved quality of care for the patients. On the other side, shared care is unable to function properly if the general practitioner does not have sufficient time for shared treatment since this mode of health care involves added burdens for the general practitioner. It is important to avoid the emergence of status rivalry as an effect of sharing responsibilities. In some cases, the specialist may have the impression of releasing control over the health status of the patient. The lack of well designed incentives will understandably lead to tensions on which the success of the collaboration may depend. In arrangements offering remuneration for the participating doctor subject to actual visits made by the patient at his/her practice then, even with the availability of updated electronic software products, as recommended by health strategists to ensure an amplified flow of information - it appears safe to assume that practitioners will check the test results and status reports of the patient not before he/she actually makes a personal call at the doctor's office. Finally, I would call attention to the important challenge inherent in the limitations of measurement techniques, namely: it is hard to establish with a sufficient degree of exactitude as to how the health status of the patient changes due to results attributable to shared care practices.

I also wish to add as a reminder that I deliberately avoided captioning this section as ‘advantages and disadvantages’. Keeping in mind the ‘triple-aim’ formula: improved service quality will contribute to the better health status of patients while reducing the overall expenditures of the service. Following this blueprint, we should talk about ‘challenges’ instead of ‘disadvantages’. Such challenges can be successfully responded to by appropriate, well designed policy measures.

1.2.2. Collaboration between doctors

This dissertation is set out to explore relationships and networks developing between general practitioners and specialists in the course of creating and operating shared care practices. Related to this objective, in the subsequent paragraphs I am going to present an overview of studies and articles on the subject as related to the empirical approach employed in my own analysis.

The findings of the systematic literature review published by Lublóy and Váradi [2013] imply that the selection of medical specialists by general practitioners is usually based on the assessment of the following traits:

- SP medical skill;
- Patient experience of and satisfaction with SP
- GP's personal knowledge of SP
- Quality of SP communication with GP
- Patient access to SP
- Patient request of SP

It is important to note that, in Hungary, the selection of a specialist is not necessarily based on the general practitioner's decision. The patients can exercise the right to select a specialist and to advise the general practitioner on their selection. On the first occasion of making a choice, patients are usually guided by the accounts of acquaintances. The primary considerations, when selecting a specialist comprise information received on the personal affability of the doctor, accuracy and reliability in the timing of visits, accessibility, service quality, professional acumen, and certain social and demographic aspects of demeanour (Lublóy – Váradi [2013]).

As a result of the patients' freedom in choosing a specialist, the nature of the relationship between the general practitioner and the specialist is not necessarily decided by the general practitioner's choice but it is necessarily shaded by the patient's own decision. I am inclined to assume in my analysis of the strength of general practitioner-specialist ties that shared care arrangements involving a relatively low number of joint patients have developed largely as a consequence of the patient's choice in assigning a specialist.

Shared care presumes a professional collaboration between medical doctors which can be either formal or informal In agreement with the findings of Keating et al. [1998], this dissertation describes general practitioner-specialist ties as informal when the participating practitioners exchange e-mail messages, call each other by phone, or make personal appointments to discuss professional issues with each other falling short of the general practitioner referring his/her patient to the specialist. By referring the patient to a specialist, the general practitioner-specialist ties become formalized since any further communication between the general practitioner and the specialist as related to the health status of the patient will be henceforth conducted in a regulated manner (Barnett et al. [2011]). In this dissertation, the scrutiny of general practitioner-specialist relations will be confined to formal ties based on the data gleaned from prescription entries.

1.2.2.1. Qualitative methodology employed in the research of the characteristics of collaboration

In earlier publications on the subject, findings presented on general practitioner-specialist relations were primarily based on data extracted from questionnaires. In this section, I intend to offer an introduction to some of the most cited publications on the subject.

Marshall [1998] in his paper on questionnaire based research examined the form of collaboration between general practitioners and medical specialists working in hospitals. Marshall conducted 24 structured and 4 focus-team interviews in South West England. He found that collaboration between medical doctors can be described as reflecting a high level of mutual appreciation a strong dedication to shared efforts. Conflicting views may emerge occasionally in some areas but the parties involved seek to avoid enduring tensions.

Lou et al. [2011] concentrated on the relationship between general practitioners and specialists in the area of rheumatology. Their sample covered 84 general practitioners maintaining ties with 52 specialists. Based on questionnaire responses, general practitioners designated the following properties as dominating their choice of a specialist: the quality of communication and the ease of exchanging information carry primary significance; appointment lead-times are similarly important; the division of

duties and responsibilities ought to be clearly agreed; furthermore: patient reports should be generally favourable.

Wensing et al. [2011] have drawn up a map on the network of relationships applicable to specialists treating Parkinson's disease patients, using voluntary and structured questionnaire responses. The researchers found that relationships develop along the line of geographical distances. They also pointed out that doctors providing care for a number of Parkinson's disease patients ted to develop stronger ties with specialists of other medical disciplines.

Barnett et al. [2011], used questionnaire distributed on the web to examine the interrelations between doctors. 616 doctors responded by filling out the entries: giving a return rate of 63%. The objective of this research exercise was to demonstrate that the relationships connecting medical professionals can also be described by an analysis of administrative records. The research concluded that with a higher number of patients receiving shared care, the probability of personal contacts between the medical professionals involved increases. The research conducted by Barnett et al. [2011] demonstrated the validity and applicability of the findings based on quantitative research techniques and supporting the assumption according to which - as attested primarily by clinical records - the number of patients treated jointly has a seminal effect on the strength of ties connecting the professionals involved.

1.2.2.2. Quantitative methodology employed in the research of the characteristics of collaboration

Relying on the Scopus database, I drew up a systematic review of projects employing quantitative research techniques. In my selection of this database, I was guided by the fact that Scopus contains the largest collection of abstracts and quotations covering scientific journals (Elsevier [2016]). The analysis covers only those projects which examine shared care medical relationship employing quantitative research methodology. The screening of Scopus took place on September 4, 2015.

The compilation of the survey proceeded through the following phases:

- As the first step, I confined my inquiry to publications the title, the abstract, or the key phrases of which include the terms ‘patient sharing’, and ‘physician’

As research areas, I designated both ‘Health Sciences’, and ‘Social Sciences & Humanities’. I restricted the search exclusively to scientific journals and conference presentations. No geographic or language constraints were specified. Along the screening parameters applied, I obtained 29 publications the bibliographic references and short scientific abstracts of which I imported into an Excel matrix.

- In the second cycle, based on the abstracts, I excluded the papers which omitted the application of quantitative methodology. Upon the further exclusion 15 papers on this count, I subjected the remaining 14 studies to closer scrutiny.
- In the third phase of my systematic survey, upon reading the residual publications, I further excluded six articles. The reason was that the focus of the articles thus excluded had largely bypassed the issue of joint treatment. Two studies concentrated solely on the description of relationship between physicians, another paper discussing the research methods applied in the analysis of collaborative practices had been published in two different journals; while three further papers were limited in their scope by focusing on referral practices followed by physicians in the early stages of joint treatment.
- In the fourth phase, poring through the bibliographic references once again, I decided to add two further discussions to the take of my systematic survey: (Pham et al. [2009] and Uddin et al. [2011]).

Based on the systematic review on the subject, as described, it can be deduced with some assurance that in the related field of research not more than ten publications devote themselves to the exploration of collaborative relations among physicians relying primarily on quantitative research techniques (Barnett et al. [2012], Landon et al. [2012], Pham et al. [2009], Pollack et al. [2013, 2014, 2015], Uddin [2016]), and Uddin et al. [2011, 2015]).

Research projects employing quantitative methods usually endorse the assumption that relationships connecting doctors are induced by joint treatment provided to patients. As related to the subject of structural traits recognized in the formal relationships of physicians, only a very few research projects have been undertaken: all of them focusing on overseas countries, excluding European settings in every case. No empirical studies of the discussed angle have been published so far treating the

European experience, while those tackling the issue of practices beyond Europe have no immediate applicability regarding European systems. Nonetheless - while they exclude direct applicability - a short introduction to the findings of overseas research is certainly required for a better understanding of the methodology employed in my own approach.

Barnett et al. [2012] analysed relationships on a sample of 61461 medical doctors. The physicians queried were employed in one of the 528 US hospitals covered in the survey. This taking of physicians, numbering more than sixty thousand, had provided shared care for more than 2.6 million patients. As established by the results obtained, with 100 patients treated in shared care, one doctor liaises with 187 other doctors as an average. The central question of the survey concerned the influence of networks generated in shared care on the costs and the intensity of health provisioning services. Barnett et al. [2012] came to the conclusion that the larger the number of physicians one particular doctor liaises with the greater will be the amount of financial outlays consumed in providing treatment, and the more intensive the use of medical equipment and instruments. The contrary is the case in practices where the number of participating medical professionals is smaller, but the ties connecting them are appropriately stronger. In summary, it can be stated that closer connections among doctors serves important social objectives by reducing the overall costs of health care.

Landon et al. [2012] examined the relationship among 68288 doctors belonging to 51 different health care districts in the United States of America. The authors discovered differences in the nature of doctor to doctor relationships prevailing in the several geographic regions studied. Doctors tend to develop stronger mutual ties if they work in the same medical institution or maintain practices close to each other. The homophyly[4] of relationships, as evidenced by the findings of the survey, is more dominant between doctors displaying similar personal traits and attending to a similar assembly of patients.

[4]The homophyly denotes a principle stating that interpersonal relationships are more likely to develop between people displaying kinship of character as opposed to those better described by the differences in their personal traits. Similarity can be detected in a number of areas: closer relations are likely to develop among people explained by similarities of age, religion or vocation (McPherson et al [2001]).

Pollack et al. [2013] studied the network of relations between doctors working in the United States and providing shared care for 95965 patients treated with cardiac and circulatory ailments, and 52.688 diabetes patients. The patients in the sample belonged to 5 major health insurance systems. The authors explored the nature of relationships by comparing strong and weak collaborative ties. They came to the conclusion that in partnerships where the ratio of shared patients is high - viewed by the researchers as indicating strong ties - the overall costs of treatment, similarly to the ratio of inpatient treatment, are markedly reduced. The study attributed these results to better communication between doctors.

Pollack et al. [2014] arrived at a similar conclusion as in their 2013 research when on the basis of surveying involving 8661 cancer patients they asserted that the lager the number of cancer patients treated jointly the lower will be the specific cots of the treatment provided. In their most recent project, Pollack et al. [2015], upon screening a database containing 1.7 million patient records, asserted that the rate of repeated hospitalization is lower in the case of patients treated in closely tied therapist relationships as compared to other groups.

Uddin et al. [2011] examined the cost and service quality data pertaining to the medical treatment of patients. Quality levels were measured on the count of repeated hospitalization. Australian research projects conducted on the same subject produced very similar findings, when compared to the studies presented above, showing that the strength of collaborative ties among doctors exerts a positive impact on the quality of health care, both in terms of diminished overall costs, as well as regarding the rate of repeated hospitalization.

Uddin et al. [2015], using a methodology of linear regression, analysed the effects of collaborative practices and structures on the costs related to hospital care and the rate of re-registration at clinics based on networks connecting 2229 therapists and 2352 patients. The authors found that the larger the number of therapist participating in the same network, the higher the overall costs of the treatment provided will be.

Uddin [2016] expanded the 2015 research with a number of explanatory variables and - using statistical models of multiple variables - arrived at results confirming his earlier findings.

Pham et al. [2009] examined the relationships of 576875 patients with their respective therapists. The described pool of patients received treatment from a total of 2248 general practitioners. One practitioner typically liaises with 229 specialists representing a total of 117 practices. The researchers concluded that those general practitioners who work alone or have one other doctor in their respective practices, and are located in a town or a metropolitan area, are more likely to have a higher number of patients with chronic diseases and receive a lesser amount in insurance revenues.

Summarizing this section, I may advance the proposition that the current practice of shared care relies on a long historical experience; it has been studied and analysed in numerous studies and scholarly publications, and is well accepted in a majority of national health care systems. The practice of shared care manifests a range of meaningful advantages, while promising a successful response to the challenges embodied in the triple aim emblem: providing for the health of the community; keeping health provisioning expenses at a reasonably low level while improving the quality of health care services. For the presentation of the analysis addressing the nature of relationships as they emerge in a shared care environment, I have decided to use the quantitative methodology becoming increasingly popular in our days. The selected approach was made possible thanks to my singular access to data bases containing the medical records of patients. This paper is the first in Europe to examine the formal relationships connecting general practitioners and specialists emerging in the practice of shared care as reflected in the medical records entered for patients.

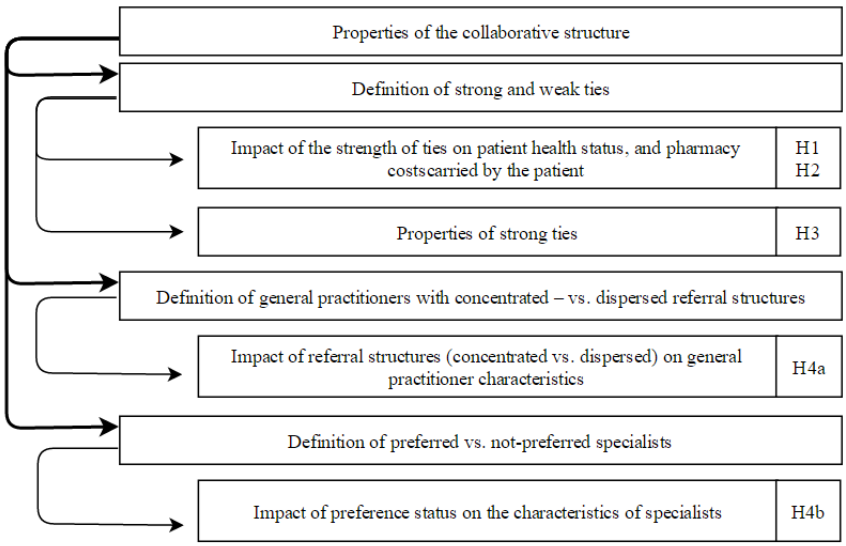
2. EMPIRICAL RESEARCH

This chapter discusses the details of the empirical research process followed in the compilation of data for my thesis. In the first sub-chapter, I give a presentation of the methods employed in my own research, followed by a review of the results acquired. This part is rounded up by a discussion of conclusions inferred by the results of this study, followed by policy recommendations for the health sector.

2.1. Methodology

In the present sub chapter, I discuss the methodology used in my own research and, in this context, the data bases accessed, as well as the method of linking the data bases to each other. Furthermore, I describe the characteristics of patients, general practitioners and specialists as they are reflected through the screening and interconnection of these databases. Subsequently, I take a close look at the nature and properties of collaborative structure developed between general practitioners and specialists in the process of providing shared care for patients. The research process is summarised in fig. 4.

Figure 4. Research Structure



After an introduction to the structure of collaboration, I will be in a position to define which are the ties I can designate as strong, and which are those I would rather call

weak. Subsequently, I shall proceed to qualify general practitioners as maintaining concentrated versus dispersed practices with respect to structure of referrals, and similarly, I carry on with the classification of specialists as representing a preferential versus a non-preferential choice. This sub-chapter is going to be closed with the presentation of the hypotheses linked to the three definitions discussed.

2.1.1. Databases used

In my analysis, I have relied on two primary and three further databases. Of the two major databases one contains prescription data, while the other contains records on the characteristics of doctors.

2.1.1.1. Pharmacy prescriptions database

Data from this database containing prescription data have been provided for research purposes by the firm DoktorInfo Ltd. The records for this database are provided by nearly 900 general practitioners. The Doctor Info Ltd. the health care data collection and information service company was established in 2003. They provide services in the area of data-retrieval, market analysis, secondary research analysis, as well as the design and development of electronic data processing systems. Data collection is performed with the assistance of medical software producing companies (DoktorInfo Ltd. [2015]). Close to one fifth of all general practitioners active in Hungary supply prescription records on qualified access pharmaceuticals to this database on a voluntary but remunerated basis.

In the database which I had been provided access to there are four main groups of data.

- I have a name and the identification number of the prescribing practitioner. The sample of general practitioners is representative in terms of sex, region, type of settlement and the possession or absence of the statutory internist qualification. As to the representative quality of the sample, I have subjected the data provided by DoktorInfo Ltd. to a careful scrutiny on a variety of facets. The results of the assessment of the representativeness of the sample used are provided subsequent to the data summaries.

- The database also contains patient data including information on age, sex and a patient ID. The general practitioners carry a statutory obligation to pass on patient data related to pharmacy prescriptions to the National Health Insurance Fund of Hungary (NHIFH) covering such data items as the identity code (TAJ - social insurance number), the name and the home address of the patient. However, these and similar data items relating to the patient are handled as strictly confidential and are not integrated in the data retrieval services offered by DoktorInfo Ltd, where data collection is audited by the Office of the Data Protection Authority for the same reason, I am merely provided with a patient identity code which does not allow me to identify patients individually but enables me to aggregate patient data.
- With 01 January 2009, general practitioners are required to comply with the statutory provision of posting either the name or the identification number of the specialist requiring the post prescription of medication by the general practitioner in the case of patients receiving shared care. This provision allows me, indirectly, to obtain information on the specialist providing care for the patient.
- Prescription data cover information on the characteristics of the medication prescribed, including:
    - the name of the prescribed product;
    - the prescribed dosage of the pharmaceuticals;
    - the rate of insurance subsidy in the price of the product;
    - the ATC code (Therapeutic Chemical Classification System), an anatomical, therapeutic, and chemical classification system developed by Collaborating Centre for Drug Statistics Methodology Division of WHO in 1976 for the classification of chemical compounds in pharmaceutical products (WHOCC [2016]);
    - the TTT code (Social Security Product Subsidy code) is a unique nine digit code allocated for every single pharmaceutical product defined by NHIFH at the time of entering the product on the register of pharmaceuticals subsidized by the social insurance fund (Act 53/2007 (XII. 7.));

- the ICD code allocated by the International Statistical Classification of Diseases and Related Health Problems abbreviated as ICD in international literature (ESKI [2016]).

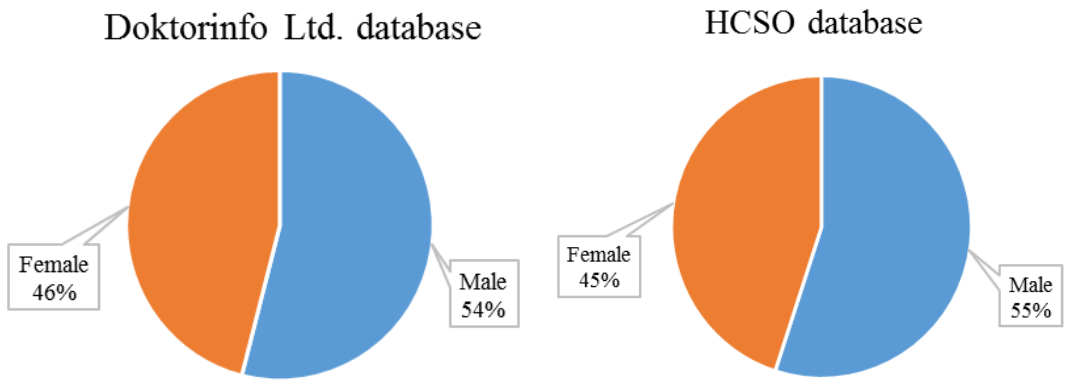
It ought to be emphasized that any individual general practitioner either supplies data to DoktorInfo database on all of his/her patients or on none of them. Consequently, I have access to data on all patients treated by any individual general practitioner participating in the scheme; and similarly: the database contains records on all prescriptions issued to a particular patient by the general practitioner, not merely those recommended for prescription by the specialist.

Relying on this database, I had the opportunity to define the samples to be employed in the analysis of the selected patient populations by using both the ATC-codes, as well as the ICD codes for screening the records.

The use of this database raises two possible concerns: one is related to the issue of representativeness, while the other is the question of data submission on a voluntary and remunerated basis.

As a first step, I undertook to explore the representativeness of the samples used in the course of my research. The voluntary data transmission of the general practitioners may render the representativeness of the sample questionable. For the assessment of the representativeness of the samples, I have subjected the data received from DoktorInfo Ltd to a close scrutiny from various angles. The database receives records from nearly 900 family doctors. Considering the fact that - based on the statistics published by the Hungarian Central Statistical Office (Hereinafter: HCSO) [2011] - by the end of 2010 there were 4926 general practitioners actively practicing in Hungary. The 900 general practitioners providing data for the system represented a coverage of 18.27% the entire population studied. This coverage is large enough to provide the basis for a nation-wide representative sample. The further phases of my scrutiny included:

Figure 5. The composition of general practitioners by genders comparing HCSO and DoktorInfo databases

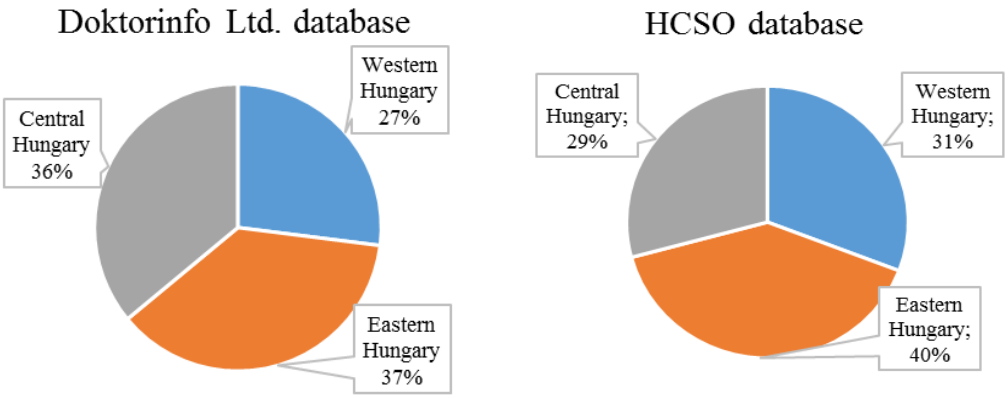


Data source: HCSO (provided on request), DoktorInfo database.

In Figure 5., I have presented a comparison of gender ratios among general practitioners as they appear in HCSO statistics versus data provided by general practitioners to the database of DoktorInfo Ltd.

In terms of regional ratios, I have made a comparison between HCSO health care data on general practitioner distribution with the information received from DoktorInfo Ltd. on the regional distribution of general practitioners providing records to the latter's database (Fig. 6).

Figure 6. The regional distribution of general practitioners comparing HCSO health care statistics and DoktorInfo databases

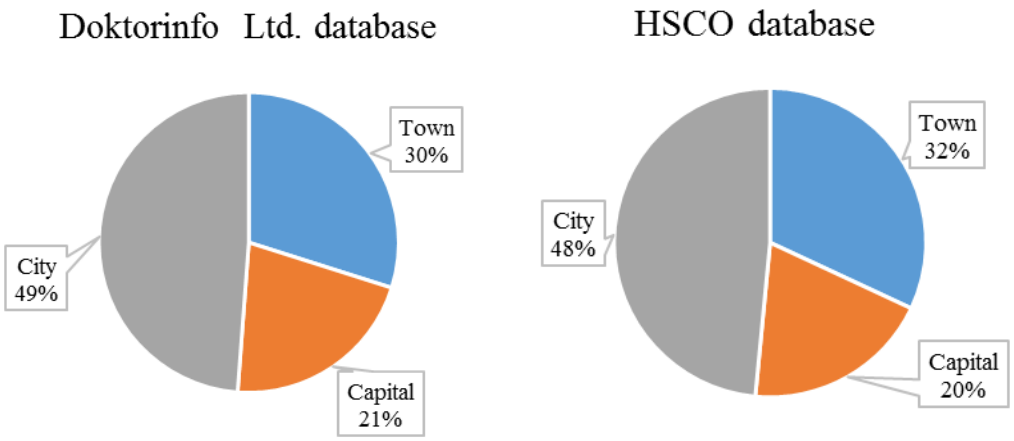


Data source: HCSO [2011a], DoktorInfo database.

In Figure 7., I drew up a comparison between HCSO health care data and the information received from DoktorInfo Ltd. (covering those general practitioners who

provide records to the latter's database) on the distribution of general practitioners according to types of settlements.

Figure 7. The regional distribution of general practitioners according to settlement types: a comparison of HCSO health care statistics with the DoktorInfo database



Data source: HCSO [2011a], DoktorInfo database.

Finally, another important aspect of the representativeness of the sample available on general practitioners is the ratio of general practitioners equipped with a statutory internist certificate. The DoktorInfo database can only be compared to the database supplied to them by HCSO on their submission. Based on that comparison it can be concluded that the sample employed ought to be viewed as representative even in this respect.

In summary, it can be asserted that, with regards to all measurable factors selected, the DoktorInfo database on general practitioners has proved to be representative for all distribution ratios examined.

The second question emerging as to the potential insufficiency of the sample concerns its applicability to the full population studied in the light of voluntary and remunerated data contribution. In my assessment data contribution can be motivated by a number of possible objectives beyond the advantages of additional earnings. The decision to join the data contribution scheme may be viewed as a reasonable choice taken by general practitioners considering the fact that the submission of data does not add to the doctor's workload since data transmission takes place automatically, installed as a component of the prescription printing software. Secondly, general practitioners are

also required to submit prescription data to the National Health Insurance Fund of Hungary (NHIFH) where the records supplied are subjected to similar analysis. Herber et al. [2009] have pointed at a number of reasons explaining the reluctance of doctors to participate in research projects. Of the reasons thus referred to, the one most relevant for the case presently explored is that many general practitioners are uneasy about their prescription habits being divulged to outsiders.

When drawing up general conclusions, it is well advised to keep the precepts of Hunyadi and Vita [2002, p. 255.] in mind: 'The statistical error ensuing partly from the specificities of the methodology applied, is an inevitable component of statistics as a discipline.'

2.1.1.2. Doctors' database

Another one of my main sources of data is the Health Centre of Registry and Training database (Hereinafter: HCRT). On the statutory functions and responsibilities of HCRT to maintain an operational register of health care employees. I the Basic- as well as in the Operational Data retrieving systems anyone is entitled to access the data pertaining to qualified personnel employed in the health care system within the limitations defined by statutory provisions. Using these instruments of data retrieval, I have downloaded information relating to the socio-demographic and working-environment conditions characterizing general and specialist practices (HCRT [2015]). Of the available data I used, the following records data: name, identification number, age, school and date of acquiring an academic degree, number of statutory specialist certificates, professional experience in years, present place of employment, years of tenure at the current institution of employment, description of the position/assignment currently held, size of the employing institution.

2.1.1.3. Other databases used

I have used three further databases in my research.

1) The Price Subsidy Department of the National Health Insurance Fund of Hungary (NHIFH) regularly issues a Public Pharmacy Register (PUPHA) in a public database on subsidized pharmaceuticals (NHIFH [2014]). I used another

database containing 2011 pharmacy prices to define the full prices of pharmaceutical products. It is important to mention that this database also contains the reduced prices of the products at different subsidy rates but, in my research, I only used the full prices supplied. The reason for this was that of the various forms of price subsidies, the subsidy for pharmaceutical products fall in the jurisdiction of the respective regional authorities, therefore the results of the analysis would be distorted by differences in the price of prescribed medicines. To avoid distortions of this kind, in my empirical research, I used full prices as opposed to prices actually paid by patients.

2) The 2011 Annals of the Designation Register of Populated Areas published by the Hungarian Central Statistical Office (HCSO) contains in its database the population figures of all inhabited settlements which enabled be to arrange by size all towns examined in my research (HCSO [2011b]).

3) Using Google Maps, I was able to calculate public road distances between health care practices. I wrote a Visual Basic code to facilitate the use of this database in Excel, so it became more convenient to download the data required for a matrix of distances between doctors.

2.1.2. Database construction, definition of test samples

In the present section, I describe the successive phases of database construction, as well as the mode of interconnecting the five databases referred to earlier. Furthermore, I discuss the method applied in defining the sample for this research.

2.1.2.1. Database construction

Before proceeding to develop a database, I had to reflect to the issue of possible incongruities contained in data posted, which may emerge, typically, in the transfer of records such as, for instance, the number and name figuring on the doctor's identification. In my case, there was no need to address this problem since the filtering of the prescriptions database had been performed by DoktorInfo Ltd. The data filtering

exercise, as performed by the data supplier, covers the following types of inconsistencies:

- the identification number of the doctor is missing but the name is known;
- the format of the doctors' names is not used consistently, for instance: some of the names are preceded by the title "Dr." while others are not;
- the same identification number may use by several different doctors;
- the same doctor's name may appear under differing identification numbers;
- only the identification numbers figure in the records while the names are missing.

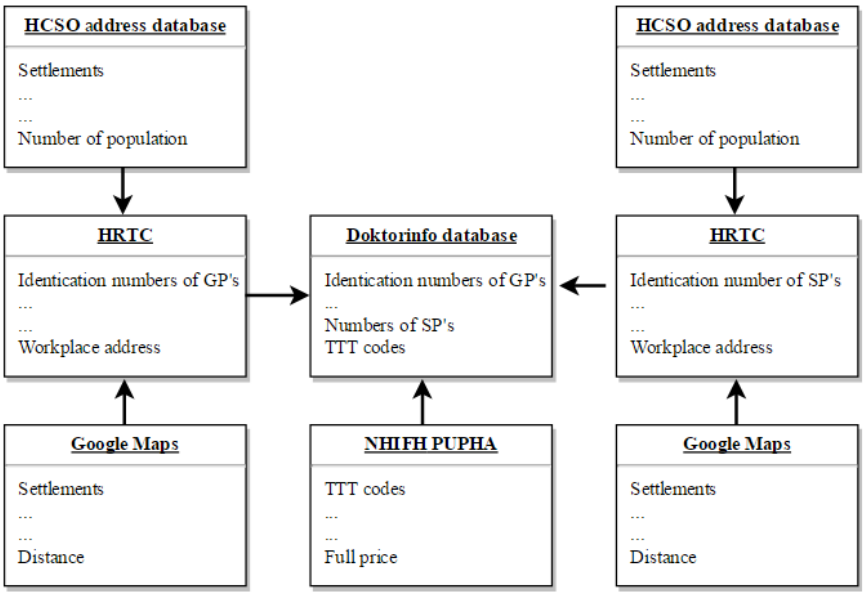
DoktorInfo Ltd. performed the filtering exercise by applying data mining methods and supplying the missing data by searching the HCRT database. They have restructured the names of the doctors in a consistent format. They have corrected data entry mistakes such as identical identification numbers apparently used by different doctors as well as differing identification numbers shown with the name of the same doctor - by the application of text-distance functions.

Figure 8. shows the interrelationship of the five databases used. By linking the TTT codes appearing in the DoktorInfo database with the TTT codes in the NHIFH database, I was able to define the pharmacy costs of medication prescribed for individual patients by the general practitioner. In order to determine the pharmacy cost carried by an individual patient, I rolled up all prescriptions issued by the general practitioner for that patient: not only those issued on the recommendation of a specialist.

Based on prescription data retrieved from the rectified database and using identification numbers, I was able to connect the DoktorInfo database with the records of the HCRT database describing doctor characteristics. Beyond linking it with the identification numbers of general practitioners, I used the same prescriptions database for linking it with the identification numbers of specialists since all records on the characteristics of doctors appearing in the database may become necessary for this research.

In the address database, I allocated the postal codes against the size classification of settlements and, relying on the Annals of Settlement Designations Database of HCSO, I defined the settlement size variables for the addresses of institutions recorded in the HCRT database. Assisted by the data described, I am now able to attach a size category to the urban areas where individual doctors conduct their respective health care practices. Using Google Maps databases, I calculated the respective distances between health practices. Using the Doctors' Addresses database and contrasting it with the Google Maps database, I was also in a position to establish public road distances between general practitioners and specialists on the one hand and between specialists on the other.

Figure 8. Extract of interconnections between databases



2.1.2.2. Definition of patient population

In the empirical phase of the research, within the total patient population, I limited the scope of my inquiry to patients suffering from type 2 diabetes. I had a number of reasons for narrowing the scope of inquiries to this segment but my primary objective was to select a population best suited for studying the effects of general practitioner-specialist collaboration.

The ratio of patients suffering from type 2 diabetes is extraordinarily high in our times and growing. World-wide, there are currently 347 million people suffering from

diabetes (Danaei et al. [2011]) and according to prognoses on the subject, this disease may be the seventh gravest cause of mortality by 2030 (WHO [2011]). In Hungary, the treatment of diabetes is offered in the framework of shared care. The appropriate medication for the patient is to be defined by the specialist, in the first place, and subsequently, on his/her recommendation, the general practitioner issues post-prescriptions for an agreed period of time, usually covering a further twelve months.

The selection of type 2 diabetes patients offers a promising approach to the examination of collaborative practices between general practitioners and specialists since, on the one hand, patients suffering from this chronic disease constitute the largest patient population receiving shared care provided jointly by general practitioners and specialists; and also, on the other hand, this area of health services produces the largest number of general practitioner prescriptions issued on the recommendation of specialists. Thirdly, medication applied in the treatment of diabetes can only be prescribed by a well-defined group of licensed specialists comprising internists and endocrinologists (Ministerial Decree 44/2004. - IV. 28. - ESzCsM - Ministry of Health, Social and Family Care). As a result of these particularities of scope, I was able to delineate and analyse the largest possible subset in terms of the number of transactions performed.

Considering the fact that the prescriptions database covers all patients of all general practitioners, I was compelled to restrict the sample to type 2 diabetes patients: this screening was accomplished with reliance on the data offered in the prescriptions database, which means that I selected the patient population to be explored applying the relevant ATC and ICD codes. In the next phase, I selected the patients above 40 in order to avoid the inclusion of type 1 diabetes patients. Similarly, I excluded the patients receiving care from general practitioners whose practice provides treatment for less than 10 diabetes patients.

2.1.3. Database characteristics

In this section, I provide a detailed description on the characteristics of the type 2 diabetes patients in the composite and rectified database as well as those of the general practitioners and specialists providing care for the same. Using the descriptive

statistical analyses thus obtained, an opportunity is offered for a closer scrutiny of the contents of the database.

2.1.3.1. Patients' characteristics

Table 2. provides a descriptive statistic on the patient population of 31 070 type 2 diabetes patients analysed in the empirical research. In the sample, 53,04% of patients were male. The median age of the sample was 65.81 years, while youngest patient was 40. With 69.91% of the patients' complications occurred. Typical diabetes complications include cardiovascular diseases, nerve damage, kidney, eye, and visual impairment, skin and mouth diseases and osteoporosis (Hídvégi [2013]). In my research, I classified a patient as suffering complications, on a single occurrence of the patient being diagnosed by the doctor in the two year analysis period (2010-2011) as having a diabetes complication status judging from the ICD code posted to the prescription.

The fourth significant feature of the patient population, as shown in Table 2., was the type or the applied therapy which could be insulin based or not insulin based therapy. The type of the therapy applied was determined on the basis of the ATC code. As described above, in section 2.1.1.1., a five level ATC is applied to every pharmaceutical product. The third level ATC code defines the main anatomical groups (first level, one letter), the main therapeutic groups (second level, two digits), and the therapeutic subgroup (third level, one letter), followed by the chemical / therapeutic / pharmacological subgroup (fourth level, one letter), and the active chemical component of the product (fifth level, two letters) (WHO [2003]). The third level A10 ATC code means that the general practitioner has prescribed for the patient a product suitable for treating diabetes (antidiabetic). The 10A code designates insulin therapy, while A10B - non-insulin therapy. Based on these codes, 56.65% of patients receives insulin therapy.

The fifth, and likewise important patient population attribute shown on Table 2, relates to the volume of prescriptions issued to patients. In the 2010-2011 period, the total number of prescriptions issued by general practitioners was 4085107, of which 841 916 were furnished for the treatment of diabetes. One patient received an average of

131.5 prescriptions over the two year period examined, of which an average of 27.1 were provided in connection with the treatment of diabetes.

Table 2. The descriptive statistics of the patient portfolio

Description		Average	Min	Max	St. dev
Gender (% of persons)					
male	16479 (53.04%)	-	-	-	-
female	14591 (46.96%)	-	-	-	-
Average age (years)		65,81	40	103	10.92
Type of diabetes (based on the ICD code, (persons, %))					
complication-free	21721 (69.91%)				
with complications	9349 (30.09%)				
Type of therapy (based on the third level ATC code, (persons, %))					
insulin	17600 (56.65%)				
no-insulin	13470 (43.35%)				
The number of prescriptions per patient (units)					
Total number of prescriptions		131.5	2.0	634.0	97.0
of which: number of prescriptions issued for diabetes		27.1	1.0	139.0	18.0
A number of consultations per patient (occasions)					
at the general practitioner, based on the number of prescriptions issued		22.5	1.0	150.0	13.6
at the specialist, based on the number of new recommendations generating post-prescriptions		2.3	0.0	29.0	2.2

Data source: DoktorInfo database.

The sixth feature listed is the per capita number of consultations for the patient population. Over the two years examined, one general practitioner received an average of 22.5 consultations from the same patient thus providing consultations which generated a combined total of 697552 prescriptions. The number of consultations paid at the specialist and generating new recommendations was 2.3 occasions per patient on average. It could be safely assumed that the actual number of consultations at the specialist were probably higher since some of the consultations were taken up by reviewing the therapy and modifying dosage.

2.1.3.2. General practitioner characteristics

Upon the screening and the rectification of the DoktorInfo database for diabetes patients as used in my research, 794 general practitioners have been identified.

Table 3. Descriptive statistics on 794 general practitioners

NAME OF VARIABLE	Database	Average	Min	Max	St. dev
General practitioner's gender (%)	HCRT				
male		432 (54.41%)	-	-	-
female		362 (45.59%)	-	-	-
General practitioner's age (years)	HCRT	54.5	29.0	86.0	10.4
30-39		76 (9.57%)			
40-49		170 (21.41%)			
50-59		276 (34.76%)			
60-69		212 (26.7%)			
70-79		60 (7.56%)			
University degree (%)	HCRT				
Budapest:		224 (28.21%)	-	-	-
Debrecen		227 (28.59%)	-	-	-
Szeged		118 (14.86%)	-	-	-
Pécs		150 (18.89%)	-	-	-
abroad		75 (9.45%)	-	-	-
Professional experience (years)	HCRT	30.5	5.0	62.0	10.4
Time served with current employer (years)	HCRT	17.6	0.0	51.0	10.5
Settlement size of place of current practice	HCSO, HCRT				
Capital city		121 (15.24%)			
Major municipality(< 100e)		131 (16.5%)			
Medium settlement (40-100)		53 (6.68%)			
Small town (> 40e)		489 (61.59%)			
Number of specialty certificates acquired	HCRT	1.9	0.0	6.0	0.8
Number of patients (persons)	Doktorinfo	39.1	10	153	20.2

Data source: HCRT, HCSO and DoktorInfo databases.

2.1.3.3. Specialists' characteristics

As a reminder: I excluded from the general practitioners' sample those practitioners who provided treatment for less than 10 diabetes patients. With this data cleansing operation, my objective was to exclude those general practitioners who continued to supply data for the DoktorInfo database for no longer than a few months.

It is apparent from Table 3., that 54.9% of general practitioners covered by my sample were men 54.4%, with an average age of 54.5 years, while the youngest person in this class had 29 years. The age distribution of doctors convincingly demonstrates the fact, frequently cited by professionals, that one third of general practitioners are around or beyond retirement age. Most general practitioners earned their medical degree in Debrecen. On average, the general practitioners of the sample received their medical degree 30.5 years earlier. They serve in their current practice for 17.6 years on average, but at least one doctor of the sample has served in the same practice for 51 years. 15.24% of the general practitioners work in the capital; 16.5% in large cities (with a population over 100K, excluding the capital), 6.68% work in medium-sized municipalities (with populations between 40-100K) and 61; 59% work in small townships and settlements (with populations of less than 40K.) On average, general practitioners 1.9 specialist's certificates. Typically, many general practitioners have certificates in such specializations as occupational health, internist, or cardiologist. Six general practitioners conduct a practice with no statutory specialist's certificates, explained by the fact that, in the period when they earned their general medical degree, the acquisition of a general practitioner's certificate was not a statutory requirement. On average, general practitioners provide care for 39.1 diabetes patients each.

The descriptive statistics of the 318 specialists included in the sample in Table 4.

47.35% of specialist covered by my sample were men with an average age of 52 years. One third of the specialists had graduated from the Semmelweis University and held their medical degree for an average of 26 years. They serve in their current practice for 14,6 years on average, but there was one specialist of the sample serving in the same practice for 50 years.

Table 4. Descriptive statistics on 318 specialist practitioners.

NAME OF VARIABLE	Database	Average	Min	Max	St. dev
Specialist's gender (%)	HCRT				
male		152 (47.35%)	-	-	-
female		169 (52.65%)	-	-	-
Specialist's age (years)	HCRT	52.0	32.0	78.0	9.9
30-39		33 (10.28%)			
40-49		109 (33.96%)			
50-59		99 (30.84%)			
60-69		67 (20.87%)			
70-79		13 (4.05%)			
Institute of graduation (%)	HCRT				
Budapest		110 (34.27%)	-	-	-
Debrecen		74 (23.05%)	-	-	-
Szeged		51 (15.89%)	-	-	-
Pécs		64 (19.94%)	-	-	-
abroad		22 (6.85%)	-	-	-
Professional experience (years)	HCRT	25.98	6.00	52.00	9.94
Length of tenure with current employer (years)	HCRT	14.56	0.00	50.00	11.56
Settlement size of place of current practice	HCRT, HCSO				
Capital city		70 (21.81%)			
Major municipality(< 100K)		92 (28.66%)			
Medium sized settlement (40-100)		47 (14.64%)			
Small town (> 40e)		112 (34.89%)			
Number of specialty certificate	HCRT	1.78	1.00	4.00	0.77
Specialist assignment (%)	HCRT				
Administrative management position		73 (22.74%)	-	-	-
Executive assignment		107 (33.33%)	-	-	-
Non-executive assignment		141 (43.93%)	-	-	-
Number of patients (persons)	Doktorinfo	123.5	14	784	114.7

Data source: HCSO, HCRT and DoktorInfo databases.

21.81% of the specialists covered work in the capital; 28.68% in large cities (with a population over 100K, excluding the capital), 14.64% work in medium-sized municipalities (with populations between 40-100K) and 34.89% work in small

townships and settlements (with populations of less than 40K). On average, specialists own 1.8 statutory specialty certificates.

22,74%-of specialists are in management positions of whom 33,3% are ward directors. One specialist in the sample provides care for an average of 123.5 patients over the two year period studied.

2.1.4. Characteristics of the structure of collaboration between general practitioners and specialists

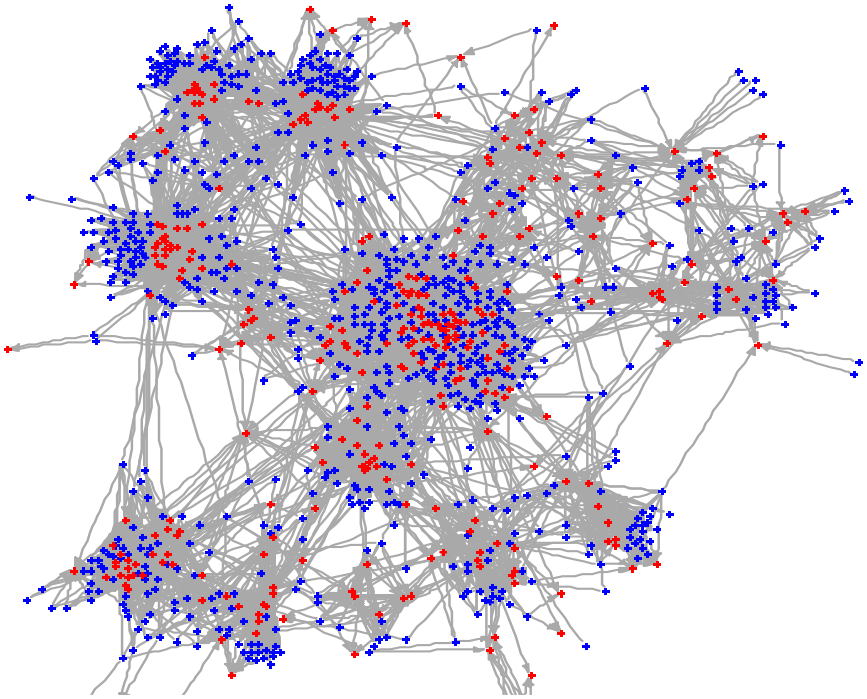
In the present section, I proceed to discuss the structure of collaboration between general practitioners and specialists. The characterization of the collaborative structure is considered important with a view to the objective of mapping the network of relationships emerging between general practitioners and specialists. Similarly, such an analysis of relationships is certainly necessary in drawing up professional hypotheses. Information on the number of patients in shared care as well as on the number of specialists liaising with one particular general practitioner may prove to be helpful in identifying strong ties between doctors, and also: in the analysis of the character of their collaboration. In the characterization of the structure of collaborative between general practitioners and specialists, I relied on the prescriptions database of DoktorInfo Ltd.

As presented in my empirical research, a general practitioner is described as connected with a particular specialist in the case if they provided shared care for at least one diabetes patient in the course of the two year study period (January 2010 - December 2011). Under the current Hungarian health care regulations, the general practitioner is required to mark the name of the specialist recommending the medicine on the prescription (for details see section 2.1.1.1.). This arrangement allows for outlining the network of relations among general practitioners and specialists.

Figure 9. shows 6323 relationships maintained among 318 specialists and 794 general practitioners presented with the application of the Fruchterman-Reingold algorithm. The diagram shows that a structure of a large number of nodes has been created. This complex structure is explained by the fact that one general practitioner refers patients to a variety of specialists, and the same specialist receives a number of patients sent

by a variety of general practitioners. The nodes represent the specialists. Figure 9. provides a substantially distorted scheme of the network in the sense that it displays only those specialists who receive diabetes patients. If the diagram contained specialists of all disciplines, then the general practitioners would be positioned in the nodes since they are the ones who refer patients to specialists. The structure is significantly fragmented.

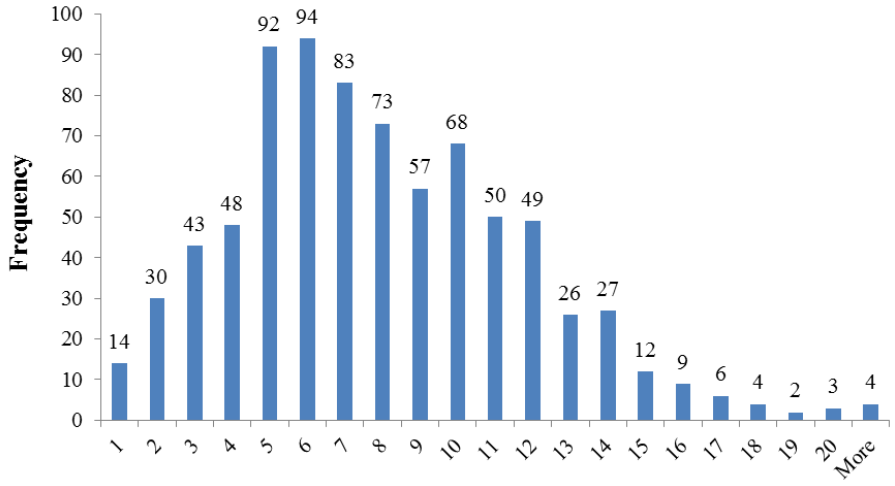
Figure 9. The network structure of general practitioners and specialists



Data source: DoktorInfo database.

Figure 10. shows interconnections between one general practitioner and a number of specialists. 14 general practitioners maintain relationships with only one specialist each, while there is one general practitioner in the database who referred his patients to 28 different specialists. More than 50% of the general practitioners maintain relations with five to nine specialists. On average, one general practitioner liaises with eight specialists.

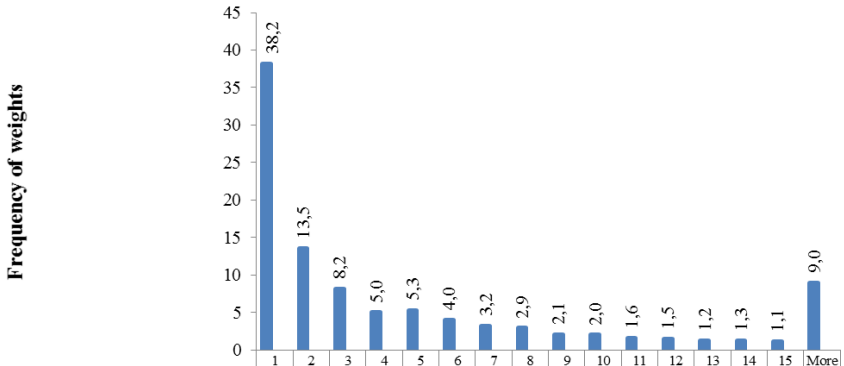
Figure 10. The number general practitioners connected to one specialist



Data source: DoktorInfo database.

Figure 11. Shows the distribution of patients in general practitioner-specialists shared care according to the number of patients treated. In close to 40% of the cases, general practitioners and specialists provide shared care for only one patient. This selection covers no more than 6.6% of all patients receiving shared care. The largest number of patients provided shared care in one single general practitioner-specialist relationship is 111. In 70% of the cases, shared care relationships provide care for one to five patients representing an aggregate ratio of 23.2% of all patients. 9% of shared care relationships provide care for more than 15 patients each covering a total of 43.2% of all patients.

Figure 11. The distribution of patients in general practitioner-specialists shared care according to the number of patients treated



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	More
Proportion of relations	38,2	13,5	8,2	5,0	5,3	4,0	3,2	2,9	2,1	2,0	1,6	1,5	1,2	1,3	1,1	9,0
Cumulative proportion of relations	38,2	51,7	59,9	64,9	70,2	74,2	77,4	80,3	82,4	84,4	85,9	87,4	88,6	89,9	91,0	100,
Cumulative proportion of patients treated	6,6	11,2	15,5	18,9	23,5	27,6	31,5	35,5	38,7	42,1	45,1	48,3	50,9	54,0	56,8	100,

Data source: DoktorInfo database.

In summary, one can say that general practitioner-specialist relationships display a variety of patterns both with respect to relationships presented with general practitioners positioned at the nodes of the network, as well as regarding the number of patients provided shared care in individual relationships.

2.1.5. Defining Collaborations

In this section, I proceed to define a strong and weak ties. Viewing the results produced regarding strong and week ties, it becomes necessary to undertake a closer scrutiny of doctor characteristics. In the framework of such further explorations, it appears opportune to take a look at the general practitioner-specialist characteristics in the light of the type of the relationship connecting them. Based on the definition of strong and weak ties, a particular general practitioner or specialist may fall simultaneously into the class of week- as well as strong ties. For this reason, the introduction of two further definitions for a clearer differentiation of doctor characteristics may be well justified. For these reasons, it becomes necessary to provide a definition of general practitioners having a concentrated referral structure as opposed to those having a dispersed referral structure, on the one hand, and preferred vs. not-preferred specialists on the other.

It has been shown that the number of specialist liaising with one particular general practitioner widely varies (Fig. 10). In addition, the number of patients treated in collaboration in any particular relationship also varies significantly (Fig. 11.). For these reasons, the identification of the different types of collaboration is by no means an easy task. In relationships, where shared care is provided for a higher number of patients, the ties are presumably stronger since it can be assumed that in the case of the doctors involved, professional interaction takes place more frequently. The distribution of the strength of general practitioner-specialist relationships is skewed and their relation is not linear as inferred by Pollack et al. [2013]. On the force of these findings, and due to the differences in the number of patients treated jointly by collaborating doctors, we need a threshold figure applying to a relative rather than an absolute number of patients for the definition of the strength of ties connecting medical professionals. The two decisive factors in defining the threshold values are the number of patients receiving shared care and the distribution of patients among specialists.

2.1.5.1. The definition of strong and weak ties

In my research, I first allocated patients to general practitioner-specialist relationships. If a patient consulted several specialists during the observation period, then I allocated the patient to a number of general practitioner-specialist relationships simultaneously, in the following manner. I first defined the ratio of all pharmaceuticals prescribed for one patient on specialist recommendations falling on each particular specialist. This ratio index was then allocated as a weighing factor to the patient of the relevant specialist. Next, I arranged the 6323 general practitioner-specialist relationships according to patient ratios in diminishing order (Table 5). I qualified the relationship as strong in cases which fall into the uppermost quintile of collaborative ties.

Table 5. The definition of strong vs. weak ties

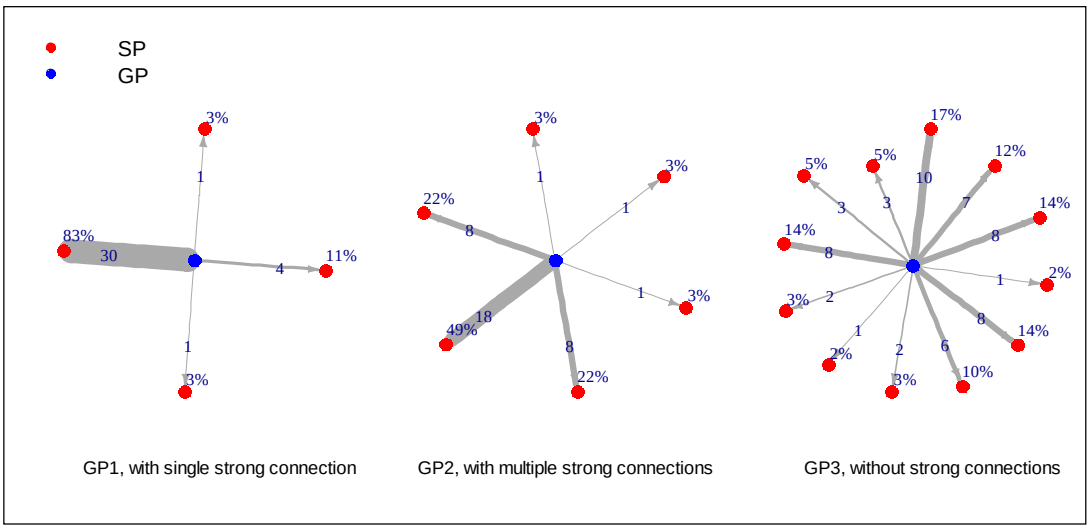
	Serial number	GP	SP	Patient proportion	
Uppermost quintile	1	GP1	SP1	100%	Strong ties
	2	GP2	SP1	100%	
	…..				
	1263	GP50	SP20	19,2%	
	1264	GP51	SP21	19,2%	
	1265				
	…..				
	5058				
	5059	GP444	SP140	2,3%	Weak ties
Lowest quintile	5060	GP444	SP77	2,3%	
	…..				
	6322	GP750	SP250	0,6%	
	6323	GP555	SP56	0,6%	

This criterion was met, for the purposes of my research, in cases where one general practitioner referred more than 19.2% of his/her patients to one particular specialist. In contrast, a particular general practitioner-specialist relationship was qualified as weak if that relationship fell into the lowest quintile of the cases studied. In this category, a particular general practitioner provides shared care for less than 2.3% of his/her patients in collaboration with one particular specialist. Cases falling in between

the two extremes described have been defined as medium strength ties. It is important to note that one general practitioner may maintain strong ties with more than one specialist at any one time. In the perspective of my own research, this simple criterion is met when one general practitioner refers at least 19.2% of his patients to at least two specialists each.

Figure 12. demonstrates the various cases of tie strengths. General practitioner No. 1 (GP1) refers a decisive majority of his/her diabetes patients, 83% (30 patients) to one single specialist. This relationship qualifies as a strong general practitioner-specialist tie. The other relationships of this general practitioner qualify as week ties, since he/she refers more than 2.3% but less than 19.2% of his remaining patients to any single specialist. General practitioner No. 2 (GP2) maintains strong ties with three specialists. These relationships are qualified as strong on account of the fact that the general practitioner in the example refers more than 19.2% of his/her diabetes patients to each one of the indicated specialists. He/she provides shared care for 18, 8 and 8 patients with the respective specialists. These numbers represent 49-, 22-, and 22% of the diabetes patients of this general practitioner. General practitioner No. 2 maintains medium strength ties with three colleagues. As general practitioner No. 3 (GP3) refers less than 19.2% of his/her patients to any one or the collaborating specialists therefore none of these relationships qualify as strong ties; a number of them can be termed medium strength ties while the remainder must be classified as weak.

Figure 12. Strong and weak ties in the example of three general practitioners



Data source: DoktorInfo database.

In the framework of a sensitivity study, I examined the strength of ties against two further definitions, first: by qualifying strong and week ties as falling into the uppermost and the lowest deciles of the cases reviewed, and then: qualifying the same as falling into the uppermost and the lowest tertiles of cases.

In the result variants obtained, we also need to take into account the fact that one patient may obtain shared care in more than one general practitioner-specialist relationship therefore, in these cases, weighted averages need to be applied.

2.1.5.2. The definition of general practices as having concentrated vs. dispersed referral structures

Following the definition of strong ties vs. weak ties, for a more thorough analysis of the subject of my research it became necessary to provide a definition of concentrated vs. dispersed referral structures characterizing general practitioners. Here, my objective is to identify similarities and differences in the description of general practices. A majority of the 794 general practitioners (481 doctors) can be described as maintaining strong times with some specialists and simultaneously weak ties with some others. This means that the definition provided in the preceding section is not entirely satisfactory with respect to the objective of separating general practitioners with a concentrated referral structure from those maintaining a dispersed structure.

In my definition, a general practitioner maintains a concentrated referral structure if he/she operates in close ties with one or more specialists. In the determination of the concentrated character of referral structures, I used the most widely accepted measuring technique, the Herfindahl-Hirschman index as applied to individual general practitioners (Rhoades [1993]),

$$HHI = \sum_{i=1}^{n} s_i^2, \text{ where}$$

$$s_i = \frac{number\ of\ patients\ referred\ to\ one\ SP\ by\ one\ particular\ GP}{all\ patient\ of\ one\ particular\ GP}$$

I defined the HHI index for every general practitioner and, subsequently, I sorted the 794 general practitioners in a sequential order. Based on this sequence, I placed general practitioners into categories as characterized by concentrated vs. dispersed referral

structures. This means that I applied a relative indicator: defining the referral structure of a particular general practitioner as concentrated when his/her practice fell into the uppermost quintile of the cases studied on this feature. The analysis showed that both the uppermost and the lowest quintiles contained 158 practices. A general practitioner maintains a concentrated referral structure if the value of the applicable HHI index is higher than 0.1990, while a dispersed referral structure is defined by a HHI index value below 0.1743.

2.1.5.3. The definition of preferred vs. non-preferred specialists

For a comparison of specialists working in strong vs. weak ties it is necessary to define preferred as opposed to non-preferred specialists since, according to the definition presented in section 2.5.1.1., a particular specialist may maintain both strong and weak ties simultaneously and thus a further definition becomes requisite for the completion of the current analysis. It ought to be emphasised that it is not the specialists who initiate the 6.323 relationships studied but either the general practitioners or the patients of general practitioners. This fact must be taken into account when I attempt to offer the definition required.

By my definition, a specialist maintains strong ties with a general practitioner if he/she is one of the preferred specialist of that particular general practitioner. A specialist qualifies as being a preferred partner of a general practitioner if the latter refers at least 30% of his/her patients, or a minimum of nine patients, to that particular specialist. Any one general practitioner may have more than one preferred specialists. Preferred specialists receive patients with referrals from five general practitioners or more. Using this definition, of the 318 specialists in the sample, 47 are qualified as preferred specialists. Accordingly, I assigned those doctors to the group of non-preferred specialists who have not been preferred by at least one general practitioner meaning the referral - to that particular specialist - of at least 30% of his/her patients or a minimum of nine patients. By this criterion, 140 of the specialists in my sample fell into the category of non-preferred doctors.

I performed a sensitivity study on preferred vs. non-preferred specialists. For this purpose, I changed one criterion of the analysis: while the basic definition required at least five general practitioners choosing a specialist as a preferred one (by referring at

least 30% of his/her patients, and a minimum of 9 patients to this specialist) - by the revised criterion, the number of general practitioners making this choice with respect to the same specialist was reduced to three. Applying the altered criterion, 84 of the 318 specialists in the sample qualify as preferred specialists. In this sensitivity analysis, I continued to compare the 140 non-preferred specialists with the 84 classified as preferred ones.

2.1.6. Hypotheses

Upon the presentation of the applicable collaborative structures and the definition of strong vs. weak ties, in the following part, I proceed to draw up the four hypothetical propositions forming the core of my research.

First, I attempt to respond to the question whether or not there is a recognizable relationship between the strength of ties as reflected in the health status of shared care patients on the one hand, and the pharmacy costs carried by the same patients on the other. As to the first two of my hypotheses, numerous research studies have been published on both (including Barnett et al. [2012], Landon et al. [2012], Pollack et al. [2013, 2014], Pham et al. [2009], Uddin et al. [2011]), all of them exploring the subject as related to countries outside Europe. As to the simultaneous treatment of both hypotheses, no research is known to have been conducted to date.

H1: The health status of patients treated in strong-ties general practitioner-specialist relationships tends to be better.

H2: The pharmacy costs carried by patients treated in strong-ties general practitioner-specialist relationships tend to be lower.

The issue is treated in response to two simultaneous hypotheses since the results offered by such dual analysis may provide three positive conclusions:

- First - if both hypotheses prove to be valid, then it can be concluded that strong collaborative ties contribute to the improved health status of patients at lower pharmacy costs.
- Second - rejecting the first hypothesis while accepting the second would mean that there is no significant improvement noticeable in the health status of

patients, yet pharmacy costs tend to be lower in the case of patients treated in strongly tied shared care relationships.

- Or third: should I accept the first hypothesis and reject the second one would lead me to conclude that the health status of patients treated in strongly tied shared care relationships tends to be significantly better, while the pharmacy costs incurred remain largely unchanged.

With a view to the three possible outcomes, it appears justified to follow up on the two hypotheses simultaneously and treat them in conjunction with each other in subsection presenting conclusions.

Should at least one of the first two hypotheses be endorsed, it would read as a substantial argument for the further exploration of strong relationships. With a view to the findings of Landon et al. [2012], it can be expected that homophyly also functions in Hungary, meaning that general practitioners display a preference for similarly endowed professionals (place of graduation, age, gender, work experience) in choosing collaborating specialists. It was in this context that I drew up my third hypothesis. My expectation is that strong ties between collaborating doctors emerge when supported by similar backgrounds.

H3: Doctors having strong ties to one another share many similarities (homophyly).

Following up on the fourth hypothesis, I attempt to demonstrate whether or not general practitioners maintaining concentrated vs. dispersed referral structures, on the one hand, and doctors qualifying as preferred or not-preferred specialists, on the other - display similarities in their characteristics. In my view, the cited questions, when explored, will be instrumental in understanding the reasons behind the emergence of both strong and weak ties.

H4a: Based on their characteristics, general practitioners maintaining a concentrated referral structure can be differentiated from those maintaining a dispersed referral structure.

H4b: Based on their characteristics, preferred specialists can be differentiated from those defined as non-preferred.

2.1.7. Definition of output variables

In the present section, I proceed to discuss the techniques employed in the definition of the health status of patients, on the one hand, and pharmacy costs, on the other. These variables of the empirical phase of my research are referred to as output variables.

Health is a multi-dimensional concept, according to the definition offered by WHO: ‘Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity’ ([WHO 1948]). The concept of health can be paraphrased either by a definition of health status, or by grading the quality of life. The health status of individuals can be measured by various tests or medical examinations, or, respectively, using questionnaires filled in by the patient. Measurements taken on individual health status may focus on medical test results (such as blood pressure readings, glucose level tests), symptoms, co morbidity reports, or consequential conditions (amputation, pain) (Blackwood [2009]).

In my dissertation, I use approximate indices on the health status of patients based on diagnosed and treated comorbidities. Comorbidities list the ailments shown under the classification algorithms of the indices referred to. It needs to be emphasized, that comorbidity indices measure only one dimension of a person's health status. Nonetheless, there are empirically tested facts which support the reliability of these indices in the prognosis of mortality (Charlson et al. [1987], Lix et al. [2013], Li et al. [2008], Sharabiani et al. [2012], Quail et al. [2011], Quan et al. [2011]). The copious use of these indices is explained by the fact that apart from the prediction of mortality, they can be employed in forecasting undesirable future events (such as hospitalization, amputation) and anticipating changes in the patient's health status (de Groot et al. [2003], Kieszak et al. [1999], Lix et al. [2013], Quail et al. [2011], Rochon et al. [1996]).

Numerous research publications have shown that comorbidity indices can be relied on in the assessment of the health statuses of patients (Bayliss et al. [2005], de Jonge et al. [2006], Manen et al. [2003], Rebollo et al. [2000]).

Sharabiani et al. [2012], in their systematic literature review, took a close look at the most widely used comorbidity indices. They came to the conclusion that the most

popular comorbidity index was that of Charlson followed by the measure of Elixhauser. This study found that the Elixhauser measure came closest to accurately forecasting long- and short- term mortality.

De Groot et al. [2003], in their systematic literature review, performed a similar survey of prognostication indices for mortality and came to the conclusion that the most reliable rating systems used for the prediction of mortality are Charlson comorbidity index, CRS (Cumulative Illness Rating Scale); the ICED (Index of Coexisting Disease); and the Kaplan Index.

Huntley et al. [2012] in their systematic literature review propose that in the area of primary care, the Charlson comorbidity index provides the best approximation in defining certain dimensions of an individual's health stratus (such as mortality, quality of life, potential need for health care services).

Based on the studies referred to above, in my own research, I employed four different comorbidity indices:

- the Charlson comorbidity index (Charlson et al. [1987]);
- the Quan-modified Charlson comorbidity index (Quan et al. [2011]);
- the Elixhauser measure (Elixhauser et al. [1998]); and finally
- the ATC-based comorbidity count.

I decided to select these indices regarding the fact that in the international literature on the subject there is some ambiguity as to the rating of these systems in terms of representing the highest grade of reliability. For this reason, I chose to employ several variables in approximating the qualification of the patient's health status.

The Charlson comorbidity index offers predictions as to the 10 year survival probability of the patient using a weighted scoring system which evaluates the presence or the absence of 19 different diseases (Charlson et al. [1987]). The Charlson comorbidity index applies a weighted co-efficient for each one of the 19 diseases (any malignancy, including lymphoma, and leukaemia, except malignant neoplasm of skin, cerebrovascular disease, chronic pulmonary disease, congestive heart failure, dementia, hemiplegia or paraplegia, metastatic solid tumour, mild liver disease,

moderate or severe liver disease, myocardial infarction, peptic ulcer disease, peripheral vascular disease, renal disease, rheumatic disease). Higher scores imply a higher mortality rate. Considering the fact that since the first publication of Charlson comorbidity index in 1984, developments effecting the mortality rates related to particular diseases, changes in the quality of life, as well as progress made in medical science: it could be argued that the application of this rating system may require adjustments. Therefore, I chose to define the relevant index values, additionally, with the aid of the Quan-modified Charlson comorbidity index: thus revising the mortality rate scores assigned to particular diseases - while the list of diseases remained unchanged (Quan et al. [2011]).

The Elixhauser measure examines the occurrence of 30 carefully selected diseases (AIDS/HIV, alcohol abuse, blood loss anaemia, cardiac arrhythmias, chronic pulmonary disease, coagulopathy, congestive heart failure, deficiency anaemia, depression, drug abuse, fluid and electrolyte disorders, hypertension, complicated, hypertension, uncomplicated, hypothyroidism, liver disease, lymphoma, metastatic cancer, obesity, other neurological disorders, paralysis, peptic ulcer disease excluding bleeding, peripheral vascular disorders, psychoses, pulmonary circulation disorders, renal failure, rheumatoid arthritis/ collagen vascular diseases, solid tumour without metastasis, valvular disease, weight loss). My research defines the Elixhauser measure in line with the publication of Quan et al. [2005], using the ICD codes entered on prescriptions.

The fourth comorbidity rating technique applied in my research is an alternative index referred as the number of prescription drugs dispensed in the relevant literature (e.g., Lix et al. [2016]). This alternative index relies on the ATC codes entered on the prescriptions. My objective in using this alternative index was the rectification of potential mistakes occurring in the ICD codes. With the help of the comorbidity indices based on the ATC codes, I took account of the occurrences of diseases with respect to which the patient received at least one prescription in each quarter year analysed. The ATC-based comorbidity count, therefore, does not provide a weighted value, instead: it represents the aggregate number of each three digit ATC code occurring on prescriptions issued to the patient.

Sharabiani et al. [2012] suggest that - not counting the ATC-based comorbidity count just described - the rating techniques selected for my research represent most widely employed and accepted methods in measuring comorbidity. Evidently, the higher the index the worse is the rating of the patient's health status. For all four of the comorbidity indices, I have taken into account all prescriptions raised by the general practitioner whether issued for the treatment of diabetes or any of the other diseases. By using the comorbidity indices, an opportunity is offered for the comparison of the health status of patients treated in strong vs. weak general practitioner-specialist relationships.

In the case of diabetes patients, both Meyers et al. [2014], as well as Lix et al. [2013], made use of the Charlson comorbidity index for measuring the health status of patients. Lix et al. [2013], as well as Quail et al. [2011], relied on the Elixhauser measure in assessing the health status of diabetes patients. The research studies referred to, made it possible for me to compare the distribution of comorbidities as presented by other researchers in their samples with the distribution revealed in my own sample. The result of the described comparison allowed me to conclude that frequencies noted in the earlier studies show remarkable similarities to the frequency indices arrived at in my own research. No strikingly outstanding values have been obtained with respect to any of the diseases indexed (for details see supplements 1, and 2.)

The four comorbidity indices employed can be defined on the basis of overlapping arrays in the light of which a high degree of correlation can be recognized among the indices (Table 6.). This result largely coincides with my expectations since the same concept - that of the health status of the patient - is approximated with the aid of various indices. The various comorbidity indices have been developed on differing premises. They use different techniques and focuses for prognosticating mortality (short term, in some cases, long term in others), also: undesirable consequences are predicted with varying coefficients (amputation, prolonged hospitalization, drawn-out inpatient treatment) (de Groot et al. [2003], Lix et al. [2013], Li et al. [2008], Sharabiani et al. [2012]). The differences referred to appear to support the perception that using a variety of indices in my empirical research for defining output variables may be well justified.

Table 6. The measure of correlations among comorbidity indices

	Charlson comorbidity index	Quan-modified Charlson comorbidity index	Elixhauser measure	ATC-based comorbidity count
Charlson comorbidity index	1			
Quan-modified Charlson comorbidity index	0.774	1		
Elixhauser measure	0.702	0.635	1	
ATC-based comorbidity count	0.425	0.316	0.527	1

Data source: DoktorInfo database.

It ought to be emphasized that the meaning of the term: comorbidity, as used in the context of comorbidity indices, differs from the denotation used with respect to diabetes complications. I defined the nature of the patient's diabetes - whether it carries complications or is free of complications - on the basis of the ICD codes posted to the diabetes prescriptions issued to the patient. For instance the code E1090 - denoting medication for insulin-dependent patients free of complications - indicated that the patient had not been exposed to complications, with the obvious constraint that, for the duration of the two year observation period, no prescriptions carrying ICD codes implying complications had been issued. On the other hand, in the calculation of comorbidity indices, I looked at the ICD codes defined by the indices as the basis for my empirical research. In the procedure followed, I used the matrix of codes presented in the publication of Quan et al. [2005], which contained the applicable ICD code for every particular disease within the scope of the study.

In defining pharmacy costs, I calculated the aggregate cost of medication, without subsidies, prescribed by the general practitioner for every single patient throughout the years 2010 and 2011 using information retrieved from the NHIFH database (see section 2.1.1.3.). It is important to stress that, in the course of this research, I was not using medication expenditures carried by the patient when calculating pharmacy cost. Instead, I used the full prices which would be payable for the pharmaceuticals in the pharmacy shops by the patient complemented by government subsidies. As a result, I was able to take into account the pharmacy cost for the whole society.

2.1.8. Model specification

In the case of hypotheses H1 and H2, I have calculated the weighted averages of the comorbidity indices, on the one hand, and that of the pharmacy expenditures, on the other, of patients treated within particular specialist-general practitioner shared care relationships. The calculation of the weighted averages appeared necessary in order to avoid distortions in the analysis results on account of differences in the number of patients treated jointly in general practitioner-specialists shared care relationships. The differences between such weighted averages have been further analysed with the application of statistical tests. I have performed a *t*-test for comparing both the health status and the pharmacy expenditures of patients treated in shared care relationships with diverging strengths of ties. I defined a particular output variable as significant if the p-value is <0.05. I completed sensitivity tests regarding the two remaining definitions of strong vs. weak ties (for the definition alternatives cf section 2.1.5.1.) I also applied a multivariate regression analysis of pharmacy costs with the objective of assessing the aggregate impact of output variables on calculated expenditure results.

Regarding the hypothesis H3, I compared the characteristics of general practitioners and specialists maintaining strong ties. For hypothesis H4a, I took a close look at general practitioners maintaining concentrated- versus those maintaining dispersed referral structures. For hypothesis H4b, I compared preferred specialist vs. non-preferred specialists. I tested this hypothesis with the use of a χ^2 function. I defined a variable as significant if the p-value is $p<0.05$.

For my empirical research calculations, I used the IBM SPSS Statistics 22 software, Microsoft Access, Excel 2016, and the R program package.

2.2. Results

In the present subsection, I first proceed to analyse the impact of strong vs. weak general practitioner-specialist relationships on patient health status and pharmacy costs (H1, H2). Upon endorsing or rejecting the first two hypotheses, the next important phase of my research is to identify those relationships which exert an influence on the health status of patients and pharmacy costs carried respectively.

The question arises as to whether the properties of general practitioners and specialists working in close relationships differ from the characteristics of those general practitioners and specialists who maintain weak ties with each other (H3).

In the concluding part of this subsection, I present the results obtained in following up on hypothesis H4. As a first step, I explore the question of recognizable differences in the characteristics of general practitioners maintaining a concentrated referral structure as opposed to those working with a dispersed structure (H4a). Secondly, I take a look at the differences, if any, between the characteristics of preferred as opposed to not-preferred specialists (H4b).

2.2.1. The appraisal of the health status of patients and the pharmacy costs carried in juxtaposing strong vs. weak ties

As defined in section 2.1.5.1., in the present subsection, I take a close look at the health status of patients and the pharmacy costs carried with respect to patients treated in strong-ties relationships as opposed to those receiving care in weak-ties relationships. I first compare the characteristics of patients receiving shared care in strong vs. weak relationships then I carry on with the exploration of health status and pharmacy expenditures. I also performed sensitivity and robustness tests for both strong and weak relationships with respect to patient health status and pharmacy costs. I close this section by presenting the results obtained through the application of a regression analysis for the computation of pharmacy costs.

In Table 7., I provide a comparison between certain characteristics of patients treated in strong- vs. weak specialist-general practitioner relationships. With respect to patients receiving shared care in strong vs. weak relationships, significant differences between the two groups of patients are manifested primarily in the average age of

patients, in the type of therapy provided, in the number of specialists consultations per patient (taking into consideration visits generating new specialist recommendations for prescriptions).

Table 7. Patient characteristics in. strong vs weak general practitioner-specialist relationships

Patients' characteristics	Strong ties (uppermost quintile)	Weak ties (lowest quintile)	p-value (%)
Gender (%)			
male	53.34	52.09	42.66
female	46.66	47.91	
Average age (years)	66.11	64.33	0.00
Seriousness of diabetes condition (based on the ICD codes, %)			
without complications	56.92	59.34	12.03
with complications	43.08	40.66	
Type of therapy (based on the third level ATC code, (persons, %))			
insulin	68.44	72.61	0.43
not-insulin	31.56	27.39	
The number of prescriptions per patient (units)			
Total number of prescriptions	132.99	133.52	86.66
of which: number of prescriptions issued for diabetes	27.42	27.33	88.18
The number of consultations per patient (occasions)			
with the general practitioner taking into account all prescriptions	22.74	21.95	7.47
with the specialist. based on the number of new recommendations generating prescriptions	2.34	2.62	0.00

Data source: DoktorInfo database.

The average age of patients treated in strong relationships is 1.78 years higher compared to that of patients belonging to the other group. They visit their specialist doctors less frequently, and the number of patients receiving insulin therapy in the strong-ties group is relatively smaller.

In the two patient populations, there are no significant differences with respect to gender distribution; the severity of diabetic conditions; the number of prescriptions per patient taking either the total number of prescriptions or prescriptions related to the treatment of diabetes. Nor could I establish notable differences in the frequency of consultations with their respective general practitioners.

Table 8. shows the test results calculated for the first two of my hypotheses. All four comorbidity indices support the conclusion that patient health status is not influenced by the nature of general practitioner-specialist relationships providing care, be the respective ties classified as either strong or weak. The numbers of comorbidities per patient, with a view to any of the comorbidity indices used, are very much the same and do not appear to be influenced by the strength of specialist-general practitioners relationships. This implies that I have to discard my first hypothesis.

Table 8. Description of strong and weak general practitioner-specialist relationships in the light of output variables

Output variables	Strong ties (uppermost quintile)	Weak ties (lowest quintile)	p-value (%)
The patients' health status (excluding diabetes)			
Charlson comorbidity index	0.93	0.91	43.64
Quan-modified Charlson comorbidity index	0.60	0.60	82.66
Elixhauser measure	1.98	1.95	42.33
ATC-based comorbidity count	8.01	7.98	83.93
Pharmacy costs (thousand HUF)	612.18	721.41	0.00

Data source: NHIFH and DoktorInfo databases.

On the other hand, and in the light of my computations, the strength of ties between doctors, certainly makes an impact on pharmacy costs. Patients treated in strong general practitioner-specialist relationships carry pharmacy costs which are 15.14% smaller than those carried by patients treated in weak relationships. For patients in the uppermost quintile, the average amount of pharmacy costs is 612.18 K HUF, for the two-year analysis period; while the same average for patients in the lowest quintile amounts to 712.41 K HUF. The difference is significant, therefore my second hypothesis has to be endorsed.

The correlation rate applying to a comparison of pharmacy costs as reflected by the Charlson comorbidity index, the Quan-modified Charlson comorbidity index and the Elixhauser measure is below 0.2. The correlation rate between pharmacy costs and the ATC-based comorbidity count is 0.47.

In the sensitivity studies performed, a comparison between the uppermost and the lowest deciles, as well as the uppermost and the lowest tertiles, with respect to the four comorbidity indices, provided the results shown in Table 9. In the case of patients treated in strong vs. weak relationships, the results demonstrate no significant differences regarding patient health status: with the exception of the ATC-based comorbidity count, where a difference is noted in the case of the uppermost, vs. the lowest tertile.

Table 9. Sensitivity tests results describing the characteristics of general practitioner-specialist relationships with respect to the health status of patients

Output variables	Strong ties (upper-most decile)	Weak ties (lowest decile)	p-value (%)	Strong ties (upper-most tertile)	Weak ties (lowest tertile)	p-value (%)
The patients' health status (excluding diabetes)						
Charlson comorbidity index	0.93	0.97	52.21	0.94	0.93	88.77
Quan-modified Charlson comorbidity index	0.60	0.63	57.34	0.61	0.62	68.26
Elixhauser measure	1.98	1.95	71.61	1.99	1.94	13.31
ATC-based comorbidity count	7.99	8.30	16.35	8.03	7.79	3.25

Data source: NHIFH and DoktorInfo databases.

Table 10. contains the results of a sensitivity and robustness study on weak and strong general practitioner-specialist ties. The objective of the sensitivity analysis was to explore whether or not using diverse definitions for the description of the strength of ties will have an impact on the results obtained. I also completed a robustness test for the same database with the objective of excluding extreme pharmacy cost values from the sample. Regarding the results of the sensitivity tests as applied to the entire

database, we can reasonably conclude that in the case of patients treated in strong relationships, pharmacy costs are significantly lower than in the case of patients treated in weak relationships. The average pharmacy costs tend to grow with the size of the subset selected: looking at the uppermost decile, the average cost calculated is as low as 584.65 K HUF; reading the uppermost quintile, if is 612.18 K HUF; while in the uppermost tertile, the amount calculated is 616.60 K HUF. Similarly, for weak ties, pharmacy costs are shown as lower with the increase of the size of the sample. In the Table exhibited, aggregate averages are provided for the two-year analysis period sorted according to the strength of ties.

Table 10. Sensitivity and robustness tests results describing the characteristics of general practitioner-specialist relationships with respect to pharmacy costs carried by the patients

Output variables	Sample database	Without patients carrying pharmacy costs above 8 M HUF (over the two year analysis period)	Without patients carrying pharmacy costs above 5 M HUF (over the two year analysis period)
Strong ties , (uppermost decile)	584.65	582.83	575.64
Weak ties (lowest decile)	771.55	773.93	754.45
p-value (%)	**0.00**	**0.00**	**0.00**
Strong ties (uppermost quintile)	612.18	610.34	601.90
Weak ties (lowest quintile)	721.41	721.41	707.39
p-value (%)	**0.00**	**0.00**	**0.00**
Strong ties (uppermost tertile)	616.60	614.30	606.44
Weak ties (lowest tertile)	661.16	661.04	652.70
p-value (%)	**0.01**	**0.05**	**0.32**

Data source: NHIFH and DoktorInfo databases.

With the robustness test performed, I excluded patients with higher than 5 M HUF, respectively: higher than 8 M HUF, aggregate two-year pharmacy costs. Threshold values have been established with the aid of a box-plot drawn up for pharmacy costs. Excluding high pharmacy cost patients from the sample, the average pharmacy cost figures have been diminished. Still, upon such exclusions, pharmacy costs carried in the case of close-ties patients are significantly lower, compared to those carried by weak-ties patients.

The results obtained in the sensitivity and robustness tests are consistent with the results displayed in Table 8. do not distort the conclusions of the analysis. Therefore, in the further part of the analysis, I proceed to examine the entire sample without the exclusion of outstanding values.

The question emerged, whether a patient's pharmacy costs are veritably influenced by the strength of ties between doctors providing shared care? To handle this concern, it appears to be promising to complement the bivariate model with a multivariate regression analysis for pharmacy costs.

As a first step, I made a selection of independent variables. Within the spread of the data available, I selected 15 independent variables for the analysis to be performed which may have a potential effect on pharmacy costs: strong vs. weak ties between general practitioners and specialists (0 - for strong; 1 - for weak ties); patient's gender, patient's age in years, the four comorbidity indices, (the Charlson comorbidity index, Quan-modified Charlson comorbidity index, the Elixhauser measure, the ATC-based comorbidity count), the number of consultations per patient (with the specialist - taking into account the number of visits generating new specialist recommendations for prescription pharmaceuticals); the number of consultations per patient with the general practitioner (taking into account the number of prescriptions for diabetes related medication), the number of prescriptions issued per patient; the number of prescriptions issued for the treatment of diabetes; the number of all prescriptions per patient with the exclusion of diabetes related prescriptions; the type of the therapy provided (0 - for insulin based; 1- for not insulin based) the severity of the patient's diabetes condition (0 - for free of complications; 1 - for status with complications).

I drew up a correction matrix for the 15 independent variables selected in order to exclude those variables between which a strong linear correlation is recognised I then proceeded to exclude those independent variables of the model which display a high degree of correlation with each other (Chiulli [2009]).

In section 2.1.7., I have already pointed out that there is high degree of correlation among comorbidity indices, therefore I use only one comorbidity index in the final models. The value of correlation between the ATC-based comorbidity count and the variable defining the number of prescriptions issued per patient is 0.84 as a consequence of which I decided to exclude the ATC-based comorbidity count from the analysis since, inevitably, the number of prescriptions issued will fundamentally influence the aggregate amount of pharmacy costs. Of the indices based on ICD codes, I selected the Quan-modified Charlson comorbidity index, guided by the fact that this index displays the greatest interpretive force with respect to pharmacy costs. I defined these costs by drawing up a linear regression model employing one single comorbidity index as an independent variables relating to pharmacy costs as a single output variable.

There is also a very high degree of correlation (0.65-0.98) observed with respect to further independent variables: the number of prescriptions issued per patient; the number of prescriptions issued per patient for the treatment of diabetes, and the number of all prescriptions issued per patient with the exclusion of diabetes - therefore, in my model, I only used the variable defining the number of prescriptions issued per patient.

The number of consultations per patient (with the general practitioner, taking into account prescriptions for the treatment of diabetes) and the total number of consultations (with the general practitioner) show strong correlation with the total number of prescriptions issued, therefore I also omitted the former two variables in my analysis. Following the omissions, 8 variables have been retained in my final model.

It is a fundamental principle of the application of linear regression that there must be a linear correlation among the variables. Nonetheless, based on the graphic presentation of the data, I came to the conclusion that the linear correlation is missing between the patients' age and pharmacy costs. Therefore, I decided to include the

square of the patient's age, as a result of which it was expected that these two variable will provide a more transparent interpretation tool for the output variable.

Table 11. contains the results of a regression analysis applied to the pharmacy costs carried by the patient. The coefficient of determination of the model (R^2) is 0,396.

Table 11. Multivariate regression analysis applied to the pharmacy costs carried by patients

Independent variables	**Stand. coefficient**	**Sig.**
	Beta	
Strong and weak ties between general practitioners and specialists (0 - for weak; 1 - for strong)	0.011	0.030
Quan-modified Charlson comorbidity index	-0.009	0.113
Patient's gender (0-female, 1-male)	-0.024	0.000
Diabetes severity (0-complication-free, 1-with complications)	0.014	0.007
Type of therapy (0-no insulin, 1-insulin based)	0.202	0.000
The number of prescriptions per patient (units)	0.570	0.000
The number of consultations per patient (with the specialist, generating new recommendations for prescription medicines)	0.062	0.000
Patients' age	0.174	0.001
Patients' age squared	-0.272	0.000

Data source: NHIFH and DoktorInfo databases.

Viewing the results of the linear regression presented, we can conclude that strong vs. weak ties in shared care provided for the patient bear a marked influence on pharmacy costs: which means that the strength of relationships between doctors unquestionably effects pharmacy costs. In the case of patients receiving shared care in strong relationships, pharmacy costs are significantly lower than those characterising patients treated in weak relationships.

The results presented similarly imply that female patients carry significantly higher pharmacy cost compared to mail patients. The Beta value of the severity of diabetes condition is likewise positive, indicating that patients suffering complications carry significantly higher pharmacy costs compared to those whose condition is free from

complications. Further, the type of therapy provided also has an influence on pharmacy costs since these costs are significantly higher with the application of insulin based, as opposed to not insulin based therapies.

In accordance with our expectations, pharmacy costs increase in line with the number of prescriptions issued and the number of consultations with the specialist. The Beta value of the age of patients is also positive, meaning that the higher the age of the patient, the higher the expected volume of pharmacy costs. The Beta value of the square of patient age is negative which implies that the impact of patient age on pharmacy costs diminishes with the passage of years beyond a certain age.

It is important to point out that, the impact of the Quan-modified Charlson comorbidity index, in the case of using a bivariate regression model, has been found positive, which means that the higher the number of comorbidities of a certain patient, the higher the respective pharmacy cost are expected to be. In the case of applying a multivariate model, the Beta value changes to negative (-0.009), nonetheless, the variable itself will be rated insignificant. This outcome is explained by the fact that the correlation between pharmacy costs and the health status of the patient is not linear.

In summary, with a view of the results obtained in the analyses of the present chapter, I am in a position to confirm the significant influence exerted by the strength of doctor relationships on pharmacy costs carried by shared care patients. In other words, patients shared treatment in strongly tied relationships carry lower pharmacy costs when compared to other patients with a comparable health status.

2.2.2. Characteristics of strong vs. weak ties

In the present section, I am trying to define the properties characterising strong ties between collaborating doctors. Based on the findings of the previous section, I came to the conclusion that patients of similar health status carry lower pharmacy costs when receiving shared care in a strong-ties general practitioner-specialist relationship. The question emerged if it were possible to identify personal or professional traits with respect to collaborating doctors which may contribute to the development of strong ties.

The results of such scrutiny will be influenced by the provision that general practitioners are required to refer their patients to specialists of territorial charge. I believe, however, that with an availability of more than one specialists working in the district, the general practitioner will consider the option of selecting a specialist with characteristics closer to his/her own.

In Table 12., I examine the similarities and differences between doctors working in strong vs. weak general practitioner-specialist relationships, respectively.

Based on the results presented in Table 12., we find a notable difference between strong vs. weak specialist-general practitioner relationships with respect to the gender composition of both groups. The ratio of strong ties is significantly higher between practitioners of the same sex than between those of the opposite sex. Accordingly, I have to discard my earlier hypothesis which assumed stronger ties between doctors representing opposing sexes.

The number of statutory certificates acquired appears to produce significant differences in the strength of ties: where these numbers are close to each other the ties developed tend to be stronger. In this case, the effects of homophyly are at play in these relationships. Doctors apparently prefer to collaborate with colleagues not much different with regards to the number of medical certificates acquired.

Furthermore, results displayed in Table 12. also demonstrate that the longer the period of collaboration, and the closer the location of the practices of the general practitioner and the specialist to each other: the greater the likelihood of strong collaborative ties developing between them.

No significant differences have been revealed in the strength of general practitioner-specialist ties with respect to differences in the partners' age, the school of their graduation, or the time elapsed since their graduation. In other words, it does not seem to matter for general practitioners how old their specialist counterpart was, nor the year or the school of their medical graduation. What does appear to matter, is the regional authorisation for providing health services and the length of the period of joint collaboration.

Table 12. Similarities and differences applying to doctors providing shared care in strong vs. weak ties

Categories	Top 20%	Lowest 20%	p-value (%)
Gender Distribution (%)			0.52
male to male	25.67	27.40	
female to female	49.92	53.52	
male to female	24.41	19.08	
Deviations in age distribution (%)			17.50
0-5	29.79	26.60	
6-10	23.93	23.91	
11-15	19.73	19.40	
16 -20	13.07	15.04	
21-25	6.81	8.87	
26-	6.66	6.18	
School of graduation identity (%)			9.42
same medical school	59.11	55.82	
different medical school	40.89	44.18	
Year of graduation, distribution of differences (%)			5.57
0-5	29.24	26.13	
6-10	24.09	22.80	
11-15	19.81	19.71	
16 -20	12.12	15.99	
21-25	7.13	8.31	
26-	7.61	7.05	
The distribution of differences in the number of medical certificates acquired (%)			1.03
0	35.66	30.01	
1	46.20	50.36	
2	18.15	19.64	
Distribution of the duration of the collaboration period (%)			0.00
0-10	5.86	9.34	
11-20	36.93	42.60	
21-30	43.03	35.47	
31-40	12.92	11.80	
41-	1.27	0.79	
Distribution of distances (km) between practices (%)			0.00
0-9	57.22	18.37	
10-19	20.00	18.84	
20-29	12.86	15.76	
30-39	5.87	13.38	
40-49	2.62	9.82	
50 -	1.43	23.83	

Data source: HCRT, Google Maps NHIFH and DoktorInfo databases.

In this light, I cannot avoid discarding my third hypothesis on the expected similarities of doctors working in strong relationships. Strong ties tend to develop between doctors of the opposing sex, and those looking back on a long period of joint collaboration. Homophyly was evidently present in preferences based on the number of medical certificates but had no noticeable impact on other criteria. In this respect, the results of my analysis were at variance with my expectations.

The contradictory results may be traced to a number of reasons, such as the accepted practice of specialists being chosen by the patient rather than by the general practitioner; or such as the absence of a specialists with similar professional characteristics in the patient's area of health administration. Another possible reason for the adverse results may be that the limited role played by homophyly in the development of strong shared care ties between professionals is a general phenomenon prevailing much beyond the borders of Hungary. In the light of these potential reasons, it may be expedient to subject the characteristics of doctors working in strong, or respectively, weak relationships to closer scrutiny. Similarly, a further exploration of strong vs. weak ties between practitioners working in small or medium size townships appears to be opportune.

2.2.3. Characteristics of doctors working in strong vs. weak relationships

In 2.2.1., I presented the conclusion that patients of comparable health conditions incur lower pharmacy costs if treated by collaborating general practitioners and specialists connected by strong ties. On this note, with a reference to the preceding section, I have asserted that those doctors are amenable to develop strong ties with each other whose practices are not separated by larger distances, have a long standing relationship, and the difference between the respective numbers of their statutory medical certificates is small. A further question to be asked concerns the shared characteristics of general practitioners and specialist, respectively, regarding their individual professional and socio-demographic traits. This section is devoted to the exploration of the question above.

Hypothesis H4 contains two subsidiary hypotheses. First, I propose to examine the differences in the characteristics of general practitioners maintaining a concentrated referral structure as opposed to those working with a dispersed referral structure (H4a).

And secondly, I proceed to look at the differences, if any, between the characteristics of specialists qualified as preferred, as opposed to those described as non-preferred (H4b).

2.2.3.1. General practitioners

In this section, I continue to discuss my thesis relying on the definition of general practitioners as maintaining a practice characterised by concentrated vs. dispersed referral structures as presented in the earlier section of 2.1.5.2., thereby taking a closer look at the deviations in the characteristics of general practitioners opting for strong ties as opposed to those working in weak relationships.

In Table 13., I compared the characteristics of general practitioners maintaining strong vs. weak ties as representatives of the uppermost as opposed to the lowest quintiles of the listed criteria. There is a significant difference noted between the size of the municipalities where general practitioners maintain their respective practices described as having concentrated as opposed to dispersed referral structures. This difference is probably explained by the differences in the number of available specialists in the administrative area of the general practitioner selected. In the capital city of Budapest, 3.8%, of general practitioners maintain strong ties with their specialist counterparts. The analogous ratio in major cities is 1.3%; in medium-sized towns: 7.0%; whereas, in the case of the remaining settlements, it is 87.97%. The capital city, weak ties are noted in 20.8% of the cases, in major cities the number is 39.6%, in medium sized towns it is 0.6%, while the case of minor settlements the ratio is 38.99%.

With respect to gender, age, the number of statutory medical certificates acquired, the length of professional experience or the number of years spent in the current institution of employment: no significant differences have been discovered between general practitioners having concentrated vs. dispersed referral structures. The statistical results obtained indicate that between general practitioners maintaining a concentrated referral structure vs. those maintaining a dispersed referral structure: differences of significant consequence can only be detected in connection with the school of graduation and the size of the municipality where their respective practices are offered.

Table 13. A comparison of general practitioners with concentrated vs. dispersed referral structures

Categories	Uppermost 20%	Lowest 20%	p-value (%)
Gender Distribution (%)			28.39
male	55.70	49.69	
female	44.30	50.31	
Age distribution (%)			23.33
30-39	6.33	12.58	
40-49	25.32	18.24	
50-59	33.54	35.22	
60-69	25.95	27.04	
70-79	8.86	6.92	
School of graduation identity (%)			0.00
Budapest:	27.22	23.27	
Debrecen	17.72	44.03	
Szeged	17.72	5.66	
Pécs	22.15	19.50	
abroad	15.19	7.55	
The distribution of differences in the number of medical certificates acquired (%)			11.22
1	39.24	39.62	
2	48.10	40.25	
3	9.49	18.24	
4-	3.16	1.89	
Distribution according to the size of municipalities (%)			0.00
Capital city	3.80	20.75	
Major city (more than 100K inhabitants)	1.27	39.62	
Medium-sized town (population 40-100K	6.96	0.63	
Small townships (population of less than 40K)	87.97	38.99	
Professional experience (in years) (%)			50.15
5-14	6.33	9.43	
15-24	22.78	18.24	
25-34	31.01	37.11	
35-44	29.75	27.67	
45-54	10.13	7.55	
Distribution in the number of years spent at the current place of employment (%)			64.43
0-9	24.05	18.87	
10-19	45.57	49.06	
20-29	13.29	17.61	
30-39	12.03	10.06	
40-	5.06	4.40	

Data source: HCSO, HCRT and DoktorInfo databases.

Among general practitioners maintaining concentrated referral structures some medical schools represent a majority in terms of the ratio of their graduates, such as Budapest (strong ties: 27.2%, weak ties: 23.3%), Szeged (strong ties: 17.7%, weak ties: 5.7%), Pécs (strong ties: 22.2%, weak ties: 19.5%), while some other schools represent a minority, such as Debrecen (strong ties: 17.7%, weak ties: 44.0%), schools of foreign countries: (strong ties: 15.2%, weak ties: 7.55%).

There is a significant difference noted between the size of the municipalities where general practitioners maintain their respective practices described as having concentrated as opposed to dispersed referral structures. This difference is probably explained by the (occasionally substantial) differences in the number of available specialists in the administrative area of the general practitioner selected.

3.8% of general practitioners of the capital city maintain concentrated referral structures. The comparable ratio is 1.3% in major cities; 7.0% in medium sized towns; while in the remaining towns and settlements the ratio is 87.97%, indicating - according to the definition offered - the presence of strong ties with respect to the collaborating specialists in each case. Dispersed referral structures are maintained by 20.8%, of all general practitioners in the capital city; by 39.6%, in major cities; 0.6%, in medium sized towns; and 38.99% in the remaining towns and settlements. Here again, by the same definition, the relationships with the respective specialists should be qualified as weak.

No significant differences have been established among general practitioners maintaining centralised, vs. dispersed referral structures in terms of gender, age, the number of statutory medical certificates acquired, the length of professional experience or the number of years spent at the current place of employment.

I also performed a sensitivity analysis on the characteristics of general practitioners represented in the uppermost and the lowest deciles, as well as in the uppermost and the lowest tertiles respectively. In both cases, I have received results similar to those presented earlier in Table 13. The results of the sensitivity analysis are shown in Supplementary 3. I defined a variable as significant if the p-value was $p<0.05$.

In summary, the assertion can be upheld that general practitioners maintaining concentrated referral structures typically work in smaller townships and settlements,

and also: that in a majority of cases, they received their medical degrees from Szeged, Pécs or abroad (primarily in Eastern neighbouring countries.)

2.2.3.2. Specialists

In this section, I am going to present the results of my analysis concerning preferred, as opposed to non-preferred specialists as defined under 2.1.5.3. above. I intend to look at the significance of differences between the characteristic properties of preferred as opposed to non-preferred specialists.

In a majority of cases, preferred specialists occupy significantly higher positions, meaning supervisory positions: a fact which - in certain ways - is also related to seniority in terms of age.

Results related to hypothesis H4b are presented in Table 14. As regards to preferred specialists, we can conclude that they are generally of higher age: 79% in this group are above 50, compared to non-preferred specialists of whom only 49% are over 50 years of age. Thence, preferred specialists tend to be older, on average, than their non-preferred colleagues, and have a longer period of service in their current practices. These results are consistent with my expectations in the sense that, with the length of service grows the professional experience of specialists and, characteristically, such experience is accumulated in keeping with the period of time spent in the same practice.

Preferred specialists typically work in small or medium sized municipalities. Again, this finding appears to be consistent with our original assumption considering the fact that the smaller the number of specialists in a selected municipality, the more constrained is the choice available to general practitioners as to the referral of their respective patients. Thereby the chance of selecting a preferred specialist increases.

Preferred relationships with specialists are more likely to develop in neighbourhoods where the number of available specialists - typically within a distance of 30 km - is low.

Table 14. A comparison between preferred, as opposed to non-preferred specialists

Categories	Preferred	Non-preferred	p-value (%)
Gender Distribution (%)			42.36
male	40.43	47.14	
female	59.57	52.86	
Age distribution (%)			0.50
30-39	2.13	16.43	
40-49	19.15	34.29	
50-59	51.06	28.57	
60-69	21.28	17.86	
70-79	6.38	2.86	
School of graduation identity (%)			21.89
Budapest:	27.66	40.71	
Debrecen	27.66	23.57	
Szeged	19.15	10.00	
Pécs	17.02	21.43	
abroad	8.51	4.29	
Distribution in the number of years spent at the current place of employment (%)			2.26
0-9	36.17	44.29	
10-19	12.77	28.57	
20-29	31.91	14.29	
30-39	12.77	10.00	
40-	6.38	2.86	
Distribution according to the size of municipalities (%)			0.00
Capital city	3.80	20.75	
Major city (more than 100K inhabitants)	1.27	39.62	
Medium-sized town (population 40-100K)	6.96	0.63	
Small townships (population of less than 40K)	87.97	38.99	
The distribution of differences in the number of medical certificates acquired (%)			77.81
1	46.81	42.14	
2	40.43	44.29	
3	10.64	12.86	
4	2.13	0.71	
Specialist assignment(%)			2.27
Higher management position	27.66	19.29	
Management position	44.68	30.00	
Non-managerial position	27.66	50.71	
The average number of specialists within 30 km	20.34	35.41	0.14

Data source: HCSO, HCRT, Google Maps and DoktorInfo databases.

No significant differences have been identified between preferred and non-preferred specialists in terms of gender, school of graduation, and the number of statutory certificates acquired.

In the sensitivity test performed on specialists preferred by three general practitioners, at the least, I have obtained results which are very similar to those presented in Table 14. The sensitivity test results referred to above are presented in supplement 4.

In summary, it can be stated that preferred specialists are usually of higher age and consequently - as a general rule - their period of service in the same practice is longer; they hold higher professional positions; and typically: they practice in small or medium-sized municipalities.

2.2.4. An analysis of small and medium-sized municipalities

The question emerges as to whether the issue of territorial charge ought to be viewed as the single factor responsible for the development of close vs. weak ties, and also: whether the same issue predetermines the strength of ties in small communities. My analysis also explored the question of differences - whether significant or other - in the health status and pharmacy costs of patients receiving care in small and medium-sized municipalities from general practitioners working in strong vs. weak relationships. With respect to this analysis, variables were applied as moderating coefficients.

In the course of the analysis, I relied on the HHI concentration index calculated for general practitioners. I allocated the size of the municipality to every particular general practitioner and subsequently I narrowed down the data base focus on practitioners working in municipalities of less than 100K inhabitants (resulting in 542 general practitioners of the 794 in the sample). As a next step, I sorted the practitioners of the residual base identifying those belonging to the uppermost quintile as well as those belonging to the lowest quintile. In the next phase, I computed the comorbidity indices and the pharmacy costs of patients treated by general practitioners belonging to the uppermost quintile, as well as of those belonging to the lowest quintile.

The t statistics based on the independent variables describing the health status and the pharmacy costs of patients treated by general practitioners working in small and medium-sized municipalities, are shown in Table 15.

Table 15. A comparison of the respective health statuses and pharmacy costs of patients treated by general practitioners working in small and medium-sized municipalities

Output variables	Strong ties (uppermost quintile)	Weak ties (lowest quintile)	p-value (%)
The patients' health status (excluding diabetes)			
Charlson comorbidity index	0.88	0.91	16.03
Quan-modified Charlson comorbidity index	0.59	0.60	58.15
Elixhauser measure	1.93	1.96	30.81
ATC-based comorbidity count	7.98	8.38	0.00
Pharmacy costs (thousand HUF)	591.89	696.60	0.00

Data source: HCSO, HCRT and DoktorInfo databases.

The results are in full conformity with those predicted by hypotheses H1 and H2, confirming that in the case of small and medium-sized municipalities, where the number of available specialists with whom general practitioners are offered an opportunity to develop strong ties is relatively small: the pharmacy costs carried by patients treated in strong relationships are definitely lower at comparable health status indices - with the exception of readings based on the ATC-based comorbidity count.

2.3. Discussion

In the present sub-section, I am going to discuss the conclusions and the possible policy recommendations offered by the findings submitted above, while also taking a look at the constraints and limitations of the analytical work carried out in support of the same findings.

In my empirical research, I explore the characteristics of relationships between general practitioners and specialist which emerge in the process of providing care jointly for patients with type 2 diabetes. In the sample, both the number and the distribution of patients treated by particular general practitioners show large variation. On average, a general practitioner collaborates with eight specialists - nonetheless, the standard deviation of this factor in the sample is fairly high. The structure of collaboration between doctors is rather fragmented. The number of patients receiving shared care in any particular general practitioner-specialist relationship may substantially differ from case to case. Also, the number of specialists collaborating with one particular general practitioner may show large variations. Therefore, in the analysis of relationships I used a relative threshold.

Throughout my research, I came to the conclusion that patients treated in strong relationships generally enjoy a better health status compared to those receiving care in weak relationships. Nonetheless, these differences are not significant. In summary, it can be stated that, the strength of ties exerts no substantiated impact on health status of patients. This result is in conformity with earlier research data. O'Connor et al. [2008] concluded that HbA1c[5] test results reflect exclusively patient characteristics in as much as 95% of the cases. Therefore, the mode of receiving health care - just as the characteristics of doctors - play a rather inconsequential part in the alteration of these test values. In their systematic literature review, Craven and Bland [2006] also asserted that a more efficient collaboration between doctors does not necessarily contribute to better test results on the part of the patient. The authors have drawn attention to the

[5]The HbAc1 (haemoglobin A 1 c) level signalises the ratio of haemoglobin ties with glucose among red blood cells. The higher the blood's glucose level, the higher the HbA1c levels are going to be. The HbA1c readings reflect the average blood sugar levels of the 6-8 week period preceding the test taken. The results obtained allow for assessing the value of the therapy applied (Larsen et al. [1990]).

fact that, while certain trends appear to suggest that the improvements in the patients' health status can be demonstrated as related to medial or strong ties between collaborating doctors: other studies reach an opposing conclusion stating that weak relationships between collaborating doctors may also be conducive of improved health status. Smith et al. [2007] used approximation functions to define health status improvements attributable to enhanced efficiency in shared care - arriving at a similar conclusion, namely: that only some of the cases provided proof of consistent improvement.

With respect to diabetes patients, the systematic literature reviews of both Greenhalgh [1994] and Griffin [1998] offered the conclusion that the benefits of shared care models are independent of the health care systems in which they are applied. Greenhalgh's research [1994] demonstrated that therapy results show close resemblance to each other without regard to the type of therapy: be it provided in the framework of either primary or secondary care. In his publication, Griffin [1998] arrived at a similar conclusion, meaning that he too fell short of finding differences in the mortality rates of diabetics as a function of primary, as opposed to secondary health care received. Renders et al. [2001] analysed the effectiveness of targeted interventions with respect to improvements achieved in the health status of diabetes patients. The authors concluded that complex interventions (whereby they meant the patients' tuition and the augmented role of medical attendants) did not demonstrably contribute to the improved health status of the patient.

The differences between the respective pharmacy costs of patients treated in strong, vs. weak general practitioners-specialist relationships, as I found them, are in conformity with the results presented in the research publications of Barnett et al. [2012], Landon et al. [2012] and Pollack et al. [2013], all of which have demonstrated that those relationships which provide shared care for a larger number of patients: generate comparatively lower pharmacy costs. Barnett et al. [2012] showed that both inpatient, as well as outpatient care, when provided in strong-ties relationships between doctors, are conducive of reducing expenditures related to applicable laboratory tests and electronic imaging techniques. Pollack et al. [2013] explored the interrelations between primary and secondary care expenditures as well as the volume of pharmacy costs, on the one hand, and the strength of ties between doctors providing

shared care for diabetes patients, on the other. The authors came to the conclusion that combined costs as related to shared care are prone to decrease in line with the increasing strength of doctor relations; however, on the examination of the individual components of overall expenses, they established that a larger shared patient portfolio produces higher pharmacy costs. I should add, however, that the authors of the cited report failed to provide an explanation for this latter assertion which clearly contradicts the findings of my own research. It is important to point a finger at two important differences between my own research and some of the findings presented in international literature. First, the studies reviewed did not address the issue of collaboration between the exponents of primary care and secondary care, as I did; since, to the best of my knowledge no earlier publications have endorsed this subject as the focus of research. It also needs to be mentioned that the studies referred to reviewed conditions applying to health care systems outside Europe. Despite of the differences referred to, they have all arrived at conclusions similar to mine.

For a better understanding of the deviations discovered in pharmacy costs, I also completed regression analysis beyond the by-variate computations already presented. With the assistance of this method, I was better positioned to examine the variables providing a complex explanation of observed differences in pharmacy costs. I determined that the strength of ties, similarly to other patient characteristics (gender, age, severity of diabetes condition) bear a significant impact on pharmacy costs, alongside with the type of therapy applied (insulin based, not insulin based).

Here bellow, based on the results of the regression analysis performed, I proceed to take a closer look at the following factors:

- patient characteristics (gender, age, severity of disease) in both strong weak relationships;
- differences in the composition of medication as related to strong vs. weak ties, with a special emphasis on the type of therapy applied.

Patients' characteristics

Based on the results obtained in the regression analysis performed, it can be stated that pharmacy costs are significantly higher in the case of female patients as compared to

those of male patients (Table 11). Upon comparing the results obtained with respect to patients treated in strong, as opposed to weak ties, I established that the number of female patients treated in strong relationships is higher compared to the number of male patients treated in similar ties. However, the difference revealed is not significant (Table 7). In my view, this difference is not sufficient to explain the recorded deviations in pharmacy costs.

The age of the patients plays an important role in the construction of pharmacy costs. Also: the average age of patients treated in strong relationships is demonstrably higher. With patients treated in strong relationships the average age is 66, while the same average of those treated in weak relationships is 64. These findings could be contradictory, but there has been no linear or - for that matter - no monotonous relationship discovered between patient age and pharmacy costs. Rare exceptions notwithstanding, average pharmacy cost are the highest at the age of 63. Beyond that age, average pharmacy costs tend to decrease. This could be explained by a number of reasons. It may be possible that patients in very severe conditions departed during the period studied; respectively, they received treatment in another form - of which I have no relevant information (such as outpatient or inpatient care). Taking the entire patient population, patients aged 64 carry an average pharmacy cost of 672 K HUF, while those aged 66 carry an average pharmacy cost of 660 K HUF (for the two year period). Looking only at patients treated in strong relationships and aged 64, the average pharmacy costs carried is 670 K HUF, while the comparable amount carried by patients in the same group and aged 66, is 652 K HUF. As regards comparable figures in the case of patients treated in weak relationships: they amount to 827 K HUF and 1,075 K HUF respectively. For weak relationships, average pharmacy costs are at the highest in the case of patients aged 66. With respect to the two groups considered, deviations in average age do not explain the differences in pharmacy costs, less so, since I specifically reviewed differences in pharmacy costs attributable to average age disparities and came to the conclusion that - in the case of strong relationships - pharmacy costs are consistently and significantly lower irrespective of the average age of the patients.

Based on the regression analysis, results show that pharmacy costs are significantly affected by the severity of the patient's diabetes condition. Nonetheless, looking at the

health status of patients treated either in strong or in weak relationships, no significant differences between the two groups can be evidenced in terms of diabetes severity, therefore, this factor could hardly be assumed as significantly contributing to the differences between the pharmacy costs of patients belonging to either of these groups.

The composition of prescription pharmaceuticals

No significant difference has been noted in the average number of prescriptions issued to patients receiving treatment in strong relationships, as opposed to those treated in weak relationships (cf. Table 7.), therefore the reasons behind the differences in pharmacy costs must be found elsewhere. Upon a careful examination of the data received, there emerged two conditions which may be instrumental in understanding the source of differences between pharmacy costs. The first condition is that the product is important for the patient, and is regularly prescribed by the general practitioner: meaning that the aggregate values attached to the second level ATC code of a selected pharmaceutical amounts to 3% of all prescriptions received as a minimum. The second condition is that the differences in pharmacy costs as calculated on the basis of second level ATC value aggregations for patients treated in strong, as opposed to week relationships, be demonstrated as significant. I looked at the share of each particular pharmaceutical product in the total pharmacy costs disbursed by patients belonging, respectively, to either of the two groups studied. For each product, I defined the differences in ratios calculated, then I concentrated on those products regarding which the differences between the spending ratios fell in the uppermost decile of the scale. Supported by the PUPHA database of NHIFH, I defined the medication prices aggregated for ATC codes, by calculating an average pharmacy price applicable to the ATC level examined: using the product records retrieved from the prescriptions database of DoktorInfo.

Relying on the two conditions defined above, I managed to identify four possible reasons explaining the observed differences in pharmacy costs.

- The share of A10 drugs from the total number of drugs patients receive is high irrespective of tie strength, but slightly lower for patients treated in strong GP–SP connections (27.48 %) than for those treated in weak GP–SP connections (28.18 %). Based on retail prices as of January 2010, A10 drugs are much more expensive

than non-A10 drugs: Hungarian Forint (HUF) 7260 (weighted average of all A10 prescriptions) compared with HUF 1936 (weighted average of all non-A10 prescriptions)—slight differences in prescribing shares lead to important differences in pharmacy costs.

- The *treatment method* varies with tie strength—significantly fewer patients are treated with insulin and significantly more patients are treated with oral antidiabetic agents in strong GP–SP connections than in weak GP–SP connections (see Table 1). Oral antidiabetic agents are generally cheaper than insulin—HUF 3428 (weighted average of all oral antidiabetic agent prescriptions) compared with HUF 9029 (weighted average of all insulin prescriptions)—metformin is a very cheap oral antidiabetic agent and has been used for decades as the choice/first-line treatment for type 2 diabetes mellitus.
- The *prescribing of beta blockers (C07)*[6]*, calcium channel blockers (C08)*[7]*, analgesics (N02)*[8]*, and phycholeptics (N05)*[9] also varies with tie strength, being significantly higher for patients treated in strong GP–SP connections than for those treated in weak GP–SP connections. At around half the mean price of all the other non-A10 drugs in the sample, these are relatively cheap drugs.
- *The prescribing of A02*[10] *drugs* also varies with tie strength, being significantly lower for patients treated in strong GP–SP connections than for those treated in weak GP–SP connections. These drugs cost around 8 % more than all the other non-A10 drugs in the sample.

Having evaluated hypotheses H1 and H2, the question arises: if the reduction of health care costs at the level of the whole society is found to be attributable to strong general practitioner-specialist ties, as demonstrated, then can we identify those characteristics of collaborating doctors which might support the development of such relationships? Reviewing the literature on the subject, I came to the conclusion that attempting to

[6] Cardiovascular system drugs for treating angina, irregular heartbeats, heart attack, heart failure, and high blood pressure.

[7] Cardiovascular system drugs for treating angina, irregular heartbeats, and high blood pressure.

[8] Nervous system drugs for alleviating pain.

[9] Nervous system drugs with calming effects.

[10] Alimentary tract and metabolism drugs for acid-related disorders.

draw up appropriate policy recommendations for the health care system, it is important to understand the factors which appear to contribute to the development of the described relationships, and likewise: to provide an appraisal of the individual properties characterising general practitioners and specialists working in strong relationships; general practitioners with concentrated, vs. dispersed referral structures; and finally: preferred and not-preferred specialists. On the appraisal of the named properties, I expect to acquire a position based on which it should become possible for me to draw up policy recommendations conducive of the sustenance as well as the propagation of such relationships.

My empirical research did not find support for the third hypothesis (H3) related to the emergence of homophyly in strong general practitioner-specialist relationships. It has been demonstrated that in strong relationships doctors have a long record in collaborating with their partners in shared care, and that their practices are geographically close to each other. The impact of homophyly is limited, and it can only be detected in the number of specialties acquired. General practitioners tend to refer their patients to specialists they know well and with whom they have a long standing collaborative partnership. This result is consistent with the findings of Barnett et al. [2012], who also argued that homophyly cannot be detected in all categories of doctor characteristics.

Subsequently, I investigated the possible differences in the characteristics of general practitioners maintaining a concentrated referral structure as opposed to those working with a dispersed referral structure (H4a), and whether preferred specialists differ in their characteristics from their non-preferred colleagues (H4b).

My results show that general practitioners maintaining concentrated referral structures mostly work in minor municipalities, and that graduation from the same medical school probably impacts the development of strong ties. It may well be that general practitioners working in minor municipalities are constrained in their choice of selecting a specialist. In comparing preferred as opposed to non-preferred specialists, I came to the conclusion that preferred specialists are usually older, have more professional experience, the period spent in their current practices is usually longer, they work mostly in small municipalities, fill senior management positions in their respective medical institutions and have a relatively small number of colleagues of the

same specialization working in the neighbourhood. Accordingly, it can be concluded that professional experience is an important consideration in the choice of a specialist made by either the general practitioner or the patient, similarly to the professional recognition and acclaim accorded to the specialist also assuming that professional reputation is probably a consequence of more experience.

The above findings are in line with my intuitions regarding the fact that the longer the period of joint collaboration the more intimate is the mutual understanding of the parties, the more extensive the familiarity with each other's therapeutic techniques and preferences, the greater the confidence of recommending each other as trusted professionals, and the more smooth is the communication developed with each other. The distance between the practices is highly important for the patient since, obviously, the majority of patients is either not willing, or is not capable of travelling large distances. The third major factor contributing to the emergence of strong ties between collaborating doctors is related to the obligation to provide healthcare services within particular geographic areas.

In weak relationships the ratio of distances of above 50 km between practices is fairly large (28.2%). Given the freedom of choosing physicians, in case of larger distances instead of the regionally assigned specialist, the patient is more likely to select a specialist of his/her own choice with whom he/she is already well acquainted; or one recommended by somebody else. In these cases, it can be reasonably assumed that the general practitioner does not know the specialist personally, and therefore joint treatment is only a theoretical.

The obligation to provide healthcare services within particular geographic areas ought to be viewed as a critical factor in developing strong vs. weak ties: It may well be that the obligation to provide healthcare services within particular geographic areas predetermines the strength of ties in small communities. Therefore, I have investigated weather the health status and pharmacy costs of patients receiving care in strong general practitioner-specialist relationships is significantly different from the health status and pharmacy costs of patients receiving care in weak general practitioner-specialist relationships in small and medium-sized municipalities as well. In this analysis moderating coefficients were added to the model.

Having only small and medium-size municipalities in the sample, the results show that in geographic areas where the number of available specialists is low the chances for developing strong collaborative relationships are higher as compared to the whole sample. Of the 794 general practitioners in the sample, 158 have concentrated referral structures and only six of the latter maintain practices in Budapest. In the case of general practitioners with dispersed referral structures these ratios show an inverse relationship.

Patients treated by general practitioners working in small and medium-size municipalities and maintaining concentrated referral structures display no significant differences in terms of health status, while the pharmacy costs carried by the same patients are significantly lower. We might thus conclude that even in geographic areas where the number of available specialists is limited the finding remains valid: doctors working in strong collaborative ties contribute in a meaningful way to the reduction of pharmaceutical expenditures carried by society. The obligation to provide healthcare services within particular geographic areas is thus not the only factor responsible for the emergence of strong ties.

2.3.1. Policy recommendations

The most important policy implication of my dissertation pertaining to healthcare economics is related to the free choice of healthcare providers. Free choice of providers has been recently enacted in a number of developed countries, including the Netherlands and the United Kingdom. In an environment where patients can freely choose their specialists, the free choice may compel the general practitioners to expand the circle of collaborating specialist in the provisioning of shared care. In my dissertation I have shown that the patients of those general practitioners who provide care in collaboration with a relatively larger number of specialists carry higher pharmacy costs. This might be achieved through offering patients limited rather than unrestricted choice-patients need excellent providers, in small numbers and close geographic proximity. 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 pharmacy costs. It appears beneficial

to develop incentive schemes with the objective of encouraging general practitioners to enhance strong relationship with their specialist counterparts.

2.3.2. Limitations

My dissertation presents a number of limitations the rectification of which may mark the way for further research efforts.

One of the first of the mentioned inadequacies is that I defined the nature of formal relationships between general practitioners and specialists on the basis of prescription data - a relationship assessment method validated by the research of Barnett et al. [2011]. Shared care practices presumably come with the enhancement of the intensity of information exchange and interactive communication between doctors. The larger the number of patients receiving shared care, the more intensive the communication between collaborating doctors, and the more valuable is the contribution to improved service levels provided to patients. At the same time, we have insufficient knowledge on the quality and the content of information exchanges, and likewise: on the reciprocal adoption of patterns of attitude (if any) taking place between collaborating doctors as a result of formal shared care relationships. The assumptions formulated as providing points of departure for my research, have been proven substantially correct, and factually validated. In all probability, a larger number of patients treated in shared care brings about a more intensive mode of communication between participating doctors. However, the proposal that collaborating doctors providing shared care to a relatively larger number of patients will discuss every particular patient more extensively - is not necessarily valid.

The second item to be discussed pertaining to the insufficiencies inherent in my dissertation ensues from my limited understanding of the reasons underlying most of the significant correlations discovered. The validation of assumptions deciding on the direction of my research would require further qualitative deliberations on the subject.

The third insufficiency to be looked at is related to the questionable applicability of comorbidity indices, used as a measure of the health status of patients, in any effort to demonstrate the positive impact of strong collaborative ties between doctors on the quality of care: acknowledged and reported as satisfying by the patients concerned. I

have only used one single variable in the assessment of patient health status, failing to acquire access to HbAc1 test results which are generally accepted as the most important and most reliable measure of the health status of diabetes patients. Similarly, I was in no position to retrieve or employ patient satisfaction data.

The fourth insufficiency to speak of is related to the fact that pharmacy costs constitute just one component of the overall health care expenditures carried by any patient. A more extensive exploration of other expenditure components, such as costs emerging in primary and secondary care, could not be accomplished within the scope of the present dissertation - both on account of limitations of space, and also: due to the scarcity of relevant data available.

The fifth insufficiency to be mentioned concerns the fact that, in the research completed, I focused on just one segment of the health provisioning system, namely: on the area of internal medicine and endocrinology. A further potential research objective would be to test the validity of my present findings in other health care disciplines.

A sixth shortcoming to be examined further concerns possible changes in general practitioner-specialist relationships with the elapse of time. To resolve this issue, longitudinal analyses may become necessary at some future stage.

There is a seventh flaw, brought about by the fact that the prescription practices of particular general practitioners are only known to me to the extent facilitated by voluntary prescription data submissions. Therefore, the possibility must not be dispensed with that general practitioners not covered in my sample would display collaborative-structure characteristics at variance with those presented in my dissertation.

Summary

In my dissertation, I addressed the characteristics of networks emerging in health systems. With a view to the diversity and complexity of relationship networks developed and operated in the health sector, I limited the span of my research to specific areas of professional relationship networks operating within the health system. The objective of my research was to explore the question whether or not the nature of relationships maintained among various health professionals, more specifically: the nature of relations developing between collaborating general practitioners and specialists bears a recognisable influence on the health status of patients and/or the volume of pharmacy costs.

Successful cooperation among general practitioners, specialists and patients constitutes the cornerstone of any efficiently functioning health care system. This is emphatically true for the practice of shared care, where patients with chronic diseases are treated in a collaboration between general practitioners and specialists. Of the numerous models appearing in shared care, I focused on the relationships developing in specialised care between general practitioners and specialists. I relied on the definition put forward by Keating et al. [1998] in determining formal relationships emerging between two professional medics in cases when a general practitioner has referred one of his/her patients to specialists. In the course of my research I analysed and identified the attributes of individual shared care relationships on the basis of the data posted to pharmacy prescriptions. Earlier, only a few studies investigated the relationships between doctors with the aid of applying quantitative analysis techniques. The results obtained in these studies implied that an increase in the number of patients treated in a shared care relationship improves the cost-effectiveness of the service provided.

My dissertation exceeds the scope of earlier publications inasmuch as - in addition to exploring pharmacy costs - it also investigates factors which possibly affect the health status of patients. This broader approach is concurrently a response to the "triple aim" requirements as explained earlier. Secondly, no earlier research conducted in Europe attempted to address the described topics.

On the simultaneous exploration of my first two hypotheses, I came to the conclusion that the strength of relations between collaborating doctors is not related to the number of diagnosed and treated comorbidities, which means that no proofs could be offered in support of the proposition that the strength of the relationship necessarily affects the health status of the patient. At the same time, I found that a better coordination of shared care procedures is conducive of reducing health expenditures, more pointedly: the pharmacy costs of patients treated in strong general practitioner-specialist relationships are significantly lower compared to those carried by patients treated in weak relationships.

In accordance with the propositions of the first two of my research hypotheses, a reduction of pharmacy costs can be confidently expected in the case of patients treated in strong shared care relations. Undoubtedly, the support provided for the development of such relationships should be seen as serving the common interests of all parties concerned. Following up on both the third and the fourth hypothesis, I subjected the same relationships to further scrutiny. In effect, I came to the conclusion that homophyly does not appear to play a meaningful part in strong-ties doctor relationships. Strong ties typically develop between general practitioners and specialists of the opposite sex, representing a similar level of professional and scientific dedication, and maintaining practices within reasonably moderate distances to each other. As regards general practitioners maintaining concentrated referral structures, I submitted that they usually work in smaller municipalities, and, in a majority of cases, they hold medical degrees earned in Pécs, Szeged, or one of the (Eastern) neighbouring countries. Preferred specialist are typically of higher age, their professional experience is greater, the period spent in their current practices is usually longer, they work mostly in small municipalities, in hospitals or primary care institutions, they hold senior management positions, frequently heading departments, and they are practising in neighbourhoods with a limited number of available specialists of the same discipline. In summary, it can be stated that instead of working with specialists with comparable characteristics: general practitioners, as a primary rule, tend to collaborate with specialists offered by geographical proximity and territorial charge.

I wish to stress here repeatedly that in smaller municipalities where the number of available specialists is limited, and where specialists are dominantly selected on the basis of territorial charge, on a closer scrutiny of the described practices, we may safely conclude that, while there are no significant disparities in the health status of patients treated in strong doctoral relationships, pharmacy costs tend to be demonstrably lower.

Regarding the message of this dissertation pertaining to the economic options offered in health provisioning, my conclusion is that a lower level of fragmentation in the structure of shared care is conducive of lower pharmacy cost, therefore, in the pursuit of this objective, the relative number of specialists liaising with general practitioners ought to be reduced where applicable. Savings becoming available as a consequence of enhanced patient-coordination can be increased and retained, as one of the perceivable means: by partially limiting the statutory freedoms of patients in selecting doctors, which is a task for health-policy strategists and politicians to follow through.

Health care networks constitute an unusually complex system to a better understanding of which I hoped to contribute with my present dissertation.

SUPPLEMENTARY

Supplementary Material 1: Prevalence of comorbid conditions included in the Charlson comorbidity Index for various diabetes cohorts (%)

Charlson comorbidity index	Keresztúri	Meyers et al. [2014]		Lix et al. [2013]	
	Study cohort, *n*=31,070	**Upper cost group (top 20%), *n*=344,019**	**Lower cost group (bottom 80%), *n*=1,376,022**	**Cohort 1, n=29,058**	**Cohort 2, n=41,925**
AIDS/HIV	0.0	0.5	0.1	<0.1	<0.1
Any malignancy, including lymphoma, and leukemia, except malignant neoplasm of skin	2.4	15.7	5.9	5.5	5.8
Cerebrovascular disease	23.2	15.6	6.3	5.5	4.7
Chronic pulmonary disease	13.3	26.1	12.6	14.0	13.7
Congestive heart failure	15.5	16.2	4.7	8.0	8.1
Dementia	0.9	1.4	0.7	0.8	0.9
Hemiplegia or paraplegia	0.2	1.5	0.2	0.6	0.4
Metastatic solid tumor	0.3	3.6	0.4	1.3	1.8
Mild liver disease	2.0	1.6	0.3	0.6	0.6
Moderate or severe liver disease	0.3	19.2	6.3	0.1	0.2
Myocardial infarction	4.2	8.4	1.7	2.5	3.0
Peptic ulcer disease	4.3	2.5	0.7	2.0	1.7
Peripheral vascular disease	18.5	10.0	4.0	1.4	1.6
Renal disease	1.5	7.6	1.5	1.9	3.2
Rheumatic disease	1.5	4.4	1.8	0.8	0.8

Supplementary Material 2: Prevalence of comorbid conditions included in the Elixhauser measure for various diabetes cohorts (%)

Elixhauser measure	Keresztúri	Lix et al. [2013]		Quail et al. [2011]	
	Study cohort, *n*=31,070	**Cohort 1, *n*=29,058**	**Cohort 2, *n*=41,925**	**Full cohort, *n*=662,423**	**65+ years, *n*=41,925**
AIDS/HIV	0.0	<0.1	<0.1	<0.1	0.0
Alcohol abuse	0.5	0.4	0.7	0.7	0.4
Blood loss anemia	1.1	0.0	<0.1	0.1	0.1
Cardiac arrhythmias	9.3	2.3	2.8	2.8	4.7
Chronic pulmonary disease	13.2	13.9	13.5	13.5	14.3
Coagulopathy	0.4	1.0	2.5	2.5	3.9
Congestive heart failure	15.5	8.0	8.0	8.0	13.4
Deficiency anemia	4.4	0.5	0.8	0.8	1.3
Depression	20.1	5.8	6.0	6.0	4.8
Drug abuse	0.0	0.3	0.4	0.4	0.1
Fluid and electrolyte disorders	4.4	1.9	2.7	2.7	4.0
Hypertension, complicated	2.7	0.7	1.0	1.0	1.5
Hypertension, uncomplicated	89.4	33.3	42.7	42.7	51.1
Hypothyroidism	2.9	0.4	1.1	4.7	5.6
Liver disease	2.2	0.6	0.7	0.7	0.6
Lymphoma	0.2	0.2	0.2	0.2	0.3
Metastatic cancer	0.3	1.3	1.7	1.7	2.8
Obesity	0.4	0.6	1.0	1.0	0.9
Other neurological disorders	3.5	1.1	1.2	1.2	1.3
Paralysis	0.2	0.6	0.4	0.4	0.6
Peptic ulcer disease excluding bleeding	3.1	0.3	0.4	0.4	0.5
Peripheral vascular disorders	18.5	1.4	1.5	1.5	2.2
Psychoses	0.4	2.4	2.7	2.7	4.4
Pulmonary circulation disorders	0.1	0.7	0.8	0.8	1.2
Renal failure	1.5	1.8	3.1	3.1	4.2
Rheumatoid arthritis/ collagen vascular diseases	1.6	1.9	1.9	1.9	2.2
Solid tumor without metastasis	2.1	5.0	5.4	5.4	8.8
Valvular disease	0.7	1.5	2.2	2.2	3.1
Weight loss	0.4	0.1	0.2	0.2	0.2

Supplementary Material 3: A comparison of general practitioners with concentrated vs. dispersed referral structures: sensitivity analysis for outcome measures

Categories	Uppermost 10%	Lowest 10%	p-value (%)	Uppermost 33%	Lowest 33%	p-value (%)
Gender Distribution (%)			**47.19**			**45.62**
male	55.70	50.00		55.68	52.45	
female	44.30	50.00		44.32	47.55	
Age distribution (%)			71.93			22.99
30-39	10.13	15.00		6.82	11.32	
40-49	24.05	21.25		22.73	19.25	
50-59	36.71	28.75		34.85	37.74	
60-69	24.05	28.75		26.14	25.28	
70-79	5.06	6.25		9.47	6.42	
School of graduation identity (%)			0.96			0.00
Budapest:	25.32	26.25		29.92	24.53	
Debrecen	17.72	38.75		21.59	38.11	
Szeged	15.19	5.00		18.56	7.55	
Pécs	22.78	21.25		18.18	20.38	
abroad	18.99	8.75		11.74	9.43	
The distribution of differences in the number of medical certificates acquired (%)			81.92			24.96
1	40.51	41.25		38.64	39.62	
2	48.10	45.00		44.32	39.62	
3	8.86	12.50		13.64	18.87	
4-	2.53	1.25		3.41	1.89	
Distribution according to the size of municipalities (%)			0.00			0.00
Capital city	1.27	23.75		8.33	20.75	
Major city (more than 100K inhabitants)	1.27	45.00		1.14	32.45	
Medium-sized town (population 40-100K	6.33	1.25		9.85	0.75	
Small townships (population of less than 40K)	91.14	30.00		80.68	46.04	
Professional experience (in years) (%)			99.55			35.97
5-14	10.13	11.25		6.44	8.68	
15-24	21.52	20.00		20.08	18.11	
25-34	35.44	33.75		33.71	38.87	
35-44	25.32	27.50		28.79	27.17	
45-54	7.59	7.50		10.98	7.17	
Distribution in the number of years spent at the current place of employment (%)			74.95			50.30
0-9	26.58	21.25		25.38	19.25	
10-19	48.10	52.50		42.42	47.17	
20-29	11.39	16.25		15.91	18.11	
30-39	11.39	8.75		11.36	10.94	
40-	2.53	1.25		4.92	4.53	

Supplementary Material 4: A comparison between preferred, as opposed to non-preferred specialists: sensitivity analysis for outcome measures

Categories	Preferred	Non-preferred	p-value (%)
Gender Distribution (%)			53.29
male	42.86	47.14	
female	57.14	52.86	
Age distribution (%)			23.84
30-39	7.14	16.43	
40-49	30.95	34.29	
50-59	36.90	28.57	
60-69	20.24	17.86	
70-79	4.76	2.86	
School of graduation identity (%)			8.25
Budapest:	25.00	40.71	
Debrecen	28.57	23.57	
Szeged	17.86	10.00	
Pécs	20.24	21.43	
abroad	8.33	4.29	
Distribution in the number of years spent at the current place of employment (%)			8.06
0-9	44.05	44.29	
10-19	15.48	28.57	
20-29	26.19	14.29	
30-39	9.52	10.00	
40-	4.76	2.86	
Distribution according to the size of municipalities (%)			0.00
Capital city	3.80	20.75	
Major city (more than 100K inhabitants)	1.27	39.62	
Medium-sized town (population 40-100K)	6.96	0.63	
Small townships (population of less than 40K)	87.97	38.99	
The distribution of differences in the number of medical certificates acquired (%)			18.82
1	51.19	42.14	
2	35.71	44.29	
3	9.52	12.86	
4	3.57	0.71	
Specialist assignment(%)			42.20
Higher management position	22.62	19.29	
Management position	35.71	30.00	
Non-managerial position	41.67	50.71	
The average number of specialists within 30 km	22.80	35.41	0.24

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