CATCHING GAPS WITH HEALTHCARE MAPS

CARDIOLOGY AND ONCOLOGY

The use of quantitative methods to assess quality of care and demand for service provision in oncology and cardiology in Poland

Edited by

Barbara Więckowska

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Contents:

Foreword

Barbara Więckowska

The health care system, also the Polish one, keeps changing. The reforms of financing health protection (provision system vs. insurance system), changes in the medical services basket (co-payment, modern medicines or therapies) or in service organisation (integrated care vs. dispersed care) do not change the fundamental elements of the system composed of: service provider (regardless of the organisation and legal form), service beneficiary, payer institution (regardless of their number and system financing method), and the state as the regulating body (OECD model). Between these three entities of the health care system there are also permanent elements of information asymmetry, (smaller or greater) patient selection or demand induced by supply. For this reason, the need to assess the operation of health care system entities and health care needs becomes also a permanent postulate in managing the health protection system. Creating/analysing indicators requires nonetheless taking into account current systemic solutions.

This paper is an attempt to present the methodology of the quantitative approach to assessment of health care needs in Poland and the possibility of applying analyses to making decisions on structural and functional transformations of the health protection system. The book is the final volume in a series of publications documenting the results of analyses by the team of experts working under the project "Improving the quality of management in health care by supporting the process of developing regional maps of health care needs as a tool streamlining the management processes in the health care system – training in estimating health care needs", implemented by the Department of Analyses and Strategy of the Ministry of Health, co-financed with the European Union funds under the European Social Fund. An expert working group on projection models, composed of physicians specialising in oncological diseases and heart diseases, epidemiologists, experts in social policy, health economists, demographers, statisticians, econometrists, and people working on large data sets, performed an in-depth analysis of the Polish oncological and cardiological care system, and focussing on the available information resource it developed a method of projecting health care needs in these two groups of diseases.

The purpose of this publication is to present the scope of analyses and their results necessary to define future health care needs. Yet the projected number of services must translate into an expected/justified number of service providers (which in turn influences the need to define indicators which determine these values) and may not be considered separately from elements such as assessment of demand for medical staff.

The presented methodology was the basis for creating maps of health care needs in the area of oncology and cardiology. The first two editions of maps, covering only hospital treatment, will be prepared by the Ministry of Health,[1] and beyond this period they will be developed by voivodes and by their Voivodeship Councils for Health Care Needs (at offices of the voivode), with significant support from the National Institute of Public Health – National Institute of Hygiene. The content of maps of health care needs is regulated by the Regulation of the Minister of Health of 26 March 2015 on the scope of contents of maps of health care needs (Journal of Laws of 2015, item 458) and from it results the fact of the need for analysis of the current operation of service providers and of future recommended changes.

It does not mean, however, that a completely new mechanism is created in Poland or there had been no previous attempts to develop maps of health care needs. There were initiatives of this kind in previous years. In 1997, i.e. when health care funds were in place, Article 55a of the Act of 6 February 1997 on universal health insurance stipulated that local government bodies, having obtained the opinion of medical professions' self-governments and in consultation with the regional health care fund, shall develop a plan of securing outpatient health care.[2] Article 101 of the Act of 23 January 2003 on universal insurance in the National Health Fund (Journal of Laws of 2003, No 45, item 391, as amended) introduced the obligation of voivodeship authorities to develop voivodeship health care plans and the obligation of the Minister of National Defence, the Minister of Justice, and the minister responsible for internal affairs – to develop a plan of securing health care services for uniformed services.[3]

[1] The obligation to develop maps of health care needs in Poland was introduced by the Act of 22 July 2014 amending the Act on health care services financed with public funds and certain other acts (Journal of Laws of 2014, item 1138). According to the Act, first maps of health care needs are to be developed by 1 April 2016 at the latest and will cover hospital treatment.

[2] The rules and conditions to be followed by a plan have been defined by Regulation of the Minister of Health of 10 October 2001 on the rules and conditions to be followed by a minimum plan of securing outpatient health care (Dz.U.01.121.1315).

[3] The rules and conditions to be followed by a plan have been defined by Regulation of the Minister of Health of 16 June 2003 on the conditions to be followed by voivodeship health care plans and on the scope of data necessary to develop such a plan (Dz.U.03.115.1087).

It should be noted that maps of health care needs are created by a number of countries (for example by Austria, Czech Republic, and France), where they are an important tool that supports evidence-based management in the health care system, in terms of both ensuring durability of actions (partial independence from the political process and making decisions based on objective analyses) and supporting the process of explaining social policy to citizens, which is very difficult, especially in the area of health care policy.

For this reason, mapping health care needs has been significantly supported by the European Commission by introduction of so-called ex ante requirements. According to Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013[4] disbursement of structural funds will depend on meeting the ex ante conditionality requirements, or ensuring fulfilment of specific entry conditions that allow efficient implementation of programmes co-financed with European funds. According to Annex XI to the above General Regulation, these requirements concern *inter alia* "The existence of a national or regional strategic policy framework for health within the limits of Article 168 TFEU ensuring economic sustainability" (conditionality 9.3).[5] This framework should result from the provisions of maps of health care needs.

This publication is not a direct attempt at developing a map of health care needs (pursuant to Article 2 of the said Regulation) in part two (analysis of the state and use of resources) and part three (diagnosis of health care needs). The purpose of the paper is to explain the advisability of (selected) adopted indicators of assessment and to present the assumptions of projection models (including one related to projecting demand for medical services and one relating to projection of demand for physicians). A map of health care needs is a formally defined official document in which it is difficult to present details of estimation methodology and assumed criteria. At the same time, as the Regulation on the contents of maps of health care needs is a general regulation that covers all scopes of diagnoses, the types of services and the ways in which they are provided (in-patient care, outpatient specialised care), it cannot

[4] Regulation laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006 (OJ L 347, 20.12.2013.

[5] Under thematic objective 9 of the Partnership Agreement (PA) – Promoting social inclusion, combating poverty and all forms of discrimination.

contain a detailed methodology of data handling that largely depends on the area under analysis (existence of registers, popularisation/application of diagnostic and therapeutic standards, manner and level of detail of reporting on procedures). Therefore we believe that the presented publication is an essential element supplementing the analytic material included in the map of health care needs.

The paper is a cohesive whole composed of eight chapters presenting the concept of analyses and its results. It can be divided into two parts: general (cross-cutting) and detailed (situation and results of analyses for Poland).

The first part comprises three chapters. The first one, by Tadeusz Szumlicz, presents deliberations on the possibility of financing the health care system and characteristics determining the rules: provision, insurance, and philanthropy. Particular emphasis is placed on assessment of how the Polish health care system is financed – the extent to which the conditions of the insurance rule are not met. The deliberations end with designation of the relationship between the manner of financing the health care system and the way in which medical services are contracted.

The next chapter, by Marcin Kawiński, concerns international experience in financing oncological and cardiological services. Based on OECD reports, the author points to differences between sources of financing of medical services (public funds vs. private funds), with focus on funds earmarked for oncology and cardiology and the manner of their use, i.e. expenditure on hospitalisation, medicines, screening tests.

An overview of international standards concerning modelling of costs in cardiological and oncological diseases by Michał Jakubczyk is the final overview article. The author presents various approaches to cost analysis: depending on the perspective (institution type) and analysis purposes (description and explanation of costs – heterogeneity). A very important aspect described in this chapter concerns problems with data analysis, and among them data censorship, which can affect the results of analytical models to a considerable extent.

Subsequent chapters concern the situation in Poland and the results of analyses conducted by the personnel of the Department of Analyses and Strategy. Chapters IV and V present the manner of contracting oncological services (Chapter IV by Beata Freier) and cardiological services (Chapter V by Ewa Kowalik) in Poland. Both chapters describe how a given group of

services is financed before and after introduction of the Homogenous Patient Groups system and problems connected with introducing a new financing system. Although the general HPG rules are the same for all service scopes, there are significant differences within individual groups, such as absence of limits for financing (cardiology), merging catalogues, i.e. financing some services outside HPGs (oncology).

An attempt to show possibilities and advisability of introducing quantitative measures in assessment of medical services in Poland is presented by Barbara Więckowska and Adam Czerwiński in Chapter VI. The authors state that assessment of quality of provided services is based on three basic categories of measures: quality of structure, quality of process, and quality of result, which should be interpreted simultaneously for the needs of drawing conclusions and assessment of the health care system. Examples of application of these measures for oncology (impact of the number of radical surgical procedures conducted by the service provider on 30-day mortality, impact of the distance between the place of residence and the place where services are provided on availability of teletherapy) and cardiology (impact of the number of coronary artery bypass grafts (CABG) and percutaneous coronary interventions (PCI) conducted by the service provider on 30-day mortality, impact of cardiological rehabilitation on mortality) provide the basis for defining the desired systemic parameters improving not only the quality of provided services, but also, more importantly, the level of patients' safety.

Chapter VII, also by the staff of the Department of Analyses and Strategy, concerns modelling of demand for hospital services in the area of oncology and cardiology between 2015 and 2025. The point of departure of analyses is the projection of individual diseases' incidence. As the prognostic approach has been described in detail in the previous two volumes that crown the effort of working groups, in this chapter the problem is described as synthetically as possible. Another element necessary to project the needs in the area of hospital treatment of oncological and cardiological diseases is determination of so-called service delivery curves that present the number of services provided to patients from the time they start hospital treatment (the curves are constructed separately for each group of services and each group of patients, e.g. radical breast surgery, coronary catheterization). On their basis, annual service use coefficients are determined. After taking both information

into account, i.e. annual service use coefficients and the number of new patients, health care needs can be determined for hospital treatment in Poland.

The last chapter of this publication is a projection of demand for physicians in Poland. The model takes into account data supplied by the Polish Chamber of Physicians and Dentists (the Department would like to use this opportunity to thank the Chamber for cooperation in this respect), life expectancy tables (to determine mortality), and information on annual average number of new specialists (in order to define assumptions on staff education stability). Thanks to the model, additional demand for physicians specialising in oncology and cardiology can be determined (apart from ongoing education) in a given time perspective.

We hope that the readers will find this publication inspiring and that it will contribute to greater understanding of quantitative methods used in the area of health and thus that it will contribute to popularisation of those statistical tools of relevance for management. This is very important, since the health care system should be developed in a well-planned manner, based on thorough analyses of the current situation and on reliable forecasts, and not only on variable political decisions.

We would also like to thank the paper's reviewers: Professor Christoph Sowada and Professor Bogumił Kamiński. Thanks to their remarks, many threads touched upon in particular chapters of the book have been considerably enriched.

Financing of the health care system – model approaches

Tadeusz Szumlicz

Introduction

The health care system should be examined in the context of the social policy carried out by state and - in its framework – the health policy, or from the point of view of policies that, on principle, make reference to the idea of solidarity[6] (even if this concept has diverse interpretations). The specific scope of these policies encompasses the organization and functioning of the social security system[7], together with one of its components: health insurance. The system (subsystem) of health insurance forms an integral part of the social security system, relating to the risk of sickness[8] (non-health, loss of health[9]).

The risk of sickness may bring about a financial loss or a loss of the expected income of a household (loss of salary), or a loss of the household's assets (due to expenditure incurred for health care services)[10]. The paper outlines issues related to the financing of the health

[6] Solidarity should be the main reason (feature, justification) of the social policy conducted by the state (Szumlicz 2013, 145).

[7] We assume that the social security system means all social arrangements (taking institutional forms, created upon the initiative of the state, stimulated and promoted by the state) that guarantee to specific entities a certain standard of social security (Szumlicz 2013, 146).

[8] A directory (list) of social risks in force today was published back in 1944 in the Income Security Recommendation of the International Labour Organisation (ILO). It refers to contingencies that can cause a loss of income by a household (Recommendation No. 67, 461 nn.). It is worth noting that in this document, the risk of sickness was associated only with the loss of income due to one's inability to work. The loss of income due to the expenditure for medical treatment was provided for in another recommendation issued in the same year and pertaining to medical care (Recommendation No. 69, 480 nn.); it stated that the availability of adequate medical care forms an important element of social security. Importantly, no reference has been made to old-age infirmity (more about this risk – see Więckowska 2008), whose separation within the social security system "frees" from the "infirmity" factor the risk of sickness or the risk of old age (Szumlicz 2003, 284–285).

[9] Although authors refer to the "risk of non-health" (Jończyk 2001, 18) and the loss of health (Holly 2013), semantically, these terms overlap at least partly with the risk of incapacity to work (disability), which in the Polish social security system is regarded as an independent concept (the risk of incapacity to work and disability benefits). In Poland, long-term illness gives grounds for the conversion of a sickness benefit into a disability pension.

[10] In the subjective approach to social security (health insurance), it should be emphasised that the loss referred to is a loss of household resources (especially in the case of households based on family ties), as - for substantive reasons – the socio-economic aspect of insurance should prevail over the legal aspect. For insurance participant and beneficiary is the household (and not a household member, formally covered by insurance). It is the household - as an economic entity - who covers the costs (through taxes, contributions, premiums) of the provided protection and benefits from the provided services, although formally (from the point of view of public law or civil law), the protection applies only to the specific member/members of the household.

system in terms of the risk of sickness as a threat of an event (loss of health), the occurrence of which requires expenditure for health services (the loss is cost of the service).

In the financing of the health care system, we need to distinguish between the principles governing the collection of funds allocated for a specific purpose (associated with a specific purpose), in this case used to meet health care needs on the one hand and the principles governing the allocation of resources for financing health services on the other hand. In this paper, we shall focus on the rules of collecting funds. Further observations on the role of the payer and the principles of financing health services (remuneration for service providers), in particular regarding practical problems of financing health services and medical procedures, have been presented in subsequent chapters of this publication.

Health care system and its financing methods

As far as the dilemmas concerning the financing of the health insurance system – just as in the case of the social security system - the problem consists in a more or less consistent choice and application of possible solutions, as evidenced by creating more or less autonomous funds associated with a given insurance.

For our discussion, it is important that the characteristics of health services make it a typical social good (a public good in the broad sense) and not a (pure) public good (cf. Owsiak 1999, 26-32). This is particularly important for deliberations pertaining to health as desirable social wellbeing and defining the nature of measures (public, public-private, private) allocated to financing healthcare for a given population. A public good is financed from both public and private sources. It is, however, important to establish the right proportions of financing.

In the discussion on the organization and functioning of the healthcare system, just as in the case of social security, six aspects must be taken into account: objective (answering the following question: What are the risks from the effects of which the system should protect?), subjective (Who is to be encompassed by the system?), instrumental (What principles, methods and techniques of insurance should be applied within the system?), redistributive (What rules of financial participation in the system should be established?), compensatory (To what extent the resulting losses should be covered by the system?) and legislative (How should regulations pertaining to system solutions be enacted and applied in practice?).

Analysing methods of financing the health care system, we must consider first and foremost the instrumental and redistributive aspect, even though all of these aspects interpenetrate[11].

The instrumental aspect is of the essence, considered through the prism of fundamental principles (methods, techniques) of insurance, distinguished on the basis of clearly defined financing sources and the type of entitlement to a given service. If we disregard individualistic concepts (individualism) in the approach to financing health care needs, three model[12] principles (methods, techniques) of insurance can be identified in social security systems; they are distinguished primarily by the criterion of the financing source; these are (Szumlicz 2002):

- the provisional principle,
- the insurance principle,
- the philanthropic principle.

From the point of view of funding sources:

- the provisional principle involves financing from taxes and related budgetary funds,
- the insurance principles involves financing from premiums and insurance funds,
- the philanthropic principle involves financing from donations and charity funds.

Model differences in social security principles apply also to the type (title) of entitlement to services:

- the provisional principle implies civic entitlement[13],
- the insurance principle implies the entitlement of an insured member of a community of risk,
- the philanthropic principle implies the possible access to charity support.

Against this background, it is important to ask about the construction of the social security (health care) system. It should be emphasized that the choice involves the use of a combination of model principles. In the health insurance system, the problem of the predominant

[11] The issue of principles of financing the health system is also connected with the preferred nature of the entitlement (civic, insurance of members of a community of risk) to health services. The problem of financing the health care system also applies to establishing standard health insurance (range of offset losses, which is expressed by the guaranteed service package).

[12] The term "model" is used primarily because they do not occur independently in the construction of any real social security system (subsystem). The real problem consists in determining a combination of solutions, which - in practice - form a more or less efficient and effective system, despite the existence of a prevailing principle.

[13] Entitlement understood in this manner is sometimes extended to encompass members of socio-economic and political communities, as exemplified by social rights of EU citizens (e.g. the European Health Insurance Card).

instrumentation and the clarity of specific solutions are observed, which evidences the difficult task of shaping social relations. This applies in particular to determining the applicability – within the social security system - of "truer" (actuarial, underwriting) insurance regulations. One can argue that the application of the insurance method, as one of the possible methods of risk management also in the social sphere, is disregarded in Poland and, at the same time, there is the myth of the „insurance"[14] concept; this term is applied in reference to provisional solutions, as exemplified by the method of financing the health care system.

Of particular importance is the redistributive aspect of insurance, i.e. the proportion (appropriate participation) in financing the social security (health care) system. Differences in the redistribution of income (for the purpose of the so-called social transfers) are worth examining; they are based on the financing of insurance:

- taxes (compulsory redistribution),
- contributions/premiums (random redistribution),
- donations (voluntary redistribution).

Provisional redistribution involves in particular a proportionally greater share of taxes paid by wealthier citizens into the budget fund. In turn, the insurance redistribution is based on a financial contract in which the amount of contributions to the insurance fund depends on the level of risk brought into a given community of risk, while the losses incurred by only some of its members, experiencing risks as a result of specific random events, are adequately compensated from the insurance fund established previously. On the other hand, the charity redistribution relies on the flow of funds from those who wish to donate funds to those in need of support.

There are justified doubts about the understanding and dealing with the insurance principle in the social security (health insurance) system and the application of parafiscal or parainsurance (quasi-insurance) practical solutions. From this point of view, the organization and functioning of the National Health Fund must also be subject to critical assessment.

Therefore, referring to social risk management in social policy (Szumlicz 2010) and to social change management (Szumlicz 2009), considerations relating to the instrumental aspect of the social security system (in particular the health insurance system) should be complemented

[14] In the majority of cases, no distinction is made between the Polish terms of „zabezpieczenie" and „ubezpieczenie".

with the issues of organization and functioning of public social funds[15]. It should be noted that they are clearly undervalued, both when it comes to theoretical assumptions and formulating practical proposals. Meanwhile, the use of financial solutions in the form of public social funds (associated with a particular social risk, including the risk of a disease) could, under certain conditions, rationalize the financing of the social security (health insurance) system; it would also have a real impact on social relations, resulting from changes in the rules and the scope of the redistribution of income in the state social policy in general, and in healthcare policy that forms a critical part thereof.

Given the above, we can try to define public social funds, whose essence, organization and functioning must be presented by reference to the notion of public purpose funds as a particular form of collecting and spending public resources (Owsiak 1999). It should be noted that public finances in modern terms encompass the financial policy, the fiscal policy and the social policy (Gaudemet, Molinier 2000). In the description of the public purpose fund (Owsiak 1999), it is emphasized that the creation of a fund consists in separating – financially and organizationally – a portion of public funds from total public funds and making them available to administrators. This means earmarking some public funds for specific tasks, providing sources for financing selected areas of activity, which enhances its role among the obligations of public authorities. This should ensure a kind of financing independence and continuity, along with a reserve of unused funds. It must be emphasised, however, that such freedom in the use of funds is real provided that carrying out tasks does not require subsidies from the state budget. Another problem is the adherence to the principle of creating reserves, the implementation of which may - in practice - be compromised for political reasons.

When analysing reasons for creating public purpose funds and using them in practice, reference is made to their important functions (Owsiak 1999):

- allocation of public funds,
- redistribution of income,
- mobilization of public funds,
- rationalization of public spending.

[15] Anticipating further arguments, we can briefly say that the public social fund is a solution in the field of public funds. A public social fund, for example a public health fund, entails certain social risks.

It is emphasised that in the case of the first function, it is the administrative allocation mechanism, and in the second - the redistribution of income that is – in principle - compulsory (these two functions are, as a rule, carried out analogously, just as in the case of the state budget) (Musgrave, Musgrave 1984). At the same time, the distinctive character and the vital importance of the mobilization function are highlighted, as well as the aspect of a greater social acceptance of fiscal burden and the rationalization function, as the aspect of purposefulness weakens the impact of the political factor, arbitrariness in determining the hierarchy of objectives and tasks (the following are also referred to in the description of benefits resulting from the rationalization of public expenditure: the possibility of breaking with the principle of annual budgeting, stabilization of public revenue by the statutory determination of financing sources, ensuring the continuity of tasks, flexible spending contingent on the evolving needs).

After this theoretical introduction, we can – by reference to types of purpose funds (Owsiak 1999) - define public social funds as various types of funds, created in conjunction with a particular social risk, collecting – in accordance with the established principles - monetary public funds with a view to financing specific social services provided by nominated public entities.

This definition requires at least a few comments regarding the risk of disease. Firstly, reference to the category of a public social fund in social policy (more precisely in the social security system, in the public finance system) should be identified with a particular social risk, as it is the basic premise for distinguishing the fund on the basis of its purpose and used for conferring an appropriate social rank on the fund. Secondly, we should pay special attention to accumulation principles in place in a particular fund which, on the one hand, determine the financial participation in various solutions, as the financial contribution to the social fund is contingent rather on the material status than on the risk; on the other hand, these rules have a decisive influence on the size of the fund, from which services are to be financed or allocations paid out.

Saying that any social policy involves the redistribution of income (Szumlicz 2008), as this is the financial sense (aspect, dimension) of social solidarity stemming from the assumptions of social justice to which the policy refers, is too general. A closer look at the system of income transfers that result from the formation of public social funds, is - as emphasized above –

of the essence, as changes to the rules and scope of redistribution of income within the social security system are clearly undervalued in the real process of shaping social relations. Generally, regardless of the final form of the redistribution of income, it is most important to establish who, in fact, finances a social project and who benefits from specific social solutions. It should be the case despite irrational fiscal burden or cases of abuse of social services that occur in the redistributive process.

Again, we should turn our attention to the sources of funding that predominate (would predominate) in social security systems. In the case of taxes, the redistributive function is of particular importance; it should be performed with appropriate consideration[16], even if it refers to satisfying the most important social needs[17]. In the case of contributory financing, differences in terminology and classification are essential, and legal acts referring in the case of societal risk to contributory financing, premiums/contributions are not defined. Instead, "contribution payables" are referred to.

A similar situation is observed in relation to defining health insurance contributions/ premiums. According to the Act on health care services financed from public funds[18], "health insurance obligation shall be deemed fulfilled upon [...] the payment of the contribution" (Article 67), and "health insurance contribution shall amount to 9%[19] of the contribution assessment basis" (Article 79). It should be noted that the Act on Personal Income Tax[20] states that "income tax [...] shall be reduced, in the first instance, by the amount of health insurance contributions referred to in the Act [...] on health care services financed from public funds" and "the amount of health insurance contributions by which the tax is reduced may not exceed 7.75% of the contribution assessment basis" (Article 27b).

The Act on Insurance Activity[21] (within that activity, we refer to private health insurance, insurance against the risk of sickness) provides quite clearly that insurance activities should

[16] Redistribution of income is carried out for someone's benefit, but generally also at someone's expense, which may be considered just or unjust, depending on the purpose (Szumlicz 2008, 52–53).
[17] For information on historical and sociological determinants of taxes, see Gaudemet, Molinier 2000, 441–458.
[18] Act of 27 August 2004 on healthcare services financed from public funds, Dz. U. 2004, No. 210, item 2135, as amended.
[19] Since 2007, the evolution of this premium is disregarded.
[20] Act of 26 July 1991 on Personal Income Tax, Dz .U. 2000, No 14, item 176, as amended. The size of the NHF is therefore parametrically contingent on fiscal and parafiscal obligations, and the amount of funds allocated to financing the health care system is completely independent of changes in demand for various services.
[21] Act of 22 May 2003 on Insurance Activities, Dz. U. 2003, No. 124, item 1151, as amended.

include “setting premiums and commissions due under the concluded contracts” (Article 3), that “the amount of insurance premiums is determined by the insurance company on the basis of the assessment of insurance risk”, and that “the amount of the insurance premium shall at least ensure the implementation of all obligations under insurance contracts and cover the costs of insurance activities of the insurance company” (Article 18). On the other hand, in relations to the insurance contract, the Civil Code provides that “on the basis of an insurance contract, the insurer undertakes to provide the insured with a particular benefit/service in the event of an accident indicated in the contract, and the policyholder agrees to pay premiums” (Article 805) and that “general insurance conditions specify in particular [...] the manner of determining and paying the insurance premium or fees charged by the insurer“(Article 812).

It should be emphasized that the net amount of the insurance premium should constitute an equivalent cash contribution (hence the term “risk-premium”), paid by and on behalf of all members of the risk community to the net insurance fund, from which losses resulting from certain random events, experienced only by some members of the community should be compensated for. The fundamental task of the insurance company, namely organizing and supporting a risk community, involves additional costs of insurance activity (administrative costs, acquisition costs, reinsurance costs, a reasonable profit) and determining the actual cost of protection, i.e. the gross amount of premiums. From the point of view of the policyholder, insurance means replacing a great and uncertain loss (which is possible, as the effects of the occurrence of the risk shall affect a certain number of members of the community of risk) with a minor loss (i.e. the insurance premium), although the amount of the certain loss (the cost of the insurance) is significant to the policyholder.

The principle of equivalence is fundamental for financing insurance. The equivalence of the cash contribution can be examined in the dual sense of the “insurance equivalence”:

- collecting, through contributions, an adequate insurance fund (enabling the payment of benefits due to members of the community of risk, adequately compensating losses resulting from certain random events);
- maintaining an adequate relationship between the contribution and the benefit (depending on the financial participation in the insurance fund, reflecting the degree of insurance coverage, the scope of offset losses).

Equivalence can be interpreted as the “equivalence of funds” (comparison of total contributions with total benefits) and as the “equivalence of compensation” (comparing the amount of the contribution with the amount of the benefit).

As it turns out, this understanding of insurance equivalence poses a serious problem within the system of social security (health insurance) for a variety of reasons:

- lack of fund equivalence may be, in a way, acceptable and associated with the expected (guarantee) contribution to the fund (mainly from the state budget);
- more or less legitimate derogations from the compensation equivalence can be adopted - either in terms of the premium (the amount of financial contribution contingent on the income situation, if a greater contribution is expected from those who are better off), or the provision (the amount of the benefit depends on the needs, or a lesser loss is compensated to a relatively greater extent), or even simultaneously in terms of both the premium and the provision.

Unfortunately, in the majority of cases, a very casual approach is adopted towards payments to a special purpose fund as a premium, and therefore regarding as insurance these solutions that involve the parafiscal collection of “contributory” funds (in which case we could use a distinct term and consistently call this quasi-premium a “*składatek*”: something in between a tax and a premium/contribution).

A terminological commentary is necessary at this point. In the Polish language, in reference to financing social security, only the term składka is used, which has two distinct equivalents in English: a premium, in reference to insurance based on underwriting premiums (the amount of which depends on the risk of the community of risk) and a contribution that refers to a system where it can be where financing represents a de facto financial share, and such a contribution may be diversified based on the financial status of a person who is the beneficiary of a given risk protection mechanism.

In the context of social policy and the social security system, it must be assumed that the model insurance principle consists in a strictly contributory financing and the existence of insurance funds.

On the basis of the foregoing, we can propose to extend model insurance principles that differ in terms of the sources of financing of the social security system (health insurance) and of entitlements to benefits based on this insurance.

Four principles can be listed:

- provisional,
- parainsurance[22],
- insurance,
- philanthropic.

On the basis of the financing source:

- the provisional principle involves taxes and budget funds,
- the parainsurance principle involves parataxes and public purpose funds,
- the insurance principle involves premiums and insurance funds,
- the philanthropic principle involves donations and charity funds.

In turn, according to the nature of the entitlement to services:

- the provisional principle means civil rights,
- the parainsurance principle means the rights of a member of a parainsurance community of risk,
- the insurance principle means the right of members of an insurance community of risk,
- the philanthropic principle means the possibility of obtaining solidary assistance.

A particular opportunity is the possibility of verifying in this respect the construction of a public social fund associated with the health care system. In the case of the parainsurance principle, set between the provisional principle and the insurance principle (in particular regarding fiscal and contributory financing[23]), which we relate to the organization and the functioning of the public social fund, focus should be placed primarily on:

[22] No better term springs to mind, although the author is aware of the pejorative tone of the "para-" prefix. The idea could be rendered by the notion of „public insurance principle".
[23] It can be subject to theoretical and practical interpretation on the basis of the argument for social security in France (Gaudemet, Molinier 2000, 417-420).

- the nature of participation in the fund (a risk community should be of participatory nature in a financial sense, arising from the defined obligation of participation and payment of a particular financial contribution to the fund, regardless of whether a specific obligation of financial participation is assumed by the person benefitting from the insurance, his/her employer or the designated authority),
- the nature of the financial burden (the burden should be determined parametrically, which means the size of the financial contribution dependent on the appropriately defined assessment basis, which can be contingent on the material status, i.e. take the form of a flat tax rate, or possibly a lump sum contribution),
- the nature of the service/benefit (the equivalency feature of the insurance benefit should apply, providing a specific scope of protection in exchange of the required contribution to the fund),
- the redistributive aspect (the use of forced redistribution, typical of the provisional principle and fiscal financing of the insurance, yet with random redistribution typical of the insurance principle),
- the principle of associating public resources with particular types of risk (close links between sources of parafiscal financing with the area of social security, which is to ensure the independence and continuity of financing, taking into account the reserve accumulation of unused funds),
- fund equivalence principle (the equivalence requirement, which consists in balancing the sum of fiscal contributions with the sum of benefits, and therefore the budgetary contribution to the fund may be allowed only as a guarantee and within a defined scope, whereas the crediting of the fund should not be ruled out).

In spite of a more general belief about the use of special purpose funds of a social nature (benefits)[24] in Poland, we can conclude that there are no grounds for regarding real solutions occurring in social policy in general, and even in the formal social security system, as public social funds (according to the definition adopted in this paper). In particular, it is difficult to refer to the possibility of using the mobilization function and the rationalization function (as described above) of financial structures that involve purpose funds. We cannot, therefore, expect a greater

[24] Specific purpose state funds, which are related to the state's social tasks, are listed in the budget act and classified according to their purpose. The financial plan of the National Health Fund (state-owned organization) should be identified with the social tasks of the state and the purposefulness of the collected resources.

public acceptance for a specific fiscal burden, or the weakening of the influence of the political factor in a particular field, the associated arbitrary nature of the decisions, or breaking with the annual budgeting or flexible collection and spending of public funds.

The impact of the method of financing the system of contracting health care services

At this point, we should turn our attention to the model approach applied to the important problem of functioning of the health care system as a mechanism for the flow of financial resources. We can refer here to the concept popularized by the OECD[25], which should be presented and interpreted more subjectively. The aim of the modelling procedure applied should be to give prominence to subjective types of financial relationships that could be considered from the point of view of demand (nature of financial resources allocated to "health") and supply (nature of financial resources received for "health" purposes), which has been described in these studies - in excessively technical terms - as raising funds and paying providers of health services[26].

Designing models should begin by taking into account, first, the criterion of the financial participation in the system[27], which refers more to the manner than to the source of acquiring funds. The order in which basic principles were mentioned stems from the general obligation of joining the basic part of the health care system. Financial participation in the health care system, which should determine the actual participation in the system and participation in different parts thereof, can be:

- mandatory or
- voluntary.

It should be added that the obligation does not mean the obligation to participate in the system, but only to make financial contribution[28].

[25] Model approach disseminated by the OECD in 1992. Cf. Evans, 1981; OECD, 1992; Rhodes, Schaapveld, Fernandez 1996, 5-8; Wlodarczyk 1996 342-345 (see also the rather mediocre translation of this concept (Rhodes, Schaapveld, Fernandez 1997, 6-9)).
[26] See footnote 20.
[27] See footnote 20.
[28] The distinction between joining the system and participation in the system, especially in the case of the health care system, seems important, since participation is often – and to a certain extent - illusory.

Secondly, in designing models, we should take into account the criterion relating to the form of payment for the service provided, highlighting the consumer's (patient's) share in the amount paid. It is important, as it makes the payment more or less visible to the consumer and more or less understandable. The order of listing of these forms reflects the high degree of "sensing" and "readability" of the patient's real participation in a given system of financing the health care system.

The payment of appropriate charges for the provision of services may take the following forms:

- payment directly out of the patient's pocket,
- reimbursements to the consumer,
- payments made by the institution that contracts out health services (payer29),
- ownership payment to the institution providing services.

On this basis, we can refer to models of cash flow mechanisms, that is specific permutations (2 x 4) of the above principles and forms. Three models (1 x 3[29]) of this mechanism are associated with the mandatory financial participation in the system:

- centralized budget model: there is a general obligation of fiscal financial participation and the payment of charges for a service takes the form of (internal) ownership payment to the institution providing health services, carried out with fiscal resources allocated to the system;
- de-concentrated budget model[30]: there is a general obligation of fiscal financial participation[31] and payment of charges for the provision of services takes the form of payments made to a specialized institution contracting out the provision of services from the fund accumulated within the system, based on de facto fiscal financial contributions;
- compulsory insurance model with reimbursable expenses: there is an obligation to participate in the insurance fund through the payment of a premium and the payment

[29] The model of compulsory participation and „out of pocket" expenses is practically non-existent.
[30] It should be noted that the de-concentration of the management of health care resources is more frequent than the decentralization of management.
[31] In this case, we could refer to the previously suggested term of "*składatki*" (combination of tax and premium) and "*składatki* financing".

of charges for the provision of services takes the form of payments reimbursed to the consumer on the basis of its contractual financial participation (contribution) in the system.

The four models (1 x 4) involve voluntary financial participation in the system:

- voluntary budget model: financial participation is voluntary (voluntary taxation) and the payment of charges for the provision of services takes the form of ownership (internal) payment made to the institution providing health care services, carried out with fiscal resources allocated to the system;
- voluntary insurance model with service contracting: voluntary financial participation and the payment of charges for the provision of services takes the form of payments made by the insurance institution contracting out services from the fund created on the basis of financial contribution (premiums)[32];
- voluntary insurance model with reimbursable expenses: voluntary financial participation and payment of charges for the provision of services takes the form of payments reimbursed to the consumer fund created on the basis of financial contribution (premiums)[33];
- model of direct service purchase: voluntary financial participation and the payment of charges for the provision of services directly out the patient's pocket.

The modified models also fail to specify all relevant aspects of financing the health care system: (1) the possibility of varying the principles (obligation or voluntariness) of financial participation in a given subsystem (established principles of participation), (2) different status of intermediaries in the financing and delivery of health care services (private insurance, public insurance, companies providing prepaid medical services, local government, the state), (3) different forms of cash contribution to the system (tax, purpose tax, local tax, underwriting premiums, flat-rate premiums), (4) changing basis of the financial participation in the system (cash contribution contingent on risk, wages, income, financial situation, subsidy principles), (5) different scope and structure of benefits (different service packages, scope of guaranteed services, emergency, outpatient and hospital services), (6) other principles of equalizing the financial burden of particular health care institutions, arising from risks (taking into account

[32] In this model approach, insurance principles are generally retained.
[33] Also in this model approach insurance principles are generally retained.

age, gender, place of residence, epidemiological data, cost of medical services, patients' income, the financial standing of a community), (7) diversity of service contracting principles (market prices, regulated prices, functions of financial supervision).

The principles of financial participation must be described in detail to reflect the complexity of the system's financing process and its impact on the contracting of health care services, i.e. also the subjective approach to the financial aspect of the health care system. Differences of financing health care entities must also be emphasised, even if different forms of remuneration for providers depended primarily on the type of facility (outpatient: fixed salary, per-visit fees, per-service fees, capitation rates, fee per sickness; stationary: the budget, hospitalization fee, fee per person/day, homogeneous groups of patients).

Conclusions

There are two approaches to risk in social philosophy:

– managing "social risks" and
– "social management" of risk (Szumlicz 2005, 88).

The first highlights the extraordinary (social) rank of risks being managed. In social security, this means paying particular attention to the objective aspect in the construction of the system.

The second emphasizes the unique (social) nature of risk management in general, and the risk of illness (non-health, loss of health) in particular. In social security (health insurance) this means paying particular attention to subjectivity in the construction of the system.

The issue of a narrower or a broader perspective on the social security (health care) system cannot be settled without taking into account both social approaches in dealing with risk. To a certain extent, this is related to solidarity in health insurance, but in particular to the application of insurance solutions within it (Sowada 2013). It is crucial to understand (Szumlicz 2005, 88):

– "social solidarity in risk management", which means community and reciprocity *per se*, and, within the context of solidarity understood as such,
– "insurance reciprocity in social risk management", which means particular community and reciprocity (anticipated in financial terms).

From the point of view of the subjective form of the health insurance system, it is crucial to incorporate solidarity understood as:

- income (income solidarity) and
- risk (risk solidarity).

Income solidarity can be referred to as financial and regarded solely from the financial point of view, emphasising the "final" participation in the financing of the health insurance system, although reference to "income" draws attention not only to the necessary acceptance of the diversity of participation in the financing of insurance, but also to the fact that differences in contribution depend (should depend) on the real income (mostly wages) and the objective opportunity of a greater financial participation in a specific health care system solution.

The solidarity of risk refers to the risk that is "transferred" to the community covered by the insurance. System solutions in the area of universal (publicly funded) health care must take into account differences in health care needs, for instance related to one's age and general physical condition.

When we take a closer look at the principles of financing the social security system, which is designed to protect us from the effects of social risks and provide a certain standard of social security, it becomes clear that there is the possibility of applying - within the social security system - solutions founded on public social funds. The practice of social policy, as well as the organization and functioning of the social security system, including health insurance, shows that we are far from compliance with the described parainsurance principles. This should not, however, exclude the possibility of using an appropriately constructed public welfare fund for the purpose of managing health insurance.

A consistent combination of the provisional solution with the insurance solution through the use of the so-called health voucher also deserves to be discussed (Szumlicz 2007, 78 nn.).

In summary, when it comes to financing health care, we need to rely on a greater social acceptance of targeted fiscal burden and on weakening the impact of the political factor on the collection and spending of public funds in the context of the social functions of the state.

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Financing oncology and cardiology services - international overview

Marcin Kawiński

Financing health expenditure – sources of financing and expenditure classified according to function

The level of current expenditure on health care varies considerably between countries. Interestingly, different levels of expenditure are predominantly contingent on public spending. The level of private expenditure, calculated in relation to GDP (measured by standard deviation), generally varies less than public expenditure (Figure 1).

Oncological and cardiovascular disorders form a very important component of the current expenditure on health care, not least due to the fact that both are a common cause of death. Generally, in countries where the general level of current expenditure is higher, the provision of oncology and cardiology services tends to benefit from higher levels of funding.

Private sources of financing may affect the funding of oncology and cardiology care directly and indirectly. Direct impact is observed when some or all services are financed from non-public resources. Indirect impact consists in the fact that the funding of services other than oncology and cardiology raises the level funding for the treatment of cancers and cardiovascular diseases from public resources (or, at least, it does not result in a decrease of available funds).

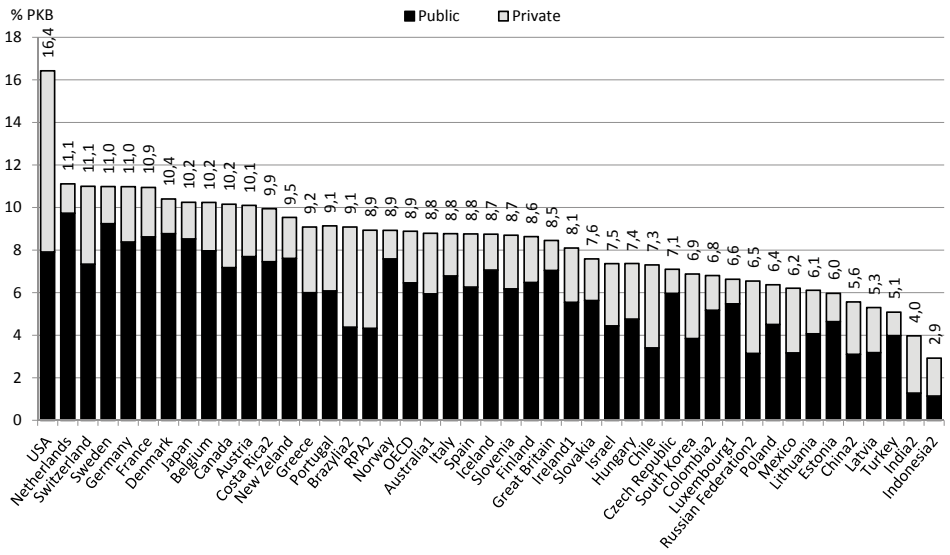

Figure 1. Current expenditure on health as a share of GDP in 2013 (source: own study based on OECD Health Statistics 2015, WHO Global Health Expenditure Database)[34]

As part of the public sources used for financing the current expenditure on health, we can indicate government spending and social security funds, which together form the current public expenditure. The structure of public sources depends on the accepted model of financing the health care system. If a social security system exists in this area, it usually takes over the majority of public spending (Figure 2).

[34] With the exception of investment, unless stated otherwise; „1" – data for 2012; 2 – Includes investment.

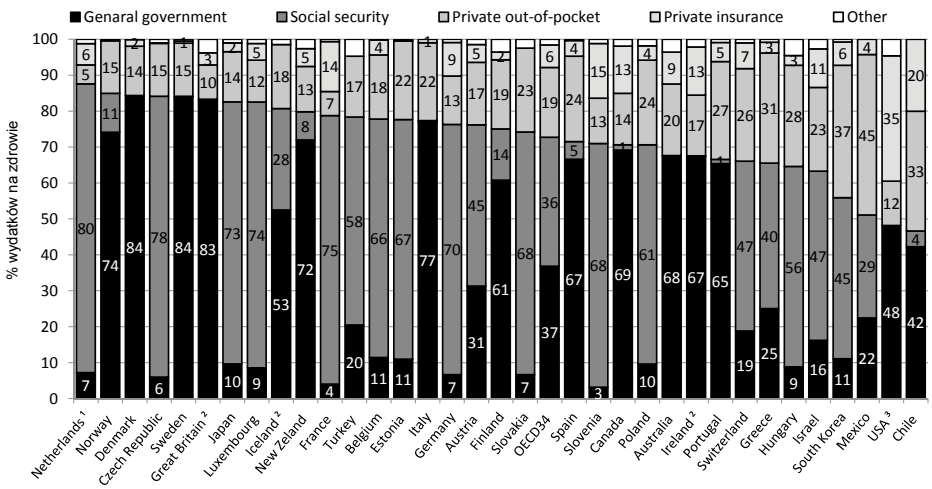

Figure 2. Current expenditure on health by source of funding, 2013 (or the most recent year for which data is available, source: own study based on OECD Health Statistics 2015)[35]

The use of private sources in the financing of health expenses may result from the possibility of replacing public services with private services, restrictions with respect to the guaranteed package of services and patients' participation in the cost of services that are partially guaranteed, as well as the low quality of services financed from public sources. Private sources include: expenditure financed out of the patient's pocket, private insurance and other sources. Out-of-pocket expenses (a form of self-insurance) should include expenditure whose probability is high and the possible cost tends to be low. On the other hand, private insurance should prevail with respect to low probability events that may entail high financial losses. In practice, however, the nature of private insurance is of the essence: it can be substitutive, supplementary and complementary (Szumlicz, Więckowska 2005).

Particular attention should be paid to the diversity of the structure of expenditure on health, according to function. The relationship of hospital care, as well as hospital care and outpatient care as compared to other functions seems very important (Figure 3).

[35] 1 –The Netherlands took into account the mandatory co-payment in health insurance or social security (*Exceptional Medical Expenses Act*), resulting in the underestimation of expenses out of the patient's pocket;
2 – Data relate to total health expenditure (current expenditure on health and accumulated capital);
3 – Social security together with government spending.

The distribution of individual functions can significantly affect the cost effectiveness of individual health care systems.

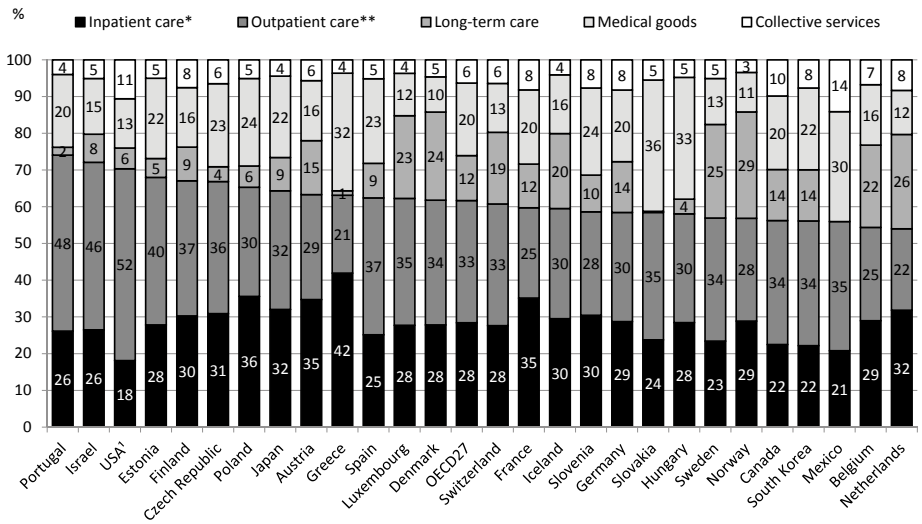

Figure 3. Current expenditure on health, classified by function in 2013 (or the most recent year for which data is available, source: own study based on OECD Health Statistics 2015)[36]

Figure 3 evidences a certain pattern in the cost of hospital and outpatient care, which together represent a relatively fixed part. In the context of treatment costs, it is important to what extent long-term care is actually carried out in hospitals over long periods of time.

Hospital care forms an important part in the treatment procedure for both cancers and cardiovascular diseases. Certain similarities can be observed in the percentage of hospitalizations of cancer patients and those affected by cardiovascular diseases (Figure 4 and 5). There are countries where the percentage of hospitalized patients is small in both combinations (e.g. Israel, Ireland, the United Kingdom, Australia) or relatively high (e.g. Estonia and Germany). On the other hand, in countries such as Poland and the United States,

[36] The order of countries on the basis of the share of expenditure on treatment and rehabilitation in the current health expenditure. *Reference to treatment and rehabilitation expenses in hospital treatment and day health care facilities. **Includes nursing care and additional services. "1" - Hospital services provided by doctors whose remuneration is settled independently are included in the outpatient care.

there are vast differences between the percentage of patients hospitalised in the framework of cancer treatment and the treatment of cardiovascular diseases.

It should also be pointed out that the share of hospitalized patients suffering from cancer or cardiovascular diseases is not fully correlated with the participation of hospital care in the current spending on health care in individual countries (Figure 3).

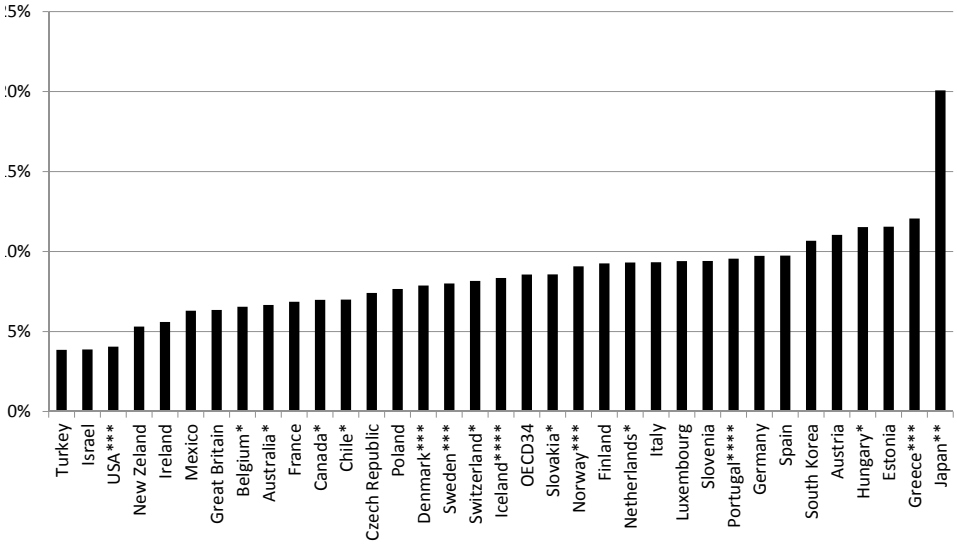

Figure 4. Percentage of hospitalized cancer patients, 2013 (or the most recent year for which data is available, source: own study based on OECD Health Statistics 2015) [37]

[37] *Data from 2012; **Data from 2011; ***Data from 2010; ****Data from 2009.

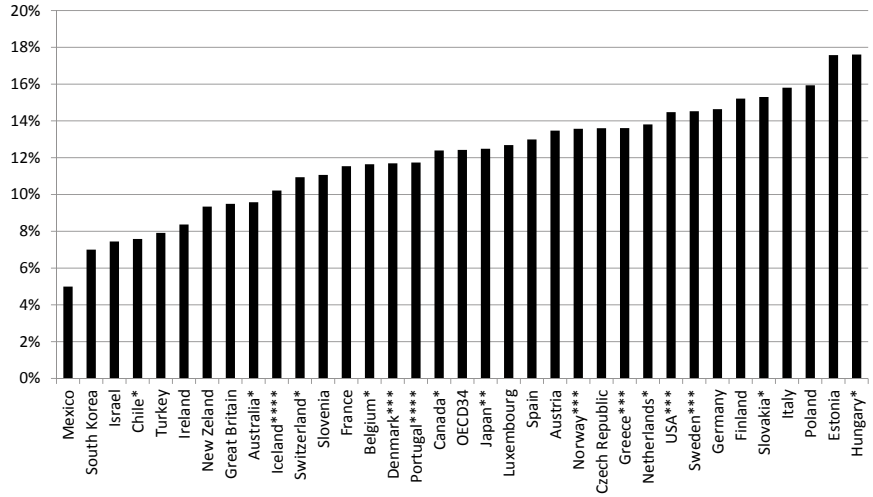

Figure 5. Percentage of hospitalized patients suffering from cardiovascular diseases, 2013 (or the most recent year for which data is available, source: own study based on OECD Health Statistics 2015)[38]

Oncology and cardiology services form an essential part of health care spending[39]. In the case of cancer treatment, they range from 3 to 7% of total expenditure on health care. Due to the size of expenditure, the financing of oncology and cardiology care is important for households whose members have suffered from such illnesses. A long-lasting and expensive treatment is, potentially, a major challenge from the point of view of household budgets. Increasingly costly new technology treatments and drugs also pose a challenge for financing systems, particularly in the context of differences in the effectiveness of certain treatments and medicines.

Spending on cancer treatment

Cancer incidence, mortality and survival

Cancer incidence and mortality rates are rather varied, with large differences between the highest and lowest observed values, especially in the case of cancer incidence. It should be noted that the low values of the analysed indicators might be due to efficient prevention and effective treatment programmes, as well as the low detection rate of cancer and the relatively low life expectancy.

[38] Idem.
[39] OECD Disease Expenditure Studies and OECD Questionnaire on Systems of Cancer Care 2010.

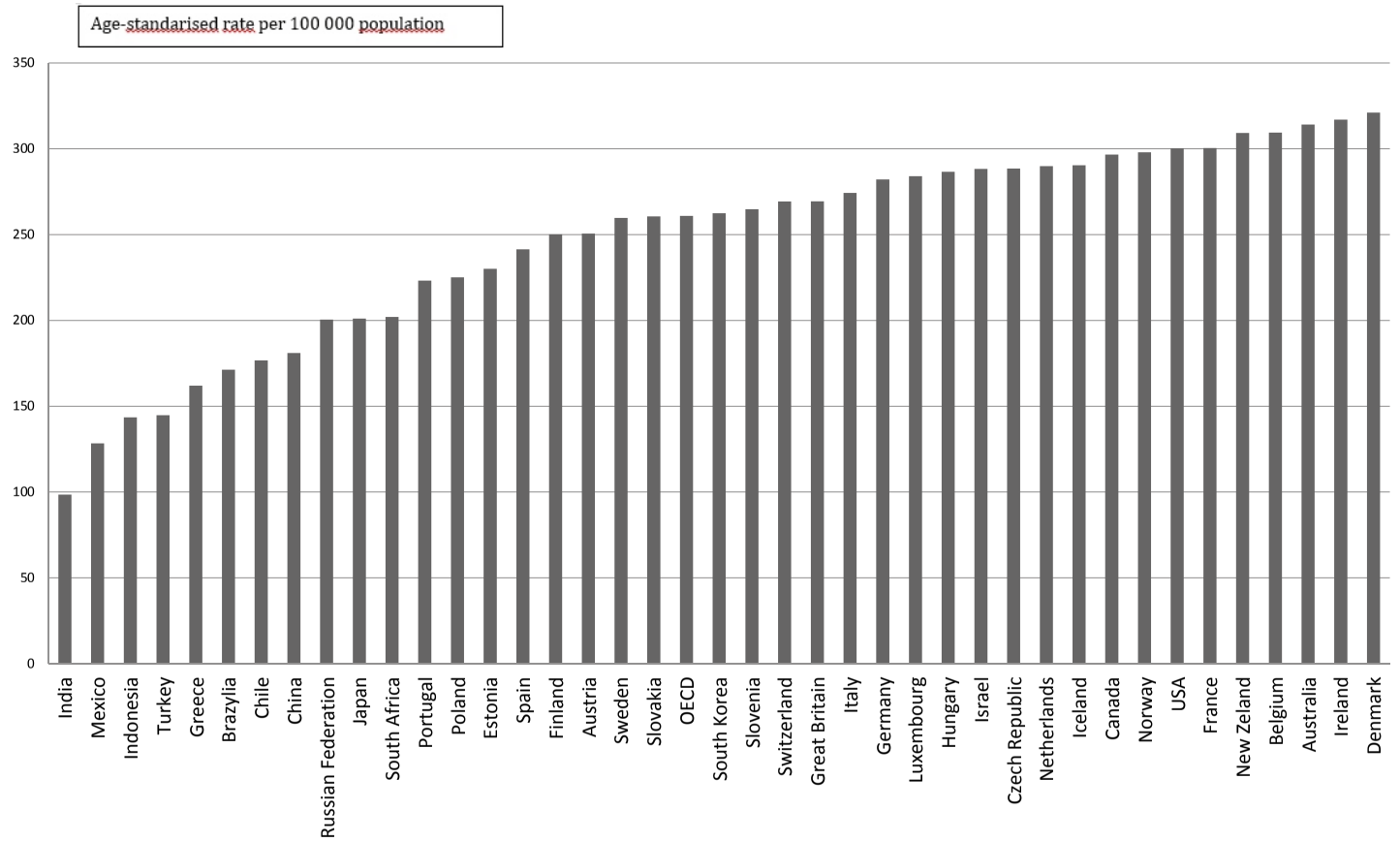

Figure 6. Cancer incidence in 2008 (source: OECD, 2011 *Health at a Glance 2011*, Paris)

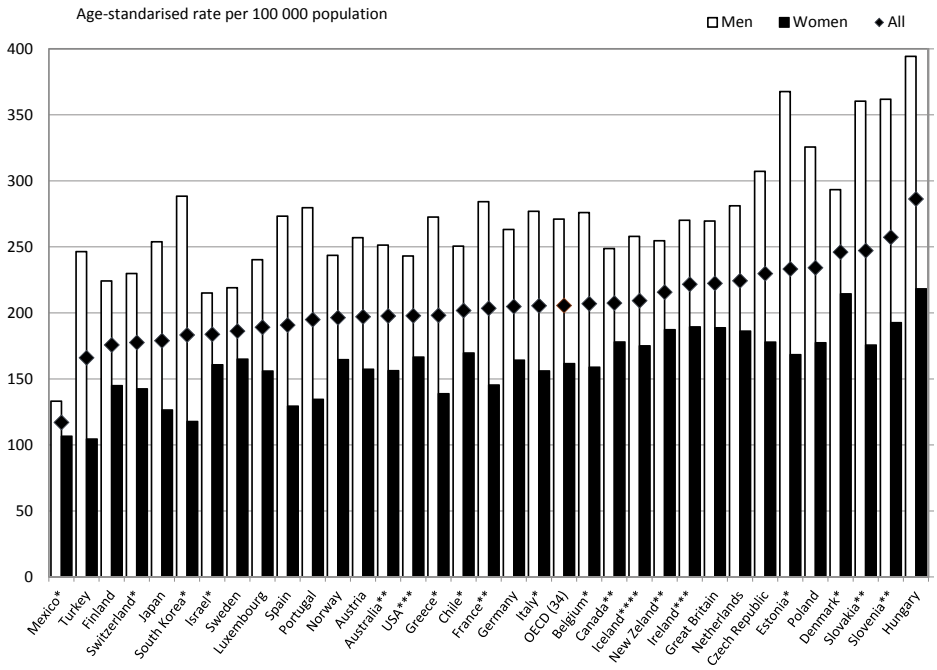

Figure 7. Mortality from cancer in 2013 (or most recent year available, source: own study on the basis of OECD Health Statistics 2015)[40]

Significant differences in overall mortality from cancer and gender-based differences should also be noted. High mortality among men is typical for countries where cancer mortality rates are highest.

Survival among cancer patients is correlated with numerous factors. A positive correlation of several types of cancers with the country's overall GDP has been observed (regardless of GDP spending). Also, overall expenditure on health care per citizen confirms that more resources earmarked for health care increase - in the case of various types of cancer - survival chances in the first five years, even though there is evidence that does not support this general correlation (OECD Health Policy Studies 2013).

[40] *Data from 2012; * Data from 2011; *** Data from 2010; **** Data from 2009.

Expenses and sources of funding

The analysis of expenditure on cancer treatment and its financing indicates many ambiguous relationships. Gaps in comparable data sets form an important obstacle. For example, data on cancer treatment spending in various OECD countries pertain to the period between 2002 and 2010 (Figure 8). However, even if we allow for potential changes in the level of expenditure in time and excluding extreme values, differences in relative spending (in total health costs) remain important – they exceed 100%.

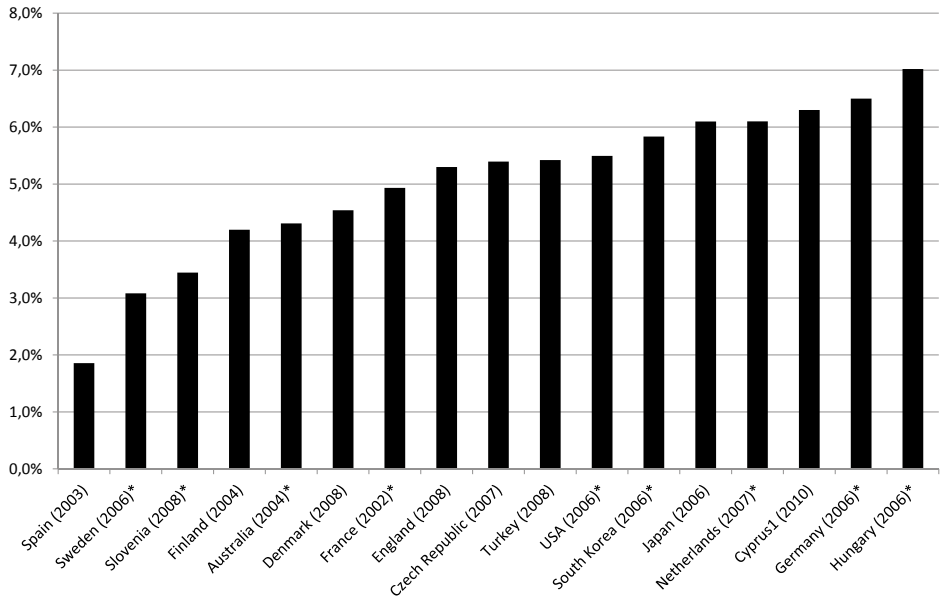

Figure 8. Share of cancer treatment spending in total health care costs (source: own studies on the basis of OECD Expenditure Disease Studies and the OECD Questionnaire on Systems of Cancer Care 2010) [41]

Access to cancer treatment depends on financing rules in force in each country (OECD 2013). In some of them, patients are generally provided with free access to care. This applies

[41] Data marked with "*" is derived from *OECD Disease Expenditure* and includes expenditure on benign cancers. Data for the remaining countries has been collected with the use of *OECD Questionnaire on Systems of Cancer Care 2010*. The scope of data from Sweden and Denmark is limited to hospital treatment. Data from Finland does not include medicine. "1" - Cyprus is currently divided into two parts (Turkish and European) and the available data pertains to the European part.

to the following countries: the Czech Republic, England, France, Greece, Israel, Italy, the Netherlands, Scotland, Slovakia, Slovenia (for chronically ill), Spain and Turkey. It should be noted, however, that the range of free services and treatment options vary from country to country - for example, in Slovakia and Spain, patients have to pay for certain types of innovative medication available free of charge in other countries.

In another group of countries (e.g. Canada, Denmark, Hungary, Malta, Poland, Portugal and Sweden), free access to treatment is provided in the majority of cases, yet not all of them. Generally, the diagnosis and treatment are free, but patients need to pay for certain drugs or treatments.

In certain cases, cancer drugs are subject to co-payment. On the other hand, for example, in Denmark and Sweden only drugs that are used in hospital treatment are reimbursable. A similar situation is observed with respect to private sector care in Portugal. The patient's own share in the cost of medicines in Denmark (for chronically ill patients who take medication over long periods of time or in large quantities) and Sweden is restricted and, beyond a certain limit, drugs are provided free of charge. In Malta, patients need to pay for drugs that are not included in the government's list of subsidized medication (it is the case of many innovative drugs).

In some countries, cancer patients are obliged to participate in the cost, although only to a limited amount. It is the case, for example, of South Korea, where patients participate in the cost of care services and medication (reduced for cancer patients). In Belgium, Finland, Iceland and Norway, restrictions pertaining to co-payment apply only to certain pharmaceutical products. The scope of co-payment differs in these countries and includes: in Belgium – prescription cancer drugs available in pharmacies, in Finland – medication administered in hospitals (drugs sold in pharmacies are excluded), Iceland – medication administered in hospitals, Norway - intravenous drugs and a certain number of analgesic drugs.

Generally, all primary health care services are provided free of charge, including programmes for the eradication of cancer such as Pap test, mammography, palliative care and many routine tests. Co-payment (contingent on the patient's income) is applied in the case of additional services and procedures and limited to certain types of cancer (e.g. in Chile). Co-payment may also be applied to general outpatient care costs (approx. EUR 2 per day)

and hospital costs (approx. EUR 3.5 per day), as well as certain medical procedures, yet with general limits to co-payment (e.g. Latvia).

In several countries (i.e. Australia, Germany, Ireland, Japan, Singapore, Switzerland and the United States) no special financing rules have been introduced that apply specifically to cancer patients. In Germany, the maximum limit of co-payment amounts to 1% of the patient's gross annual income, as compared to the 2% limit that applies to other patients. In addition, insured persons under 18 years of age are exempted from co-payment. General rules governing co-payment apply in Germany: the patient's participation stands at 10% (minimum EUR 5, maximum EUR 10).

In Luxembourg drugs for seriously and chronically ill patients, including oncology drugs, are provided free of charge. Patients are also exempt from co-payment for hospital treatment, care and cancer therapies, including analgesic drugs. Co-payment is not required in the case of outpatient care. 5-20% share in health care costs is mandatory in the case of patients who do not suffer from chronic diseases.

Rules governing access to medication, in particular expensive cancer drugs considered innovative are an important element in financing cancer treatment. The first stage is the process of drug authorization, the duration of which varies (Figure 9). The mere registration of a drug is not synonymous with its use, since the latter depends on the decision of assessment agencies in charge of evaluating each product's cost effectiveness. Depending on the country, the agency's decision to include a particular product in the list of reimbursable drugs may or may not be binding. In the latter case, a drug can still be included in list of reimbursable drugs approved at the central level. The inclusion of a drug in the list does not mean freedom of access, as - especially in the case of expensive therapies - initial co-financing (risk-sharing) is required by pharmaceutical companies until the drug's efficacy in a particular case (for a particular patient) has been proven, and certain prerequisites qualifying a patient for a particular treatment are satisfied. Authorisation is required for each use of a drug within a therapy (for instance in Italy), or the use of drugs is controlled.

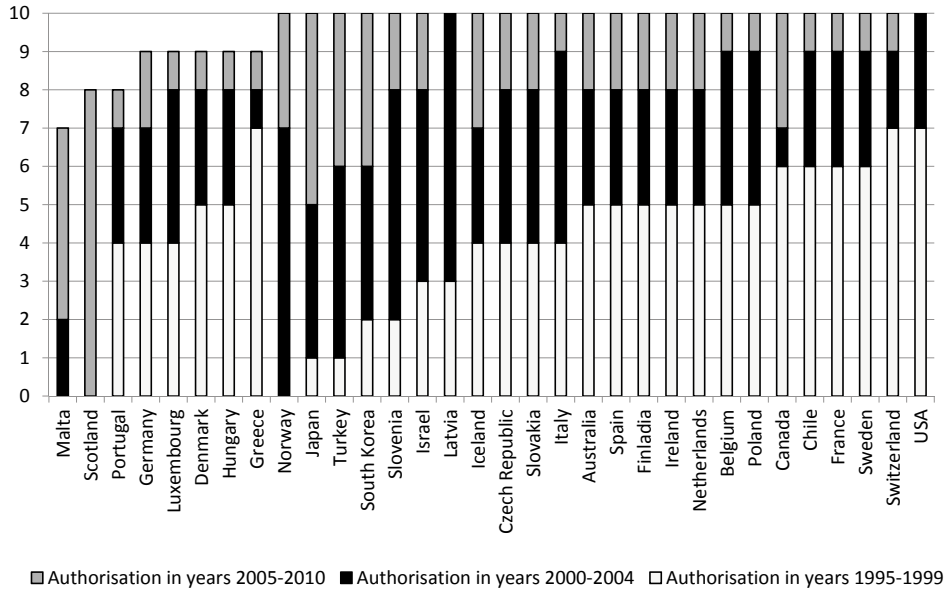

Figure 9: Years during which authorizations were issued for 10 selected innovative cancer drugs (source: own study pursuant to OECD calculations based on HCQI Questionnaire on Systems of Cancer Care).

In many countries financial support is provided to those in a more difficult financial situation. In addition, due to the centralization of oncology centres in many countries, public systems participate in the costs of transport and accommodation.

Expenditure on prevention (screening)

Prevention is essential for increasing the survival rate of cancer patients. The most important devices are CT scans, MRI scans and mammographic X-ray equipment.

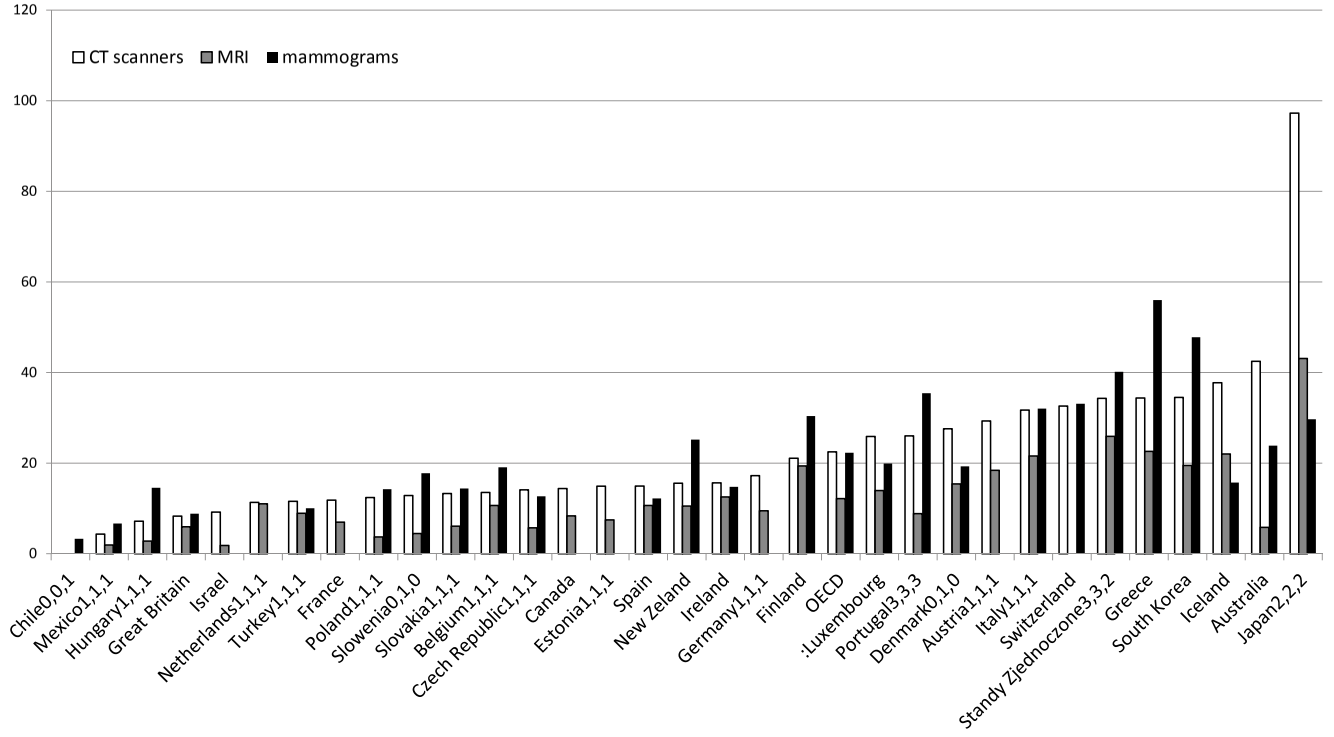

Figure 10. Medical technology resources per one million citizens in 2010 (or the nearest year for which data is available) (source: own study on the basis of OECD Health Data 2012)[42]

[42] 0 – data from 2010; 1 – data from 2009; 2 – data from 2008; 3 – data from 2007; no indication – all data from 2010.

Due to the high cost of purchasing and maintaining specialized equipment, cost effectiveness is analysed (Bernard, Vicaut 2008). Data for selected OECD countries shows great differences in technological resources (Figure 10). Yet, from the point of view of health indicators, the availability and use seem more important; this may be associated with certain organization aspects, e.g. the existence of comprehensive oncology centres.

Investments in technologies [according to the indicator proposed by Verdecchia, i.e. the quotient of CT scanners and GDP (Verdecchia et al. 2008)] are crucial for patient survival rates.

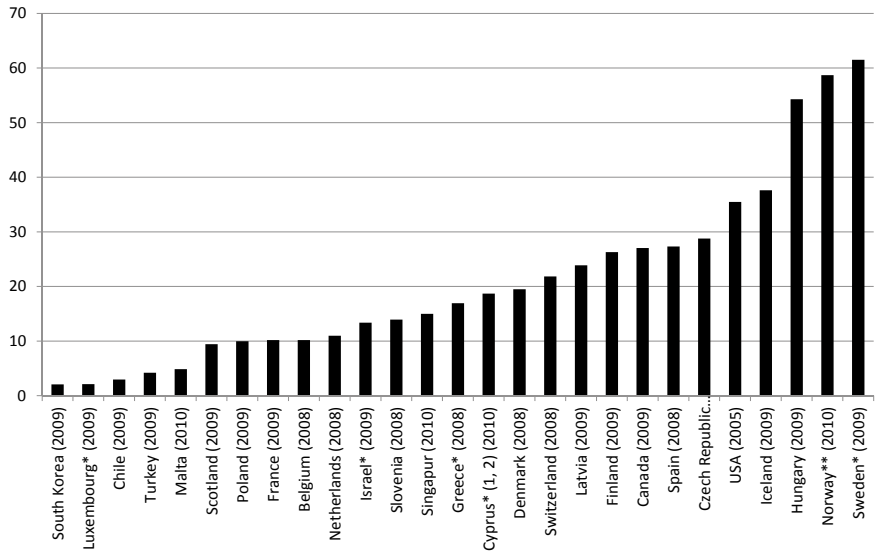

Figure 11. Number of certified oncologists per 1 million citizens, 2010 (or the most recent year for which data is available, source: own study on the basis of OECD Health Data 2011 OECD, Eurostat, Malta and Slovenia, as well as the Office for National Statistics for England and Scotland and OECD HCQI Questionnaires on Systems of Cancer Care)[43]

Organizational support is also very important. However - due to definitional differences - the number of oncologists seems to be a vague category. It is therefore difficult to refer to the analysis of the impact of the number of oncologists on patient survival rates. Nevertheless,

[43] Polish and Turkish data relate only to oncologists, while Danish data pertain to all doctors working within the framework of oncology treatment. Data for Israel, South Korea and the Netherlands are estimates. *Countries without oncology specialisation (OECD Questionnaire on Systems of Cancer Care). Norwegian figures relate to 111 doctors specializing in education in hospitals. 1,2 - applies to the European part of Cyprus.

the number of integrated oncology centres has a substantial impact on patient survival rates (OECD 2013).

Due to the fact that the effectiveness of cancer treatment programmes depends on various factors, among which the source of funding is not the sole determinant, one should not seek to establish a direct relationship between the forms of financing and performance indicators, although the level of expenditure determines the quality of oncology programmes.

Financing the treatment of cardiovascular diseases

Incidence of cardiovascular diseases

Cardiovascular diseases, like cancer, are characterized by a relatively high mortality rate. Yet, unlike cancer, knowledge about their causes and treatment is far greater. In the case of cardiovascular diseases, prevention and outpatient care are of utmost importance. Treatments and operations (hospital care) are of the essence and have a significant impact on the patient survival rate; Poland is a good example of this. However, without the first of these elements, it is difficult to significantly reduce the impact of unfavourable indicators.

When analysing statistical data on mortality from ischemic heart disease (Figure 12), great diversity is observed among countries. Three of them - Slovakia, Hungary and the Czech Republic - have some of the highest mortality rates: on average more than three times higher than the OECD average. From the economic point of view, the key is the answer to the question of the cost of an effective programme for the prevention of cardiovascular diseases and their treatment. While it is possible to assign costs to different stages of the treatment process of cancers, it is most difficult in the case of cardiovascular diseases. Data provided in international rankings refers to general categories, rarely identifying the costs of treatment of cardiovascular diseases.

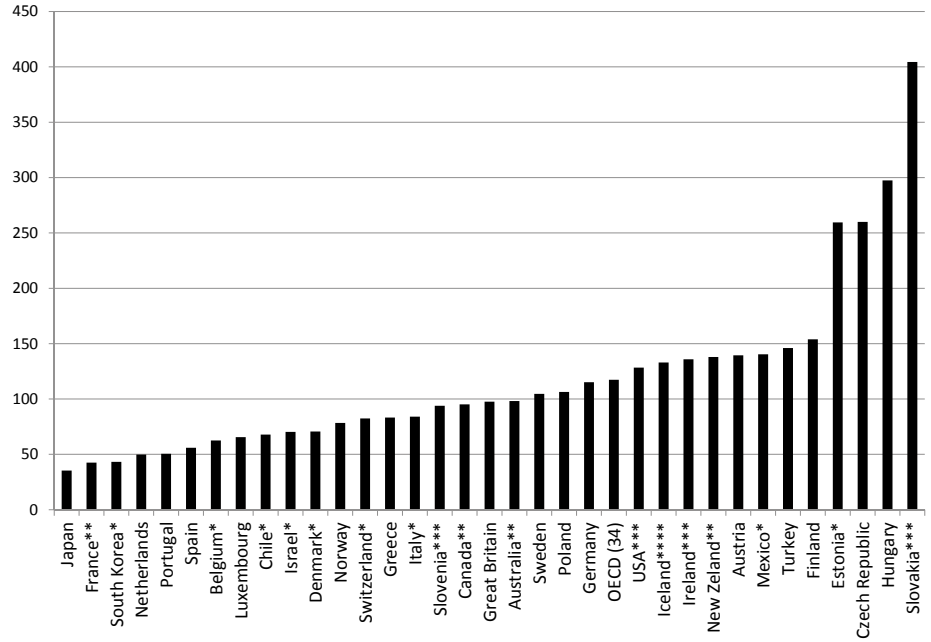

Figure 12. Mortality from ischemic heart disease in 2013 (or the most recent year for which data is available; source: own study on the basis of OECD calculations based on Health Statistics 2015)[44]

Expenses and sources of funding

When analysing expenditure on treatment of cardiovascular diseases, two important areas should be singled out: outpatient care and hospital care. The total share of outpatient care in current expenditure on health has already been discussed, yet it seems interesting to identify its funding sources (Figure 13). With the exception of the United States and Turkey, the main source of financing is the public system. Other private sources of financing - most often private health insurance - have a significant share in the United States, Israel, Turkey, the Netherlands and Slovenia. The share of out-of-pocket financing (OOP) varies significantly: from 5% in Estonia to 47% in Turkey. Interestingly, some countries with a relatively high level of co-payment (which can hardly be considered symbolic) are at the forefront in terms of the highest

[44] Standardized rate by age per 100,000 population; * Data from 2012; ** Data from 2011; ***Data from 2010; **** Data from 2009.

mortality due to cardiovascular diseases (e.g. Turkey, Hungary, Greece and Slovakia). At the same time, we can identify countries where despite a high level of co-payment, mortality rate for coronary disease is low, for example Portugal and South Korea. These countries, however, rank lower in terms of mortality due to cerebrovascular accidents.

In the majority of countries, the treatment of cardiovascular diseases is financed through public programmes (e.g. Chile, Portugal, France). In many, access to treatment funding is contingent on satisfying certain criteria of age and income (e.g. in Australia). However, given the high potential costs and the long-term character of treatment, co-payment may prove a valid solution in the context of access to treatment.

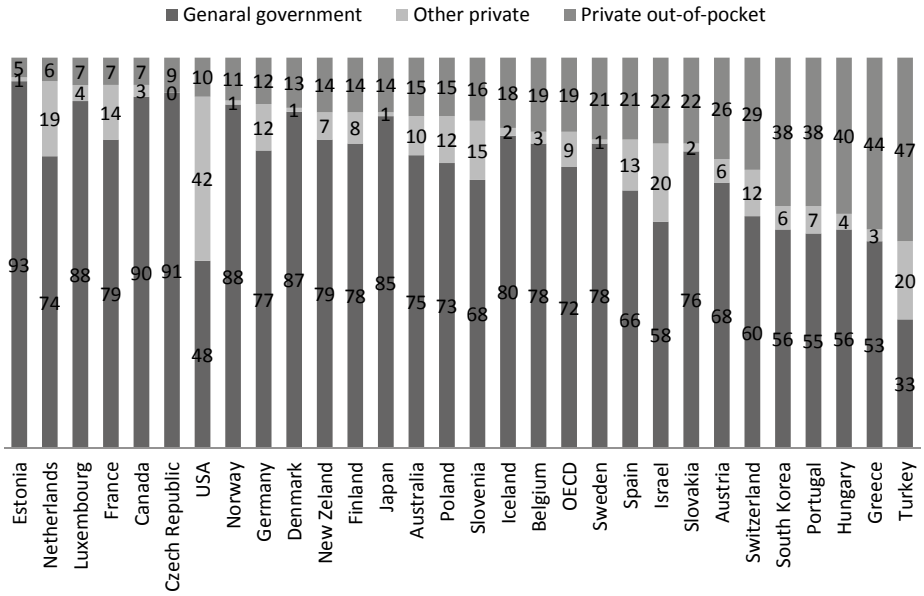

Figure 13a. Sources of financing outpatient care and medication in selected OECD countries (source: own study on the basis of OECD Health Policy Studies 2015, 95)

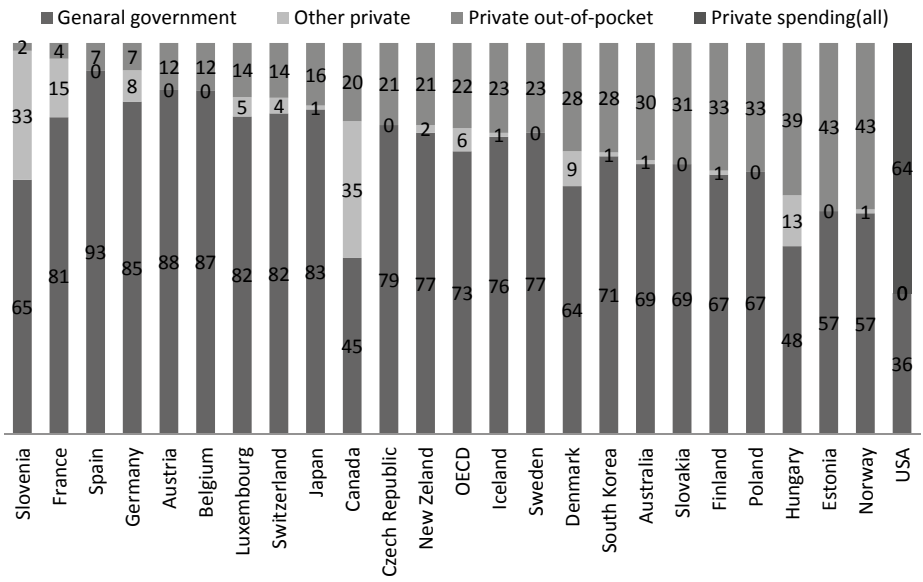

Figure 13b. Sources of financing of outpatient care and medicines in selected OECD countries (source: own study on the basis of OECD Health Policy Studies 2015, 95)

The issue of co-payment is particularly important for the financing of medication. In this respect, the share of public funding prevails in the vast majority of countries (with the exception of Canada, Hungary and the United States), where private insurance schemes predominate and finance medication, to a large extent also in Slovenia and France. However, the share of insurance in the financing of medication is significantly lower than in the case of outpatient care. A significant level of co-payment (above 30%) is observed in Slovakia, Poland, Finland, Hungary, Estonia and Norway.

When analysing countries in terms of financing rules and mortality rates from cardiovascular diseases, interesting cases of Luxembourg and France should be pointed out, with record low mortality rates and low levels of co-payment for both outpatient care and medication. We must note that co-payment in France is largely financed through additional insurance, which can significantly reduce the financial burden on patients and their families.

In the case of hospital care, significant differences are evident in the cost per capita (Figure 14). However, due to the fact that the conversion was carried out on the basis of the level of

prices in the economy and not in the health sector, differences may also arise from differences in the real cost of treatment.

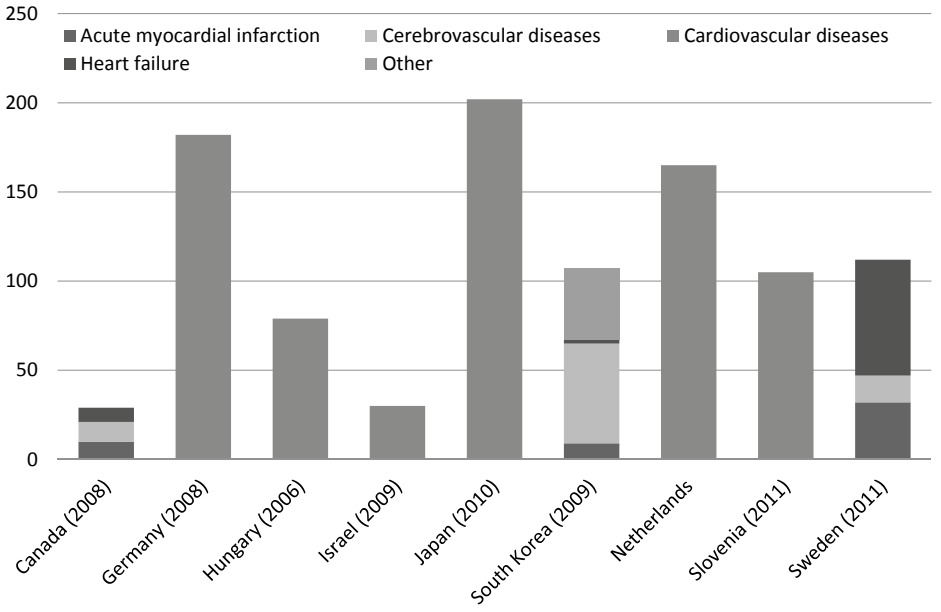

Figure 14. The cost of hospital care in cardiovascular diseases in selected OECD countries, per capita in USD for purchasing power parity in 2005 (source: own study on the basis of OECD Health Policy Studies 2015, 129)

Summary

Health care expenditure varies between countries and is different in the case of cancers and cardiovascular diseases. The level of expenditure or the forms of financing do not translate directly into mortality and survival rates.

The analysis of health care financing sources indicates the predominance of public funding. Expenses incurred outside of the public system are relatively often financed from private health insurance.

The treatment of cancer and cardiovascular diseases is most expensive – too costly to be financed with the revenue of an average household. This is why the majority of medical expenses are financed by the public system. Co-payment may be applied also in this case,

but the availability of treatment and medicines is to a large extent finances also from special schemes. In such cases, co-payment is reduced or (in certain situations) eliminated altogether. The latter element is most often observed in relation to precisely defined illnesses and requires the fulfilment of various criteria (e.g. age or financial situation).

Due to the cost of new technologies, it is essential to optimize the use of medical equipment. Significant differences are observed in this area. Currently, in order to increase the use of these devices, extend the knowledge and skills of medical staff, and to improve work organization, specialized centres have been created to cover a relatively larger area.

In addition to the involvement of private resources, of the essence are also financial settlements between taxpayers and beneficiaries, as well as payers and suppliers of medication. This area has not, however, been subject to extensive analysis, even though it appears to have significant potential in terms of increasing the effectiveness of treatment.

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An overview of international standards concerning modelling of costs in cardiovascular and oncological diseases

Michał Jakubczyk

Introduction

The aim of this chapter is to present methods used in modelling medical expenses, in particular connected with cardiovascular and oncological diseases. There are no applicable international standards that would impose a procedure in this area. The researcher/analyst should rather choose an appropriate approach in case of a specific project based on the characteristics of quantitative methods (statistical, econometric, simulation etc.) in the context of particular variables describing medical expenses (or other variables connected with them, e.g. incidence, prevalence, etc.). Due to this fact, this chapter focuses on four tasks – in the following sub-chapters the context of modelling medical expenses has been described and basic vocabulary has been introduced; the specific characteristics of variables used in the context of modelling medical expenses has been discussed; the variables characteristic for cardiovascular and oncological diseases, which make it necessary to treat them in a specific way while estimating costs, has been presented (as far as it is possible to discuss in general such large groups of diseases); finally, examples from literature have been presented.

The objective was to present quantitative aspects, providing rather intuitive approach than technical considerations (which are rather needed to design such undertakings than to understand results of publications). A reader interested in details can find more specific information in the publications referred to in this text listed in the bibliography. The review of examples of published studies has a non-systematic character, because the aim was not to reach a general conclusion (e.g. evaluation of average costs in case of a given disease), but to present the (certainty incomplete) range of possible approaches.

The formulation *costs modelling* could be understood – and this is an interpretation applied in this publication – very broadly: as using quantitative approach (statistical, econometric, simulation etc.) to analyse the amount of these costs. The analysing could be

in turn understood as e.g. (1) characterising the amount of costs already incurred in the past (due to for example censoring, explained in the following part, calculating the average costs does not have to be a trivial task), e.g. by geographical regions or patients treated with a given medicine or (2) looking for factors describing (i.e. differentiating) these costs at the individual patients' level.

Apart from analysing costs we might be interested in explaining the heterogeneity of these costs at the level of local unites, individuals, etc., i.e. defining determinants (they explain the differentiation of lung cancer treatment using demographical variables, e.g. Chirikos et al. 2011) or projecting costs, which will be incurred. This projecting can in turn be carried out assuming that the *status quo* in the area of structural variables (i.e. available medicines, recommended treatment regimen, etc.) will be maintained and considering only trends in the field of epidemiology and for example natural market trends (e.g. dissemination of recently introduced treatment methods) or on the contrary – evaluating the consequences of changing the *status quo*. Of course, it is easier to project costs assuming there are no structural changes. Assuming that historical data are available and that the quantitative changes (e.g. demographical concerning prevalence or popularity of treatment methods) are reflected in these data, the application of appropriate quantitative methods will be sufficient and understanding the specificity and complexity of clinical process is almost unnecessary. The projecting of consequences of structural changes, for example aimed at determining consequences of introducing new treatment method in the framework of the so-called budget impact analysis (BIA), is far more difficult. Thus in case of evaluating the consequences of introducing new type of medicine applied in the primary therapy it is necessary to estimate an impact on the whole treatment pathway: medicines used so far in the primary therapy may be now used in secondary therapy and patients receiving them will be in worse clinical condition. Therefore one should try to take into account and combine information concerning the effectiveness of various medicines applied in primary and secondary therapy in the framework of one model. An example of such budget impact analysis in the area of oncology using discrete-event simulation (DES) model could be found in the publication of Comas et al. (2014). Describing a clinical process could be a difficult task and in the literature there are attempts to apply quantitative methods in order to identify and represent the course of this process (cf. Meier et al. 2015).

One should also remember that in case of estimating costs based on historical data one should consider possible misinterpretation of the results. For example observing the average higher costs in the group of people using a given medicine does not have to mean that this medicine is causing high costs and from the economical point of view it should not be recommended, but rather that patients in bad clinical condition received this medicine and that replacing a given drug with other could increase the costs even more (or decrease them, but it would cause higher mortality among patients). An attempt to draw conclusions concerning the interventional character (what would be the consequences of changing procedure) based on the observational historical data requires considering in the quantitative methods these possible interdependences between the initial patient's condition and applied treatment. Teitelbaum et al. (2013) made an attempt to estimate the costs of medical care among patients with malignant melanoma treated with new drugs in comparison with other therapies based on historical data concerning the financial claims resulting from medical services form large health insurer in the United States of America. They used a multi-factorial analysis in the modelling of dependence between cost and applied treatment and took into account as egzogenous variables also the characteristics of a patient, coexisting diseases, etc. in order to obtain the influence of treatment on the costs without the impact of patient's condition on the applied treatment.

While describing the treatment costs a concept of *perspective*, from which we are defining these costs, should also be introduced (cf. Jakubczyk et al. 2010). When accepting the perspective of a given institution we are at the same time determining that we are interested in (all and only these) financial consequences concerning a given institution. Thus when accepting the patient's perspective in calculating the costs we take into consideration only events causing expenditure on patient's side. Then for example the costs of pharmacotherapy will be restricted to patients' co-payments to medicines and expenses for non-refunded medicines without, e.g. costs connected with hospitalizations. While accepting the perspective of a public payer of health services (in Poland simplifying slightly the perspective of National Health Fund, what is the most frequently applied practice) we should take into account the costs of medicines' refund (without costs of patients' co-payments) or costs of settlement of Homogenous Patient Groups. In some studies several perspectives are accepted. For example Cipriano et al. (2011) are comparing two perspectives estimating changes in the costs share

on the patient's side in case of all medical expenses (also in general costs from the combined perspective of a patient and a public payer).

While accepting the perspective of a hospital (healthcare provider) we will obviously take into account hospitalizations, but the settlement of the Homogenous Patient Groups should be then treated as a revenue and a cost will be the actual cost of providing service. This cost may be difficult to estimate, because it is necessary to take into account costs of personnel – not only medical, depreciation of equipment and buildings, etc. Yoon et al. (2012) are presenting the analysis (in the filed of neurology, i.e. among patients with stroke) of hospital costs' determinants divided into eight categories, e.g. costs of physician work, 'hotel' costs, medical procedures and others.

Some perspectives are enforcing a broader view going beyond purely medical consequences. While accepting the perspective of public finances (thus broader than the perspective of a public payer of health services) the influence of a disease on costs (or revenues most often reduced) of public institutions in Poland other than NHF. Diseases may lead to disability and need to pay out pensions (paid by the Social Insurance Institution and not NHF). Diseases may lead to reduced productivity at work, bankruptcy of small companies, etc. and thus to reduced taxes.

Even more difficult is the social perspective, which should take into account all negative consequences of a disease borne by society. Slightly simplifying (and not taking into account the difference between the accounting and economic cost) the social perspective additionally takes into account the impact of a disease on the decrease of economic activity resulting in the failure to provide goods of a specific value on the market. This lost value of a product constitutes an additional component of cost from this perspective.

It is worth to present a significant difference between the perspective of public finances and social perspective. In the first one the cost is everything connected with actual cash flows from public institutions to the society (e.g. pensions paid out by the Social Insurance Institution) or from the society to public institutions (e.g. income taxes paid by enterprises). From the social perspective the cash flow alone does not constitute the cost, because it takes place in the framework of society (i.e. the society is paying and receiving money at the same time). From the social perspective the so-called economic cost is incurred, i.e. the lose

resulting from the fact that the resources of the society are not used in order to provide goods and services sought by the society. The society is incurring a cost, if a given person does not produce goods due to a disease and these goods could be otherwise sold. The fact, if a patient will receive for this period a pension from the Social Insurance Institution is not important for the amount of costs calculated from the social perspective. While calculating the cost from the social perspective additional methodological dilemmas arise, for example how to take into consideration a possibility of hiring new employees on the place of employees, who are not productive due to the disease, whether one should adopt the human capital approach (and treat as the cost the very fact that human capital could not be used due to disease) or the method of friction costs (and treat as the cost only the actual loss of productivity, adjusting it to take into account the possibility of replacements, reorganisation of work, catching up backlog of work, etc.). This review is not restricted to any previously mentioned perspective.

The specificity of medical expenses modelling and applied quantitative methods

As indicated by Arrow (1963) the demand for medical services has a specific character, since it is often unpredictable for an individual patient (of course, it is easier to predict in case of chronic diseases with established course of treatment). Both the moment, when it will be necessary to incur cost (developing a disease, disease recurrence, deterioration of patient's state, possible adverse reaction) and the amount of this cost (determined by e.g. condition of a patient and hospitalization time, invasiveness of applied procedure and intensity of pharmacological treatment) are random. However, since at the level of population covering many individuals these random values are to the large extend averaged, an attempt could be make to estimate regularity of the moment, when the cost occurs, and average amounts of this cost. However, the fact that cost data have two specific features: censoring (connected with the issue of time until the occurrence of the cost) and skewness (connected with the diversification of the amount of cost) should be taken into account.

The distribution of treatment cost of patient in a specific clinical condition (informally: a description of values we expect in case of particular patients) is usually right-skewed. The majority of patients generates relatively low costs and a small group of patients generates costs substantially higher than the average. The figure 1 below presents an example

of distribution of a variable with a right-skewed distribution. For the purposes of this example, we should assume that this variable describes time (in days) of patient's hospitalization in case of considered clinical event. The vast majority (82%) of hospitalizations leasts no longer than six days. The average time accounts for only 4 days. However there are hospitalizations that exceed this mean several times. The median of hospitalization time is 3 days – at least 50% of cases least no longer than 3 days (precisely 57%) and at least 50% of cases no shorter than 3 days (precisely 60%). At the same time the most frequently occurring value (dominant called otherwise mode) is 2. Thus the mean is higher than the median, and median is higher than dominant, which is usually (but not always) a case for right-skewed distributions.

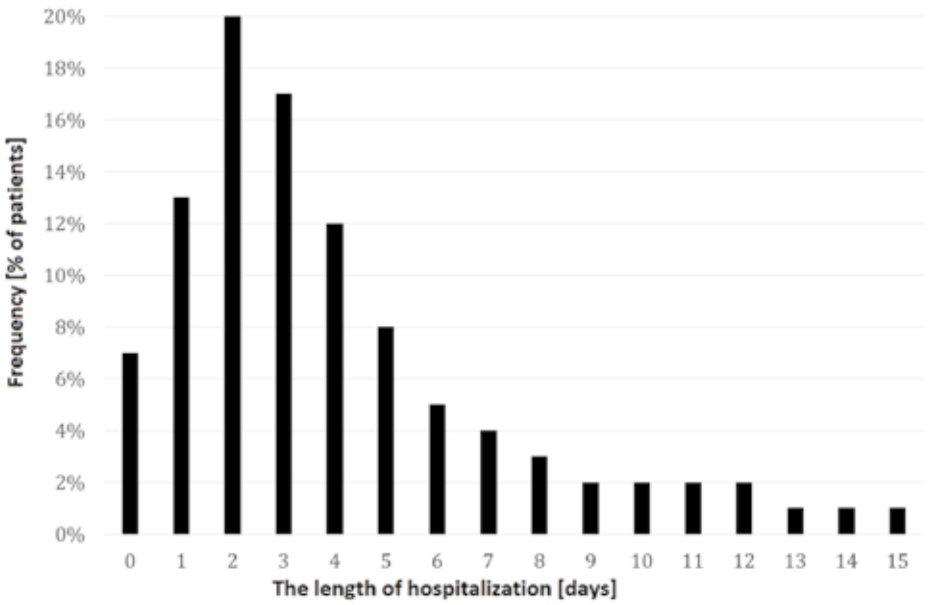

Figure 1. An example of right-skewed distribution. In this case dominant (equal 2) is lower than median (equal 3) and than average (equal 4) (source: own study)

In the context of costs estimating skewness might be significant for at least two reasons. Firstly, assuming that data concerning hospitalization time are not available and instead of that we want to estimate treatment costs in a certain population of patients using expert opinions. If the overall cost depends proportionally on the number of hospitalization days, we should use the average hospitalization time (and multiply it by the expected number

of hospitalizations). Whereas in case of the skewed distribution it may happen that experts observing many cases of hospitalization time similar to dominant, will rather perceive this value as the average hospitalization time (due to so-called availability heuristics, i.e. it is easier to remember cases occurring more often). Three most frequently occurring values (1, 2, 3) constitute as much as 50% of cases. The opposite situation can also happen, i.e. experts will rather remember several, unusual, long-term hospitalizations and will round up the mean. In case of symmetrical distribution this problem does not occur, because typical, dominant and average hospitalization time are equal (and extreme values are evenly distributed upward and downward and are occurring equally often).

The skewness of distribution pose also a problem in statistical terms. While observing a set of values of a given variable we often treat these values as a sample taken from a particular general population. Even when analysing costs of all individual patients from the last year we can treat these numbers as a random sample from a general population of patients we might expect in the following years. Since the sample is random, the mean value of cost in this sample is also random, i.e. it might differ from actual mean in the general population. In statistics in such cases often 95% confidence intervals for the mean are calculated, i.e. we can with a high probability state that the interval covers the actual value (95% from many such intervals should really contain an actual value). However it turns out that using standard statistical equations enabling to estimate such confidence intervals is not as effective in case of skewed variables. One solution would be to transform costs to symmetric form, e.g. through logarithmization (or other more general Box-Cox transformation, cf. Chaze 2005). However in such case it should be kept in mind that we estimate the average value of a logarithm, so when converting this value to average cost it may be necessary to take into account additional parameters (e.g. diversification of costs, i.e. variance). The literature proposes also analysing data using methods resilient to outliers (cf. Johnson 2015).

One more problem is connected with a distribution of a variable describing the amount of cost: in case of many patients a cost might be zero (or zero in case of a certain category of events) (cf. Gregori et al. 2011). Figure 2 below presents an example of such distribution. Interestingly, in case of this (still right-skewed) distribution the mean is lower than median (cf. von Hippel 2005).

A high percentage of patients with zero cost generates a technical problem, which makes it impossible to use logarithmical model – the logarithm of zero does not exist. However, this problem could be solved in slightly atheoretical way, by adding a given constant to costs before logarithmization. Using the linear regression model to explain a value of cost in case of a large number of zero values of egzogenous variable may result in negative value of expected costs. For this reason, the literature proposes using, e.g. the tobit model, in which the hidden variable is treated as an actual cost, only if it has a positive value. The application of a two-stage model, in which for example the Bernoulli distribution is determining a percentage of patients with zero cost and other model describes (right-skewed) distribution of cost among other patients could be also taken into consideration.

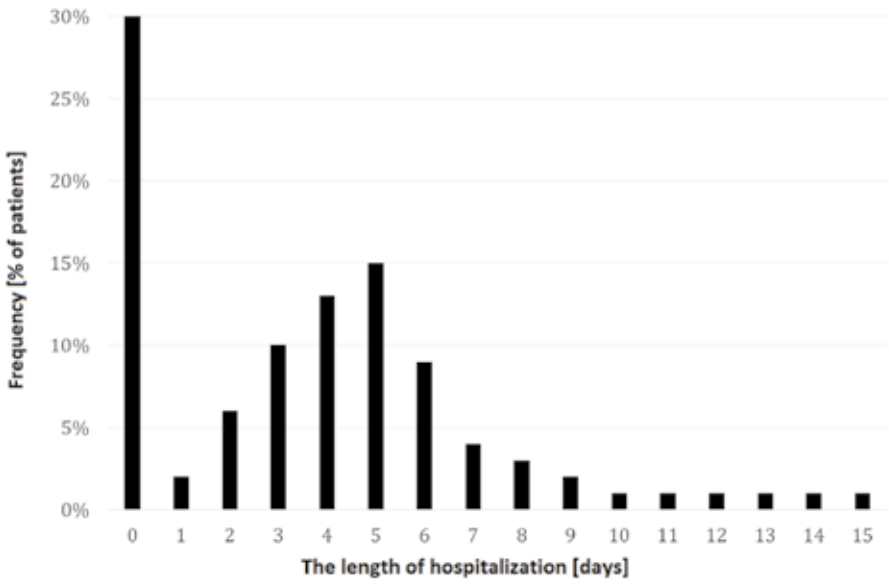

Figure 2. An example of right-skewed distribution with simultaneously multiple zeros. In this case (unusually) mean (equal 3.7) is lower than median (equal 4) and dominant is equal 0 (source: own study)

In a situation when the costs distribution has a skewed form and data contain many zero values, it is necessary to modify standard statistical methods used to estimate a mean,

confidence intervals or testing hypothesis concerning the equality of means in several groups (e.g. treated with different methods). Zhou (2002) presents appropriate statistical methods.

The literature draws also attention to the fact that patients not generating any cost probably poses distinctive features. Then, for example while explaining the determinants of cost, it is worth to consider building separate models for these both groups of patients (cf. e.g. Tian and Huang 2007). Chirikos et al. (2008) used in turn a two-stage regression model with a so-called Heckman correction (1979), i.e. separate equations described the mere fact of observing costs and separate – the mere (logarithmic) costs, using the individual tendency to generate costs as an additional exogenous variable.

As already mentioned the modelling of costs is connected with a second fundamental problem, a so-called censoring. The censoring means lack of information about an interesting event (e.g. occurring of a cost) in case of an individual included in the study due to the fact that this individual was not observed through the whole time. The cost modelling is usually based on historical data. Suppose that we want to estimate costs incurred to treat patients with a given disease. Assume that on the basis of historical data we can identify the onset of a disease (e.g. performing a given medical procedure). However, there are two problems. Historical data (of sufficient quality) are often only several years old. Therefore in case of some patients we will not be able to recognize the moment of disease's onset (since this moment occurred before starting to collect the data) or costs incurred from the onset of a disease until the beginning of data collection. On the other hand historical data are for obvious reasons limited to today. Thus we do not have information about the whole path of costs generated by patients, who are still living (and are still sick, if we are considering curable diseases) at the end of data collection. The figure 3 below illustrates such situation on the example of five patients (A–E) represented by grey-black areas. A period of a patient's life is represented by the length (horizontal, meaning along the axis representing time) of such area. Whereas the generated costs increase (in selected moments) the height of a given area.

The left vertical line represents the beginning of data availability. A patient B is censored form the left side, i.e. we do not have information about a moment of the disease's onset and costs incurred more than three years ago (so we do not have information represented by a grey colour). The vertical line represents the moment of conducting analysis (today). At the

moment of conducting analysis patient E is still alive and we do not posses information about costs that will actually concern this patient (he is censored from the right side). We have full information about patients A, C and D. Of course patients may also be censored form the both sides.

Due to the left side censoring we do not know, which part of costs are costs observed in data and to what period after the disease onset we should assign these costs. In practice bigger problem is usually right side censoring (e.g. concerning patients treated recently also more representative for applicable treatment standards). Due to censoring we are not observing full costs for a given patient, so we can underestimate the average cost of treatment by simply dividing total observed costs by a number of patients. Additionally a dependency between an amount of incurred costs and a risk of death, and thus the probability of censoring, may occur. For example often significant costs are incurred in the final period of life, just before patient's death. Then censored patients (thus patients, who lived until the end of observation period) most likely lower the average actual treatment costs (cf. Bang and Tsiatis 2000; Lin 1997). The literature proposes methods for estimating costs taking into account this phenomenon, going beyond the scope of this publication (Bang and Tsiatis 2000). Let us only mention that one of general approach consists in transferring methods used in survival analysis (also connected with a problem of censoring) to the field of costs analysis.

An interesting description of the above-mentioned problems (skewness, zero costs and censoring) could be found in studies of Gregoriego et al. (2011) or – slightly less technical approach – in Reed (2014).

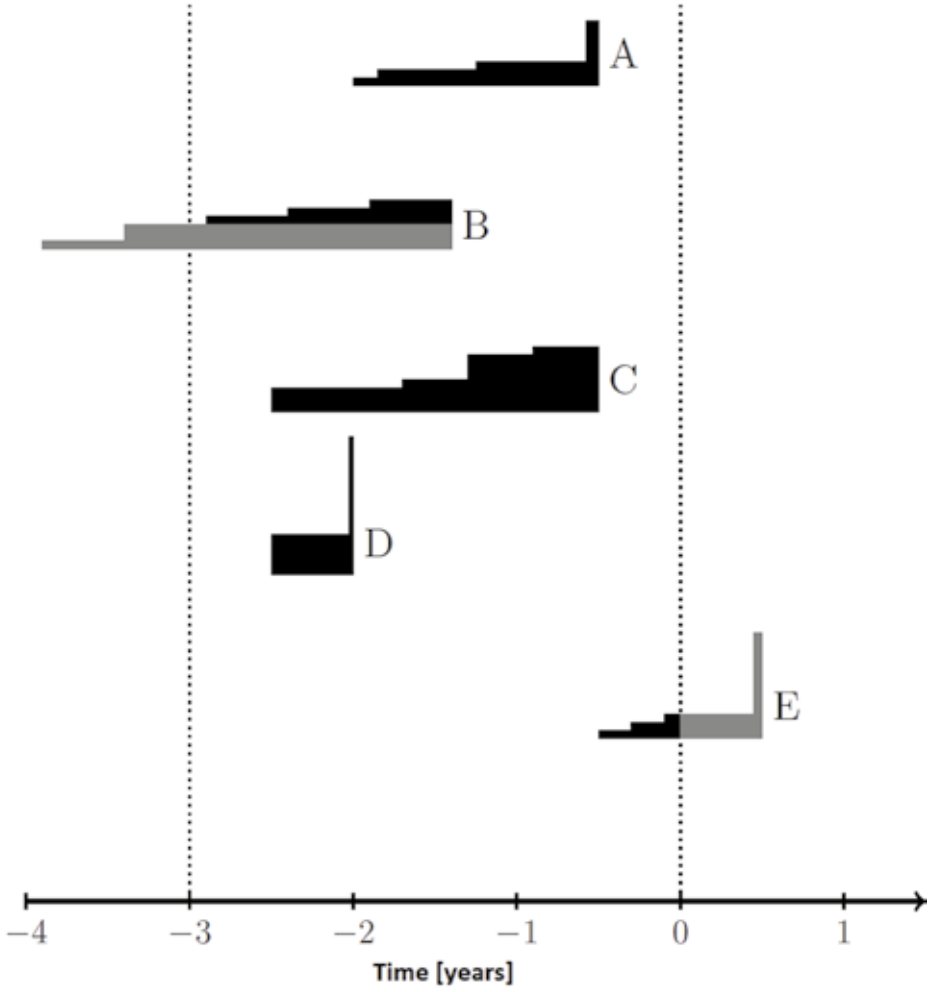

Figure 3. The illustration of censoring while measuring medical expenses. The dotted lines indicate the starting point of data availability and the present moment. The areas marked with A–E represent increasing costs of five patients. The data of B (E) patient are left side (right side) censored (the grey areas are not observed) (source: own study)

Characteristics of oncological and cardiovascular diseases in the context of costs (modelling)

Modelling costs in case of cardiovascular diseases should primarily take into consideration the chronic nature of the majority of cardiovascular conditions with periods of exacerbation generating additional costs (e.g. acute coronary syndrome in the course of ischemic heart disease or hospitalization due to heart failure exacerbation). Also due to the progress in treatment of oncological diseases (introducing targeted therapies) neoplasms are becoming chronic diseases and costs modelling should take into account the longest possible period of observation (in order to take into consideration costs of for example disease recurrence/ progression or the presence of late-onset of complications after the primary oncological treatment). Moreover in case of both groups of diseases significant changes in treatment standards could be observed over the last few years. The innovative methods of therapy (procedures and pharmacotherapy) are usually connected with higher treatment costs (e.g. implantation of cardiac resynchronisation system in patients with heart failure), but also potential savings (e.g. reducing the frequency of urgent hospitalizations). Projecting costs on the basis of historical data about patients, who currently would receive different treatment regimen, might be subject to a high error rate. On the other hand, if we take into consideration in modelling costs data coming from most recent studies (which reflect currently applied treatment standards), the problem of right censoring of costs arises, since the period of patients' observation is short in case of such studies.

The difficulties may be also caused by complicated, multi-factorial structure of medical intervention, which is subject of modelling (e.g. preventive actions) – sometimes it is difficult to evaluate the impact on change of results and costs in the future on the basis of changes of procedures.

To sum up, oncological and cardiovascular diseases have some common features, which should be taken into account when modelling costs. Due to the chronic nature of conditions, it is impossible to limit in advance the time horizon, during which costs data for individual patients should be collected, since these costs could be generated during the whole remaining life. In turn the significant progress in therapy observed in the last years in cardiology and oncology makes it difficult to use data coming from longer periods of observation and to make long-term costs prognosis. Taking into account shorter observation period (in particular

in connection with long horizon of generating costs) makes the problem of censoring very important. Examples of costs modelling in case of cardiovascular and oncological diseases together with indicated issues and problems are presented below.

Examples of costs modelling in oncological diseases

Will et al. (2000) present an interesting example of estimating medical expenses referring to cancer treatment. The authors focussed on estimating total medical expenses in the life horizon of women in Canada diagnosed in 1995. In the analysis a microstimulation model (POHEM, described in detail, e.g. in the publications of Will et al. 2001; Hennessy et al. 2015) reflecting the course of disease and treatment for the cohort of average Canadians was used. The model combined information about risk factors, prevalence according to sex (the model enables to conduct analysis also for men, but in the cited study only data for women were used) and age, the distribution of the stage at the moment of diagnosing, typical diagnostic and medical procedures and their costs, as well as a rate of disease development.

Will et al. (2000) estimated the costs at the level of approximately 450 million CAD. The difference between the estimation of costs in the life horizon and estimation of costs for treatment incurred in a given year regardless of the moment of the diagnosis is worth noticing. Firstly, these two figures do not need to be equal, as the second one depends on the incidence of cancer in the past (therefore indirectly on the dynamics of the population demographic structure). Secondly, the standards of breast cancer treatment will most probably change in the future, therefore the costs incurred for the treatment of the newly diagnosed case may vary from those estimated on the basis of the historical data.

Will et al. (2000) calculated discounted and undiscounted costs (with 3% and 5% rates), while estimating joint costs incurred in the health care system is basically similar to BIA, where discounting is not recommended (cf. Sullivan 2014 or guidelines developed in the framework of works of the then Agency for Health Technology Assessment 2009).

It is also worth noticing, that using a well defined model as the basis for estimating costs enables using the same model with different application and it facilitates the comparison of the results (between countries, for various diseases, for various subpopulations, etc.). For example, Berkowitz et al. (2000) were using the same POHEM model for analogical

estimation of the treatment costs in the life horizon of women diagnosed with breast cancer in the USA.

Dahlberg et al. (2009) analyse the costs of treatment of recurrence of metastatic breast cancer in Sweden on the basis of retrospective studies in the group of 53 female patients who died in 2005 or 2006 (the observation period was from 1.6 month to almost 10 years). Because of this specific sample construction the study included also patients diagnosed with the cancer many years ago, who were potentially treated with methods which are rarely used nowadays. It seems though, that the problem of censoring was avoided. The overall average cost amounted to EUR 93 thousand.

In contrast, the study where several limitations may be identified will be cited. Pompen et al. (2009) estimated the costs of treatment of patients diagnosed with the unresectable advanced non-small-cell lung cancer in Netherlands. The study used retrospectively a small sample of 102 patients. The details concerning the sample selection were not given (the chosen – it is not known how – hospitals were requested to present data of about 20 patients, for whom it is not known if they were chosen randomly). Patients' medical documentation was analysed from the moment of diagnosis (after October 2001) until the death or the end of the assessment period (June 2005). The study also did not mention the question of censoring. The authors state that they adopt the health care provider (hospital) perspective and at the same time, while defining unit costs of the considered resources, they adopt the values from the uniform payment scheme (it seems though, that they adopt the public payer perspective, limiting the costs to those incurred during the hospital care). The separate analysis was carried out for patients treated with the best supportive care and for those treated with chemotherapy (the therapy applied may obviously depend on the patient's condition). The authors mention, that the costs were right-skewed with the exception of the cost of the second-line chemotherapy for which the average was lower than the median (it is however worth remembering, that such inequality does not exclude the right-skewness). The average annual cost amounted to approximately EUR 32 thousand.

Kutikova et al. (2005) also estimate costs related to lung cancer treatment, but in the USA. What is interesting is that to measure additional costs stemming from the treatment of this disease, they use the case-control method, i.e. they match the group of patients diagnosed

with cancer (>2000 patients) with the group without the disease and they compare the average costs (obtained from the linear regression model) in these two groups (instead of e.g. identifying procedures resulting causally from the lung cancer). The patients of the control group were selected on the basis of conformity in age, sex, area of living, type of health insurance and time of being insured. The patients were observed (retrospectively) for 2 years maximum, from the diagnosis until the death, losing entitlement to health care or the end of the study. The censoring was >44%, however no information about including the censoring into the modelling was provided. In regression model the logarithm of cost was explained and egzogenous variables including demographic variables and concerning insurance were taken into account. Average costs related to lung cancer amounted to approximately USD 6.2 per month and to USD 43 thousand in the study horizon (bearing in mind that the time of life will differ in the case group and in the control group).

Purmonen et al. (2010) studied the costs of treatment of the kidney cancer with metastases in Finland. The study covering average costs and survival was based on the data collected retrospectively, concerning 83 patients receiving first-line treatment with interferon-alpha. The projections concerning incidence based on the epidemiological data were used. The authors estimated the projected treatment costs in the 5-year horizon for EUR 16–26 million. Although the authors mention that the analysis adopts the Finish health care system perspective, they estimate also the costs of productivity loss (characteristic of the social perspective). In their analysis they also estimate the financial consequences of the treatment change consisting in adding the sunitinib in the first-line treatment.

Robinson et al. (2015) analysed trends in treatment costs of the palliative radiotherapy of the prostate cancer with metastases in the USA. They used the data collected retrospectively concerning men >66 year old who died in 2000–2007 and who received radiotherapy during their last year of life. In the time horizon under consideration the insurer (Medicare) costs increased by approximately 44%. This increase in costs resulted from using more complex therapies (increase from 59.9% to 66.7% of patients) and longer cycles (percentage of treatment cycles ≤5 decreased from 6.3% to 2.9%).

Defining the future number of patient constitutes a crucial step in costs projecting. While estimating costs incurred in a given year, it is necessary to have the information about

the number of patients treated during that time, that is to say the information about the prevalence. Verdecchia et al. (2002) present the example approach enabling the prevalence estimation on the basis of the information concerning the incidence obtained from the medical registers and about the patients' survival. Using the new method of the analysis developed by them (called PIAMOD) and using the data from the register from 1973-1993, they project the further breast cancer incidence in the Connecticut state in the USA until 2030. They project also patients' survival rate, considering separately the scenario where the prognosis does not improve in relation to 1993 estimations and the scenario where the prognosis improvement paste is consistent with the historical data. The PIAMOD method was later used for neoplastic diseases modelling, i.e. for projecting the number of patients diagnosed with colorectal cancer in the USA (cf. Mariotto et al. 2006) and for costs of neoplastic diseases in the USA in 2010–2020 (Mariotto et al. 2011). In the second study the authors included 13 types of cancer for men and 16 types of cancer for women. The prevalence projection was developed for five age group of patients separately, on the basis of projections for incidence, survival and treatment costs. The prevalence was estimated separately for each type of cancer. Considering the significant uncertainty for future trends in incidence, survival and treatment costs, the scenario approach was applied with the following options being considered: (i) the current values of incidence, time of survival and treatment costs; (ii) extrapolation of the current trends only in the scope of incidence; (iii) extrapolation of the current trends only in the scope of time of survival; (iv) extrapolation of the current trends in the scope of incidence and time of survival; (v) extrapolation of the current trends in the scope of incidence, time of survival and treatment costs. For estimation of trends in the scope of incidence the data from 1996–2005 were used and the extrapolation with the log-linear model was applied. To estimate trends in the scope of survival rate, the mixture cure survival model was used (in which the part of the population is characterised by the same risk of death as the general population – it is assumed thus that they do not die of the assumed disease, but some of them will die of this disease and the time of survival is characterised by the Weibull distribution.

An interesting method of combining data is presented by Grande et al. (2006). With the use of the original model (MIAMOD) they project the incidence and the prevalence on the basis of the data about the mortality and the survival. They use this model to estimate the neoplastic diseases burden by regions in Italy. The results enable identification of various trends in

different parts of the country, e.g. the author project the decrease in incidence among men in almost all central and northern provinces with the constant (or slightly increasing) level of incidence in the southern provinces (the authors do not predict any changes in incidence among women in particular provinces).

Examples of costs modelling in cardiovascular diseases

While modelling heart diseases costs, some features characteristic of diseases from this group should be included. The majority of cardiovascular diseases are chronic in their character, therefore it is crucial to apply the longest time horizon in a model, optimally covering the whole period of patient's life. This is why for modelling costs and results of a given therapy the researchers often use the Markov model. This model was used i.a. for assessment of viability of cardioverter-defibrillators implantation as part of primary prevention in patients with lower left ventricle systolic function (Cowie 2009) and of implantation of cardiac resynchronisation system in patients with heart failure (Neyt 2011). In both works the costs were assessed from the perspective of the health services payer in Belgium. In the study Cowie et al. (2009) it was demonstrated that apart from effectiveness of the device and the age of patient in the moment of medical procedure, the result is influenced also by the time period until the defibrillator replacement (i.e. the next medical procedure implied by the first analysed procedure). Adopting even shorter, because fifteen years study perspective, Boriani et al. (2013) demonstrated that prolonging the time of work of the implantable cardioverter-defibrillator reduces significantly the costs of applying this therapy.

In some cases heart diseases may coexist or are causally linked (e.g. heart defect and heart failure, coronary heart disease and arrhythmia), which is problematic as to distinguishing the costs related to a particular disease and it possibly implies the decision about the calculation of overall costs for all diseases from this group. For example Heidenreich et al. (2011) made an attempt to project the changes in costs of cardiovascular diseases (i.e. arterial hypertension, coronary heart disease, heart failure, stroke, etc.) in 2010–2030 in the USA. For this purpose the data concerning prevalence and average cardiovascular diseases treatment costs per one patient were generated for 32 demographic units (according to age groups, sex and race), avoiding double costs calculation in case of patients with two or more coexisting diseases.

It should be pointed out that the work includes the phenomena of the progress observed in the field of cardiology ad the progress in the scope of medical technology. It was assumed that the prevalence in each of 32 demographic units is constant, but the projected increase in the treatment costs was based on the historical data concerning medical expenditures (direct costs) and real wages (indirect costs), assuming, that the increase in medical expenditures (i.e. increase in prices and introduction of technological innovations) will continue in the same paste for another 20 years. According to authors' calculations, 40.5% of the USA population will suffer from any form of cardiovascular disease until 2030. It is also predicted that in 2010–2030 the real direct medical costs of these diseases will increase three times (from USD 273 million to 818 million), and the indirect costs (due to lost productivity) will increase by 61% (from USD 172 million to 276 million).

Atherosclerotic cardiovascular diseases are characterised by numerous risk factors, which is best illustrated in the studies in the scope of prevention. Therefore, the modelling of i.a. costs should optimally include all factors influencing the clinical process of the disease. The international study EUROACTION assessed the influence of the annual nurse-coordinated preventive cardiology programme (modifying lifestyle and reduction of risk factors) on hospitalised patients with coronary heart disease and on patients at high risk of developing cardiovascular diseases under the care of primary care physician. Mistry et al. (2012), with the use of Markov model, were estimating the costly effectiveness of the applied preventive programme in the 10-years horizon after its finalisation. The costs of programme implementation were given in particular countries currencies (the study was conducted i.a. in Poland), and then converted into British Pounds with the use of the purchasing power parity. The researchers did not demonstrate the viability of the presented preventive programme, however they did not include into the study results and costs analysis (due to difficulties in quantitative influence assessment) the changes in the scope of diet and physical activity that they observed in the EUROACTION study.

Summary

Costs data modelling is, on the one hand, necessary in the modern health care system management (e.g. in order to project the budget expenditure in next years, e.g. by geographical regions of the country), on the other hand– it is not an easy task. Although it concerns

measurable matters (if we are not considering social perspective or the public finance), it faces a lot of difficulties and it needs thorough understanding of clinical aspects in the field concerned and the choice of appropriate analytical methods. Costs data in medicine are variables of a very special kind (skewed distribution, significant number of zeros, censoring), and while skewness seems to be often taken into account, in many studies possible problems connected with censoring are ignored and the results are often based on a small number of patients selected in a manner, which does not ensure the representative character of the group.

Moreover in case of costs modelling in cardiovascular and oncological diseases it is necessary to take into account their chronic character (e.g. the risk of the disease recurrence or of treatment complications in the long period observation) and the dynamic technological progress one may observe in recent years in these fields of medicine (e.g. common application of cardioverter-defibrillator or resynchronisation therapy in heart failure). It is therefore necessary to simultaneously take into account numerous elements while performing the costs modelling, cf. e.g. POHEM model described above (Will et al. 2010; Will et al. 2011) and sometimes to combine the information from different countries (cf. Berkowitz et al. 2000). In order to parameterize such complicated models combining different data sources it is necessary to use the mathematical transformations of the directly available data (sometimes contrary to the causal links direction, e.g. by calculating incidence on the basis of fatality, cf. Grande et al. 2006). Considering the model complexity, the analyses are characterised with the high level of uncertainty, therefore the scenario sensitivity analysis is popular (cf. e.g. Mariotto et al. 2011).

Nevertheless, with all these difficulties, the quantitative modelling seems more reliable (with the up to date monitoring of assumptions, quality of data; with the constant validation of the results received – partial and final; considering developing new analytical methods in the literature) than to build on the holistic, non-falsifiable and non-quantifiable expert assessment.

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Funding Cancer-Care Services in Poland

Beata Freier

Introduction

Continuous evolution in the operation and organization of health-care system in Poland in the recent century is an effect of searching for an optimum system of medical services funding.

In 1920s an insurance system operated in Poland, but it was not public. It was based on Sickness Funds which operated based on a statute of 1920. The system was modified in 1933, with the introduction of social insurance and the establishment of the Social Insurance Institution (Zakład Ubezpieczeń Społecznych - ZUS). It has to be noted that issues related with treating cancer and financing cancer-care were a social challenge already at that time. During the 1st Country-Wide Cancer Symposium in Warsaw held on 14 December 1924, the first National Cancer Control Programme was announced, featuring three main goals: 1) development of clinical and epidemiologic research; 2) health education; 3) establishing facilities for cancer patients, including the Radium Institute in Warsaw (Warzocha 2014).

The system was reorganized after WWII. In 1946 the Sickness Funds were wound up; in 1950 health-care facilities became nationalized and health insurance was phased out. Medical services were funded from the state budget, based on the Constitution of the People's Republic of Poland of 1952. In 1972, as a result of centralized management of economy and state administrative reform, two insurance packages were introduced. The first package allowed for individual farmers being covered with health insurance, and the second one enabled the establishment of integrated health-care complexes composed of a hospital, an outpatient facility, primary and secondary health-care facilities, and partially even a welfare institution. The year 1973 saw the establishment of the first state-owned facilities called health-care complexes (ZOZ), which were funded partially by provinces (voivodeships) (Śmigielska 2010). The economic crisis of the 1980s triggered administrative changes and adjustments in heath-care budget management. They involved an attempt at decentralization by shifting ZOZ management from the central (Ministry of Health) to provincial level. Those changes were

insufficient and at the beginning of 1990 the ground was prepared for the introduction of mixed (central budget + insurance) funding of medical system, which operates in the majority of the European countries. This resulted in a reform which, based on the Act of 6 February 1997 on common health insurance, reinstated the Sickness Funds. Seventeen independent Sickness Funds were established (one per each province plus one Branch Sickness Fund for uniformed services). They were public insurance institutions operating based on a health-insurance premium deducted from personal income tax. Sickness Funds, as well as public health-care units, became legal entities vested with significant self-governing powers. They were to represent the insured and they could establish branches. They managed their funds based on financial plans which were developed based on balance-sheets of expected incomes and expenses, the most important being the expected income from health-care premiums (Śmigielska 2010).

According to today's evaluations, a lot of mistakes were made when establishing new structures, but it was undoubtedly the first step towards contracting medical services and financing thereof in a rational way. The main complaints concerning Sickness Funds operation related to excessive bureaucracy, lowering prices, haphazard contracting, all this in correlation with low salaries of the health-care personnel.

Sickness Funds ceased to operate in 2003, with the implementation of the Act of common insurance in the National Health Fund (NHF), which was later substituted (due to its being sued as unconstitutional) by the Act of 27 August 2004 on health-care services financed with public funds. The new institution, namely the National Health Fund, acquired the tasks of Sickness Funds as well as their debt (PLN 130 million). The role of financial plan was underlined, and sticking to the annual plan of expenses became a priority in planning medical service purchases. At the same time the contracting principles were standardized and involved tender bids and negotiations.

Since 2004 a number of changes have been observed, the aim of which on one hand is to improve accessibility of medical services, and on the other hand – to improve the methods of pricing and funding of health services. The philosophy of settlements between the payer (NHF) and medical service providers was also changed. A few years of preparations resulted in launching a programme *Development of the Polish model of Diagnosis Related Groups*

(DRG). Funded by the World Bank, the programme was based on experiences gathered in the period 1996–2000 and the diagnosed needs for changes. UPGs Working Group, established based on the Decision of the Minister of Health of 12 March 2001 and acting on the Minister's behalf developed the details of the concept, especially in the scope of methodology of establishing UPGs and maintenance thereof (Grabowski et al. 2001). In the following years a Polish knowledge-based model of UPG was developed based on the collected data and a pilot programme implemented by regional Sickness Funds during their operation.

Diagnosis Related Group system for inpatient care (JGP SZP) was introduced in Poland on 1 July 2008, and on 1 October 2010 a Diagnosis Related Group system in neurological and cardiovascular rehabilitation was introduced (JGP REH). Finally, it was partially introduced in Outpatient Secondary Health Care System (AOS) of the NHF. UPG system implementation was a step in the right direction of standardizing health-care service funding, however, the implementation of the system was not free from defects. Incorrect pricing of procedures is regarded as the biggest one.

Funding of medical services prior to UPGs

January 1999 started a new period of health-care financing. Following the administrative reform, Sickness Funds started operation as independent local government bodies. Funding medical services fully from the state budget was ceased.

The majority of Polish population was subject to mandatory social insurance based on the principles of solidarity (the therapy of poor people and seriously ill people was funded with the money originating from premiums paid by the rest of those insured, according to solidarity principle). Individuals who were not covered with medical insurance had to pay for medical services. The reformed system separated expenses on health-care from the state budget. The role of the Sickness Funds was to provide health-care to those insured thanks to managing the funds originating from their premiums. Sickness Funds had to observe the principle of targeted expenses, they had to spend money economically, they had to be non-profit organizations and they had to provide equal access to services (NHF information materials, www.nfz.gov.pl). This goal was achieved by purchasing various medical services from service providers: primary care doctors (PCD), secondary care doctors, dentists, nurses, midwives and hospitals. Sickness

Funds also provided funds for the purchase of orthopedic aids and medicine by patients who participated in the costs. In addition, those institutions financed highly specialized medical procedures, also cancer care. Cancer care procedures included isotope treatments, providing patients with vascular access ports, combination therapy for lung cancer, treating cancers highly sensitive to chemotherapy and treatment with cisplatin. The majority of highly cost-consuming tertiary health-care procedures were funded directly from the budget. They included i.a. bone marrow transplants in hematologic conditions, treatment of breast cancer and ovarian cancer with taxanes (a group of cytostatics – at that time generating huge costs due to their price), brachytherapy and extended field radiation therapy (EFRT) as well as stereotactic radiation therapy or large frequency radiation therapy.

Duality of funding sources generated major problems which were evident especially in treating oncohematologic diseases. E.g. there was a problem of disproportion in the prices of the procedures of e.g. marrow transplant (funded by the Ministry of Health), and a large dose chemotherapy (funded by Sickness Funds). The pool of funds earmarked for funding tertiary medical procedures from the state budget was assumed to cover the funding of cytostatics, including 100% costs of cytostatics used in cancer care of children. In case of adult treatment, the state budget funds were to supplement the primary source of funds, i.e. the Sickness Funds. Apart from the price of cytostatics, the funding was to cover antiemetic drugs, which are necessary when using cytostatics and growth factors used during the treatment of cancers which are highly sensitive to chemotherapy (Answers to MPs written questions, http://orka2.sejm.gov.pl). However, at that time chemotherapy was paid with the funds which were transferred to hospitals by Sickness Funds. The amount of funds transferred depended on the number of patients and not always covered the costs of medical services needed by patients treated for cancer, which resulted in indebtedness of facilities treating patients who required supplementary treatment or prolonged hospitalization.

Additional disproportions resulted from Article 7(27) of the Act of 6 February 1997 on common health insurance (Journal of Laws of 1997 No. 28, item 153 as amended), which introduced reference levels of hospitals. According to the delegation included in Article 31c. (4) of the above mentioned statute, the minister of health and social welfare defined, by an Ordinance of 22 December 1998, a national hospital network, and established reference level of hospitals depending on the type of health services provided by them. Cancer treating

hospitals and wards were graded reference level 2. Teaching hospitals and medical research units were graded reference level 3. Although a majority of huge cancer hospitals provided the working base for teaching and research units, when it came to financial settlements, they were treated worse than cancer wards which were located within teaching hospitals and medical research institutes. E.g. in the Lover Silesia Regional Sickness Fund the average difference in the level of funding of wards with reference grade 1, 2, 3 amounted to approx. 1 to 1.25 to 1.5. The biggest prices were fixed for services in hematological, immunological and cancer wards (NHF, www.nfz.gov.pl).

Significant shortcomings of the system of funding medical services becoming that evident, attempts at corrective actions were made at the central and regional levels. For example, in 2001 the Lower Silesian Regional Sickness Fund started to finance ultrasound-guided and MRI-guided breast biopsies as tertiary health-care procedures provided in outpatient system. Service prices regarded as wrongly assessed were adequately adjusted. Also, a therapeutic programme of pharmacological cardioprotection in patients treated with anthracyclins due to malignant neoplasms was introduced (Dexrazoxan).

However, actions undertaken did not fulfill the expectations. This is why the establishment of an effective system to fund accessible health-care services provided according to the latest state of the art, which would at the same time take account of the service costs became one of the major tasks of the Ministry of Health. The aim was to develop a system which would take account of cost relations in Polish hospitals, and which would enable allocation of funds which were always insufficient, which would introduce a quality criterion on the market of medical services as well as a uniform method of cost calculation, which would result in transparency and stability of the system. The Lower Silesian Regional Sickness Fund developed (based on the project: *Development of a Polish model of Diagnosis Related Groups*, which was implemented i.a. in Lower Silesia, supplemented with experience and knowledge about cost data acquired during the implementation of an Austrian adaptation of LKF system) a system of uniform patient groups, which was composed of Diagnosis Related Groups, Uniform Service Groups, and Uniform Chemotherapy Groups. Base point value was fixed on annual basis, account taken i.a. of cost information provided by service providers in one of the bid attachments. Hospitalizations which exceeded the requirements defined for the uniform groups could be settled with the payer by means of flat-rate hospitalizations – A

(lasting not more than one-day long), B (lasting up to 72 hours), C (exceeding 72 hours), and hospitalizations within inter-ward patient movement were settled using a weighted average of hospitalization point value proportionally to the length of partial stays and unit point values assigned to those hospitalizations.

It has to be underlined that the development and implementation of that model of funding medical services, especially cancer care, is a continuous process which requires regular discussion at clinical level, as well as reliable knowledge of cost, epidemiology, constant response to changing guidelines, EBM rules in diagnostics and cancer therapy, as well as economic situation. The corrective actions undertaken resulted i.a. in limiting the application of chemotherapy to ready-made regimens which did not include all the clinical possibilities, but they contributed to indirect standardization of systemic therapy regimens. The model was changed with the introduction of a catalogue of drugs used in chemotherapy (relevant drugs were assigned for a given ICD-10 diagnosis), but even this resulted in a temporary blockade in therapy progress, as changes in the catalogue were not simultaneous with the changes in standards. Radiation therapy funding system was not changed significantly.

Funding medical services following UPG implementation

The launching of NHF resulted in the introduction of uniform principles of service contracting. The principles were subject to subsequent modifications. Experience gathered during the implementation of component 3 of VITAPOL project: „Overview of the Polish system of cost determination in health-care" (a twinning agreement implemented by UK experts) and a pilot project which involved cost assessment of procedures in Polish medical facilities enabled the development of the Polish system of Diagnosis Related Groups (Grabowski et al. 2001).

The aim of those modifications was to oblige NHF to pay for the effect of treatment rather than for rendering a service listed in the hospital list of services. Thus, the product funded by payer was redefined. According to the order No. 32/2008 of the NHF President, UPG system was introduced as of 1 July 2008, which forced the categorization of finished hospitalizations into one of several groups established according to a medical regimen coherence criterion, comparative level of resources used, standardized time of hospitalization

and other acknowledged parameters. UPG description is based on a diagnosis-based cause of hospitalization (principal and co-existing diagnoses according to ICD-10), the course of hospitalization (in particular major surgeries and non-surgical treatments provided, coded according to ICD-9-CM), and additional features such as patient's age and length of hospitalization. UPG system of hospitalization costs includes surgery-treatment groups and conservative-treatment groups. ICD-9-CM codes of medical procedures are decisive in qualifying a given hospitalization to the surgery-treatment group, and ICD-10 codes of diagnoses are decisive for qualifying the hospitalization to the conservative-treatment group (Gilewski 2010).

Table 1. Examples of surgical treatment and conservative treatment groups (source: own studies based on: Gilewski 2010)

Conservative treatment group			
Group name:	**G26 Biliary tract disorders**		
ICD-10 code:	**K80.0** Calculus of gallbladder with acute cholecystitis	**K80.1** Calculus of gallbladder with other cholecystitis	**K80.2** Calculus of gallbladder without acute cholecystitis
Surgical treatment group			
Group name:	**G25** Cholecystectomy		
ICD-9 procedure code:	**51.01** Percutaneous aspiration of gallbladder	**51.02** Trocar cholecystostomy	**51.04** Cholecystotomy

Hospitalizations due to cancer may be settled with the payer within UPGs, whether surgical treatment groups or conservative treatment groups. On the other hand, treatment by chemotherapy, radiation therapy (tele- and brachyterapy) follows by means of assigning a service to a relevant catalogue (which is different from the basic UPGs). If cancer care followed according to the UPG catalogue, with additional radiation or chemotherapy, the services are summed up by means of reporting services from separate catalogues. This principle has been applied from the date UPGs were introduced until today (NHF training materials, www.nfz.gov.pl).

The following basic catalogues were presented in 2008, within which cancer care can be funded:

1a – Catalogue of UPG system groups,

1b – Catalogue of separate services,

1e – Catalogue of basic services – hospitalization – chemotherapy,

1g – Catalogue of services and scopes – hospitalization – therapeutic health schemes.

Summing up of the services followed by means of additional catalogues:

1c – Catalogue of additional services,

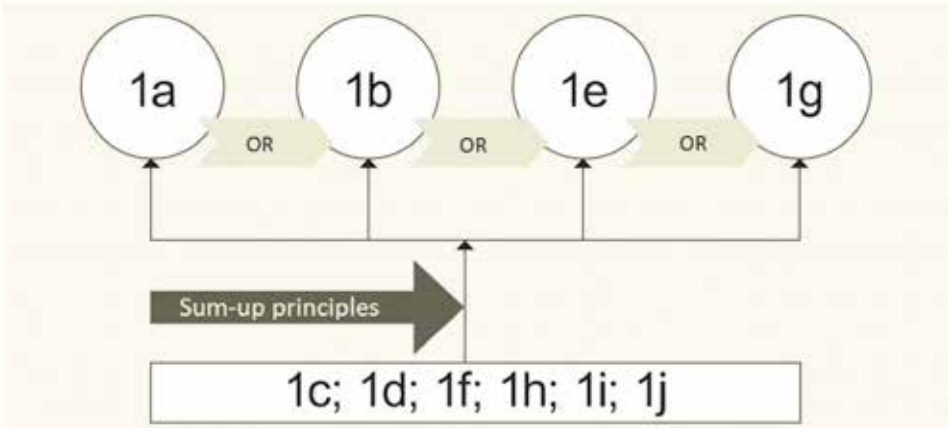
1d – Catalogue of radiation therapy services,

1f – Catalogue of active agents used in chemotherapy of cancers,

1h – Catalogue of active agents used in therapeutic health schemes,

1i – Catalogue of flat-rates for diagnostics in therapeutic schemes,

1j – Catalogue of adjuvant services – hospitalization – chemotherapies.



Flowchart 1. Catalogues' hierarchy and relationship (source: Gilewski 2010, 32)

The system was modified and improved as time went by. The most important modifications included the inclusion of hospitalization from separate agreements to the principal hospitalization agreement. Important modifications (which are continuously assessed by service providers as insufficient) include the establishment of new surgical groups which

correspond to the appearing new surgical procedures, e.g. complementing the UPG catalogue to include reconstruction treatment or conservation treatment. In addition, in the field of radiation treatment, apart from shifting the funding of tertiary procedures from the Ministry of Health to the NHF, radiation therapy products were adjusted with more detail to the applied procedures of cancer treatment by irradiation.

That the system of funding cancer care undergoes continuous modifications is best proven by numerous references to the previous orders of the NHF President when defining the terms and conditions of executing and implementing agreements for hospitalization in the scope of chemotherapy, such as: „In the Order No 80/2014/DGL of the President of the National Health Fund of 5 December 2014 defining the terms and conditions of executing and implementing agreements for hospitalization in the scope of chemotherapy, amended by Order No 7/2015/DGL of the President of the National Health Fund of 27 January 2015, Order No 19/2015/DGL of the President of the National Health Fund of 24 April 2015, Order No 25/2015/DGL of the President of the National Health Fund of 25 May 2015 and Order No 37/2015/DGL of the President of the National Health Fund of 13 July 2015, Annex No 1n to the Order receives the wording defined in the Annex to this Order".

Hitherto modifications did not solve another important problem – the so called problem of services overshot, i.e. providing medical services in excess of the value of services contracted by the payer. The overshots are primarily the effect of contracting insufficient number of services (also in terms of cancer care) in relation to market demand and the capabilities of service providers. Due to a very broad package of guaranteed medical services in the reality of limited funds, the contracts do not secure the entire needs for medical services. The practice of not paying for overshots, which often was and is the case, has been generating serious financial problems for service providers, including cancer hospitals which fall into an unsustainable debt spiral.

Contracting cancer care services by tender

According to the Act of 24.08.2004 on health-care services financed with public funds, health-care services financed with public funds may be provided following a contract for medical services to be entered into between a service provider and a public payer (NHF) on

the terms and conditions as provided for in the Act. A contract for cancer care services can be entered into following a tender procedure or – in cased defined by the law – following negotiations (this does not apply to primary care services, medical supplies and services described in Article 41. 1 and 48. 2 of the Refund Act). One has to remember, however, that public procurement law is not applicable to contracts for health-care services. The National Health Fund is statutorily obliged to equal treatment of service providers and to conduct tender procedures so as to guarantee fair competition and access to information on the same basis. Tender announcements reflect NHF's financial plan and purchase plan.

Tender (or negotiation – in particular cases) announcements for broadly understood cancer care services should be preceded by an analysis of health-care needs, epidemiology of cancers, quantitative and qualitative analysis of hitherto contracts for cancer care services, analysis of queues for those services, migration of cancer patients, effectiveness of treating cancer in a region concerned. One has to remember that cancer care services are provided at various treatment levels – within primary health-care, outpatient secondary healthcare facilities, inpatient healthcare – basic contract, radiation therapy and brachytherapy, chemotherapy, therapeutic schemes. Palliative healthcare services and drug refund for cancer patients at pharmacies are further levels of comprehensive cancer care.

Tenders (and negotiations in situations provided by law) for cancer care services are announced in the above mentioned types of services, for particular scopes of the services: services at an outpatient facility, outpatient surgical facility, at a cancer ward, hematology ward, radiation therapy ward, chemotherapy ward, within a kidney cancer treatment scheme according to the scopes contracted by NHF. The tender (negotiation) is announced for a scope of services within a defined level of health-care, at a defined territory, for a defined value, with a defined subject of the order, and for a definite duration of a contract to be awarded as a result of the procedure concerned.

The statute and its implementing provisions define what should be included in a tender announcement. Prior to the tender announcement a director of the NHF branch appoints (and dismisses after the tender procedure is completed) a tender committee in order to conduct the procedure. It is statutorily defined in details who can and who cannot be a member of the committee and what are their duties. Information necessary for a tender participant can be

found in the tender announcement. The announcement refers to all the pieces of legislation which refer to a given tender procedure, so each bidder should read and understand the announcement, read a tender form on which to prepare their bid, and pay particular attention to deadlines, dates, terms and conditions required from the future service provider, as well as to the criteria of bid evaluation. Service providers requirements and the criteria for bid evaluation apply during the entire course of the tender procedure. Any and all modifications of the service providers' requirements, or a modification of assessment criteria during the tender procedure require cancelling the procedure and announcing a new procedure on new terms. The statute also defines cases where a tender procedure must be cancelled or made invalid, and it defines the requirements for rejecting a bid.

The Ordinance of the Minister of Health of 22 December 2014 concerning the procedure of announcing tenders to award a contract for health-care services, submitting bids, appointing and dismissing tender committee, its tasks and methods of operations provides for the details of the tender committee's tasks during the procedure.

Before a bidder joins the tender procedure for providing cancer care services, it should enter into an agreement with NHF to be able to use a Service Provider Portal. Otherwise the bidder cannot enter its details (formal and legal details, resources, personnel, medical equipment, sub-contracting agreements and scope thereof) on the system which enables preparing a document which is necessary for participation in the procedure, namely an SSX file. The tender bid is composed of two dossiers – a paper documentation and documentation in electronic format. Paper dossier should include formal and legal documents.

The tender includes an open and a confidential procedures. In the open procedure the committee provides the bidders with information concerning the number of bids submitted, the correctness of tender announcement, accepts explanations/statements of the bidders. During the procedure the committee may call a bidder to provide supplementary information or explanations by a given deadline, or to conduct an inspection to verify the information from a bid (Ordinance of the Minister of Health of 22.12.2014).

The tender committee evaluates the bids submitted according to the bid assessment criteria described in NHF President's Order No. 54/2011/DSOZ of 30.09.2011 on criteria for evaluating bids in a tender procedure for awarding a contract for health-care services (as

amended). Bids are compared in terms of offering service continuity, comprehensiveness, accessibility, personnel qualifications, equipment, holding quality certificates or accreditation as a result of an external evaluation process, as well as in terms of price and number of services offered. The pricing of settlement units within a given scope of services, i.e. point value and manday price are especially controversial for bidders. Due to importance of issues related with defining the criteria of bid evaluation in April 2013 the NHF President established a Task Force for Establishing the Criteria for Qualitative Assessment of Bids. The team's task was to review and modify hitherto and propose new criteria of qualitative bid assessment in tenders for awarding contracts for health-care services. The team has finished its work by developing proposals for modifying bid assessment criteria, which have been systematically implemented by NHF. Modifications related also to the quality assessment of bids for cancer care services within all the types of services.

The confidential part of the procedure involves a selection of the most favourable bid, which will be awarded a contract for health-care services, according to the NHF mission, namely to secure access to top quality cancer care services at a favourable price to all those insured and entitled, account taken of the purchase plan assumptions. The committee may conduct negotiations with bidders and agree the price and number of services to be provided.

The negotiation part is especially important in the procedure for awarding a contract for health-care services, especially for cancer care services, if the value of the order is underestimated for various reasons, or when the settlement unit value has been too low, or the purchase plan has been wrongly planned or if there is an oversupply of services on a given area.

The tender procedure is finished after the award of the contract has been announced, on the terms and conditions as defined in the statute. As a result, a contract for services is entered into with the most favourable bidders who fulfill the requirements and who have agreed the value and number of health-care services to be provided under the contract in question.

During the tender procedure the bidder can lodge a complaint against the tender committee's actions, and following the procedure it can apply the following appeal measures: lodge an appeal to the branch director, apply for a reconsideration of the matter to the branch director, appeal against the director's decision. Procedures in each case are regulated

statutorily, the statute also lists cases where the tender procedure must be cancelled or invalidated and defines when the bid can be rejected.

A new chapter in contracting cancer care services will be opened when maps of cancer care requirements are introduced within particular scopes of services. The project assumes identification of areas for which a need for medical services will be objectively assessed. At the same time mechanisms will be introduced which will enable medical facilities' objective assessment of effectiveness and quality with a possibility of comparison. An important feature is that funding stability by the payer has been assumed by introducing agreements which enable investment planning. The implementation of the above mentioned mechanisms should result in improvement of access to medical services, leveling opportunities for all the patients and finally – in more economic spending of public funds.

Conclusion

Regime changes which followed in Poland within the last eighty years caused natural changes in insurance systems and in the operation and funding of medical services. They are a result of socio-political changes. How sensitive an issue it is to provide equal access to medical services is known only by experts who dealt with the issue. It has to be agreed that the budget-and-insurance system remains the most frequent solution in highly developed countries, but the amount of premium, the method of its collection, the amount of public spending have still been the subjects under discussion. A statement that no ideal solution exists should be accepted with a certain reservation. One has to look for system solutions which are adjusted to economic capabilities, which would at the same time enable the most effective possible spending of funds. The priority is to provide Polish citizens with access to medical services at the level which is not worse than in the remaining European countries. This means access to cutting edge therapies which are modified in 3-4 year intervals (Mróz 2012).

Cancer care is a good example of that. Unfortunately, (according to many experts) low expenses on healthcare are the main cause of shortcomings in the access to medical services. One should, however, consider, whether the cause of bad results of cancer care in Poland is not more complex. Appropriate fund management is the basic problem.

Today we are still witnessing a lively discussion over the access to free medical treatment. The Polish constitution and the accompanying legislation guarantee equal access to medical services for those entitled (the insured individuals and other people who are listed in a given statute). This does not, however, mean that medical services will be entirely free of charge. A challenge posed by securing medical services at international standards (effectiveness and quality of therapy) calls for rational and more effective contracting medical services. The currently implemented project of Health Needs Mapping is a step in the right direction. Models to be developed as a result should enable contracting in all scopes according to actual needs.

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Rules of contracting cardiological services in Poland

Ewa Kowalik

Introduction

Although since the general systemic transformation the health status in Poland has significantly improved (Golinowska 2011), the cardiovascular diseases, including the ischaemic heart disease, (in addition to cancer) are the leading cause of death in particular among older age groups (64+ years of age). Most of the cardiovascular diseases are protracted in nature, although the history of the disease may include directly life-threatening clinical conditions (e.g. acute coronary syndrome, acute decompensated heart failure or pulmonary embolism). Therefore the cardiological services constitute an important element of the healthcare sector, and the specific nature of the needs justifies the adoption of appropriate rules of contracting or waiving quotas in certain clinical situations. It should be stressed that along the healthcare system reform there have been significant changes in the treatment of the cardiovascular diseases resulting from the medical progress in this respect and from the improved quality of the cardiological care in Poland. Thus the contracting of cardiological services should be a dynamic process subject to constant evaluation.

This section firstly presents the basic sources of law regulating the method of contracting cardiological services (i.e. legislations, regulations promulgated by the Minister of Health, orders issued by the President of the National Health Fund). The chart of procurement procedures used to contract cardiological services in Poland was also presented.

Subsequently the history of methods of financing and contracting cardiological services prior to the introduction of diagnosis related groups in Poland, i.e. as a part of the centralised healthcare system financed by the state budget, was discussed. The method of financing services as a part of the diagnosis related groups system, while focusing on the section E group (heart diseases) in particular, including the surgical procedures and unlimited services. Examples of cardiological services from the catalogue of hospital services (prior to the

introduction of the diagnosis related groups) and of cardiological treatment and surgical services as a part of the diagnosis related groups.

Sources of law regulating the method of contracting cardiological services in Poland

The main legal act guaranteeing to all Polish citizens an equal access to public healthcare services, including cardiological services, is the Constitution of the Republic of Poland of 1997 (article 68). The terms and scope of the services as well as the rules of financing are described in turn in the Act of 27 August 2004 on healthcare services financed from public funds.

The terms of financing and providing the services as a part of the current system of Diagnosis Related Groups are presented in the following legal acts:

- Regulation of the Minister of Health dated 6 May 2008 concerning general terms and conditions of the healthcare service provision contracts. This Regulation discusses the terms of providing the services, the service provider's liability, service financing methods, and the contractual penalties.
- Regulation of the Minister of Health of 20 October 2014 amending the regulation concerning the guaranteed hospital treatment services – refers to human resources related aspects, formal aspects, service provision organisation, as well as the medical equipment and devices for the service providers of specific medical specialisations. This Regulation also defines additional terms and conditions for the provision of specific services (in the case of cardiology – the treatment of acute coronary syndromes, percutaneous intravascular interventions, invasive cardiological diagnostics, percutaneous closure of left atrial appendage).
- Regulation of the Minister of Health of 22 December 2014 concerning the method of announcing the procedure leading to the signing of a healthcare service provision contract, appointment and dismissal of the procurement procedure committee, its scope of duties and work procedures.
- Order of the President of the National Health Fund no. 72/2011/DSOZ of 20 October 2011 (as amended) concerning the definition of of terms of concluding and performing the hospital treatment type contracts. The Order of the President of

the National Health Fund defines the rules of procedure and requirements for the service providers, terms of service provision, verification, settlement and financing of services; the groups of services are defined in the group catalogue (annex no. 1a to the Order).

Chart of procurement procedures used to contract cardiological services in Poland

Voivodeship divisions of the National Health Fund are responsible for meeting the healthcare needs by concluding healthcare service provision contracts, including for cardiological services. The Act of 2004 on healthcare services financed from public funds regulates the contracting procedure, including the organisation of the procurement procedures resulting in the selection of the service providers offering the most attractive medical services.

The chart of procurement procedures is defined in the Regulation of the Minister of Health of 22 December 2014 concerning the method of announcing the procedure leading to the signing of a healthcare service provision contract, appointment and dismissal of the procurement procedure committee, its scope of duties and work procedures. The Director of the National Health Fund Division publishes the procurement procedure announcement defining e.g. specification of the value and object of the procurement procedure, geographical range of the procedure, the maximum number of healthcare service provision contracts to be concluded as a result of the procedure in accordance with the division's financial plan and the healthcare services procurement plan, as well as the terms of concluding and performing the contracts according to the object of the procedure. The National Health Fund Division Director's scope of competence also includes the appointment of the public procurement committee from among the division staff (there must be an odd number of committee members that is higher than 5 members). The composition of the public procurement committee is determined in line with the object and mode of the procurement procedure conducted by the committee. The public procurement committee must include a person that has at least higher education and the degree of magister or its equivalent in medical sciences, and if possible people having at least higher education and the degree of magister in legal sciences and in economics. The Division Director selects the chairman, vice chairman and secretary of the committee.

The procurement procedure is divided into public and non-public parts. During the public part the public procurement committee presents the number of offers received, including the number of offers fulfilling the eligibility requirements of the procedure. During the latter (non-public) part the best offer or offers is/are selected (taking into account the price, service provision continuity, accessibility and comprehensiveness). The committee may conduct negotiations with the bidders submitting the best offers concerning the number of contracted services and their prices.

In exceptional situations the contract may be concluded with the service provided during negotiations (upon invitation by the National Health Fund). The Voivodeship Divisions of the National Health Fund are also responsible for controlling the performance and settlement the contracts with the service providers.

The requirements for the service providers in the scope of the cardiological hospitalisation (annex no. 2 to the Order No. 90/2011/DSOZ of the President of the National Health Fund of 13 December 2011) are divided into compulsory and optional. The compulsory requirements include:

- formal requirements: Intensive Cardiological Care Unit (OINK) or at least 4 beds of intensive cardiological care at the cardiological unit or an Anaesthesiology and Intensive Care Unit or an Intensive Care Unit (at least four beds),
- human resources related requirements: at least 2 FTEs of a cardiology specialist, including a head of the unit (physician managing the unit) – a cardiology specialist.

The optional requirements include:

- human resources: at least 2 additional FTEs of a cardiology specialist, at least 2 FTEs of a cardiology specialist nurse and at least 2 FTE nurse with completed qualification course in cardiological nursing;
- service provision organisation: at least four beds of cardiological care unit, cardiological clinic, heart defect clinic, arterial hypertension clinic, pacemaker implantation unit, cardiac surgery unit, vascular surgery unit, angiography lab, cardiological rehabilitation unit, cardiological rehabilitation clinic;
- medical equipment and devices: cardiac monitor with the ability to continuously measure arterial blood saturation – on site, angiocardiography device, CT scanner

showing coronary arteries, ultrasound scanner with transesophageal scanning function – on site;

– other – at least 20 beds at the cardiology unit.

In addition, additional compulsory conditions (formal requirements and service provision organisation requirements) have been defined for the services from the groups: E11, E 12, E13, E14, E21, E22, E23, E24, E25, E26, and E27.

Cardiological services financing method

The situation prior to the introduction of the diagnosis related groups

The central planning healthcare system (so-called Semashko's model) financed from taxes and formally guaranteeing access to the services to almost all citizens has been functioning in Poland since the end of the WW2 until 1999 (Paszkowska 2006). The service provider cost reimbursement procedure was significantly simplified in that system. It did not require verification and reconciliation the quantity of provided services – the hospitals received a budget to cover the costs of services provided. During that period also the cardiological services were financed by the state budget, but their profile was significantly different from the current profile in terms of the number of applied cardiological procedures (e.g. coronary angioplasty) and their availability in the ER procedure (24 h/day).

During the general systemic transformation the centralised healthcare system financed by the state budget was replaced by the model based on the compulsory health insurance that was implemented on 1 January 1999 by virtue of the Act of 6 February 1997 on general health insurance. Initially the role of the main payer were taken over by health maintenance organisations (16 territorial organisations and one organisation for the uniform services i.e. police, military, prison system, fire brigade, border services, national railways and sea transport personnel). The task of collecting contributions from the people subject to insurance (or from their employers) has been taken over by the Social Insurance Institution (ZUS) and Agricultural Social Insurance Fund (KRUS), which in turn transferred the collected funds to the health maintenance organisations. The organisations were responsible for contracting the necessary services for the insured. Insurance contributions for certain social groups only and highly specialised services only were financed directly by the state budget. The determined health

insurance contribution rate was the same for all regardless of age and health condition, and its absolute value did not affect the quantity and type of available services (Act of 6 February 1997 on general health insurance).

The provision of healthcare services, including hospital treatment, required a signing of a contract between the payer and service provider. The contracts defined e.g. the type and scope of provided services and the method of settlement. Therefore upon the introduction of contracting the problem of proper evaluation of the demand for specific medical services and of estimating the cost of individual services arose.

On 1 April 2003 by virtue of the Act of 23 January 2003 on general health insurance with the National Health Fund substituted by the Act of 27 August 2004 on healtchare services financed with public funds because the former Act was found unconstitutional by the Constitutional Tribunal, the National Health Fund composed of the head office and 16 voivodeship branch offices replaced the health maintenance organisations.

The National Health Fund is responsible for signing contracts with the service providers. The settlements between the parties were initially based on the hospital services catalogue (annex no. 1 to the Order of the President of the National Health Fund No. 12/2006 of 23 February 2006: The Hospital Service Catalogue) covering nearly 1.4 thousand treatment or surgical services, and each service was listed in a separate item. The cost estimation constituted the basis of settlements with the payer; the number of completed items was multiplied by the settlement unit price. In certain cases it was possible to aggregate several services to settle the cost of the patient's hospitalisation. The patient' age, duration of hospitalisation, and complications did not affect the value of the service in the specific case.

Cardiological services were included in item 86 of the catalogue – examples of the catalogue items in the scope of cardiological services are presented in Table 1. In some cases there was a clear distinction between treatment services and hospitalisation, with the ability to aggregate them for the purpose of settling the cost of the patient's stay (Table 2). In some cases, however, the catalogue of services did not reflect the main aliment being the cause of the service provided at all (e.g. hospitalisation in order to assess the consequences and possible modification of the treatment, disqualification from the planned surgery procedure/invasive cardiological procedures due to the contraindications identified at the hospital and requiring

specialised diagnostics) while being unrelated to the classification of illnesses according to ICD-10, and also to the applicable classification of medical procedures. In addition, many items from the increasingly extended catalogue remained "dead" (i.e. in practice not coded by the hospitals in settlements with the payer). Therefore attempts have been made in order to reduce the number of the catalogue items while increasing their diversity in terms of the type and cost of services provided.

Table 1. The catalogue items cardiological services prior to the introduction of the DRG that could be aggregated (source: annex no. 1 to the Order of the President of the National Health Fund No. 12/2006 of 23 February 2006)

Service code	Service name
cannot be aggregated with any other service	
5.06.00.0000015	disqualification from the planned surgical/invasive cardiological procedure due to contraindications identified at the hospital (e.g. infections, cardiological illnesses, modification of the treatment – resignation from surgical treatment)
5.06.00.0000029	hospitalisation prior to transfer to a higher reference level centre
5.06.00.0000030	hospitalisation in order to assess the consequences and possibly modify the treatment (1-2 days' stay)
5.06.00.0000051	disqualification from the planned surgical/invasive cardiological procedures due to the contraindications identified at the hospital requiring specialised diagnostics (CT or NMR or echocardiography)
5.06.00.0000957	non-invasive diagnostics of myocardial infraction and unstable coronary disease, including troponin test and ECG
can be aggregated according to medical indications	
5.06.00.0000492	acute coronary syndromes – insertion of intra-aortic balloon pump
5.06.00.0000959	acute coronary syndromes – treatment using endocavitary stimulation
can be aggregated with other surgical services (compare Table 2)	
5.06.00.0001415	treatment at the intensive cardiological care unit (applies to single profile cardiological hospitals)
5.06.00.0001176	hospitalisation for the purpose of planned coronarography
5.06.00.0001177	hospitalisation for the purpose of planned coronary angioplasty or coronary artery bypass surgery

Table 2. Examples of surgery catalogue items that could be aggregated (source: annex no. 1 to the Order of the President of the National Health Fund No. 12/2006 of 23 February 2006)

Services that can be aggregated with		Aggregation options – code and name of service
Code	Name	
5.06.00.0001105	balloon coronary angioplasty without using stents with appropriate diagnostics	5.06.00.0001177 – hospitalisation for the purpose of planned coronary angioplasty or coronary artery bypass surgery
5.06.00.0001106	one vessel coronary angioplasty using a stent	
5.06.00.0001107	complex coronary angioplasty (two/three vessels) using stents	
5.06.00.0001408	multi-vessel coronary angioplasty using at least 2 stents, including 1 drug-eluting stent (DES)	
5.06.00.0001409	coronary vessel restenosis – prevention, diagnostics, treatment using 1 drug-eluting stent (DES)	
5.06.00.0001429	percutaneous coronary artery bypass angioplasty	
5.06.00.0000490	coronarography	5.06.00.0001176–hospitalisation for the purpose of planned coronarography

The situation after the introduction of the diagnosis related groups

In 2008 further changes in the financing of hospital treatment services were made. The product was replaced by treatment of a specific patient. A mechanism of financing Diagnosis Related Groups (DRG) was introduced on the basis of the British system (Paszkiewicz 2008). The system is based on financing (through a specific group) of all diagnostic and treatment costs borne during the hospitalisation (Paszkiewicz 2008)[45]. The settlements with the National Health Fund based on DRG apply to every type of hospital regardless of the ownership type, territorial reach and profile (general or specialist hospital); including cardiological services. Only highly specialised procedures (e.g. heart transplants) are still financed by the state budget.

[45] It should be stressed that the DRG system has been developed in the USA and currently functions in many European countries. Poland, however, directly used the British solutions.

In the DRG system the settlements between the payer and service provider are based on the settlement points. The Diagnosis Related Group is defined as: “a hospitalisation category with a code, name and characteristics, including such elements as medical procedure, diagnosis, patient’s age and duration of stay” (Gilewski 2010). The patient’s stay is therefore included in the DRG procedure and is not settled separately.

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Quantity measures in the assessment of healthcare services in Poland – the examples of oncology and cardiology

Barbara Więckowska, Adam Czerwiński

Introduction

The healthcare system should be constantly improved and adapted to the changing economic and social conditions. The primary aim of the development of healthcare should be continuous quality improvement. Quality in the healthcare system is, however, viewed differently by each participant in the system. For a patient, the indicator of quality is, above all, health improvement, as well as other aspects like staff behaviour, privacy and comfort. Moreover, a patient views quality in a certain way when paying for services from his or her own pocket, and views it differently when the costs of his or her treatment are covered by a private insurer or a public payer (Lewandowski 2002). For a doctor, the indicators of quality are salary, working time, the possibility of career development or working with modern equipment. International organisations or government administrations, in turn, define quality through the publication of requirements and guidelines (concerning e.g. the educational background of staff, the availability of services, or the method of treatment; Lewandowski 2002).

This differentiation in perceiving quality by various entities constitutes a serious issue when comparative analyses are to be made, i.e. the benchmarking of countries, regions, healthcare providers, or doctors. Such comparisons require the use of measurable quantity and quality indices that will result in the objective assessment of change effects and in finding other ways to improve healthcare quality. The structure of given indicators depends on factors, which are taken into account when defining quality. Donabedian (1988) proposed a concentric way of defining elements of healthcare quality, the fundamental level concerns doctors' efficiency determined by knowledge, as well as deduction and interpersonal skills. On the next levels, Donabedian adds other measures to the definition of quality: convenience (e.g. privacy, comfort), attitude and commitment of a patient (i.e. the factors that influence the quality of patient's treatment), and the factors that influence a general quality of

treatment in society, e.g. service availability or the healthcare providers' performance. In his basic definition, Donabedian purposely omits the aspect of efficiency (which, for example, for Higginson (1994) is the fundamental element of quality), that is, the relation between the level of accomplishing the objectives and the level of using the resources (especially financial). Donabedian points out that inclusion or exclusion of financial aspects in the quality assessment depends on a given attitude. The first specification of quality – "maximalist" – presumes that the best quality care insures the best possible health improvement for each patient and the whole population. The second specification of quality – "optimalist" – stresses the significance of costs, which means that the best quality is characterised by care, which provides the highest efficiency. The "maximalist" specification is definitely simpler and easier to implement. The "optimalist" specification, on the other hand, is more practical because expenditure on healthcare is characterised by decreasing marginal productivity.

The aim of this chapter is to draw attention to the measurement of quality in healthcare and the necessity of structuring appropriate indicators for such measurements. The measures should be based on the results of medical statistics, proving that better level of a given index results in better healthcare quality. This chapter consists of three parts. The first part presents the basic classification of quality measures in healthcare. The second and the third parts present the examples of empirical studies in oncology and cardiology respectively, which indicate certain correlations that provide the basis of developing indicators for quality measurement. Similar analyses for Poland are also presented. It should be underlined that the aim of this chapter is not to define the measures but to indicate the possible correlations and dependencies. The methodology used, based on standardisation and correlation analysis, cannot be the basis of drawing final conclusions because it omits many factors that may influence the direction and significance of correlations (e.g. comorbidities).

The areas of healthcare quality assessment

Healthcare quality assessment and the assessment of service quality are based on three basic categories of measures that refer to: structure (input) quality, process (output) quality, and outcome quality (Donabedian 1988). Structure (input) quality refers to the conditions of provision of medical services and allocable resources. Process (output) quality refers to

the activities performed during treatment, and outcome quality refers to the influence of these activities on the health of each patient and the whole population. Generally, these three attitudes generate results for the quality assessment. High structure quality positively influences process quality, and proper structure and process lead to good outcome. As Bowling (2002) points out, the assessment of structure and process is necessary for the interpretation of outcome. Donabedian (1988), on the other hand, observes that the measurement of structure, process and outcome quality leads to the recognition of relations and correlations of the measures. The knowledge of this may be used to improve healthcare system and its quality. Three categories of the healthcare quality measurement, and some factors and indicators that belong to these categories, are presented below.

Structure (input) quality

Structure (input) refers to any kind of resources used in treatment. They consist of: capital resources (buildings, medical equipment, hospital beds, available medicines, transport connections), human resources (staff, educational background, distribution and level of qualifications), technological resources (possible procedures), financial resources (the resources of public payers, private payers, healthcare providers and patients). Structure factors are mostly measured in a quantitative manner – by means of absolute figures (e.g. the number of hospitals) or indicators that refer to the population, e.g. the number of hospital beds per 10,000 inhabitants (Bowling 2000).

The collected information may be used both to compare entities expressed in actual values, e.g. to compare two hospital units, and to assess relative differentiation of structures between regions, e.g. deviation from the national average. Resources alone are a boundary condition of healthcare service, while drawing conclusions based on information about structure, without the assessment of process and outcome of treatment, may be subject to serious errors.

Process (output) quality

Process (output refers) to a manner of use of the available resources in the process of organisation, provision and use of services. The factors influencing availability (e.g. public transport, or queue length), and the institutional-organisation factors (e.g. financing system of healthcare, or the presence of general practitioners in the system) are included in this category.

The process quality measures are statistics that describe treatment both of the population and each patient. Thus, the exemplary process quality measures may be: the number of visits to doctors of a given speciality per patient or inhabitant, the type and amount of prescribed medicines, the average length of stay of a patient, the number of patient per a specialist in a given field or per unit of a given medical equipment, the average time between the first contact with a doctor and a diagnosis, guidelines for healthcare providers in a given region (referential level), or the level of use of given treatment methods in given cases (Bowling 2000; Donabedian 1988).

The process quality measures, because of the relatively simple methods of calculation and comparison, are used to create standards and guidelines for healthcare providers and doctors. The enforcement of these standards must be based on methods imposing the obligation of their adherence and reporting (clear legislation, association guidelines, international recommendations), as well as the monitoring of the entities (audit).

Outcome quality

Outcome shall be understood as the influence of services on the health of patient/ population. Credible and confirmed data concerning the treatment outcome are crucial for the assessment of healthcare providers and doctors, as well as the assessment of the manner of financing (Bowling 2002). According to Donabedian (1988), outcome may be defined as the change of health of a patient or population in reference to the services and standards of treatment, while health comprises not only of medical aspects but also social, like the improvement of patients' knowledge, their satisfaction and positive change of behaviour. The exemplary outcome measures are survival and mortality rates, the presence of relapses, complications and disability, the period of hospitalisation, as well as patients' assessments concerning their health, treatment comfort and satisfaction, measured by means of questionnaires (Bowling 2000; Donabedian 1988).

Quality measures in oncology and cardiology

This part presents selected examples of quality measures used in oncology and cardiology. Referring to appropriate empirical studies, four correlations between rates used to measure structure (input) quality, process (output) quality, and outcome quality are presented. The

relations presented in these empirical studies were applied to Poland through conducting the similar analyses using the data reported to the National Health Fund.

The use of quality measures in oncology

The influence of the number of procedures on mortality

Correlation between the number of surgical procedures performed annually in a hospital (*hospital volume)* and quality of these procedures (calculated by means of operative mortality rates, or the average length of stay (ALOS)) has been a subject of many medical and statistical studies in the last two decades. A general conclusion in these studies is a positive correlation between the number of surgeries performed by a given provider and treatment quality. Providers who performed more procedures of a given type (annual average),reported lower mortality rates (Begg et al. 1998), fewer complications and shorter ALOS (Hu et al. 2003). Researchers also observed similar correlation between the number of treatments performed by a single doctor annually and the quality of these treatments (Birkmeyer et al. 2003).

The correlations mentioned above are also valid in reference to surgical oncology treatments. Birkmeyer et al. showed in 2003, using the database of the Medicare programme, that mortality rate decreases with the increase of surgical treatments performed annually within all four kinds of oncology surgical procedures under study (resection for lung cancer, cystectomy, oesophagectomy and pancreatic resection). The range in mortality rate (within 30 days from a treatment), for example in the pancreatic resection was 18.8% with one treatment per year and 9.2% if a doctor performed more than six such surgical procedures annually.

Hu et al. (2003), studying the discussed correlations for radical prostatectomy, also basing their study on the Medicare database, divided hospitals and doctors into two groups according to the number of treatments performed annually. They established the threshold for 60 treatments per year for hospitals and 40 treatments per year for oncology surgeons. The results of the study showed that patients treated by less experienced doctors, that is, who perform less than 40 radical prostatectomies per year, were twice as likely to encounter complications and their patients were hospitalised, on average, a day longer. Hospitals that performed less than 60 surgical procedures per year, on the other hand, recorded nearly 7

percentage points more cases of anastomotic strictures, and they hospitalised patients, on average, for 0.8 day longer.

In order to check if similar correlations are also present in Poland, operative mortality rate of patients suffering from malignant neoplasm, who were subject to radical surgeries, was compared to the number of services of a given type performed by a healthcare provider who treated these patients. According to the nomenclature of Donabedian (1988), the number of services performed by a healthcare provider (*hospital volume*) should be qualified as process quality measure, while mortality rate as outcome quality measure. Thus, the relation between the number of services and mortality rate is an example of positive influence of good process on the results.

In the study, the database of the National Health Fund for years 2010-2012 was used, and it was supplemented with the data of the National Cancer Register[46]. From the data gathered, oncology patients, who were subject to radical surgeries and were diagnosed with malignant neoplasm that belongs to one of 10 distinguished cancer streams, were singled out (the codes of International Classification of Diseases ICD-10 are provided in parentheses, cf. icd10.pl):

- malignant neoplasm of trachea (C33) and bronchus and lung (C34),
- malignant neoplasm of breast (C50), carcinoma in situ of breast (D05),
- malignant neoplasms of lower gastrointestinal tract: malignant neoplasm of colon (C18), rectosigmoid junction (C19), rectum (C20) and anus and anal canal (C21),
- malignant neoplasms of upper gastrointestinal tract: malignant neoplasm of oesophagus (C15), stomach (C16), pancreas (C25), liver (C22), gallbladder (C23), other and unspecified parts of biliary tract (C24), and other and ill-defined digestive organs (C26),
- malignant neoplasm of prostate (C61),
- malignant neoplasms of female genital organs: malignant neoplasm of cervix uteri (C53), corpus uteri (C54), ovary (C56), and other and unspecified female genital organs (C57),

[46] For more information see the chapter: *The sources and quality of data concerning cancer epidemiology in Poland – the method of analysis of data* in publication *The treatment process in Poland – analyses and models*, Vol. 1: *Oncology*, which was created as a result of a project.

- malignant neoplasms of central nervous system: malignant neoplasm of meninges (C70), brain (C71) and spinal cord, cranial nerves and other parts of central nervous system (C72),
- malignant neoplasms of head and neck: malignant neoplasm of lip (C00), oral cavity (C01-C14), parotid gland (C07), other and unspecified major salivary glands (C08), nasal cavity and sinuses (C11-C13, C30-C31) and larynx (C32),
- malignant neoplasms of kidney: malignant neoplasm of kidney, except renal pelvis (C64), renal pelvis (C65) and ureter (C66),
- malignant neoplasms of bladder (C67).

Neoplasms were grouped in order to increase the number of cases within analysed streams, so that there was a possibility to compare healthcare providers with the same threshold of the number of radical treatments for each group. Three thresholds were established: 250, 150 and 60 radical treatments as an annual average (in years 2010-2012) reported by a healthcare provider. The first threshold assumes on average one radical surgical procedure per day, the second assumes three[47] surgeons, who perform, on average, one radical operation a week, working for a healthcare provider. In the third case, the assumed average number of treatments per surgeon was decreased to 20 per year. The proposed thresholds allowed for the division of healthcare providers into four subgroups in each cancer stream, that is, into sets of healthcare providers performing on an annual average, in years 2010-2012:

- less than 60 radical treatments,
- at least 60 and less than 150 radical treatments,
- at least 150 and less than 250 radical treatments,
- at least 250 radical treatments.

Only in the case of malignant neoplasm of prostate the treatments performed exclusively in 2012 were taken into account (based on an annual average, none of healthcare providers would exceed 60 radical treatments per year).

For all 10 groups of neoplasms and 4 groups of healthcare providers, the calculations were made for operative mortality rate defined as the percentage of patients who died

[47] Market basket requirements determine the minimum of two surgeons; however, taking into account annual leaves, or sick leaves, it was assumed that three surgeons are connected to a department.

before discharge from a hospital or within 30 days of approximate date of treatment (the date of first contact according to the National Health Fund). Operative mortality rates in each group of neoplasms were subjected to direct standardisation by age group and the stage of cancer, which means that in every group of healthcare providers the age and epidemiology structure of patients is the same. Standardised rates were used to assure better comparability of calculated values between groups of healthcare providers.

The calculated, standardised mortality rates are presented on Figure 1. The lack of bar for a given group of healthcare providers means that there was no provider in Poland who could be placed in a given range of performed radical treatments in years 2010-2012.

In five cancer streams with the highest mortality rate (upper and lower gastrointestinal tract, central nervous system, trachea, bronchus and lung, and bladder), healthcare providers who perform more radical treatments report lower operative mortality rates (the only exception are the neoplasm of trachea, bronchus and lung group where healthcare providers, who perform at least 250 treatment a year, are characterised by slightly higher standardised post-operation mortality rate than healthcare providers, who perform from 150 to 250 treatments a year). In five cancer streams with lower mortality rates (female genital organs, kidney, head and neck, prostate, and breast), the discussed correlation is visible for neoplasms of prostate and neoplasms of breast. In case of remaining 3 streams such relation could not be determined. In seven streams of neoplasms, in which a negative correlation between the number of treatments and mortality rates can be observed, the differences of rates between the sets of providers can be significant. The highest relative rate difference was reported in case of neoplasms of breast (three times higher mortality rate in group <60 than in group 250) and neoplasms of lower gastrointestinal tract (two and a half times higher mortality rate in group <60 than in group ≥250).

In case of all analysed cancer streams, with the exception of renal and head and neck cancers, it was observed that the subgroup of providers that performed the fewest radical operations on patients with a given type of neoplasm (i.e. less than 60 a year) was characterised by the highest standardised operative mortality rate. Generally, the largest decrease of standardised mortality rate is reported between the first (<60) and the second [60–150) group of healthcare providers. The most visible examples of this correlation are bladder and prostate

cancers, where mortality rate in hospitals performing 60 and more treatments was two times lower than in hospitals performing less than 60 treatments. In case of malignant neoplasms of breast, on the other hand, the difference was nearly tripled.

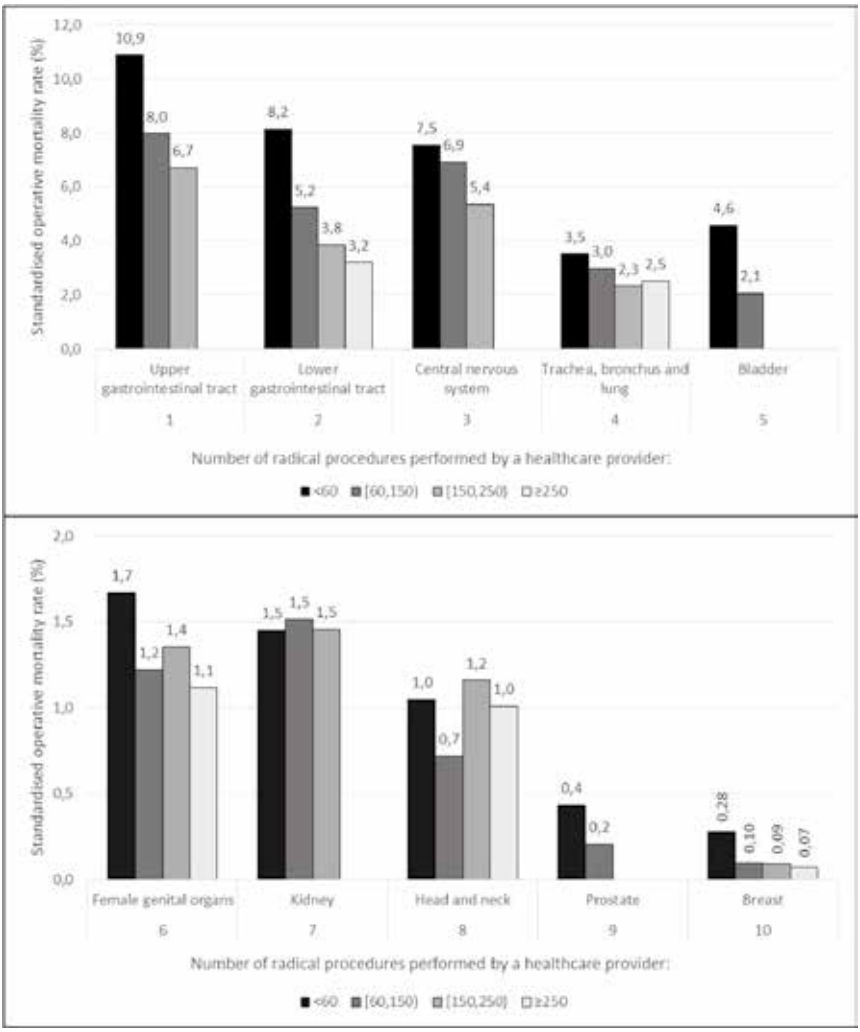

Figure 1. Standardised operative mortality rates in selected streams of neoplasms in reference to the number of radical treatments in a given group performed by a healthcare provider on an annual average (2010-2012; source: own analysis)[48]

[48] Operative ortality rates of neoplasm of prostate for 2012.

The results of the analysis show that process quality measure expressed as the number of radical surgery services performed in the patients with diagnosed neoplasm of a given group may be a predictor of the outcome shown by a healthcare provider. Moreover, the calculations indicate the validity of centralisation of radical surgical oncology treatments. It should be noted that there are no reasons to disperse healthcare providers realizing radical surgery procedures for cancer. Contrary to other treatment methods of oncology patients (chemotherapy, radiation therapy), the patient usually undergoes a radical surgical treatment only once. Therefore the concentration of services in fewer entities does not give rise to actual deterioration of availability of services[49].

In Poland, radical surgery for cancer is mostly dispersed, which is presented on Figure 2 showing the percentage of radical services for each of the analysed group of neoplasms performed in 2012 by hospitals that belong to the groups determined earlier. The values in the brackets mark the number of healthcare providers in a given bracket. Attention should be drawn to the streams of neoplasms which were characterised by significant changes in standardised mortality rates, that is, to prostate, bladder, upper and lower gastrointestinal tract (GI tract), and breast. Except the last one (because of high incidence), in all of the groups mentioned earlier, over half of the patients underwent radical surgery in the providers of the first group (less than 60 treatments a year), that is, the group that is characterised by the highest mortality rate. Thus, there is a potential in Poland (at least among the groups of neoplasms mentioned above) to consolidate providers performing radical surgery for cancer and to centralise these treatments.

[49] With simultaneous change of the value of contract for each healthcare provider.

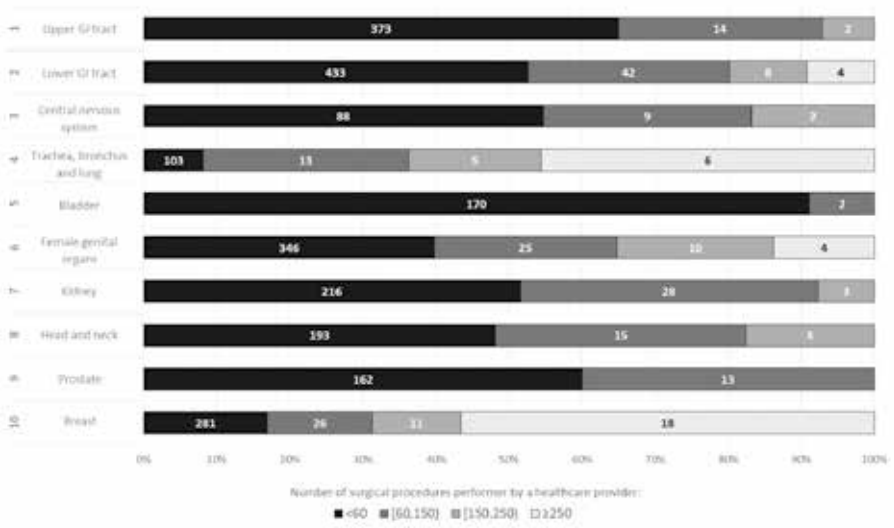

Figure 2. Share of radical surgical procedures in oncology reported by four groups of healthcare providers – Poland (2012; source: own analysis)

The influence of distance on the availability of radiotherapy[50]

The availability of radiotherapy depends of many factors: the quality of equipment, the number of the radiotherapy units, as well as human resources (the number of radiation oncologists, radiotherapy technicians and their qualifications). It also depends on the geographical distribution of providers that have the necessary equipment (linear particle accelerator) to perform the services within this scope. The distribution of the providers determines the distance that a patient must travel in order to undergo radiotherapy. The services of radiotherapy, contrary to surgical services, are performed more than once and last for several weeks (3-8), in case of radical radiotherapy, or several days, in case of palliative radiotherapy. This is why any significant distance from the radiotherapy providers may result in a situation when a patient would be less likely to use radiotherapy, and hospitals would be less likely to hospitalise such a patient (because of reasons not related to the actual health of a patient).

[50] Radiotherapy in this context means external beam radiotherapy (EBRT).

Researchers have shown the correlation between the distance from the nearest radiotherapy provider and the access to services. The influence of distance (measured by travel time) on the use was shown, among others, by Pagano et al. (2007) with the example of the Italian region of Piedmont. The influence of distance on quality can be measured by using the measure of outcome, that is, the survival rate. Baade et al. studying two- and five-year survival since the diagnosis of malignant neoplasm of large intestine in the Australian state of Queensland, showed that, *ceteris paribus*, together with the increase of distance to the radiation therapy provider, the survival rate decreases. For example, people living less than 50 kilometres from a hospital, in which radiation therapy services were performed, had 78% two-year survival, and people living more than 400 kilometres from such a hospital – 73%.

To determine if similar correlations also concern Poland, the analysis of correlations (on the level of poviats) was made between a distance of a given poviat from the nearest linear particle accelerator and the rate of using radiotherapy and the rate of using hospitalisation among patients treated with radiotherapy (according to data from 2012). The distance between poviats was measured in a straight line between poviat towns, and if in a given poviat in 2012 there was an entity with linear particle accelerator, the distance for this poviat was zero. Moreover, in case of some poviats (e.g. wrocławski, gdański), in which the local authorities are placed in the nearby cities with poviat rights, the distance was calculated from the largest town of that poviat. The term *the rate of the use of radiotherapy* shall be understood as the number of radiotherapy services (both radical and palliative) performed on inhabitants of a given poviat per 100 patients from the poviat, on whom oncology services were performed in 2012[51]. The term *the rate of the use of hospitalisation for radiotherapy* shall be understood as the number of man-days of hospitalisation for radiotherapy per patient from a given poviat, to whom oncology services were provided in 2012. The rate of the use of radiotherapy and the rate of the use of hospitalisation for radiotherapy were standardised due to the voivodeship's type and the stage of neoplasm structure. Standardisation was used in order to eliminate the differences in the disease distribution in each poviat. Radiotherapy is one of the basic treatment methods of oncology patients and it is often used together with surgery and chemotherapy (combined

[51] Usually, the denominator in such rates is the number of new oncology patients. However, because of the fact that it was not always possible to determine the year of the diagnosis of neoplasm, the method discussed above was adopted.

treatment); however, as already mentioned, it is also a long-term service so that its use may heavily depend on availability (more than in case of, for example, surgery). The reason for the analysis of the rate of the use of radiotherapy is to capture the differences in the availability of services within this scope. Assuming that the disease distribution is the same in all poviats (standardisation), the predicted negative correlation between the rate of the use of radiotherapy and the distance from the entity performing services within this scope may suggest that the patients from farther poviats are less frequently treated in accordance with their individual needs. The reason for the analysis of the rate of the use of hospitalisation for radiotherapy is also to capture the differences in availability but in reference to healthcare providers and the public payer. The predicted positive correlation between the rate of the use of hospitalisation for radiotherapy and the distance may suggest that the patients from farther poviats are not hospitalised for medical reasons, which in turn unnecessarily increases occupancy rate of hospitals and the expenditure on patient care.

The correlation between the distance and the standardised rate of the use of radiotherapy is presented on Figure 3, while the correlation between distance and the standardised rate of the use of hospitalisation for radiotherapy is presented on Figure 4.

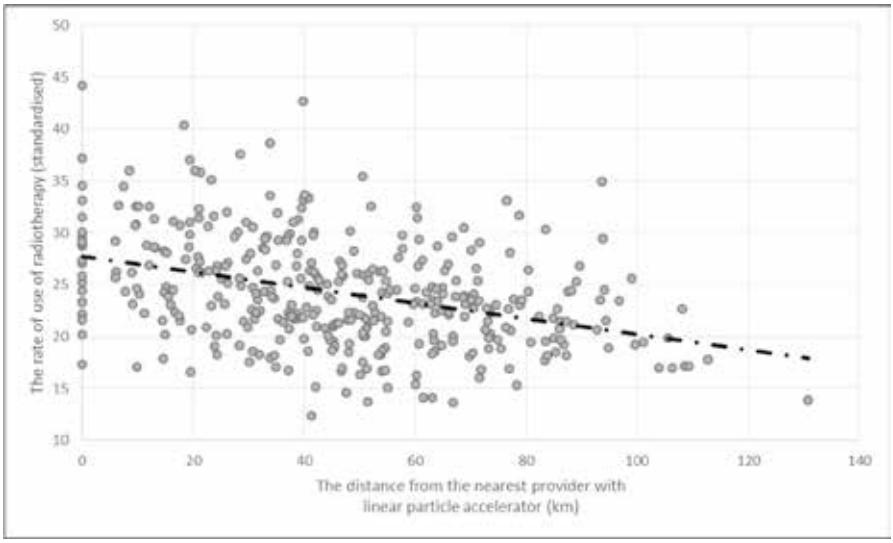

Figure 3. The correlation between the standardised rate of the use of radiotherapy (the number of radiotherapy services per 100 oncology patients) in a poviat and the distance of the poviat from the nearest provider with linear particle accelerator (2012; source: own analysis)

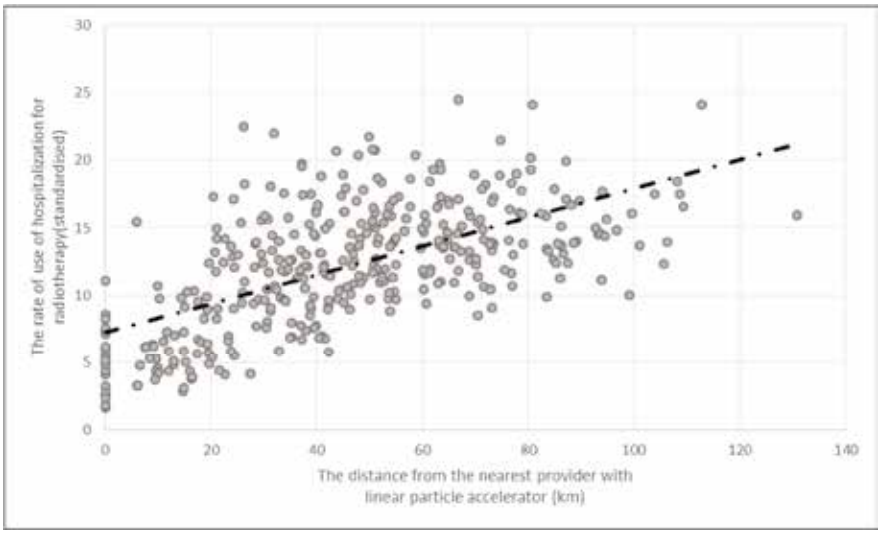

Figure 4. The correlation between the standardised rate of the use of hospitalisation for radiotherapy (the number of man-days of hospitalisation for radiotherapy patient) in a poviat and the distance of the poviat from the nearest provider with linear particle accelerator (2012; source: own analysis)

The analysis of Figures 3 and 4 suggests two correlations. Firstly, the number of radiotherapy services is negatively correlated with the distance from a given poviat to the nearest accelerator. It means that the farther a patient lives from the nearest accelerator, the less frequently he or she uses radiotherapy services. Secondly, there is a positive correlation between the distance from the nearest accelerator and the rate of the use of hospitalisation for radiotherapy. In other words, the farther a patient lives from the accelerator, the more days he or she is hospitalised for radiotherapy services. The rates of discussed correlations are presented in Table 1.

Table 1. The rates of correlation between the distance from a poviat to the nearest provider with linear particle accelerator and the standardised rates of the use of radiotherapy and hospitalisation for radiotherapy (2012; source: own analysis)

	Correlation rate		
	Pearson	Spearman	Tau Kendall
The rate of the use of radiotherapy	-0.38	-0.38	-0.22
The rate of the use of hospitalisation for radiotherapy	0.62	0.62	0.44

The correlations discussed above suggest that structure quality measure, that is, the distance to the radiotherapy provider is correlated with process quality measures, that is, the rates of the use of radiotherapy and hospitalisation for radiotherapy. Because of that, the condition of distance may be used to determine the location of new entities performing radiotherapy services to assure better availability to this type of therapy, and to decrease unnecessary costs of hospitalisations for non-medical reasons borne by the public payer.

In a separate analysis, the rates of the use of radiotherapy and hospitalisation for radiotherapy in respect of the distance and age groups are presented in Figures 5 and 6. The poviats in which linear particle accelerators were located in 2012 (and whose distance was 0) were highlighted, and the rest of poviats was divided into 4 groups using distance quartiles (in the group of poviats with distance of more than 0) as the thresholds. The rates were standardised by to the type and stage of neoplasm in each age group (i.e. in each of the age group, the correlations were calculated by the distribution of the types and stages characteristic for a given group). This is the reason why the rates between age groups are not directly comparable. The figures 5 and 6 show that the correlations presented earlier are also present in all age groups (0–44, 45–54, 55–64, 75–84, 85+). In case of the radiotherapy rate another regularity can be observed, which was not captured on Figure 3. Namely, the highest utilisation rate was not a characteristic of the patients from the cities, in which the radiotherapy providers were located, but instead the highest rates were observed in patients from the poviats located closest to these cities (i.e. located 6-23.7 km from these cities).

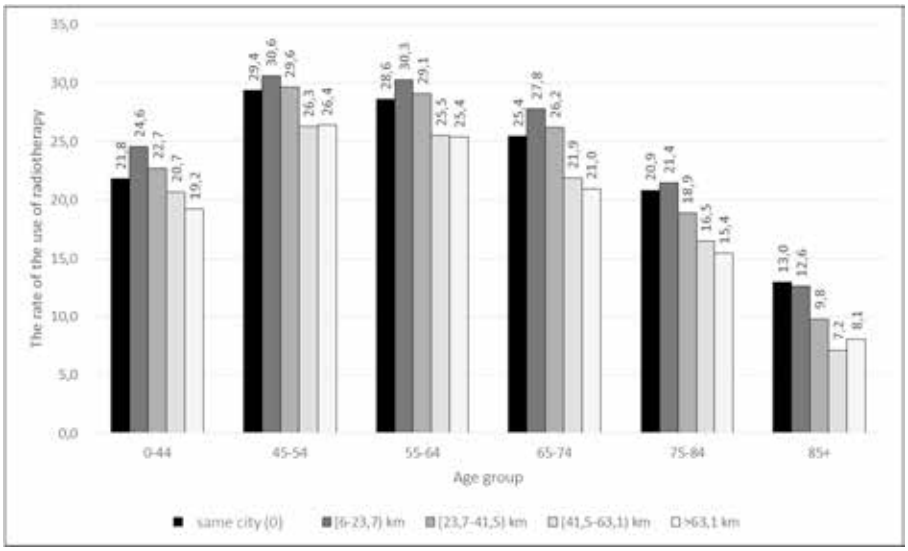

Figure 5. Standardised rates of the use of radiotherapy in age groups regarding the distance (2012; source: own analysis)

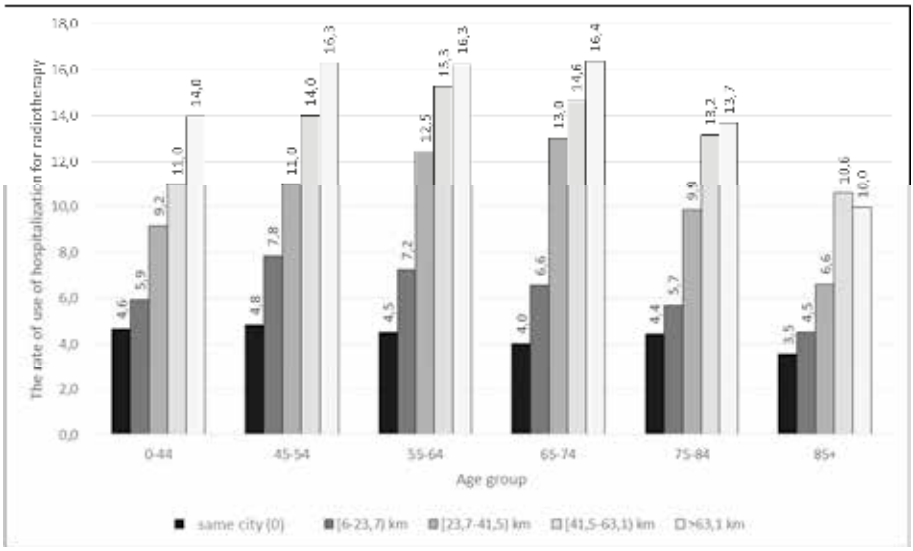

Figure 6. Standardised rates of the use of hospitalisation for radiotherapy in age groups regarding the distance (2012; source: own analysis)

The examples of quality measures in cardiology

The influence of the number of procedures on mortality

Similar to oncology services, it may also be assumed that there is a correlation between the number of cardiology treatments performed annually by a healthcare provider (*hospital volume)* and the quality of these treatments.

In order to determine if in case of cardiology procedures in Poland there is a correlation between the number of services performed by a healthcare provider and operative mortality of patients suffering from acute coronary syndromes (ACS) was compared. Two patient groups were distinguished – the patients who underwent percutaneous coronary intervention (PCI), and the patients who underwent coronary artery bypass graft (CABG).

In the study, the database of the National Health Fund for years 2011-2013 was used. The patients who were diagnosed with ACS were selected from the database. These patients were divided into three diagnostic groups: unstable angina (UA), ST elevation myocardial infarction (STEMI), and no ST elevation myocardial infarction (NSTEMI)[52]:

- Unstable angina (UA)
  - I20.0 – unstable angina
- ST elevation myocardial infarction (STEMI)
  - I21.0 – acute transmural myocardial infarction of anterior wall
  - I21.1 – acute transmural myocardial infarction of inferior wall
  - I21.2 – acute transmural myocardial infarction of other sites
  - I21.3 – acute transmural myocardial infarction of unspecified site
- No ST elevation myocardial infarction (NSTEMI)
  - I21.4 – acute subendocardial myocardial infarction
  - I21.9 – acute myocardial infarction, unspecified

From the aforementioned patients, the ones who underwent UA or CABG in years 2011-2013 were selected. Healthcare providers were divided into four groups based on the number of services performed on an annual basis for both of these treatments. Three thresholds were established for PCI: 240, 500 and 700, which correspond to the levels of complexity in Poland.

[52] The codes of International Classification of Diseases ICD-10 (icd10.pl).

For CABG, due to the lack of such guidelines, the established thresholds divide healthcare providers into four groups in such a way that the hospitals in each group performed the same number of CABG on the patients suffering from ACS. The values are: 170, 330 and 500[53].

For all three diagnostic groups and four groups of healthcare providers, the calculations were made for operative mortality rate defined as the percentage of patients who died before discharge from a hospital or within 30 days of approximate date of treatment (the date of first contact according to the National Health Fund). The mortality rates in all diagnosis groups were standardised by age group and sex, as was done in case of oncology services. The use of standardised rates assures a better comparability of calculated values between groups of healthcare providers.

The calculated standardised mortality rates for PCIs are presented on Figure 7, and on Figure 8 for CABG. The actual mortality rates are presented under the diagnoses (for all healthcare provider groups).

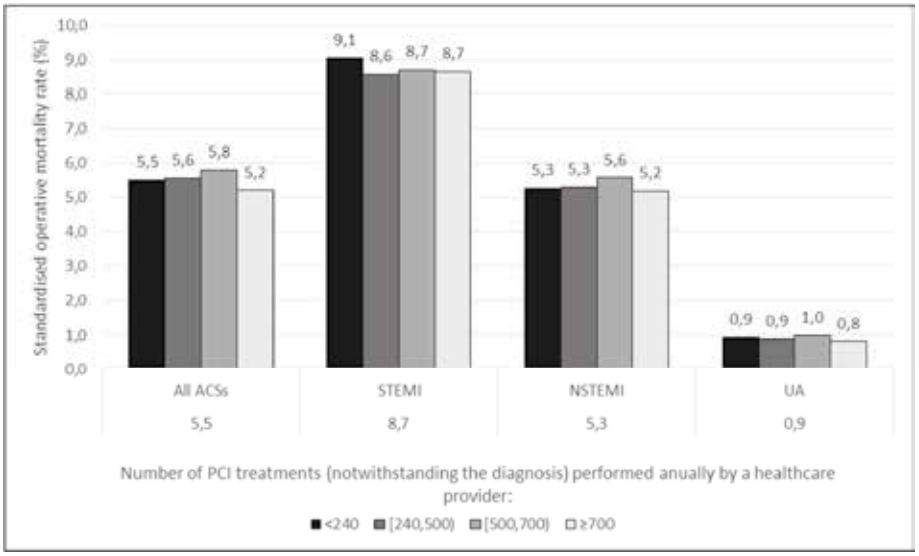

Figure 7. Standardised operative mortality rates for PCIs in selected groups of ACS diagnoses in reference to the number of treatments in a given group performed by a healthcare provider on an annual average (2011-2013; source: own analysis)

[53] In each diagnosis group, the same group division was used, that, is, the division due to the number of treatments performed on all patients suffering from ACS, and not only on the patients with a given diagnosis.

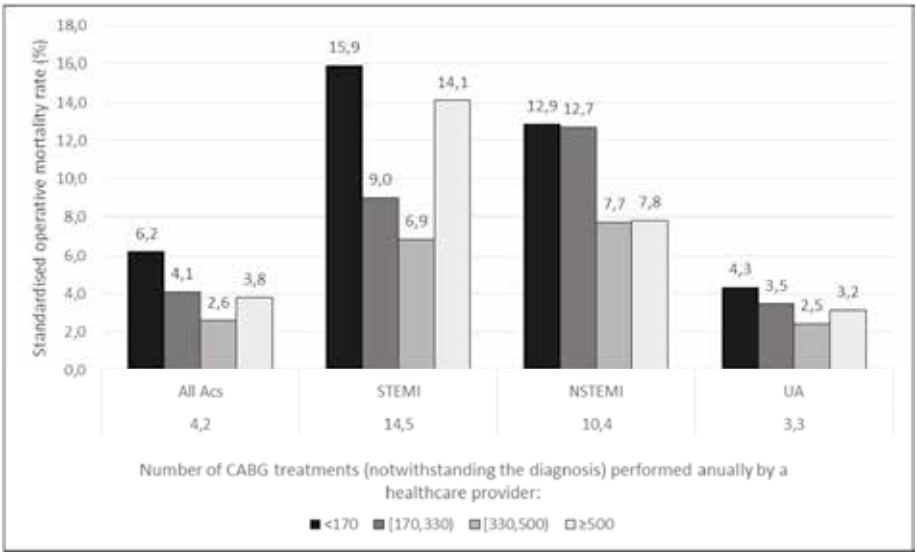

Figure 8. Standardised operative mortality rates for CABG in selected groups of ACS diagnoses in reference to the number of treatments in a given group performed by a healthcare provider on an annual average (2011-2013; source: own analysis)

The results of the analysis show that process/input quality measure, that is, the number PCI services performed on the patients diagnosed with ACS, may not be a significant predictor of the outcome shown by a healthcare provider. It appears that in case of PCIs, operative mortality, standardised by the structure of age and sex, is similar in all healthcare providers groups, notwithstanding the diagnosis. The highest mortality rate in years 2011-2013 was reported in the diagnosis of STEMI (8.7%), then NSTEMI (5.3%), and lastly UA (0.9%). The mortality rate without the division of diagnosis was, on average, 5.5%.

In case of CABG, it may be observed that in hospitals, which in years 2011-2013 performed 330 and more CABG treatments per annum (that is, in two groups of the highest *hospital volume*), the mortality rate was the lowest. Thus, it may be suggested that there is a correlation between the number of performed services and mortality. However, it should be noted that not in all diagnoses the relation could be described in such simple manner (i.e. the more treatments, the lower mortality). In case of STEMI, which is characterised by the

highest mortality, a high mortality was reported in the fourth healthcare provider group (>500 treatments)[54].

Another possibility of examining the correlation between *hospital volume* and mortality is the analysis of each healthcare providers, and not their groups. This is the reason why the standardised (regarding age, sex and the diagnoses: UA, STEMI, and NSTEMI) mortality rates after PCI and CABG treatments were calculated. Due to the fact that the standardisation may distort the results for small providers, the analysis concerned only the healthcare providers who performed more than 100 PCI treatments and more than 50 CABG treatments on an annual basis. Different cut-off values were used due to the number of each treatment performed on patients with ACS (in years 2011-2013, the total was about 217,000 PCIs and 13,000 CABGs). The results are presented on Figures 9 and 10. The correlation rates between the number of appropriate treatments on an annual basis and the standardised post-operation mortality rate is presented in Table 2.

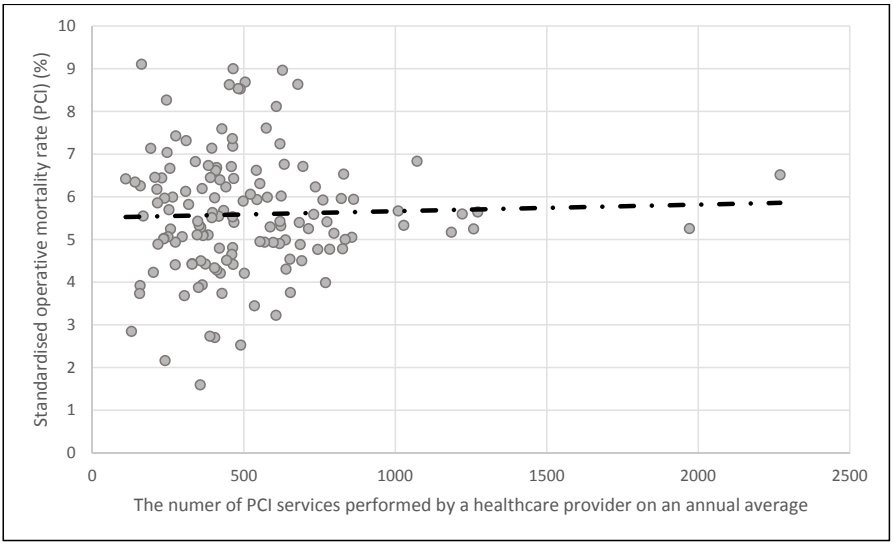

Figure 9. Standardised operative mortality rates after PCI treatment due to the number of treatments performed by a healthcare provider on an annual average (2011-2013; source: own analysis)

[54] It may result from small number of the analysed treatments. In years 2011-2013, the patients with ACS underwent 13,000 CABG treatments: the patients with UA – 11,600; the patients with NSTEMI – 1,000; and the patients with STEMI – only 400.

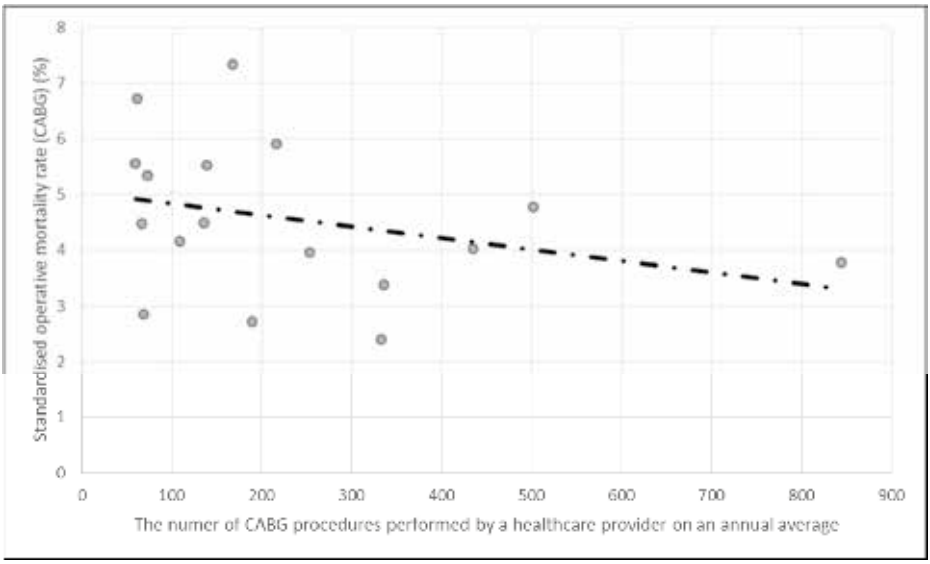

Figure 10. Standardised mortality rates after CABG treatment due to the number of treatments performed by a healthcare provider on an annual average (2011-2013; source: own analysis)

Table 2. The correlation rates between the number of PCI and CABG treatments on an annual average and the standardised operative mortality rates for these treatments (2012-2013; source: own analysis)

	Correlation rate with the number of treatments		
	Pearson	Spearman	Tau Kendall
PCI	0.03	0.02	0.02
CABG	-0.31	-0.4	-0.25

As it can be seen in case of PCI, the mortality rate is not correlated with the number of services performed by the provider. This result puts into question the requirements concerning the level of complexity (reference level) for interventional cardiology labs in Poland[55]. However, it should be noted that there is a negative correlation between the number of services and

[55] It should be, however, noted that, firstly, this method of analysis does not concern many significant parameters influencing mortality (e.g. the number of services per surgeon and comorbidities), secondly, mortality is only one of important outcome quality measure, and thirdly, the analysis concerned only patients with ACS.

mortality in case of CABG. It means that it may be expected that in case of CABG the number of procedures may be a significant predictor of mortality (i.e. quality).

The results of conducted analysis overlap to some extent the results of earlier studies on the relation of the number of services with mortality in cases of cardiology treatments. In the aforementioned study of Birkmeyer et al. (2003), it was determined that *ceteris paribus*, in case of carotid endarterectomy, aortic-valve replacement, coronary-artery bypass grafts and elective repair of an abdominal aortic aneurysm the number of treatments performed by a healthcare provider significantly affects operative mortality only when the number of treatments performed by each surgeon (*surgeon volume*) is not taken into account. Also Peterson et al. (2004) state, on the basis of American *STS National Cardiac Database*, that the number of procedures performed by a given provider is connected with mortality to little extent and cannot be an adequate quality measure of CABG treatments. In case of Poland, unfortunately, there was no possibility of capturing the influence of this variable. To determine if the relations found for PCI and CABG are, indeed, significant, and not only result from the fact the more experienced (performing more treatments annually) surgeons operate in the largest providers, *surgeon volume* should also be taken into account in the analysis. However, it was impossible due to the incompleteness of data and lack of credible data concerning operating surgeons in the National Health Fund database.

The influence of cardiac rehabilitation on mortality

One of the types of process quality measures is the rate and the structure of treatments and procedures performed on patients. They can help to determine significant correlations between how the patient was treated (i.e. which treatments/procedures he or she underwent) and his or her health. The example of such correlation in cardiology may be the influence of cardiac rehabilitation on patient's ensuing health.

As showed in many studies, the fact of undergoing cardiac rehabilitation significantly decreases the probability of death of patients with coronary artery disease (CAD). O'Connor et al. (1989), studying the influence of cardiac rehabilitation on mortality basing on the group of about 4,500 patients after myocardial infarction from the U.S., concluded that cardiac rehabilitation may decrease a three-year mortality of post-infarction patient by 20%. Similar results were presented by Suaya et al. (2009), who calculated on the basis of Medicare

programme data the correlation between mortality and rehabilitation of patients with CAD at the age of 65+. They state that cardiac rehabilitation in such group results in the decrease of a five-year mortality by 21-34% (depending on the method of analysis).

In order to determine if such a correlation also exists in Poland, a four-year mortality of patients with ACS, who underwent PCI in 2010, was examined depending on age and diagnosis (UA, STEMI, NSTEMI – defined as before). The study was based on the National Health Fund database. Only patients who were discharged from a hospital alive were taken into account. If a given patient underwent more than one PCI treatment in 2010, only the first treatment was taken into account in the four-year mortality analysis. A patient was qualified to the group that underwent rehabilitation if he or she used cardiac rehabilitation at least once within 90 days from PCI treatment. To assure comparability of mortality rates of patients from rehabilitation group and a group without rehabilitation, the analysis concerned only patients who survived 90 days from the first PCI treatment in 2010. The assumptions of conducted analysis are similar to those of Goel et al. (2015).

The results of the proposed analysis depending on diagnosis and age group are presented on Figures 11 and 12 respectively. The number of patients in each group, the share of patients from a given group, which used cardiac rehabilitation within 90 from the treatment, mortality rates in rehabilitation groups and groups without rehabilitation, and the differences between a four-year mortality rate in rehabilitation groups and a four-year mortality rate in groups without rehabilitation are presented on Table 3.

Figures 11 and 12 suggest that in each diagnosis and in every age group mortality was significantly higher among patients who did not undergo rehabilitation than mortality in rehabilitation groups (notwithstanding the number of months after the treatment). It may be also observed that mortality in all patient groups has approximately an uniform distribution, that is, the dependence between the number of months after PCI and mortality is linear. Among all patients, the ones with STEMI underwent rehabilitation most often, and the ones with UA the least often (in all age groups). It may also be observed that older people use cardiac rehabilitation less often. The share of patients with rehabilitation is negatively correlated with patient's age in all diagnoses. Rehabilitation seems to have the most impact on mortality in the diagnosis of STEMI. However, notwithstanding the diagnosis, in all subsets

consisting of a diagnosis and age group, mortality in the group without rehabilitation is at least 30% higher than in the rehabilitation group.

The analysis also indicates a possible correlation between mortality and the fact of undergoing rehabilitation among patients who underwent PCI treatment. It is, thus, justified to perform cardiac rehabilitation after PCI treatments more often and to more frequently rehabilitate elderly people, few of whom use this type of services and where there is also a lower mortality among the rehabilitated. Of course, it cannot be ruled out that the differences in rates do not result from the fact of using rehabilitation services but from the structure of patients undergoing rehabilitation and patients who do not undergo rehabilitation (e.g. due to sex, disease type, comorbidities, the place of service, etc.). However, the study is a good motivation to the attempt of determining the significance of the influence of rehabilitation on mortality and, as a consequence, to positive changes in the healthcare system.

Table 3. The mortality rates after four years from PCI treatment for 2010 cohort (source: own analysis)

Diagnosis	Age group	Number of patients	Patients with rehabilitation (%)	Mortality (%) among patients without rehabilitation	Mortality (%) among patients with rehabilitation	Difference in pp	Difference in %
Total	Total	58 875	19,7	16,8	8,3	8,5	102,4
	0-54	11 012	28,5	6,0	3,3	2,8	83,8
	55-64	19 131	23,4	10,5	6,2	4,4	71,0
	65-74	14 844	17,2	17,0	11,2	5,9	52,4
	75+	13 888	10,5	30,8	20,7	10,1	48,9
UA	Total	14 647	8,7	13,3	8,8	4,5	51,8
	0-54	2 097	11,1	5,3	4,3	1,0	23,8
	55-64	4 818	9,7	8,6	6,7	2,0	29,5
	65-74	4 387	8,2	13,7	10,0	3,7	36,7
	75+	3 345	6,3	24,0	16,2	7,8	48,2
STEMI	Total	28 089	25,8	16,9	7,6	9,3	123,2
	0-54	6 378	34,9	5,7	3,2	2,4	75,4
	55-64	9 384	30,1	10,4	5,8	4,6	80,2
	65-74	6 310	23,3	18,4	10,6	7,8	73,9
	75+	6 017	12,4	32,5	21,5	11,0	51,3
NSTEMI	Total	16 139	19,1	20,2	9,8	10,4	106,0
	0-54	2 537	26,9	7,5	3,1	4,5	145,1
	55-64	4 929	23,9	12,9	6,9	6,1	88,5
	65-74	4 147	17,6	19,1	13,0	6,1	46,8
	75+	4 526	11,0	33,7	21,3	12,4	58,4

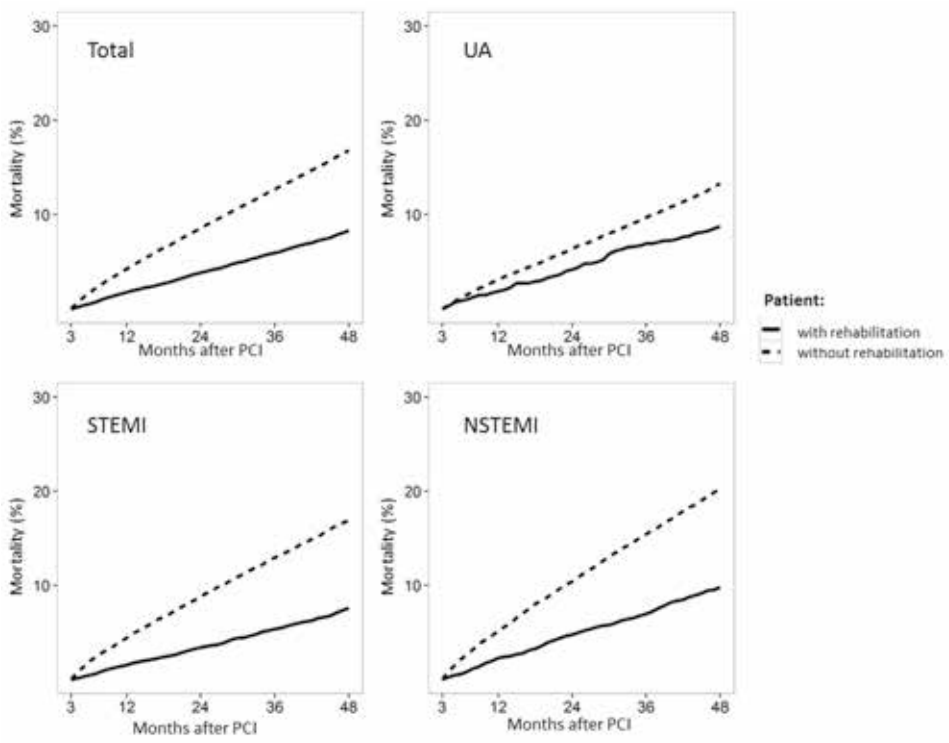

Figure 11. Mortality within 4 years since PCI in rehabilitation groups and groups without rehabilitation depending on a diagnose (source: own analysis)

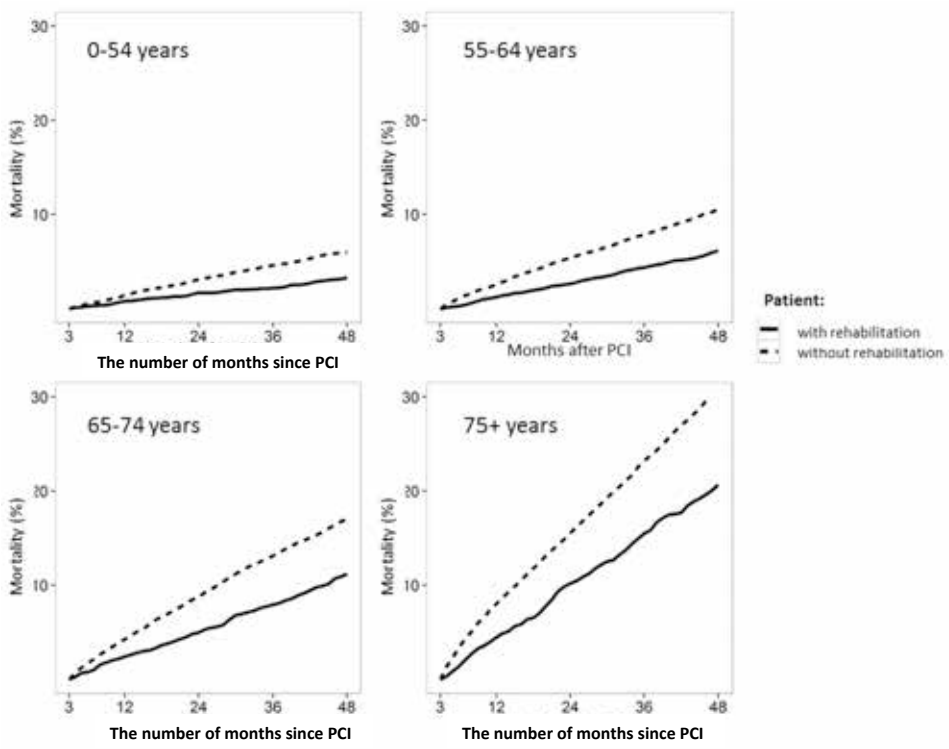

Figure 12. Mortality within 4 years since PCI in rehabilitation groups and groups without rehabilitation depending on age group (source: own analysis)

Summary

This chapter presented quality measures in healthcare system and the division of these measures into structure (input), process (output) and outcome quality measures. The possible correlations between these rates in Poland with the examples in oncology and cardiology were also presented. The measures were selected due to their common application, availability of data and literature, as well as simplicity of interpretation. The preliminary correlations should motivate a further look for well-determined quality measures in Polish healthcare system, create measurable (i.e. which can be applied in the results) requirements and directives for healthcare providers (doctors), and to create integrated and developed databases on healthcare in Poland. Such databases could help identify further dependencies and, in the case

of statistical significance of these dependencies, make attempts to achieve better treatment results in Poland through the organisational and financial changes in the healthcare system.

The growing medical needs of Poles constitute a big challenge for public medical services; even more so if the reversal of the trend concerning a part of gross domestic product (GDP) devoted to healthcare in developed countries would be taken into account. Until 2009, the share of expenses on healthcare (HCE) increased in relation to GDP (both public and total expenditure) in OECD countries (cf. databank.worldbank.org). This phenomenon has been widely discussed in literature, especially since the share of expenses on healthcare in all expenses on the individual level usually decreases along with the increase of income (e.g. Newhouse 1987; Getzen 2000). Since 2009, it can be observed that there has been a systematic decrease of share of HCE in GDP in most of OECD countries (databank.worldbank.org). The decrease of the healthcare expenditure trend in the presence of an unaltered growth of health demand (caused by, for example, the ageing of population) forces the rationalisation of the use of resources in the system. Properly defined and calculated measures may prove useful for this process.

The most important measures concerning treatment quality should be published and publicly accessible. Currently in Poland, comparing healthcare providers (doctors) is only possible through analysis of comments and opinions published by the patients on the Internet, such comments are obviously subjective. With the access to quality measures (e.g. operative mortality), a patient could decide on undergoing treatment in a given centre, or on visiting a given doctor basing on objective measures. The publication of indicators would increase competitiveness among providers, who would have to promote good values of quality measures in their hospitals, and it would result in the improvement of services.

However, it should be noted that the measure could provide credible information on treatment quality only when the reported data is robust. They should include the largest amount of information about a patient and his or her treatment process. Without full data, there is no possibility of proving the significance of dependencies between indicators. For example, the analysis is not possible if there is no information on the operating surgeon, as mentioned above. Lack of data on an operating surgeon results in inaccurate analysis of influence of the number of services of a given type performed by a healthcare provider on

treatment quality of patients (which was shown by, for example, by Birkmeyer et al. 2003). High credibility of reported data may be achieved only when the process of reporting is subject to careful inspection (e.g. in the form of an audit), and if the healthcare provider is motivated to complete reporting by financial incentives (in the form of award or penalty). Regulations that result in full publication of quality measures, as well as the creation of credible database, should be implemented gradually, so that it would be possible for healthcare providers to adapt to new requirements.

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The demand for health services in oncology and cardiology – the results of prediction model

Barbara Więckowska, Janusz Dagiel, Andrzej Tolarczyk, Beata Koń, Filip Urbański

Introduction

The modelling (and predicting) of phenomena connected with illness is an important element of the analysis of functioning and planning resources in healthcare sector. Predictions, especially in the context of health needs, play a significant part in shaping the health strategies – they allow the determination of the future health situation of population, which results in better adaptation of healthcare stakeholders to the changes taking place in the environment.

The aim of this chapter is to present the original method of predicting the demand for health services, especially the number of medical procedures. Their estimation is a relevant aspect of health policy, giving rise to the assessment of adequacy of the supply side and formulation of optimal health strategies, and, as a consequence – estimation of potential treatment expenses in the public finance sector. The predictions also allow the determination of the level of under financing of healthcare system and point to the possible systemic solutions (the increase in budgets, the lengthening of waiting times and others).

In the first part of the chapter, the concept of the method of predicting services is presented. In the following parts, there is a detailed description of the method of predicting the demand for services in cardiology and oncology diseases (separately). The example predictions achieved with this method are also presented.

The predictions presented in this chapter were developed with the use of reported data from the National Health Fund. In case of oncology, the prediction concerns the specific services from catalogue 1a (appendix to *the Regulation of the President of the National Health Fund on determining the conditions of conclusion and realization of agreements regarding hospital treatment*), excluding radiation therapy, and it includes the prediction of the number of radical surgeries for each malignant neoplasm stream. In cardiology, the prediction is two-way – it concerns the demand for individual procedures (e.g. coronary arteriography or PCIs) and the demand for hospitalisations.

The authors are aware of possible errors within the scope of the diseases studied reported by healthcare providers, caused by the so-called upcoding, i.e. the erroneous coding of a disease entity according to ICD-10 in order to assign a patient to a more expensive diagnosis-related group (DRG). The authors assume that the specialist and cost-intensive procedures (e.g. PCIs in cardiology or radical surgery in oncology), which are the subject of the prediction, are reported correctly in most cases, since it is in the interest of healthcare providers to report them in order to receive funding on an appropriate level. For this reason the authors did not attempt to predict the number of minor diagnostic or treatment services, since the reporting errors may be significantly higher (e.g. in case when during hospitalisation there is a cost-intensive procedure performed, and the cheaper procedures, because of pragmatic reasons, are not reported).

The method of predicting the demand for services

The original method of predicting the demand for services presented in this part of the chapter is shown in a flowchart presented on Figure 1.

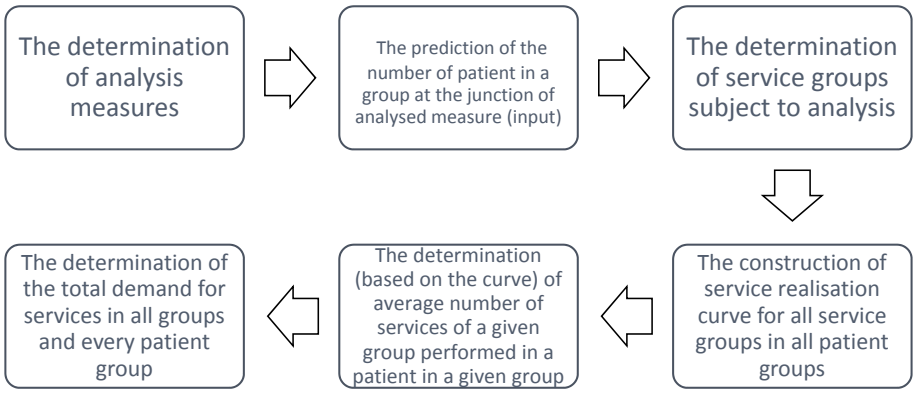

Figure 1. Flowchart depicting subsequent stages of the prediction process (source: own analysis)

A starting point of the presented method is the information on the predicted number of patients. In case of both oncology and cardiology, the prediction of the number of patients took place in two stages. In the first stage, prevalence rates concerning given disease entities or their group were determined. In the second stage, the calculated rates were multiplied

by the predicted population in appropriate areas and thus predicted prevalence concerning individual diseases was shown. It was assumed that the prevalence rates will be stable over time, and only demographic structure will be changing in each region of Poland.

The second stage for both procedures was the same but the determination of prevalence rates was different for cardiology and oncology. The difference in approach was forced by the availability of information in oncology and cardiology diseases. In case of oncology, the main source of information was the National Cancer Register[56] supplemented by the reported data of the National Health Fund. In case of cardiology, the register information concerns only some of the diseases. In Poland, there are 3 medical registers in cardiology: The National Acute Coronary Syndrome Register (PL-ACS)[57], the National Interventional Cardiology Procedures Register (ORPKI)[58] and the National Cardiology Operations Register (KROK)[59].

The prediction of the number of patients, in appropriate section, is, then, multiplied by the rate of the realization of services. Generally, the predicted number of services in a given year is described with the following formula:

$$number\ of\ services_{year} = \sum_{z1 \in Z1} \sum_{z2 \in Z2} \dots \sum_{Zn \in ZN} \sum_{r \in R} p_{z1,z2,..,zn,r} \sum_{t \in T} c_{z1,z2,..,zn,t,(year-r)} \qquad \text{(Formula 1)}$$

where:

$p_{z1,z2,..,zn,r}$ – the predicted number of patients in a given patient group,

year – a year, for which the prediction is prepared,

Z_i – the *i* measure, on which patients group analysis is based,

n – the number of measures in the analysis,

R – the set of years, in which the patients, for whom the services are performed in the year the prediction concerns, start treatment,

$c_{z1,z2,..,zn,t,(year-r)}$ – the rate of the realization of services,

T – the number of analysed services groups.

[56] http://onkologia.org.pl/.
[57] http://pl-acs.pl/.
[58] http://www.orpki.pl/.
[59] http://www.krok.org.pl/.

In the proposed formula, p is the number of patients in a certain multi-measure section. The number of measures depends on the level of detail of the prediction. The measures connected with the same disease entity, e.g. the selected disease group or the stage of disease (which is especially relevant in case of the prediction concerning malignant neoplasms) or connected to the demographic rates, e.g. sex and age group, should be included in the measures, and their inclusion is justified for the prediction process. In order to calculate the number of services, the number of patients included is multiplied by the *c* rate, determined as the rate of the realization of services from group T per a statistical patient from the analysed patient group. The values achieved in such manner are, then, added up for every separate measure.

The rate of the use of services

The rate of the realization of services *c* determines how many times a patient from a given group uses the services from a given group a year. In the calculation method two additional) measures were taken into account (over and above the grouping of patients): the number of years since the beginning of hospital treatment (while the term *the beginning of hospital treatment* shall be understood as the first hospital service characteristic for a given diagnosis, e.g. coronary arteriography or a major operation) and the type of services group.

The aim of the inclusion of the number of years since the beginning of treatment is the fact the patients, within a year of their therapy, may be treated in a different way (the dominance of interventional treatment) than patients who were diagnosed several years back. The use of the measure connected to the type of services group allows the sensitivity analysis of the prediction with the changes in the treatment methods.

Service provision curves

The rate of the use of services is determined by the service provision curve. The definition of a service and the services groups corresponds to the analytic needs within a given patient group. For example, in case of oncology, these were radical surgeries, while in case of cardiology – the procedures of coronary arteriography. Service provision curve determines the number of services performed for patients since the beginning of hospital treatment. Curves are constructed individually for every service group and every selected patient group.

The construction of service provision curve is a multi-stage process. The first step is to create a treatment path for every patient form a given group, i.e. the days, in which the services

from a given group are performed, are determined. This process is presented on Figure 2. On the y-axis, there is the number of provided services, and the date of their provision is on the x-axis. The treatment paths of individual patients are marked by *a*, *b*, *c* and *d*. For example, as Figure 1 shows, the first service was performed for patient *a* on 5 January 2013, and the second on 9 January 2013. In the period between 1 January 2013 and 20 January 2013, 7 services from a given group were performed for patient *a*.

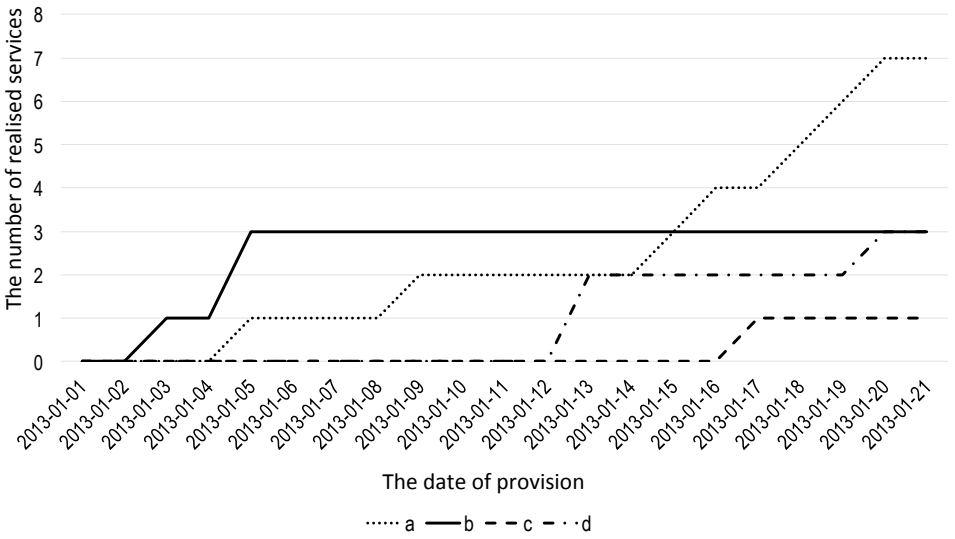

Figure 2. The construction of service provision curve – stage 1 (source: own analysis)

In order to enable the comparison of service provision curves for each patient, the date of the provision of a service was transformed into the relative time, that is, on the number of days since the beginning of hospital treatment. This operation makes the curves start at the origin of coordinate system (cf. Figure 3).

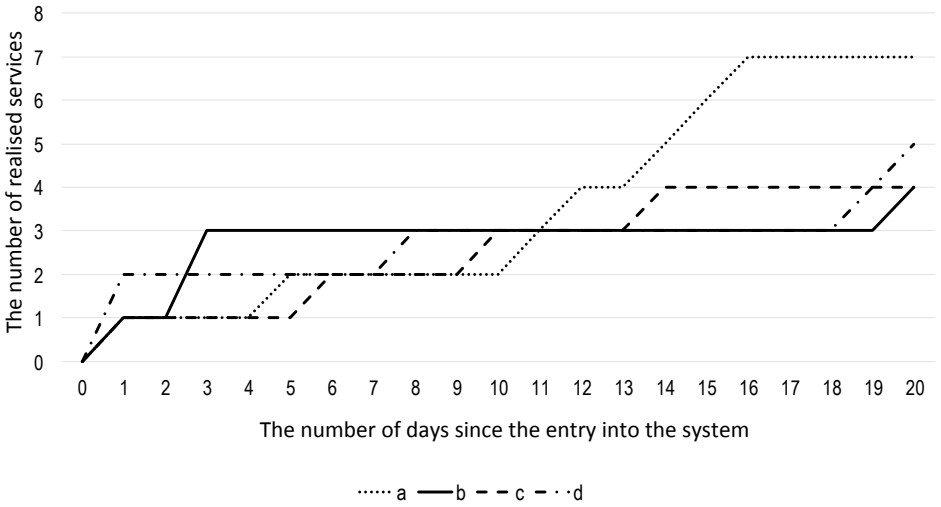

Figure 3. The construction of service provision curve – stage 2 (source: own analysis)

By adding up the individual vertical curves and then scaling the achieved curved by the number of added up individual curves (patients), service provision curve is achieved (cf. Figure 4), which shows how many services, on average, are performed for patients in a certain period since the beginning of hospital treatment.

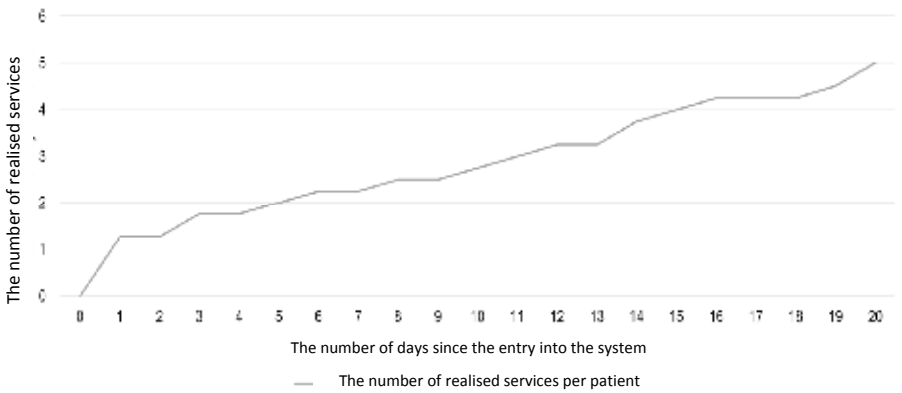

Figure 4. The construction of service provision curve – stage 4 (source: own analysis)

Assuming the example data from Figure 4, it may be stated that three services are performed for a statistical patient within 11 days from the beginning of treatment. The curve constructed in this manner concerns patients who began treatment in a given calendar year. In the prediction process an adjustment should be made to include the patients diagnosed and treated in previous years.

The prediction of the number of services performed in a calendar year

The next stage of the process requires the determining how many services from group T (cf. Formula 1) will be performed for patients from a group on the junction of the analysed measures in a given calendar year. A starting point is the service provision curve presented on Figure 5, which informs how many services form a given group were performed for a statistical patient within a year from the beginning of hospital treatment.

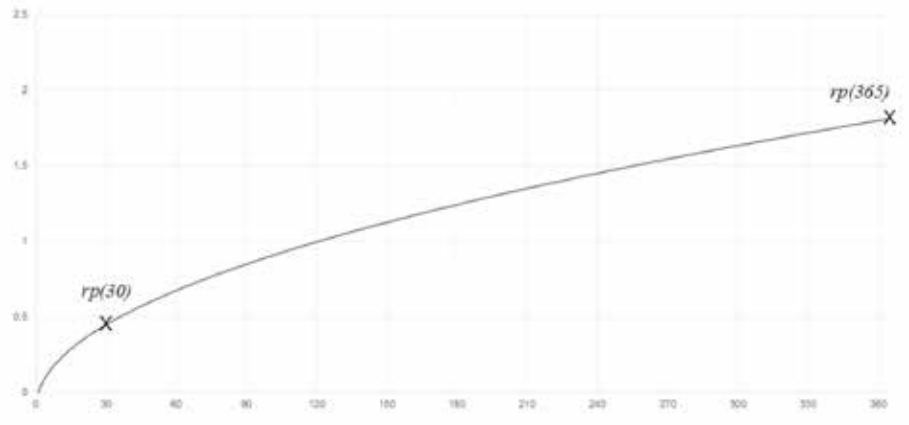

Figure 5. The exemplary service provision curve (source: own analysis)

In the prediction process, it is assumed that the same number of patients enters the system every day. The number of services performed in a given year for patients who enter the system on January 1 is equal to the value from service provision curve for the 365th day of the year (*rp(365)*), multiplied by the number of patients entering the system that day (in accordance to the assumption 1/365 p) – because patients will be present in the system for 365 days. Analogically, the number of services performed in a given year for patients who enter the system on December 2 is equal to the value from service provision curve for the 30th

day of the year (*rp(30)*), multiplied by the number of patients entering the system that day (again – 1/365 p). The total number of services is, thus, determined by the formula:

$$number\ of\ services = \sum_{i=1}^{365} \frac{p}{365} * rp(i) = p * \sum_{i=1}^{365} \frac{rp(i)}{365}$$

The value is thus equal to the number of patients in a given group (the input of the model achieved as a result of the epidemiology prediction), multiplied by the integral of the service provision curve, which was, in this case, brought down to appropriate step function and is interpreted as the average number of services from a given group performed for a patient in a given group.

The prediction of the demand for services in oncology

The predicted incidence of malignant neoplasms in Poland

The predictions conclude neoplasms defined as solid tumours, i.e. all except neoplasms of lymphatic and blood-forming systems, and skin cancer except melanoma (cf. Table 1).

Table 1. The analysed neoplasm groups according to ICD-10 (source: own analysis)

Group		ICD-10 code
Central nervous system		C70, C71, C72
Melanoma		C43
Lower gastrointestinal tract	colon	C18, C19
	rectum and anus	C20, C21
Female genital organs	cervix uteri	C53
	corpus uteri	C54
	ovary	C56
Head and neck	lip	C00
	oral cavity	C01, C02, C03, C04, C05, C06, C09, C10, C14
	parotid gland	C07, C08
	nasal cavity, sinuses	C11, C12, C13, C30, C31
	larynx	C32

Group		ICD-10 code
Upper gastrointestinal tract	oesophagus	C15
	stomach	C16, C26
	liver	C22
	gallbladder	C23, C24
	pancreas	C25
Testicle		C62
Kidney		C64, C65, C66
Urinary bladder		C67
Breast		C50, D05
Lung		C33, C34
Prostate		C61
Thyroid		C73

The data on cancer patients in Poland is registered in the National Cancer Register, and the information on services performed is reported to the National Health Fund[60]. The direct access to the National Cancer Register data is limited to sectional information only, and therefore any cohort analysis is not possible. Moreover, these data may be somewhat underestimated. In the case of the National Health Fund data, the determination of the number of services and patient's path is problematic. Due to the fact that the National Health Fund database is used to financial settling of health services, the data is shown in accordance with the settled products, and not with patients or their groups[61].

The prevalence prediction process consisted of 4 stages:

– the determination of the entry of patient into the system (defined as the date of the first entry into the National Cancer Register with a given diagnosis or the first date of a service in connection with a given neoplasm),

[60] It was assumed that the number of oncology patients in Poland treated exclusively within the scope of private health system is statistically insignificant.

[61] The phenomenon of upcoding (the settlement of patients' services in a more profitable manner in a situation when the payment depends on the diagnose), which is practically present in all healthcare systems should also be noted – European Observatory on Health Systems and Policies Series 2011, 72; Silverman, Skinner 2004, 369–389.

- the determination of the number of patients who entered into the system for the first time in a given year (i.e. as reported in the National Cancer Register or the National Health Fund),
- the analysis of the treatment path of patients (that covers 365 days from the first entry into the system and includes the information on performed procedures according to ICD-9, the use of chemotherapy, radiation therapy, and a possible patient's death),
- the estimation, on the basis of the treatment path, the stage probability of disease for patients who were not entered in the National Cancer Register, or whose stage of disease was not determined in the register.

It is worth mentioning that the second point only defines the potential number of new oncology patients, which is not enough to determine the annual prevalence. In order to determine the stage of disease, it is necessary to analyse the treatment path of a patient individually for every cancer stream. This analysis is also necessary in order to determine the patients whose treatment path is not characteristic of the newly diagnosed oncology patient, i.e. to define the patients whose treatment path indicates the follow-up process, and also those patients with malignant neoplasm diagnosis entered incorrectly (in case of patients not entered the National Cancer Register). The exclusion of these groups of patients allowed us to determine the prevalence based on linked analysis of the National Cancer Register and the National Health Fund data.

The codes D37D48 (neoplasms of uncertain or unknown behaviour) are included in the international statistical classification of diseases and related health problems, however only patients who entered the system with the diagnosis C (or D05) were taken into account in our analysis. This decision is justified by the fact that these codes are used, for instance, to report a service for which results of histopathological examination were unavailable during the reporting. In case when malignant neoplasm is confirmed the patient will come back to the public healthcare system with the malignant neoplasm diagnosis for further treatment or observation and this patient will be taken into account in further analyses). If a patient did not come back to the system with the diagnosis C (cancer), it was assumed that the malignant neoplasm was not confirmed.

On the basis of the National Cancer Register and the National Health Fund data from years 2010-2012, the incidence, which refers to the percentage of patients in a given age

group, who were diagnosed a given type of neoplasm, was determined. The incidence was determined individually for all 24 cancer streams[62] within the division into 6 age groups (0–44, 45–54, 55–64, 65–74, 75–84, 85+) and the stage of disease based on the empirical data from years 2010-2012 as:

$$\frac{number\ of\ cases\ in\ years\ 2010{-}2012}{population\ in\ years\ 2010{-}2012\ (total\ population\ in\ a\ year)}.$$

The method of grouping of cases within the period of 3 years allowed for an increase sample size, and therefore the decrease of random factors. The prediction assumes the constant rate of cancer incidence and is based mainly of the demographic forecast[63]. The results of predictions for years 2015-2016 are presented on Figure 6.

[62] The morbidity in smaller neoplasms groups, included in the group "other" is considered as 6% of all incidents on a national level.

[63] The demographic forecast used in the study was prepared by the Central Statistical Office, http://demografia.stat.gov.pl/bazademografia/Prognoza.aspx

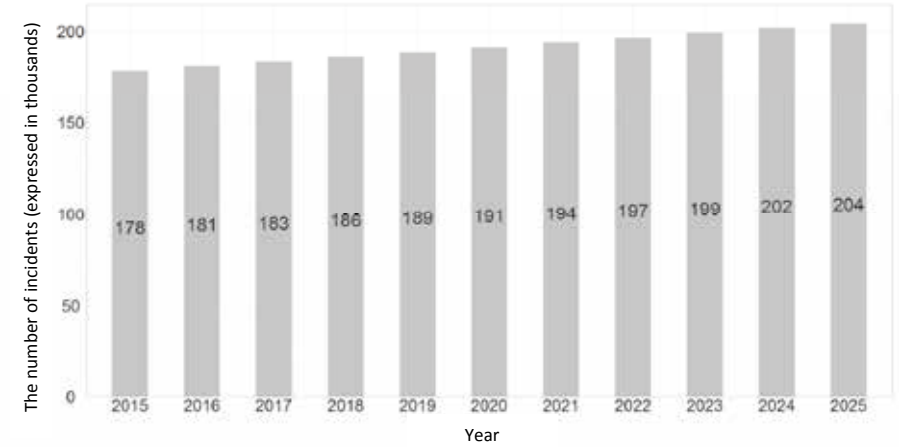

Figure 6. The prediction of cancer incidence in years 2015-2025 (source: own analysis)

In the next two years, the increase of the number of newly diagnosed patients should be anticipated. In 2015, there will be 204,000 new cases of solid tumours. It means that the number of newly diagnosed patients will grow by 14% within the period of 10 years. It should be noted that the method assumes that this increase is caused by the change of the structure of population.

The measures included in the prediction of services in oncology

A starting point of the prediction process if the demand for the oncology services is the patients populations in the groups included in several measures. They were included in the detailed form of Formula 1:

$$expenses_{year} = \mu \sum_{k \in K} \sum_{s \in S} \sum_{w \in W} \sum_{g \in G} \sum_{r \in R} p_{k,s,w,g,r} \sum_{t \in T} c_{k,s,w,g,t,(year-r)} \qquad \text{(Formula 2)}$$

where the analysed measures are:

K – the set of analysed neoplasms groups,

S – the set of analysed stages of neoplasm,

W – the set of analysed voivodeships,

G – the set of analysed age groups.

R and T are defined the same as in Formula 1. Additionally, the correction factor has been introduced . It was introduced due to the fact that the analysis covered the period of 5 years thanks to the availability of data. Thus the need to correct the result of analysis for patients diagnosed 5 or more years before. After a time and the supplementation of data, this factor will lose relevance.

Each given group of analysed cancer streams was treated separately due to different standards of therapeutic management in different types of malignant neoplasms. Moreover, the number of patients in analysed neoplasms groups is subject to demographic changes, especially to the process of ageing of population, to a varying degree. Because different stages of cancer are subject to different types of therapeutic management, it is also necessary to include the stage of disease. Regional specificity, both in the context of demography and the availability of a certain type of treatment, was taken into account in the prediction by including the measure connected to a voivodeship.

For the purpose of the prediction, the following services groups were distinguished:

- surgical procedures (according to ICD-9),
- other hospital services, with a cancer diagnosis,
- other hospital services, without a cancer diagnosis.

Service provision curves were calculated for every group of patients distinguished in accordance with Formula 2 and defined group of services. They are a starting point to determine the average number of services from a given group of services performed for patients in an analysed group of patients. The example service provision curve from the radical surgery group for patients with breast cancer and carcinoma in situ of breast (C50 and D05 according to ICD-10) per stage of disease (I, II, III and IV) is presented on Figure 7.

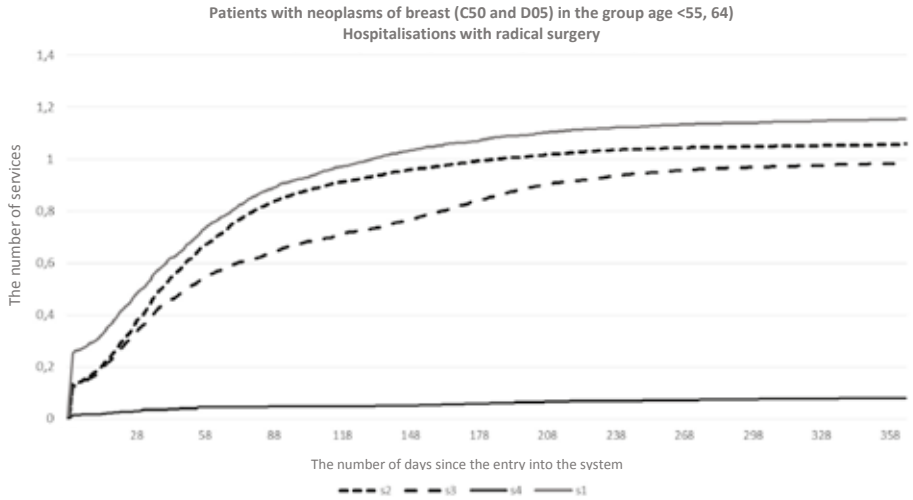

Figure 7. Service provision curves for patients with breast cancer undergoing radical surgery (source: own analysis)

From the curves, it can be observed that the treatment in the form of a radical operation of Stage I disease is implemented immediately after the commencement of treatment. It is depicted by a significant slope of the service provision curve in its initial part, and rapid saturation of the curve.. Radical treatment in Stage II and III is characterised by similar curves within a month from the beginning of the treatment, and then the service provision curve of Stage II approaches the curve of Stage I. It may also be stated that there is more than 1 radical treatment per a statistical patient after a year from the beginning of treatment in Stage I and II, which indicates the presence of reoperation.

The above information as well as the demographic and epidemiological prognoses allowed the prediction of the number of services in every selected group of patients.

The prediction of surgical services in oncology

The prediction of the demand for surgical services in oncology was based on the National Health Fund data concerning this type of treatments performed in years 2009-2014. For every patient cohort, the number and timing of performed radical operations within the measures described in Formula 2 were determined. The classification of treatment in the radical surgery groups was based on the reported surgical procedures according to ICD-9. The list of

procedures according to ICD-9 for selected cancer streams are presented in Appendix 1. Next, a five-year treatment path was determined for the selected cohorts of patients by using the latest available data (the information on treatment methods of patients from previous cohorts were supplemented for the fourth and fifth year of treatment, that is, for patients diagnosed in 2011 and 2010 respectively). The specificity of surgical treatment allows minimising errors resulting from the supplementation of data of radical treatments for the fourth and fifth year of treatment. The prediction of the demand for hospitalisations connected to the performing of radical operation was prepared using the proposed method, including the predictions of prevalence for years 2016, 2018, 2024, and 2029. It was assumed that the patients diagnosed in a given voivodeship will be treated on the territory of this voivodeship; thus, the model determines the demand of the inhabitants of a given voivodeship and it does not predict possible migration of patients. The results of the prediction are presented on Table 2. For comparison, the data concerning the performing of analogous services in 2012 is also included on Table 2.

Table 2. The prediction of demand (expressed in thousands) for hospitalisations with radical surgical treatment in selected neoplasms groups (source: own analysis)

Group of neoplasms	2012 (actual data)	2016	2018	2024	2029
Neoplasms of breast (C50,D05)	17.2	18.9	19.2	20.0	20.85
Neoplasms of large intestine (C18,C19)	7.3	9.3	9.7	10.7	11.6
Neoplasms of kidney and urinary system (C64, C65, C66)	5.8	6.4	6.6	7.0	7.4
Malignant neoplasm of corpus uteri (C54)	4.6	5.9	6.1	6.5	6.8
Neoplasms of rectum and anus (C20, C21)	4.6	5.5	5.7	6.3	6.7

The dynamic change in presented data can be explained primarily by the changes in the demographic structure, because the presented model assumes the stability of the rates of prevalence and treatment methods. Thus the relevance of the sensitivity analysis on possible changes to assumptions should be underlined. For example, the change in the structure of breast cancer stage at diagnosis may significantly affect the results of the prediction, if the percentage of the diagnosed patients with Stage IV disease decreases and for whom radical operations play a minor role. Figure 7).

The prediction of the demand for services in cardiology

The results of prediction of incidence of cardiological diseases in Poland

Similarly to oncology, a starting point to determine the future demand for services within cardiology is the prediction of the number of cases of cardiovascular diseases. This prediction was based on the reported data of the National Health Fund. Appropriate ICD-10 codes were assigned to cardiology disease groups (cf. Table 3), making sure that the groups were not too detailed. Regarding the regional changes in the diagnostic code to the fifth character (local conventions of coding are of major importance), only first 3 characters of the ICD-10 code were taken into account. The first 8 groups presented on the table (rows in bold) cover 90% of cases of cardiology diseases treated in Poland and funded by the National Health Fund.

Table 3. Cardiology diseases groups according to ICD-10 (source: own analysis)

Name	ICD-10
Coronary artery disease	**I20, I21, I24, I25**
Heart failure	**I50**
Atrial fibrillation and flutter	**I48**
Other conditions of cardiac arrhythmia	**I44-I47, I49**
Cardiomyopathies	**I42, I43**
Congenital heart defect	**Q20-Q26**
Acquired heart defect	**I05-I09, I34-I37**
Pulmonary embolism	**I26**
Endocarditis	I33, I38, I39
Pericardium diseases	I30-I32
Other pulmonary vascular diseases	I27, I28
Aortic aneurism	I71
Myocarditis	I40,I41
Rheumatic heart disease	I00-I02
Other cardiovascular diseases (unspecified, unclassified)	I51,I52

In case of cardiology patients, a new patient is defined for years 2011-2013 on the basis of the National Health Fund data from years 2009-2014. There is a possibility to analyse the history of a patient at least 2 years back and a year in the future, while a patient who enters the reporting system of the National Health Fund within this period is recognized as new if the

health services performed for this patient with a given diagnosis were reported for the first time. The patients who entered a specialist outpatient care for the first time with the diagnoses *myocardial infarction* and *pulmonary embolism* were excluded from the analysis as it was assumed that the visit in a specialist outpatient care with such diagnosis is a continuation of the hospital treatment process. These acute disease entities cannot be treated in ambulatory conditions.

In order to include the influence of demographic changes on appropriate morbidity rates, the following sections were distinguished:

- city/village – the classification based on the last figure of the TERYT code of the address of a patient, in accordance with the Council of Ministers Regulation[64] of December 15 1998,
- age, within the division on the following age groups: (0–44, 45–54, 55–64, 65–74, 75–84 and 85+) and
- sex.

A total of 28 separate patient groups were selected, for which the incidence rates were calculated for years 2015-2025. It was assumed that the values of incidence rate are stable over time, thus the estimations are based mainly on the demography prognosis. Moreover, it was assumed that there would be no influence of medical progress on the incidence of cardiology diseases. It was also assumed that there would be no changes in population's behaviour, which could affect the exposure on the risk factor of cardiology diseases.

According to our estimations there will be an increase of the number of new cardiology patients in the upcoming years,. There will be 377,000 patients suffering from at least one cardiology disease in 2015 (cf. Figure 8) and 426,000 such patients in 2025.

[64] The Council of Ministers Regulation of December 15 1998 on the detailed rules of keeping, using and sharing the national register of the land territory division, and the obligations of government administration authorities and local self-government entities. (Journal of Laws 1998, No. 157, item 1031).

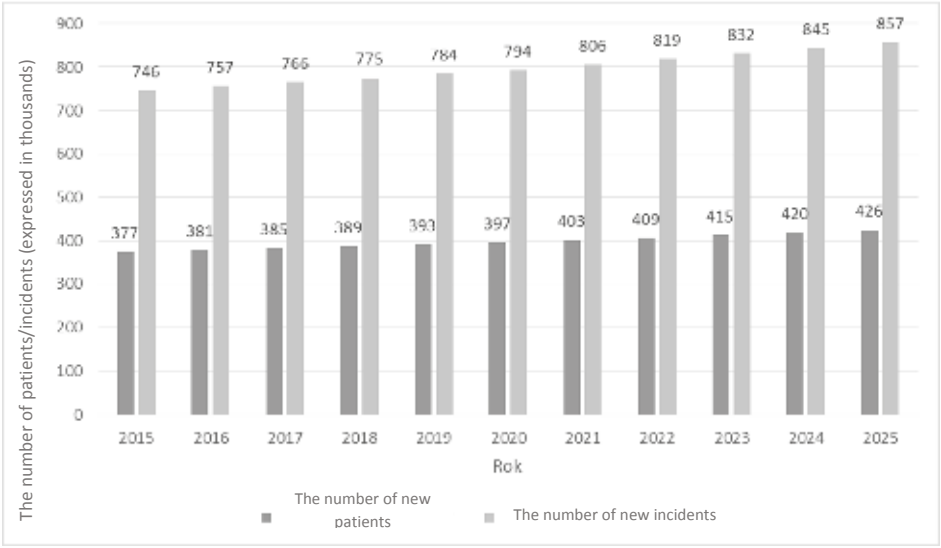

Figure 8. The prediction of total cases of cardiology diseases in years 2015-2025 (source: own analysis)

The dimensions included in the cardiology forecasts

Forecasting the demand for service in cardiology required a two-way approach due to the fact that cardiology is characterised by multiple co-morbidities and the use of multiple procedures as part of individual hospital treatment. A separate forecast was made to determine the demand for specific medical procedures recognized as essential (which in turn affects the workload forecasts, e.g. for hemodynamic laboratories or electrotherapy), and a separate one for hospitalizations and specific billing products of the National Health Fund.

The formula specifying the number of benefits, as shown in the previous part of this chapter, in case of cardiology, is as follows:

$$expense_{year} = \mu \sum_{k \in K} \sum_{s \in S} \sum_{w \in W} \sum_{g \in G} \sum_{z \in Z} \sum_{r \in R} p_{k,s,w,g,z,r} \sum_{t \in T} c_{k,s,w,g,z,t,(2016-r)} \quad \text{(Formula 3)}$$

where the dimensions analysed are the following:

K – a set of diseases subject to analysis,

S – patient's sex,

W – regions subject to analysis,

G – a set of analysed age groups,

Z – patient's place of residence – city/town or rural area.

R and T defined as in Formula 1. In addition, as in the oncology forecast, the analysis took into account the adjustment factor. In the above formula, p stands for the number of patients:

- treated for a specific cardiovascular group of diseases,
- of a given sex,
- treated in a given region,
- of a specific age group,
- of a given place of residence (rural area or city/town),
- treated in a given year.

The forecast for cardiology services distinguished more dimensions than in the oncology forecast. For instance, this forecast includes the dimension related to a given group of diseases, as various cardiovascular conditions may be subject to demographic and epidemiological factors to varying degrees. The forecast also took into account the possible demographic and epidemiological changes related to patients' sex and place of residence. In turn, the differentiation of patients in terms of regions where they are treated is to take into account the demographic diversity and the diversity of available treatment methods. Taking into account the dimension associated with the age groups reflects changes in the age pyramid, and in particular the ageing process in the population.

In order to estimate the number of services, the number of patients calculated as per the above section is multiplied by the service utilisation ratio *c*. The values thus obtained, in accordance with Formula 3, are then summed up within each of the isolated dimensions. For the purposes of this study, the following groups of services related to specific procedures have been selected:

– coronary angiography,

– percutaneous coronary interventions (PCI),

– cardiac pacemaker implantation or replacement/CRT/ICD,

– electrophysiology study (EPS),

– ablation,

– coronary artery bypass grafting (CABG),

– transcatheter aortic valve implantation,

– valve surgeries.

With regard to hospitalization forecasts, surgical hospitalisations and medical treatment hospitalisations were separated, and the adopted methodology takes into account the use of a number of procedures as part of a single hospitalization.

Estimation of the number of coronary angiographies performed

In the next step, as in the case of oncology services, each of the separate patient groups and service categories was assigned with service provision curves. However, the authors encountered a serious problem with the design of the coronary angiography curve (Figure 9). Coronary angiography is a procedure that allows for the classification of patients into different types of treatments (e.g. percutaneous coronary interventions or coronary artery bypass grafting). The specific nature of the system of service reporting to the National Health Fund gives rise to situations where an entity reports the performance of a treatment indicating a previous coronary angiography, yet it does not report the procedure explicitly as a performance of coronary angiography. In such situations, it was assumed that coronary angiography was performed, and its date matches the date of the first procedure requiring prior coronary angiography. Appendix 2 contains a list of ICD-9 procedures, in the performance of which it is assumed that coronary angiography was performed earlier.

The service curves were then used to estimate the average number of services provided to patients from the start of treatment. They are also a useful tool for comparing treatment methods in individual regions (cf. Figure 9). For instance, one may see which regions provide on average more services of a specific type, or observe the differences in the intensity of the provision of services over time.

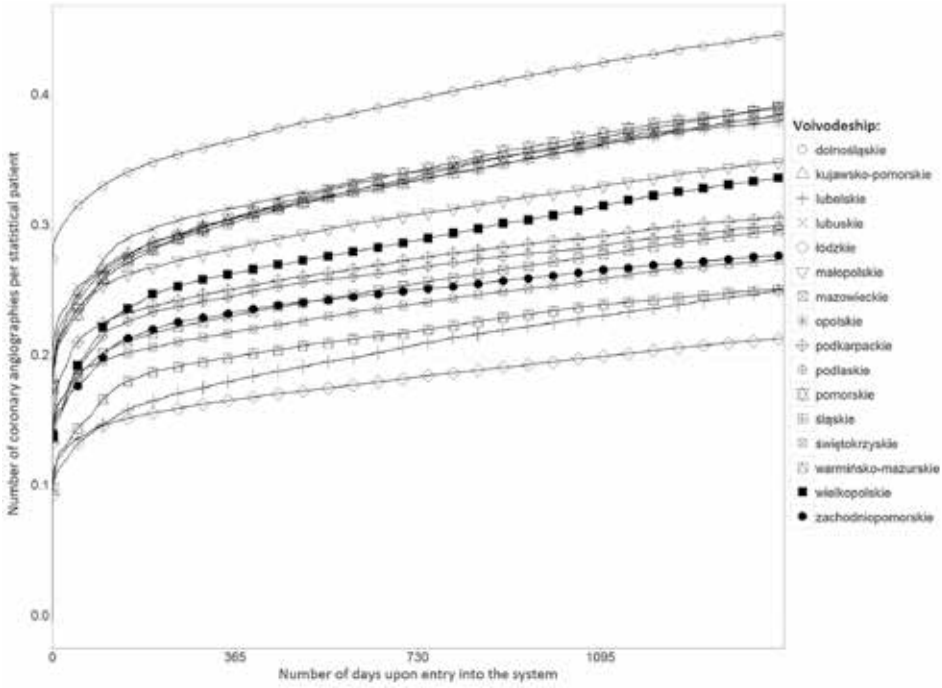

Figure 9. Coronary angiography curves for patients with cardiac diagnoses by regions in 2013 (source: own analysis)

Cardiology service forecast

Cardiac diseases taken into account in the forecast with specific ICD-10 codes are presented in Table 2. The design of the procedure and hospitalisation model was based on relevant data from the National Health Fund for the period 2010-2013, specifying the number and timing of the realized services for each cohort (according to ICD-9) by predefined dimensions. Then, for the isolated cohorts of patients, a 5-year treatment path was determined based on the latest data available. For the 4th and 5th year of treatment, information was complemented with data on treatment methods for patients from earlier cohorts, i.e. patients diagnosed in 2011 and 2010, respectively. The results of forecasts of demand for medical procedures and hospitalisations for the years 2016, 2018, 2024, 2029 are presented in Table 4. For comparison, it also provides information about the performance of the same services in 2013.

Table 4. Forecast on demand (in thousands) for medical procedures in cardiology (source: own analysis)

Procedure	2013 (actual data)	2016	2018	2024	2029
coronary angiography	195.6	204.6	209.1	223.3	235.3
PCI	119.9	127.1	130.6	141.3	149.7
pacemaker implantation	29.5	31.2	32.3	37.0	41.1
CRT	3.2	4.0	4.2	4.6	4.3
ICD	7.9	8.2	8.4	9.0	9.5
EPS	7.2	8.6	8.6	8.5	8.4
ablation	10.4	12.0	12.0	12.0	11.9
CABG	15.7	16.1	16.7	18.0	18.9
valve surgery	7.2	7.5	7.7	8.3	8.5

The dynamics of change in the data, assuming constant nature of incidence and treatment ratios, can be explained primarily by changes in the demographic structure, as was the case of radical treatment of malignant tumours. The presented results, together with information about available resources (personnel and equipment), may be an important factor in making investment decisions aimed at ensuring the availability of services in cardiology.

Conclusion

The modelling of the phenomena associated with disease is one of the key tools for the assessment of projected changes in the health care system. A model-based approach allows for a scenario-based analysis of the proposed solutions, and for a selection of optimum health strategies in which forecasting, particularly in the context of health needs, plays an important role.

The methodology of forecasting the demand for services is based on service curves, and as proposed in this chapter, it provides a number of important functionalities. It allows to take into account the impact of changes in treatment techniques by way of curve integration. It also allows estimating the number of services necessary to shorten queues for services by a specific period of time.

The authors are aware that the model is sensitive to the quality of input data. However, with time, the observed time series (cohorts) will be longer, and thus the model error will become smaller. On this basis it will be possible to analyse the patient treatment paths and observe the adherence to medical standards described in clinical guidelines.

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Appendix 1. List of procedures (by ICD-9) classified as radical treatments in selected cancer streams in the oncology forecast

Breast cancer (C50 and D05 acc. to ICD-10)

Procedure Code	Procedure
85.2	Excision or destruction of breast tissue
85.21	Local excision of lesion of breast
85.22	Resection of quadrant of breast
85.23	Subtotal mastectomy
85.26	Excision of breast tumour – BCT
85.29	Other excision or destruction of breast nipple tissue(s)
85.311	Unilateral amputation mammoplasty
85.312	Unilateral reduction mammoplasty
85.313	Bilateral reduction mammoplasty
85.33	Unilateral subcutaneous mammectomy with synchronous implant
85.34	Unilateral subcutaneous mammectomy – other removal of breast tissue with preservation of skin and nipple, other subcutaneous mammectomy
85.341	Removal of breast tissue with preservation of skin and nipple
85.342	Other subcutaneous mammectomy
85.35	Bilateral subcutaneous mammectomy with synchronous implant
85.36	Other bilateral subcutaneous mammectomy
85.4	Mastectomy
85.41	Unilateral simple mastectomy, other mastectomy, complete mastectomy
85.411	Other mastectomy
85.412	Complete mastectomy
85.42	Bilateral simple mastectomy
85.421	Bilateral simple mastectomy
85.422	Bilateral complete mastectomy
85.43	Unilateral extended simple mastectomy, other extended simple mastectomy, modified radical mastectomy, simple mastectomy with excision of regional lymph nodes
85.431	Other extended simple mastectomy

Procedure Code	Procedure
85.432	Modified radical mastectomy
85.433	Simple mastectomy with excision of regional lymph nodes
85.44	Bilateral extended simple mastectomy
85.45	Unilateral radical mastectomy
85.451	Removal of breast, pectoral muscle, regional lymph nodes [axillary, subclavicular and supraclavicular]
85.452	Radical mastectomy BNO
85.46	Bilateral radical mastectomy
85.47	Unilateral extended radical mastectomy
85.471	Removal of breast, pectoral muscle, regional lymph nodes [[axillary, subclavicular, internal thoracic, mediastinal]
85.472	Extended radical mastectomy BNO
85.48	Bilateral extended radical mastectomy

Malignant neoplasm of large intestine (C18 and C19 acc. to ICD-10)

Procedure Code	Procedure
45.7	Partial excision of large intestine
45.71	Multiple segmental resection of large intestine
45.719	Other multiple segmental resection of large intestine
45.72	Open and other cecectomy
45.721	Resection of cecum and terminal ileum
45.729	Other resection of cecum
45.73	Right hemicolectomy
45.731	Ileocolectomy
45.732	Right radical colectomy
45.733	Right hemicolectomy
45.74	Open and other resection of transverse colon
45.75	Open and other left hemicolectomy
45.76	Open and other sigmoidectomy
45.79	Other and unspecified partial excision of large intestine

Procedure Code	Procedure
45.791	Other enterocolectomy
45.799	Other and unspecified partial excision of large intestine
45.8	Total intra-abdominal colectomy

Malignant neoplasm of kidney and urinary tract (C64 and C65, C66 acc. to ICD-10)

Procedure Code	Procedure
55.3	Local excision or destruction of lesion or tissue of kidney
55.31	Marsupialization of kidney lesion
55.32	Open ablation of renal lesion or tissue
55.33	Percutaneous ablation of renal lesion or tissue
55.34	Laparoscopic ablation of renal lesion or tissue
55.39	Other local destruction or excision of renal lesion or tissue, obliteration of calyceal diverticulum
55.391	Obliteration of calyceal diverticulum
55.399	Other local destruction or excision of renal lesion or tissue
55.4	Partial nephrectomy
55.41	Calycectomy
55.42	Wedge resection of kidney
55.46	Treatment of post-traumatic injury of kidney with preservation of kidney and its partial resection
55.47	Partial laparoscopic nephrectomy
55.470	Simple partial laparoscopic nephrectomy
55.471	Laparoscopic nephroureterectomy without removal of intramural part of ureter
55.472	Laparoscopic nephroureterectomy with removal of intramural part of ureter after its catheter-assisted release
55.473	Laparoscopic nephroureterectomy with open removal of part of bladder including intramural part of ureter
55.49	Other partial nephrectomy
55.5	Complete nephrectomy
55.51	Nephroureterectomy
55.511	Nephroureterectomy with resection of part of bladder around the mouth of the ureter

Procedure Code	Procedure
55.512	Total unilateral nephrectomy
55.513	Radical nephrectomy with resection of adrenal gland and regional lymph nodes because of tumour
55.514	Radical nephrectomy with resection of regional lymph nodes and preservation of adrenal gland because of tumour
55.515	Radical nephrectomy because of tumour and cavotomy – simple operation
55.516	Radical nephrectomy because of tumour and cavotomy – complex operation
55.517	Radical nephrectomy because of tumour and removal of tumour thrombus extending to the subphrenic part of inferior vena cava with the opening of the chest and development of bypass circulation
55.519	Other nephroureterectomy
55.54	Bilateral nephrectomy
55.55	Laparoscopic nephrectomy
55.552	Laparoscopic simple nephrectomy
55.553	Laparoscopic radical nephrectomy with resection of adrenal gland and regional lymph nodes because of tumour
55.554	Nephrectomy with resection of regional lymph nodes and preservation of adrenal gland because of a tumour
55.555	Nephrectomy with preservation of regional lymph nodes and adrenal gland because of a tumour
55.556	Radical nephrectomy together with the thrombus extending to the non-renal segment of the renal vein, with resection of adrenal gland and regional lymph nodes because of tumour
55.557	Radical nephrectomy together with the thrombus extending to the pararenal part of the inferior vena cava, with resection of adrenal gland and regional lymph nodes because of tumour
56.4	Ureterectomy
56.41	Partial ureterectomy
56.411	Excision of lesion of ureter
56.42	Total ureterectomy
56.49	Ureterectomy, not otherwise specified
56.741	Transplantation of ureter with development of bladder flap
56.746	Ureterocystoneostomy with psoas hitch technique or bridging the ureter defect with Boari flap
56.747	Partial resection of the ureter and ureterocystoneostomy

Procedure Code	Procedure
56.748	Partial resection of the ureter and ureterocystoneostomy with psoas hitch technique
56.749	Partial resection of the ureter and ureterocystoneostomy with psoas hitch technique and bridging the ureter defect with Boari flap
56.75	Transureteroureterostomy

Malignant neoplasm of corpus uteri (C54 acc. to ICD-10)

Procedure Code	Procedure
54.1	Laparotomy
54.11	Exploratory laparotomy
68.311	Classical intrafascial-supracervical hysterectomy [CISH]
68.4	Total abdominal hysterectomy
68.41	Laparoscopic total abdominal hysterectomy
68.411	Simple laparoscopic total abdominal hysterectomy
68.42	Extended hysterectomy
68.6	Radical abdominal hysterectomy
68.61	Laparoscopic radical abdominal hysterectomy: smaller scale of the operation
68.62	Wertheim's operation
68.7	Radical vaginal hysterectomy
68.71	Laparoscopic radical vaginal hysterectomy [LRVH]
68.76	Histerocolpectomy
68.77	Schauta's operation
68.8	Pelvic evisceration
68.9	Other and unspecified hysterectomy

Malignant neoplasm of anus and rectum (C20 and C21 acc. to ICD-10)

Procedure Code	Procedure
45.7	Partial excision of large intestine
45.71	Multiple segmental resection of large intestine
45.719	Other multiple segmental resection of large intestine
4572	Open and other cecectomy
45.721	Resection of cecum and terminal ileum
45.729	Other resection of cecum
4573	Right hemicolectomy
45.731	Ileocolectomy
45.732	Right radical colectomy
45.733	Right hemicolectomy
45.74	Open and other resection of transverse colon
45.75	Open and other left hemicolectomy
45.76	Open and other sigmoidectomy
45.79	Other and unspecified partial excision of large intestine
45.791	Other enterocolectomy
45.799	Other and unspecified partial excision of large intestine
45.8	Total intra-abdominal colectomy
48.4	Pull-through resection of rectum
48.41	Soave submucosal resection of rectum
48.49	Other pull-through resection of rectum
48.491	Abdominoperineal pull-through resection of rectum
48.492	Altemeier’s operation
48.493	Swenson’s operation
48.5	Abdominoperineal resection of rectum
48.6	Other resection of rectum
48.61	Transsacral rectosigmoidectomy
48.62	Anterior resection of rectum with synchronous colostomy
48.63	Other anterior resection of rectum

Procedure Code	Procedure
48.64	Posterior resection of rectum
48.65	Duhamel resection of rectum
48.69	Other resection of rectum
48.691	Partial resection of rectum
48.692	Resection of rectum BNO

Appendix 2. List of procedures (by ICD-9) classified as requiring a prior coronary angiography under cardiology forecast

Procedure Code	Procedure
00.40	Procedure on single vessel
00.41	Procedure on two vessels
00.42	Procedure on three vessels
00.43	Procedure on four or more vessels
00.44	Procedure on vessel bifurcation
00.45	Insertion of one vascular stent
00.46	Insertion of two vascular stents
00.47	Insertion of three vascular stents
00.48	Insertion of four or more vascular stents
00.66	Percutaneous transluminal coronary angioplasty [PTCA]
00.661	Balloon percutaneous coronary angioplasty
00.662	Coronary atherectomy
00.668	Cutting balloon percutaneous coronary angioplasty
36	Operations on vessels of heart
36.0	Removal of coronary artery obstruction and insertion of stent(s)
36.03	Open chest coronary artery angioplasty
36.031	Coronary artery endarterectomy with patch
36.032	Coronary artery thromboendarterectomy with patch
36.033	Other open coronaroplasty
36.04	Intracoronary artery thrombolytic infusion
36.06	Insertion of non-drug-eluting coronary artery stent(s)

Procedure Code	Procedure
36.061	Insertion of non-drug-eluting coronary artery stent(s) – uncoated stent
36.062	Insertion of non-drug-eluting coronary artery stent(s) – coated stent
36.063	Insertion of non-drug-eluting coronary artery stent(s) – stent coated, e.g. with heparin
36.064	Insertion of non-drug-eluting coronary artery stent(s) – intravascular stents
36.065	Insertion of self-expanding coronary artery stent
36.07	Insertion of drug-eluting coronary artery stent(s)
36.070	Insertion of one drug-eluting coronary artery stent
36.071	Insertion of two drug-eluting coronary artery stents
36.072	Insertion of three drug-eluting coronary artery stents
36.073	Insertion of four drug-eluting coronary artery stents
36.074	Insertion of five drug-eluting coronary artery stents
36.09	Other removal of coronary artery obstruction
36.091	Coronary angioplasty, not otherwise specified
36.1	Bypass anastomosis for heart revascularization
36.10	Aortocoronary bypass for heart revascularization, not otherwise specified
36.101	Direct myocardial revascularization with the internal expansion of the coronary artery lumen / artificial vascular insert / vein as vascular insert
36.109	Other heart revascularization
36.11	(Aorto)coronary bypass of one coronary artery
36.12	(Aorto)coronary bypass of two coronary arteries
36.13	Aorto)coronary bypass of three coronary arteries
36.14	(Aorto)coronary bypass of four or more coronary arteries
36.15	Single internal mammary-coronary artery bypass
36.16	Double internal mammary-coronary artery bypass
36.17	Abdominal - coronary artery bypass
36.19	Other bypass anastomosis for heart revascularization
36.2	Heart revascularization by arterial implant
36.21	Implantation of aorta branches [ascending aorta] into the heart muscle
36.22	Implantation of blood vessels to the heart muscle
36.232	Implantation of internal thoracic artery to the chamber

Procedure Code	Procedure
36.3	Other heart revascularization
36.39	Other heart revascularization
36.9	Other operations on vessels of heart
36.91	Repair of aneurysm of coronary vessel
36.92	Coronary vessel exploration
36.93	Coronary vessel incision
36.94	Coronary vessel ligation
36.97	Percutaneous extension of artificial intracardiac or cardiovascular joints
39.592	Other coronary angioplasty

Analysis of staffing needs for the treatment of cancer and cardiac diseases

Barbara Więckowska, Karol Ciulkin, Piotr Nowosielski

Introduction

The primary objective of the health care system in each country should be to ensure an adequate level of health care services. An important element of ensuring adequate health care for patients is to have sufficient number of high-quality human resources, including medical specialists, but also the supporting staff, as these groups play a key role in the system. It is a complex task, as it requires long-term planning and continuous adaptation to continuously changing demographic, epidemiological, economic and social conditions.

The planning of the medical staff has been the subject of analysis of many international organizations. In 2006, the World Health Organization (WHO) drew attention to the fact that nearly 60 countries worldwide are struggling with shortages of medical personnel. According to WHO, this problem concerns mainly the developing countries. One of the main reasons for this state of affairs reported by WHO was the shortage or unsatisfactory level of planning for the long term demand for medical personnel in these countries (WHO 2006). In the same year, the Organization for Economic Cooperation and Development (OECD) listed the planning of personnel as one of the priorities for its member states (Simoens et al. 2006), and two years later, it pointed to the insufficient progress as a serious threat to the future development (OECD 2008). This issue was also the subject of analysis of the European Commission. In 2008, a Green Paper was published, which presented the analysis of the situation of healthcare personnel within the European Union countries. Based on the state in 2008, the Commission identified future threats and presented a number of recommendations for the future (European Commission 2008). The new roadmap for increasing the labour resources in the health sector of EU member states was presented by the European Commission in 2012 (European Commission 2012).

In Poland, the issue of medical staff planning has not yet been widely addressed. This chapter is an attempt to fill in this knowledge gap. Its purpose is to provide a demographic

forecast of medical staff specializing in the area of oncology and cardiology in Poland. This is an extremely important issue, because – as shown by demographic reports and forecasts – due to the unfavourable shape of the age pyramid of physicians and an insufficient number of young people taking up medical studies, the number of physicians in Poland will be decreasing. At the same time, in view of the ageing population, it is expected that the incidence of cancer and cardiac diseases will grow, and consequently – the demand for medical personnel will increase.

The first part of this chapter emphasizes the demographic aspects of the population of currently practising oncologists and cardiologists. For this purpose, detailed studies have been carried out with respect to human resources in years 2012 and 2013[65]. The second part, assuming a constant number of physicians commencing their practice, presents the forecast number of oncologists and cardiologists by 2030. Previous studies addressing this issue from the demand point of view assumed a stable ratio of the number of physicians relative to the number of visits or an a priori ratio of population per physician (Starkiene et al. 2005). This analysis estimates the forecast of the number of physicians assuming a constant proportion of newly diagnosed patients per one physician, guaranteeing the current level of coverage of patients' needs.

The analyses and forecasts presented are based on data on the number of physicians made available by the Supreme Medical Chamber (SMC), which were then structured using the data from the National Health Fund (NHF) on the number of contracts concluded with physicians of a given specialization in the counties all over the country. The forecast also used the data from the Department of Science and Higher Education of the Ministry of Health (DNiSW MZ) about the number of specialization diplomas awarded in recent years. Also, the use was made of the national life tables compiled by the Central Statistical Office (GUS).

The analysis of human resources in the field of oncology and cardiology was made in three steps. First, the absolute number of physicians was analysed by regions, which provided a picture of the staffing level in each of the regions and the differences between them. Then, in order to take into account the differences in the population of individual regions, the

[65] The years 2012 and 2013 were the basis for the analysis of health needs maps in the field of oncology and cardiology, respectively.

analysis was supplemented with demographic data, presenting the number of physicians per 10 thousand residents in each region. The last part involved the analysis of the differentiation chart in order to clearly illustrate the differences between the ratios of the number of physicians per 10 thousand residents between individual regions.

As part of the forecast, the number of practising physicians was calculated, assuming that they continue their practice by the end of life, and the number of new physician entering the labour market is constant. As a result of the assumptions made, the model involved the average number of specialization diplomas granted and the probability of survival. We have also calculated the scenario assuming a constant proportion of the number of physicians to new cases.

Oncological medical staff in Poland in 2012

This analysis concerns medical staff specialising in the treatment of oncological diseases and includes the following specialists: oncological surgeons, gynecological oncologists, clinical oncologists, pathologists, and radiation oncologists (hereinafter 'oncologists'). Paediatric oncologists and haematologists were not included in the scope of this analysis. This decision was made based on methodological assumptions – a fixed ratio (estimated for the projection base year) indicating the number of physicians per 1,000 new patients was assumed, which was multiplied by the cancer incidence limited to solid tumors only[66].

In 2012, the database of the Chamber of Physicians and Dentists listed 2,140 registered oncologists employed in Poland; the highest number was registered in southern and central voivodeships: Śląskie and Mazowieckie – 306 and 390 oncologists respectively (cf. Figure 1). In the following voivodeships – Łódzkie and Małopolskie – the number of oncologists was more than 50% lower (169 and 172 respectively). The group of voivodeships in which average values (between the first and third quartile[67] – between 71 and 160 oncologists) were recorded

[66] Solid tumors represent only a small proportion of cancer cases in children. Leukemias account for 28.7%, and lymphomas for 14.3% or a total of 43% of paediatric cancers (Balcerska 2009).

[67] Quartile is a measure of the location of observations. In statistics there are three quartiles: first, second and third. The first quartile indicates that 25% of observations are located below its value and the remaining 75% of observations are located above its value. The second quartile indicates that 50% of values are lower than its value and 50% are higher. The third quartile indicates that 75% of observations are located below its value and 25% are located above.

comprised eight voivodeships. This group was located mainly in the central part of Poland. The lowest numbers of oncologists – less than 71 oncologists in each voivodeship – were registered in southern belt (Opolskie, Podkarpackie, Podlaskie and Lubuskie) voivodeships. The numbers presented provide evidence for the large variation in the distribution of oncologists in the country.

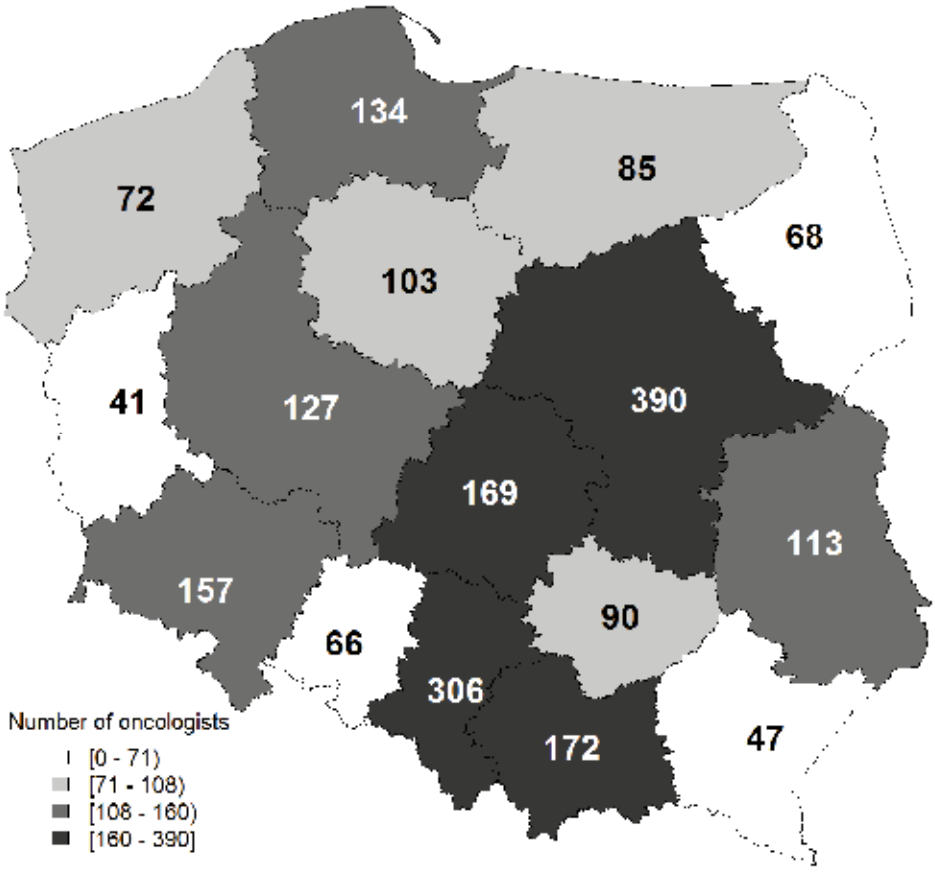

Figure 1. Number of oncologists in individual voivodeships in 2012 (source: own study)

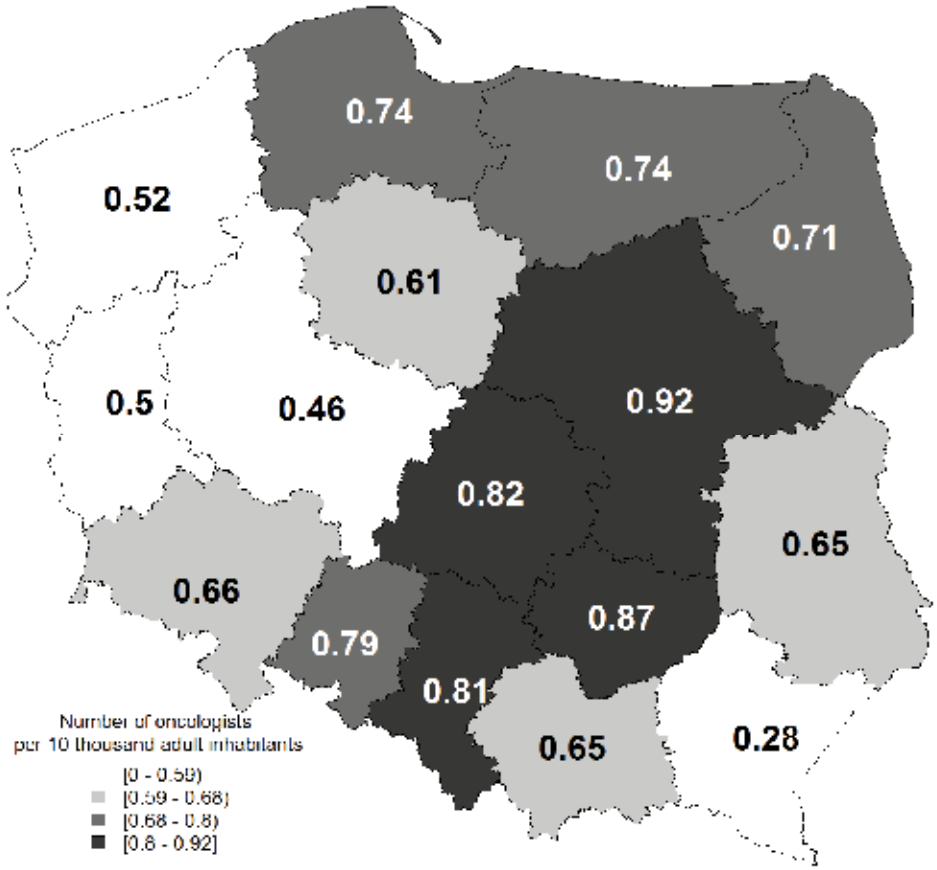

Figure 2. Number of oncologists per 10 thousand adult inhabitants in individual voivodeships in 2012 (source: own study)

Voivodeships characterised by the highest ratios of oncologists to the population were located in the part ranging from southern (Śląskie) up to the central voivodeships (Mazowieckie, Świętokrzyskie and Łódzkie) (cf. Figure 2). The core of the cluster of voivodeships characterised by the highest values remained unchanged (Śląskie, Łódzkie and Mazowieckie), however, the location of the cluster has moved to the centre of Poland – the Małopolskie Voivodeship was replaced by Świętokrzyskie Voivodeship. The highest ratio was noted in Mazowieckie Voivodeship, where its value amounted to almost 0.92 physicians per 10 thousand inhabitants in this voivodeship. Eight voivodeships recorded ratios close to the national average, which was equal to 0.67 oncologist per 10 thousand inhabitants. The group comprising voivodeships

characterised by moderately high values was divided, establishing two separate geographical clusters: northern (Pomorskie, Warmińsko-Mazurskie and Podlaskie voivodeships) and south (Opolskie voivodeship). The northern cluster connecting the voivodeships characterised by moderately low values has also disappeared. Currently the cluster is composed of voivodeships from various parts of Poland (Dolnośląskie, Małopolskie, Kujawsko-Pomorskie and Lubelskie). The inex of the four voivodeships was at the bottom end of the set, however, the result of the Podkarpackie Voivodeship (0.28 physician per 10 thousand inhabitants) was almost two times lower than the result of the north-western cluster (Zachodniopomorskie, Lubuskie and Wielkopolskie voivodeships).

The analysis of variables indicates that in the case of voivodeships characterised by an extremely high number of physicians (Śląskie, Mazowieckie and Łódzkie), the rescaling of the indicators over the population of each region has not substantially changed their relations in relation to other regions (cf. Figure 1, 2). There are small changes within ranges, e.g. after rescaling the value of the indicator for Łódzkie Voivodeship it reached the level for Śląskie Voivodeship. The use of the number of physicians in relation to 10 thousand inhabitants in voivodeships where the number of physicians was close to the national average has led to changes in formulated conclusions. For example, after the application of this indicator, the result for Warmińsko-Mazurskie and Świętokrzyskie voivodeships was above the national; median, whereas in absolute terms, the results for both voivodeships were below the national median. An inverse relationship was observed for Dolnośląskie, Lubelskie and Wielkopolskie voivodeships.

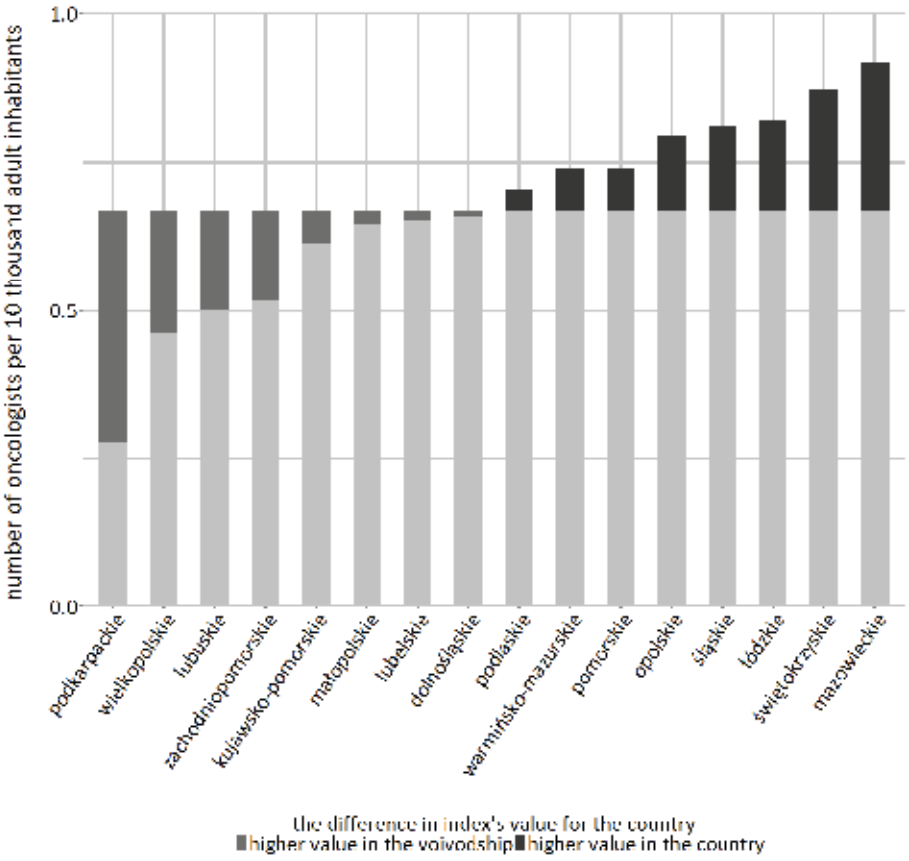

Figure 3. Number of oncologists per 10 thousand adult inhabitants in individual voivodeships in 2012 (source: own study)

The values of indicators for eight voivodeships oscillated above the national average (0.67 physician per 10 thousand inhabitants) and the value of the indicator for the Mazowieckie and Świętokrzyskie voivodeships was significantly higher (ca. 1/3) than the national average (cf. Figure 3). The remaining eight voivodeships recorded indicator values below the national average. Despite creating the index that takes into account the population of a given voivodeship, the differences between individual voivodeships were still significant. For example, the most extreme value for Podkarpackie Voivodeship was also significantly lower than the value for the rest of the country (ca. 40% of the national average).

Cardiological medical staff in Poland in 2013

The analysis of the cardiological staff comprises three fields of specialisation: cardiologists, cardiac surgeons and paediatric cardiologists (hereinafter 'cardiologists'). In 2013 the database of the Chamber of Physicians and Dentists listed 4,114 registered cardiologists. An absolute majority of cardiologists – 728 and 713, respectively – were employed in the Mazowieckie and Śląskie Voivodeships (cf. Figure 4). This number was significantly lower in the remaining voivodeships. There were about 393 in Łódzkie and 397 in Małopolskie Voivodeships. These voivodeships made up the central-southern cluster. The middle segment, between the first and third quartile, included the results characterising eight voivodeships. The voivodeships included in this segment were located mainly in central and southern parts of Poland. The number of cardiologists in voivodeships in the bottom segment, making up the north-western and north-eastern clusters, was lower than 120.

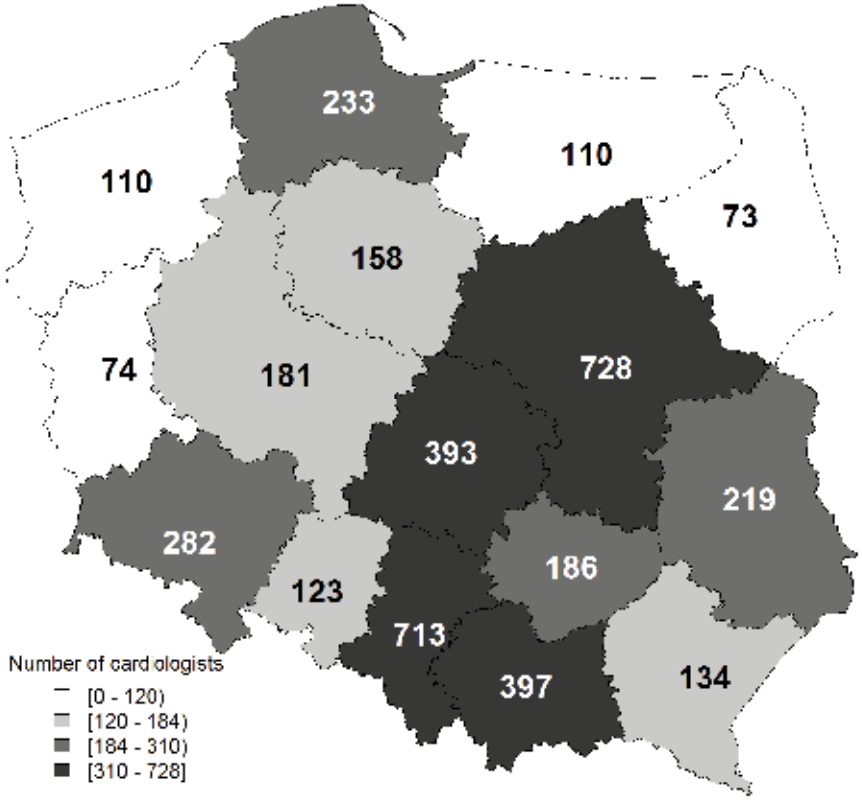

Figure 4. Number of cardiologists in individual voivodeships in 2013 (source: own study)

In order to clearly illustrate the situation of cardiological staff in Poland, a subgroup comprising paediatric cardiologists was established for a separate analysis. This resulted in the breakdown of the population in each voivodeship by age. A limit value of 18 years of age was assumed.

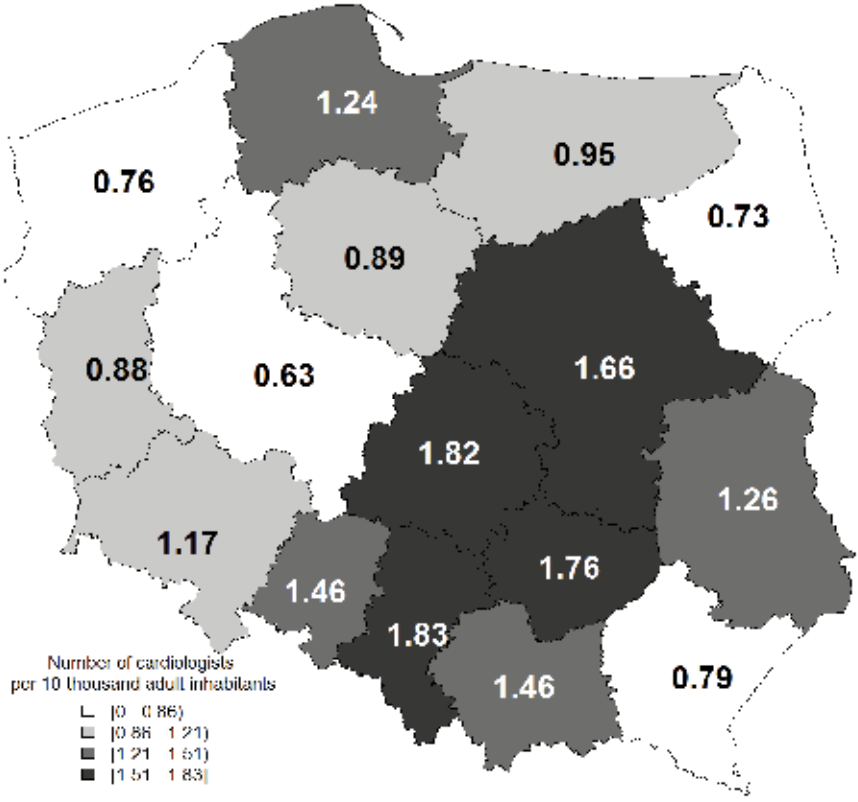

Figure 5. Number of cardiologists per 10 thousand adult inhabitants in individual voivodeships in 2013 (source: own study)

After taking into account the population of each voivodeship, the analysis has indicated that in 2013 the highest number of cardiologists per 10 thousand population characterised a continuous area of the voivodeships of southern and central Poland (cf. Figure 5). At the same time, four voivodeships: Śląskie (1.83 cardiologist per 10 thousand inhabitants), Łódzkie (1.82), Świętokrzyskie (1.76) and Mazowieckie (1.66) were characterised by clearly higher values of the indicator than other voivodeships.. As in the case of the same indicator

for oncologists, the voivodeships with the lowest analysed ratios were Podkarpackie (0.79), Zachodniopomorskie (0.76), Podlaskie (0.73) and Wielkopolskie (0.63).

As in the case of oncologists, the rescaling of the number of cardiologists over the population of individual voivodeships did not influence significantly the index of voivodeship with extremely high indicator values. The results for Śląskie, Łódzkie and Mazowieckie voivodeships, both in absolute terms and in terms of population, are still extremely high. These results remained above the median. In absolute terms, the number of physicians in the Świętokrzyskie Voivodeship was 7th highest value, and after the re-estimation the number of cardiologists per 10 thousand inhabitants was among the highest recorded alues in the country.

After rescaling, the cluster of voivodeships with the highest values of the indicator was still moderately compact – it was located in the southern and central Poland. The cluster of voivodeships characterised by moderately high values moved from western Poland to central and eastern Poland. It comprised Opolskie, Małopolskie, Lubelskie and Pomorskie voivodeships. This changed was caused by the fact that the indicator result in the absolute values decreased for the Małopolskie Voivodeship. The cluster of voivodeships characterised by moderately low values moved towards the west (the Lubuskie Voivodeship replaced the Opolskie Voivodeship) and north (the Warmińsko-Mazurskie Voivodeship replaced the Podkarpackie Voivodeship). The northern cluster, combining voivodeships with the lowest values, divided into central-western (Zachodniopomorskie and Wielkopolskie) and eastern (Podlaskie and Podkarpackie) parts.

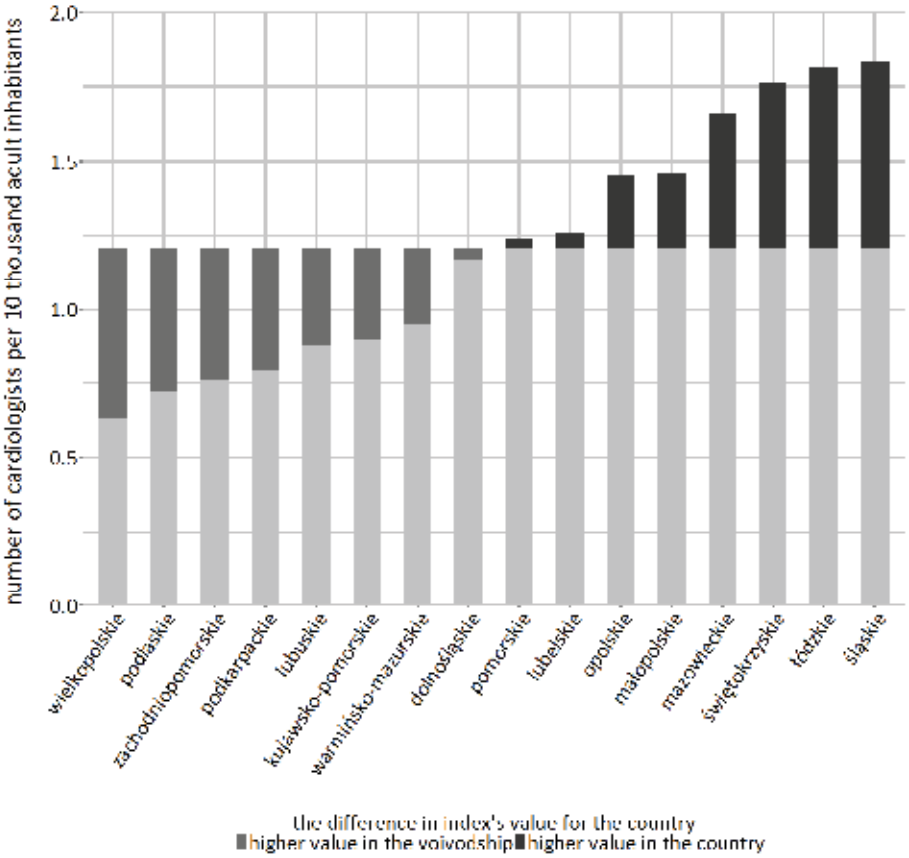

Figure 6. Number of cardiologists per 10 thousand adult inhabitants in individual voivodeships in 2013 (source: own study)

Eight voivodeships recorded the value of the indicator above the national average, which in this case was 1.2 cardiologist per 10 thousand inhabitants (cf. Figure 6). Four voivodeships (Śląskie, Łódzkie, Świętokrzyskie and Mazowieckie) were distinguished by an index well above the average (ca. 1/3). For eight voivodeships the indicator was below the national average.

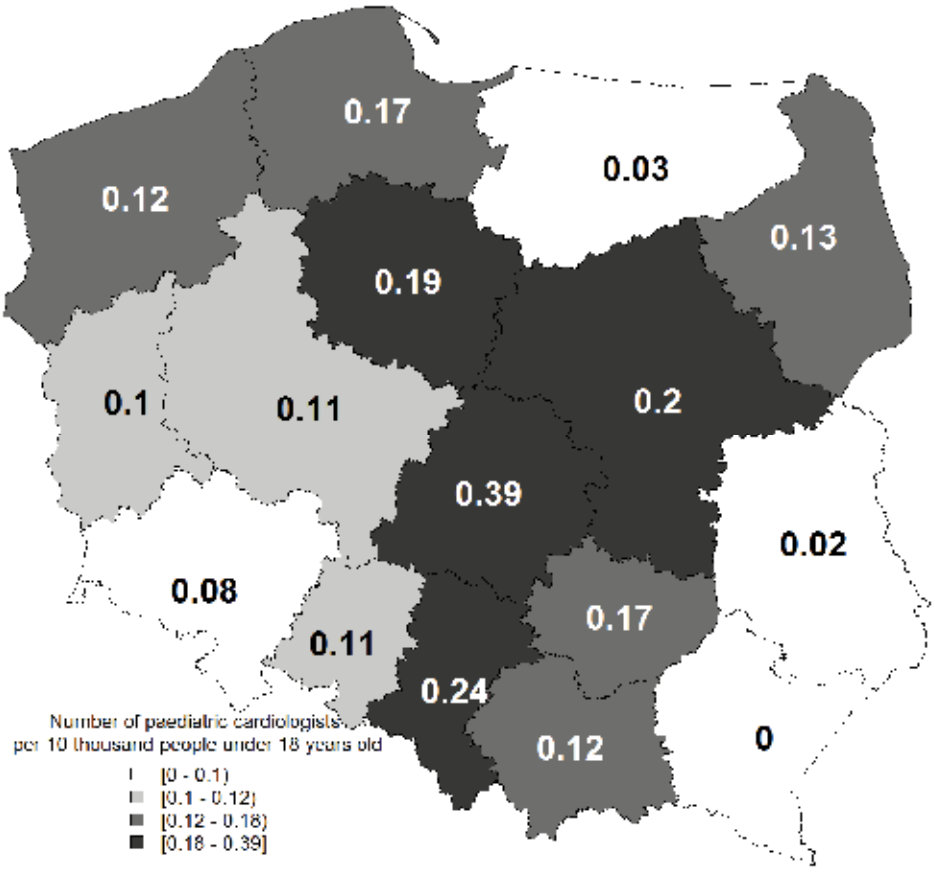

Figure 7. Number of paediatric cardiologists per 10 thousand people under 18 years old in individual voivodeships in 2013 (source: own study)

The voivodeships with the highest number of paediatric cardiologists per 10 thousand people under 18 years old are: Łódzkie (0.39), Śląskie (0.24) and Mazowieckie (0.2) (cf. Figure 7). These voivodeships recorded the highest indicator at question also in the case of an analysis considering the population over 18 years old. Indicator values for the following voivodeships: Podlaskie, Pomorskie, Małopolskie, Zachodniopomorskie, Świętokrzyskie, Opolskie, Wielkopolskie and Lubuskie were in the middle range, that is between the first and the third quartile. The lowest values of this indicator were recorded by four voivodeships:

Dolnośląskie (0.08), Warmińsko-Mazurskie (0.03), Lubelskie (0.02) and Podkarpackie, where there were no paediatric cardiologists.

Geographically, voivodeships with the highest ratio of the number of paediatric cardiologist per 10 thousand inhabitants under 18 years old created a compact area covering the central and southern Poland. In comparison to the absolute numbers, this cluster changed insofar as the Małopolskie Voivodeship was replaced by the Kujawsko-Pomorskie Voivodeship. This caused a shift towards the central Poland, however, did not significantly influence the location of the cluster. Voivodeships characterised by relatively high results created a cluster representing the northern Poland (Podlaskie Voivodeship, Pomorskie Voivodeship and Zachodniopomorskie Voivodeship) and central-south (Świętokrzyskie and Małopolskie voivodeships). In comparison to the absolute numbers, only the Pomorskie and Świetokrzyskie Voivodeships remained in this cluster. If in terms of absolute values, the voivodeships with relatively low values were located in central and southern Poland; the creation of the category of paediatric cardiology and re-estimation of the number of cardiologists of this specialisation over the number of inhabitants caused that voivodeships of this cluster were located in the south-western Poland. Voivodeships with the lowest values were mainly located in north-eastern Poland. Earlier, with regard to the absolute values, this was the north-eastern Poland.

The analysis of indicators for cardiology shows that in the Zachodniopomorskie Voivodeship and Podlaskie Voivodeship the ratio of the number of cardiologists per 10 thousand adult inhabitants belonged to the lowest in Poland. However in the case of paediatric cardiology the situation was better – the result for both voivodeships was above the national average. The indicator of the number of cardiologists with relation to the number of adult inhabitants for the Wielkopolskie Voivodeship belonged to the lowest in Poland, however, the same indicator for paediatric cardiologists was in the middle of the range (between the first and the third quartile).

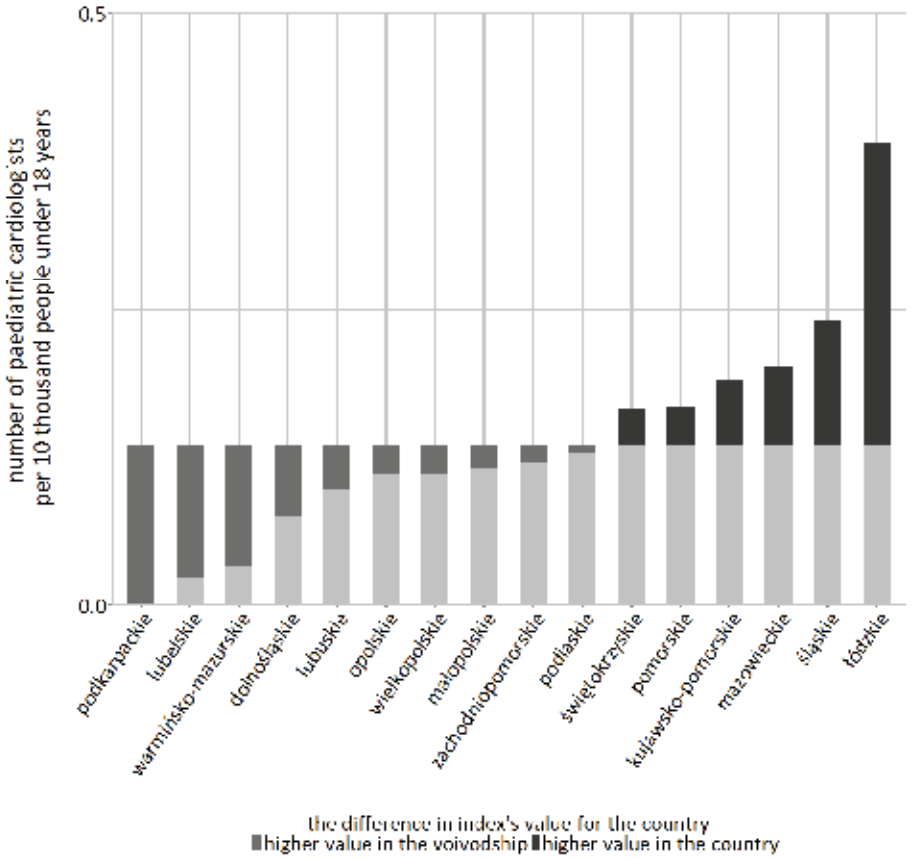

Figure 8. Number of paediatric cardiologists per 10 thousand people under 18 years old in individual voivodeships in 2013 (source: own study)

Arithmetic mean of the indicator of the number of cardiologists with the paediatric specialisation per 10 thousand inhabitants under 18 years old for Poland was approximately 0.14 (cf. Figure 8). Only six voivodeships recorded a factor value above the national average. The value of this indicator in the Łódzkie Voivodeship was three times higher than the national average. The other nine voivodeships were characterised by an indicator level below the average. The Podkarpackie Voivodeship recorded a zero value of the indicator. This results from the fact that in this voivodeship there was no cardiologist with the paediatric specialisation.

Theoretical assumptions of the projection

The projection of the number of physicians in the future years was calculated on the basis of data retrieved from the Polish Chamber of Physicians and Dentists, National Health Fund, Department of Science and Higher Education of the Ministry of Health, as well as on the basis of life expectancy tables for the years 2012 and 2013 and developed by CSO. Taking into account the fact that the projections indicate an increase in the incidence rate of cardiovascular (with an exception of paediatric cardiology) and oncological diseases (Table 1), it was decided to simulate a scenario providing for a constant ratio between the number of specialist physicians and the number of new cases of oncological/cardiovascular diseases.

Table 1. Number of new cases in oncology and cardiology by age groups (in thousand) (source: own study)[68]

Year	Oncology	Cardiology	
	Adults	Adults	Children and young people
2018	174.85	367.34	21.75
2022	184.77	387.16	21.50
2026	194.23	410.94	20.38
2030	203.25	434.11	18.80

In comparison to other professional groups, projecting the number of professionally active physicians is difficult due to the fact that they often continue to be professionally active after reaching the retirement age (cf. Figure 9 and 10). There is no significant difference in the number of physicians in particular age groups <55, 60), <60, 65) and <65, 70), so the data do not clearly show the moment in which the physicians retire. Therefore, an estimation of the retirement age requires an analysis of the panel data[69] ,which was not used in this projection.

It should be noted that in the case of cardiology the most numerous group is formed by physicians aged <40;45), and in the case of oncology – aged <40;45) and <45;50).

[68] More information can be found in *Medical treatment in Poland – analysis and models*, vol. 1 and 2, developed under the current project.

[69] The panel data are data that describe the same units in different points in time. In the case of this analysis, this would mean that it is possible to identify a physician and a year to which the information refers. The available data contained information that referred to a single year, so these data was cross-sectional.

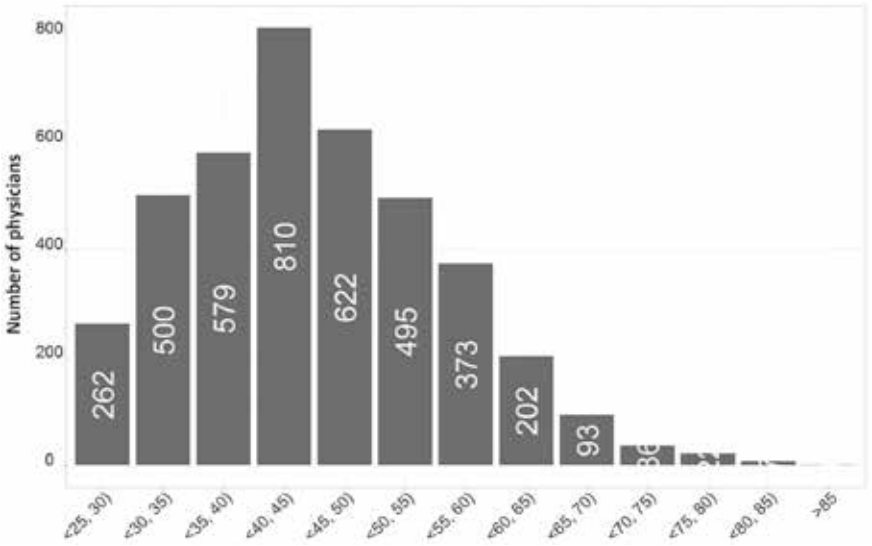

Figure 9. Number of cardiologists by age groups (source: own study)

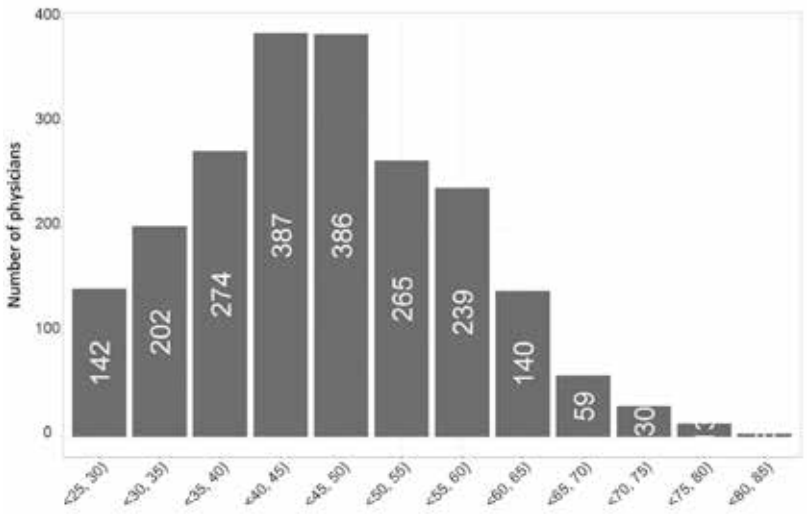

Figure 10. Number of oncologists by age groups (source: own study)

The projection was based on data from Department of Science and Higher Education of the Ministry of Health that contained the information on the number of diplomas issued in

the years 2003–2014. This is a too short time series to model the variability with the use of autoregressive processes or moving averages, therefore the projection applied the annual average numbers of new physicians from the last 10 years preceding the base year of the projection. Among the areas under consideration, the greatest number of new specialist physicians was in training in the cardiology group, and the smallest in the paediatric cardiology group (cf. Table 2).

Table 2. Annual national numbers of new physicians from the period of 10 years before the projection base year, broken down by analysed specialisations (source: own study).

Year	oncology	cardiology (not including the paediatric cardiology)	paediatric cardiology
2003	263		
2004	70	100	0
2005	138	100	0
2006	73	117	11
2007	87	155	14
2008	106	189	15
2009	105	203	5
2010	135	133	9
2011	148	120	10
2012	159	184	11
2013		209	10
annual average	128.4	151	8.5

For the projection purposes, it was assumed that:

1. distribution of the survival probabilities in the professional group of physicians is the same as the national distribution;
2. the survival probabilities are consistent with the life expectancy tables from the projection base year (2012 for oncologists, 2013 for cardiologists and paediatric cardiologists), i.e. they are stable over time;
3. physicians who started a practice continue during the entire life;

4. the number of new specialisit physicians on the labour market is constant and is equal to the annual average from the past 10 years before the projection base year.

Given the assumption 1, the expected physicians number in $t+i$ year, where t means the base year (2012 in case of oncology and 2013 in case of cardiology and paediatric cardiology) and constitutes the next projection year, is calculated on the basis of the following recursive formula:

$$N_{t+i} = \sum_{x} n_{t+i-1}^{x+i-1} * p_{x+i-1}$$

In this formula N_{t+i} means the number of physicians of given specialization in the year $t+i$, x constitutes age, p_{x+i-1} is the next year survival probability of $x+i-1$ year olds and n_{t+i-1}^{x+i-1} means the number of physicians aged $x+i-1$ in the year $t+i-1$, i.e. those who reached the age of x in the base year (also those who entered the labour market in the subsequent years of projection).

The expected number of physicians in the year $t+i$ is also presented by the following general formula:

$$N_{t+i} = \sum_{x} \left(n_t^x \prod_{k=0}^{i-1} p_{x+k} \right)$$

The annual projection for the incidence estimated within the framework of the development of maps of health care needs in the field of cardiology and oncology was used to the projection of scenario assuming constant ratio of the physicians number to the new cases. This helped to achieve the estimation of the physicians number necessary to sustain the availability of specialised physicians. The following additional designations were used to fill in the formula for the number of physicians who maintain the quality of the health care system: $N(M_{t+i})$ constitutes the physicians number consistent with the assumption on the constant ratio of the physicians number to the number of new cases in the year $t+i$, and M_t means incidence in the year t.

$$N(M_{t+i}) = \frac{N_t}{M_t} M_{t+i}$$

Results of the projection

Figures 11–14 shows projections of the number of physicians in the selected specialisation groups in Poland. To improve the legibility of the figure, the darker line indicates the projection in the scenario assuming constant ratio of the physicians number to the new cases, and the paler line indicates the base projection.

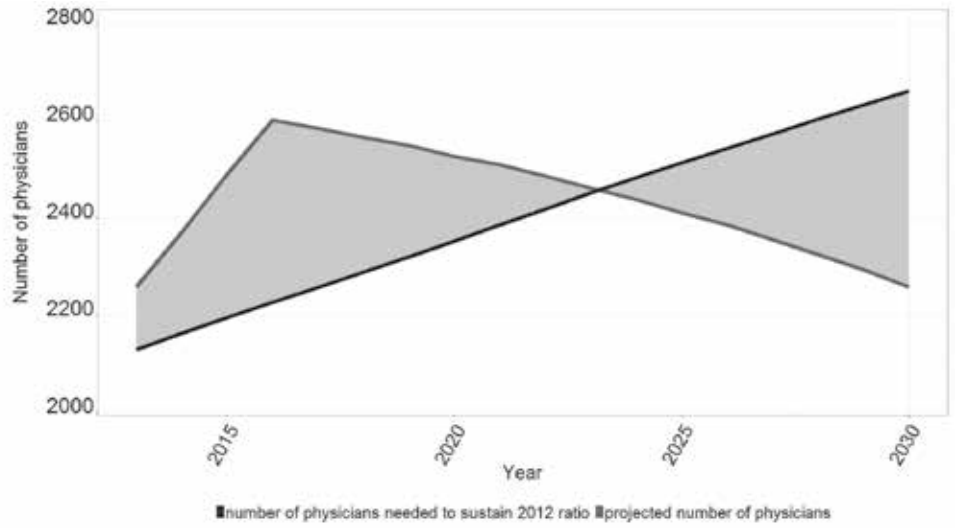

Figure 11. Projection of the number of oncologists in Poland in 2013–2030 (source: own study)

The number of oncologists at the beginning and at the end of the projection period will be similar (2.3 thousand). Initially, the trend will be increasing but in 2017 this trend will collapse as a result of the process of ageing of this professional group. In 2017 decline rate will be 0.6% (decline by 16 physicians in comparison with 2016) and in 2030 it will be as much as 1.6% (decline by 36 physicians in comparison with 2029).

The number of physicians necessary to maintain the ratio of the physician number to the number of new patients will increase and the growth rate will be relatively stable. In 2013 almost 2.2 thousand of physicians were necessary, and in 2030 2.7 thousand of physicians will be necessary to maintain this ratio. In 2014 the increase in the number of necessary physicians will be 1.5% (increase by 34 physicians in comparison with 2013) and in 2030 it will be 1.1% (increase by 29 physicians in comparison with 2029). Therefore, after 2022 the demand for

additional number of physicians, in addition to the currently maintained pace of the entry of new specialists on the market, will increase systematically and will reach 389 physicians in 2030. As the specialisation period is around 5 years, the increased recruitment for medical specialisations should start today.

Table 3. Projection of the number of oncologists in individual voivodeships in 2013 and 2030 (source: own study)

Voivodeship	Projection of the physicians number		Number of physicians who maintain the ratio of 2012	
	2013	2030	2013	2030
Dolnośląskie	163	143	155	192
Kujawsko-pomorskie	113	98	105	133
Lubelskie	132	147	124	150
Lubuskie	41	41	33	42
Łódzkie	186	242	178	206
Małopolskie	182	203	174	225
Mazowieckie	406	381	398	502
Opolskie	66	85	58	70
Podkarpackie	47	38	39	51
Podlaskie	68	56	60	74
Pomorskie	140	143	132	173
Śląskie	327	315	319	380
Świętokrzyskie	96	115	88	105
Warmińsko-mazurskie	91	94	83	108
Wielkopolskie	126	98	118	154
Zachodniopomorskie	74	59	66	84

The largest relative decrease of the number of oncologists will take place in Wielkopolskie voivodeship, where in 2030 only 77.8% (98 oncologists) of the physicians working in 2013 (126) will be professionally active (cf. Table 3). The physicians' age structure in this voivodeship has been dominated by the elderly. According to the projection, the highest growth will take place in the Łódzkie voivodeship. In 2030 the number of professionally active physicians there will increase t by 30.1% (56) when compared with 2013.

In the scenario of the maintenance of the ratio of physician number to the number of new patients, the highest relative growth of the physicians number will take place in Wielkopolskie voivodeship. The difference between 2030 and 2016 will be 31.2%, which amounts to 42 oncologists. In this scenario, the lowest relative growth of the physicians number will take place in Łódzkie voivodeship, where the increase in incidence will lead to growth in the number of physicians necessary to maintain the constant ratio to the number of new patients by 15.5%, which amounts to 28 oncologists.

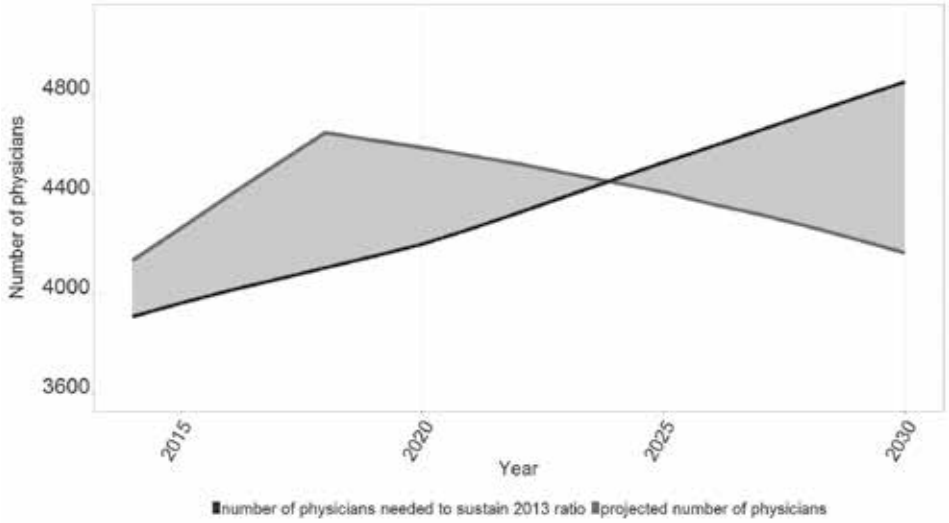

Figure 12. Projection of the number of cardiologists (without paediatric cardiologist specialisation) in Poland in 2014-2030 (source: own study)

In the projection horizon, the number of cardiologists will equal 4.1 thousand in 2014 and 2030. In 2018 the initial upwards trend will collapse and the number of practitioners will decrease as a result of the process of ageing of this professional group.

The number of physicians necessary to maintain the ratio of the physician number to the number of new patients will increase and the growth rate will be relatively stable. In 2014 this number will amount to 3.9 thousand of physicians and in 2030 4.8 thousand of physicians will be necessary to maintain this ratio. In 2015 the increase of the number of physicians necessary to maintain this ratio will be 1.3% (increase by 53 physicians in comparison with 2014) and in

2030 it will be 1.3% (increase by 62 physicians in comparison with 2029). Therefore, after 2024 the demand for additional number of physicians, in addition to the currently maintained pace of the emergence of new specialists, will increase systematically and will reach 655 physicians in 2030. As the specialisation period is around 5 years, the increased recruitment for medical specialisations, also in the case of cardiology, should start today.

Table 4. Projection of the number of cardiologists (without paediatric cardiologist specialisation) in individual voivodeships in 2014–2030 (source: own study)

Voivodeship	Projection of the physicians number		Number of physicians who maintain the ratio of 2013	
	2014	2030	2014	2030
Dolnośląskie	293	297	272	335
Kujawsko-pomorskie	154	151	143	179
Lubelskie	224	221	211	255
Lubuskie	75	76	64	82
Łódzkie	393	391	369	428
Małopolskie	412	570	386	492
Mazowieckie	733	706	707	887
Opolskie	122	125	113	135
Podkarpackie	133	113	127	162
Podlaskie	70	59	61	75
Pomorskie	234	221	220	285
Śląskie	713	680	693	829
Świętokrzyskie	187	186	175	207
Warmińsko-mazurskie	110	113	101	129
Wielkopolskie	172	140	166	215
Zachodniopomorskie	108	114	98	124

The highest relative decrease in the number of cardiologists will take place in Wielkopolskie voivodeship (cf. Table 4), where in 2030 only 80.9% (140) of the physicians working in 2014 (172) will be professionally active. As in the case of oncologists, physicians' structure in this voivodeship has been dominated by the elderly. The lowest relative growth will take place in

the Małopolskie voivodeship (compare Table 3), where in 2030 the number of professionally active physicians will increase by 40.6% (158) when compared with 2014[70].

In the scenario where the level of availability of physicians to patients is maintained, the highest relative growth in the number of physicians will take place in the Wielkopolskie voivodeship. The difference between 2030 and 2014 will be 29.8%, which amounts to 49 cardiologists. The lowest relative increase in the number of physicians will take place in the Łódzkie voivodeship. An increase in incidence will lead to an increase in the number of physicians in a scenario where the level of availability of physicians to patients is maintained by 16.2%, which amounts to 59 oncologists.

Because of low projection values in some voivodeships, the analysis of the number of paediatric cardiologists assumes that in a scenario where the ratio of the number of physicians to the number of patients is constant, the number of physicians may change by multiples of 1/4 of FTE, while in the base scenario it may change by multiples of 1 FTE.

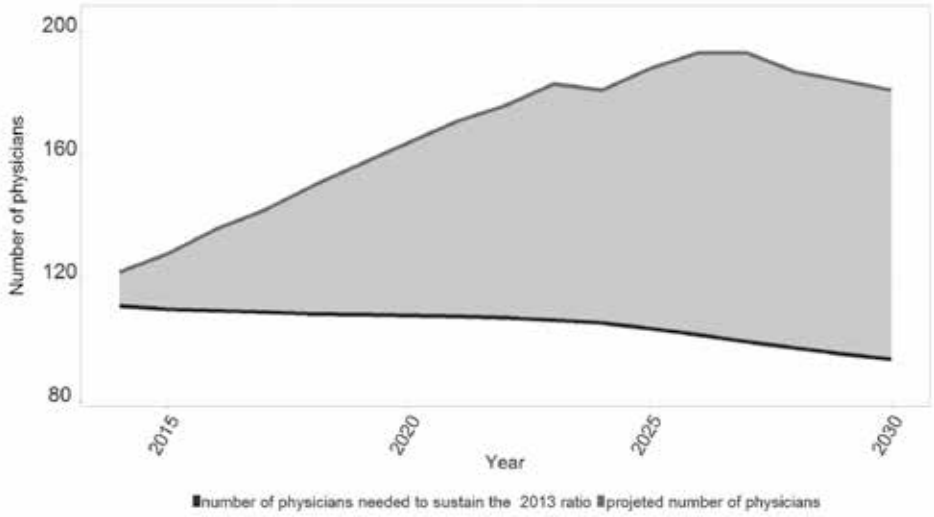

Figure 13 Projection of the number of paediatric cardiologists in Poland in 2014–2030 (source: own study)

[70] Substantial growth in Małopolskie voivodeship is a result of young physicians' population in this voivodeship. This causes low mortality rate in the considered population and high growth in the projection period. In the result growth in number of physicians is higher than needed (158 new physicians compared to 106 new physicians needed to cover new cases ratio). In the conclusion one might say that human resources needs in cardiology are covered much better than in the rest of the country.

The number of paediatric cardiologists will increase in the projection horizon from 122 in 2014 to 181 in 2030. Due to demographic changes in society (low fertility rate), the number of physicians needed to maintain availability of physicians to patients will move in the opposite direction (that is, it will fall). In 2015 the decline rate will be 0.6% (a decrease by 1 physician), whereas in 2030 it will amount to 1.9% (a decrease by 2 physicians).

It should be emphasised that in the base projection of incidence of cardiovascular diseases in children constant incidence rates have been assumed, which directly determines a constant share of cardiovascular diagnoses in this group of patients[71], although the situation may look different in reality. It is probable that due to development in medical technologies children suffering from more serious diseases will survive the neonatal period. The number of children requiring treatment and cardiovascular care may increase, and in turn so may the time of necessary hospital care in the case of such patients.

On the other hand, if such a scenario is not fulfilled, the assumption according to which the number of new physicians completing a specialization in paediatric cardiology is constant may turn out to be false. Usually, this specialization is chosen by physicians who have already gained the first specialist grade (according to the data, the youngest physician specialising in this field is 37, with a small percentage of those under 47). It can be assumed that they are familiar with the situation in the healthcare market so when they take the decision to specialise in yet another field they take into account competition and current trends. It means that they respond to the information on the number of new cases and, when it decreases, they are unlikely to make a decision to pursue a new specialization. For the same reasons, the physician's self-governing body may take the decision not to recruit within a specialization in a given year.

[71] More information can be found in *Medical treatment in Poland – analysis and models*, vol. 2: *Cardiology*, developed within the project.

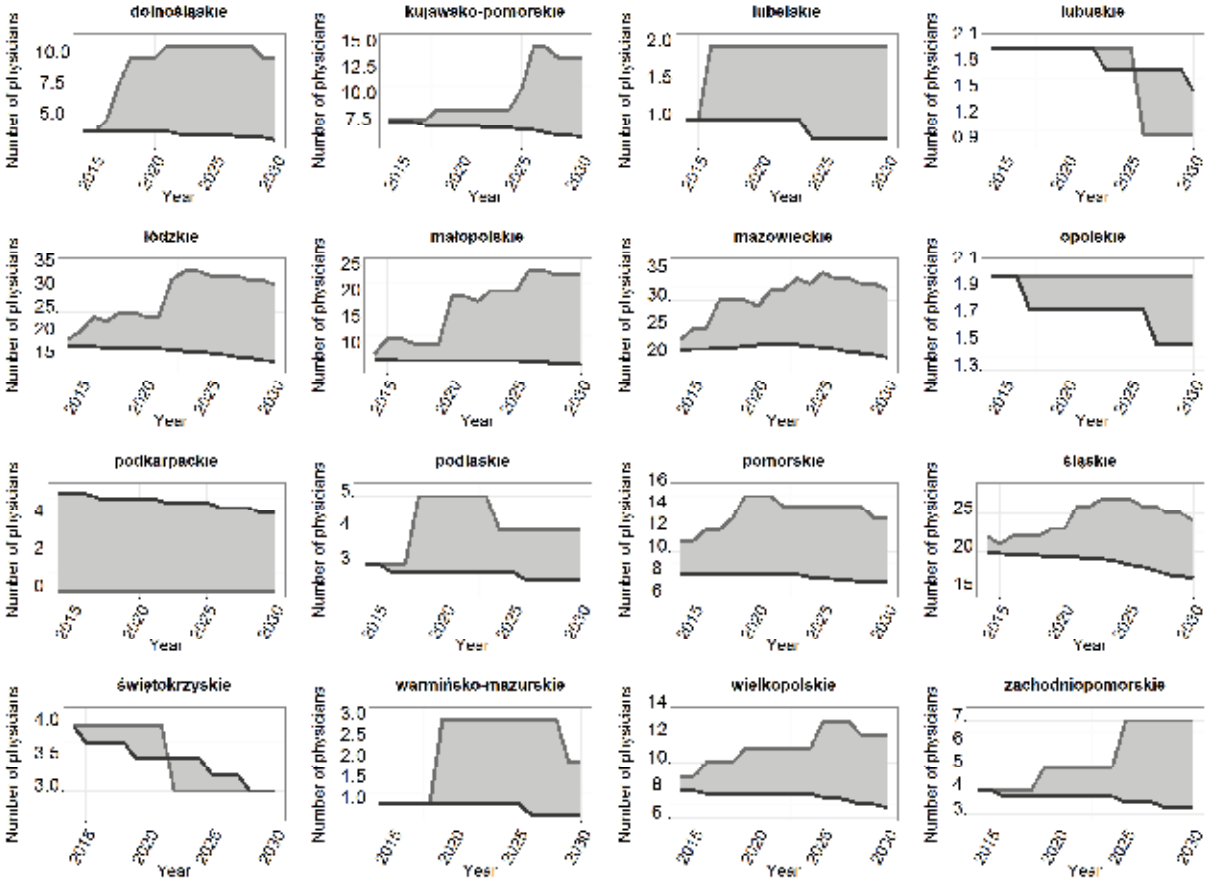

Figure 14. Projection of the number of paediatric cardiologists in voivodeships in 2013–2030 (source: own study)

In two voivodeships (in the Opolskie and Podkarpackie) the projected number of paediatric cardiologists will be constant during the entire projection period, and for the Podkarpackie voivodeship[72] it will mean no paediatric cardiologists (compare Figure 9). In the Lubuskie and Świętokrzyskie voivodeships the number of physicians will decline in the projection period. In the Dolnośląskie, Kujawsko-Pomorskie, Lubelskie, Łódzkie, Małopolskie, Mazowieckie, Podlaskie, Pomorskie, Śląskie, Warmińsko-Mazurskie, Wielkopolskie and Zachodniopomorskie voivodeships the number of physicians will increase in the projection period. In five voivodeships (in the Lubelskie, Łódzkie, Mazowieckie, Pomorskie, Śląskie and Wielkopolskie voivodeships) an initial increase in the number of physicians has been noted, with a subsequent change in this trend. Unfortunately, low projection values make it impossible to analyse the dynamics of changes in voivodeships.

Summary

The purpose of the forecats presented in this article was to point to (additional) medical staff required to maintain a time-constant indicator of the ratio of the number of physicians to the number of new patients (maintaining a constant number of patients per physician). This additional demand (considering the noted rate at which new specialists are entering the market) will need to be fulfilled in 2024 in the case of physicians, and in the case of cardiologists – already in 2020. Additional demand for specialist physicians will increase in the projection horizon to 389 in the case of oncologists and to 655 in the case of cardiologists. However, due to a lengthy process of educating medical staff, the steps necessary for extra recruitment within specializations should be taken as early as today.

Bearing in mind media reports, according to which the current number of physicians is already insufficient in terms of needs, the Authors are aware of the fact that projection values do not take account of every aspect of this phenomenon. However, these projections make it possible to estimate the necessary future demand for medical staff and a proportionate increase of projected values by an index of the current shortfall in medical staff.

[72.] Due to a shortfall in paediatric cardiologists in the Podkarpackie voivodeship, in a scenario where the level of availability of patients to paediatric cardiologists in the Podkarpackie voivodeship is maintained, a nation-wide ratio of paediatric cardiologists to new cases in the base year has been used.

The analysis carried out assumes that the number of new physicians completing a specialization and entering the job market is constant. It is a strong assumption. In reality the number of new specialist physicians may change in time, as decisions on the scale of recruitment within given specializations are taken by self-governments of physicians and result from their strategy and negotiations with other institutions. Therefore, this analysis may serve as a supportive measure in the process of taking decisions on the number of places available within specializations in the coming years.

The medical staff projection in oncology indicated an increase in the number of physicians of those specializations in a scenario where the level of availability of physicians to patients is maintained. Apart from this scenario, an initial increase, rapid decline and a subsequent fall in the number of oncologists employed have been forecast. It has been shown that the rate of change will differ between voivodeships.

As in the case of oncologists, an increase in the number of cardiologists, in a scenario where the level of availability of physicians to patients is maintained, has been projected. Apart from this scenario, an initial increase, rapid decline and a subsequent fall in the number of cardiologists employed have been forecast due to the age profile in this profession. Moreover, it has been observed that the decline rate regarding the number of oncologists and cardiologists differs between voivodeships, which is caused by age heterogeneity.

The projection of paediatric cardiologists indicated an increase in the number of professionally active physicians. However, declining incidence of congenital heart defects (which is the main cause of cardiovascular problems in children) related to the low fertility rate in the country will contribute to a decrease in the number of paediatric cardiologists needed to maintain availability of physicians to patients. It is the only specialization that has been projected to have more physicians than needed to maintain a constant ratio of the number of physicians to the number of new cases.

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