



Assessment of the use of analytical tools in the management of a healthcare entity

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Abstract

Introduction and Objective. Healthcare is one of the strategic areas of social and economic life undergoing continuous and significant systemic changes. Medical institutions are generating increasing amounts of data, which has led in recent years to a noticeable rise in the demand for solutions that enable the creation of well-functioning and efficient analytical tools to support the improvement of management processes in these institutions.

Materials and Method. Data sets (revenue and cost-related) connected with the delivery of healthcare services, collected within internal hospital IT systems, as well as data obtained from applications provided by the National Health Fund, were analyzed. The MSR report enables control over the current performance of services during a given settlement period, both for the entire hospital and for individual organizational units, with a breakdown of the detailed scope of healthcare services provided.

Results. The creation of an innovative analytical tool which supports and streamlines the management process of the entity, is immediately feasible and does not generate additional costs. Automation of controlling methods significantly improves the quality of verification and the effectiveness of optimizing the processes of health service settlements.

Conclusions. The creation and implementation of individualized, automated, dynamic analytical tools enables efficient management of the healthcare entity. The use of aggregated data through analytical tools increases the level of knowledge and awareness regarding the current condition of individual organizational units within the entity. The use of analytical tools supports making accurate and appropriate management decisions, which have a significant impact on the financial efficiency of the facility.

Key words

hospital, financial management, healthcare entity, analytical tools

Abbreviations

BHCS – Basic Hospital Care System; **BI** – Business Intelligence; **CODS** – Costly Outpatient Diagnostic Services; **HIS** – Hospital Information System; **IFMS** – Information Flow Management System; **IT** – Information Technology; **MRS** – Medical Reporting System; **NHF** – National Health Fund; **OSC** – Outpatient Specialist Care; **PLN** – Polish zloty; **QI** – Quality Index; **SFS** – Separately Funded Services

INTRODUCTION

Healthcare, as one of the key sectors of state activity, is an area of dynamic change and constant development. Digitization, globalization, and the automation of processes within medical institutions present these organizations with unique challenges that require accurate and purposeful management decisions [1, 2]. Today, the steadily growing medical services market and the need for their rational management have made reliable information the most valuable — and even strategic — business resource. The increasing volume of data, combined with the growing demand for medical services, forces healthcare institutions to continuously adapt their practices to a changing reality, and to constantly improve their management strategies and methods.

The 2008/2009 study ‘eHealth for a Healthier Europe’,

which involved the Czech Republic, France, The Netherlands, Sweden, Spain, and the United Kingdom, identified and recommended 11 technologies [3, 4]. Despite the recommendations, hospitals still face challenges in effectively analyzing their own data to improve their economic performance [5, 6]. Whose implementation in the healthcare systems of European Union countries would bring measurable benefits—not only political, but above all social and economic. Among these technologies—alongside electronic medical records, electronic patient histories, electronic patient registration, electronic medical orders, barcodes, prescription transfer, and medical documentation systems—is the broadly defined field of Business Intelligence. The practical importance of this research is underlined by statistics showing that hospital expenditures constitute a significant share of national health budgets, with inefficiencies having a direct impact on the quality of care and financial stability [7, 8].

The main directions of development for Poland in this area were defined in ‘The e-Health Poland Digitization Plan

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for the year 2029–2015 (Pol. *Plan informatyzacji e-Zdrowie Polska na lata 2009–2015*) and included:

1. facilitating citizens' access to healthcare information;
2. improving the efficiency of the healthcare system in the area of electronic document circulation;
3. modernizing the medical information system to analyze the demand for provided healthcare services;
4. practical implementation of IT solutions in healthcare, in line with the guidelines of European Commission [9–13], enabling the inclusion of the Republic of Poland in the area of interoperable medical records.

The implementation of digitalization processes in the healthcare system varies in pace across the countries included in the Euro Health Consumer Index 2009 report [14]. Poland ranked 18th out of the 33 evaluated countries. The absence or insufficient availability of comprehensive, centralized solutions for integrating IT systems within medical institutions hinders data collection and, consequently, its reliable analysis. This also leads to additional costs associated with staff training and system maintenance. For smaller medical institutions, a possible solution could be the free use of available analytical tools.

Since October 2017, the financing system for medical institutions has been reformed, introducing the organization and settlement of medical services based on a hospital network that forms the system of basic healthcare provision. This change introduced new rules for funding healthcare services and prompted many medical institutions to take measures to adapt their organizational units to the new conditions [9–15]. Institutions qualified under specific levels of the Basic Hospital Care System – BHCS (Pol. *System Podstawowego Szpitalnego Zabezpieczenia- PSZ*) receive a fixed lump-sum payment (Pol. *ryczałt*) as well as a financial and material plan for the Separately Funded Services – SFS (Pol. *Świadczenia Odrębnie Finansowane – ŚOF*). The so-called 'hospital network Act' created the need for rapid and precise management information regarding the delivery of medical services—particularly the ongoing monitoring of contract performance, including the utilization of the lump sum. Such data directly affect decisions related to the financial resources disbursed by the National Health Fund – NHF (Pol. *Narodowy Fundusz Zdrowia – NFZ*). It has become essential to strengthen control over the settlement and financing of healthcare services within medical institutions through the use of analytical tools. These tools must allow for monitoring the implementation of medical services against the financial and material plan proposed for a given area by the relevant NHF Provincial Branch. They must also support forecasting the cost-effectiveness of the institution by assessing contract performance within a given settlement period [16].

OBJECTIVE

1. To demonstrate that it is possible to create free, individualized, and dynamic analytical tools based on internal resources to support and improve the management process of a medical institution.
2. To present a case study illustrating the process of developing a customized analytical tool, namely the Medical Reporting System – MRS (Pol. *Medyczny System Raportowy – MSR*), designed for effective monitoring of healthcare service delivery, and proper settlement and financing.

3. To demonstrate the positive impact of the implemented analytical tool on financial efficiency—using the example of a first-level hospital within the Basic Hospital Care System – BHCS (Pol. *PSZ*) in the Province of east-central Poland.

MATERIALS AND METHOD

Data sets (revenue and cost-related) connected with the delivery of healthcare services collected within internal hospital IT systems, as well as data obtained from applications provided by the NHF (Pol. *NFZ*), were analyzed. The management team of a first-level hospital within the BHCS (Pol. *PSZ*) undertook its own analytical and implementation Pwork to create a personalized analytical tool—reports within Medical Reporting System (MRS, Pol. *MSR*) designed to efficiently monitor service delivery and ensure proper settlement and financing of healthcare services. The MRS enables control over the current performance of services during a given settlement period, both for the entire hospital and for individual organizational units, with a breakdown of the detailed scope of healthcare services provided [17–19]. The report is based on data sets continuously fed by the internal IT systems of the medical institution as well as external NHF applications, namely:

- Hospital Information System (HIS);
- Information Flow Management System – IFMS (Pol. *System Zarządzania Obiegiem Informacji – SZOI*);
- human resources and remunerations data;
- other sources of internal databases.

RESULTS

The first stage of the project to develop the individualized analytical tool, namely the Medical Reporting System (MRS), included:

1. analyzing the needs of the hospital management, existing IT systems, and the structure of existing databases;
2. defining a standardized method for data acquisition and the scope of information necessary to build the reporting system;
3. analyzing the provider's contracts with the National Health Fund (NHF), including defining the financial and material plan for specific service points and locations,
4. mapping individual service delivery locations in the contracts to the current organizational structure of the medical institution;
5. allocating the funded plan—that is, the lump-sum amount calculated by the NHF Provincial Branch (Pol. *Oddział Wojewódzki NFZ*) for the Basic Hospital Care System (BHCS) for the settlement period—along with precisely defining limits for individual service delivery points.

In the second stage of creating by MRS the final report, the following tasks were undertaken:

1. developing methods for data presentation and visualization necessary to obtain the desired management information;
2. defining a user interface enabling simple and intuitive navigation between the available report summaries;
3. integrating the system with data sources and generating report templates along with defining the parameters that form the basic configuration;

4. designing calculation mechanisms and algorithms to verify data as well as the user interface;
5. defining components that allow exporting reports in graphical or text formats.

The report derived by the MRS is based on up-to-date data retrieved from the Hospital Information System (HIS) and the Information Flow Management System – IFMS (Pol. *System Zarządzania Obiegiem Informacji – SZOI*). The IFMS is an electronic platform enabling two-way data exchange (sending files, statistical messages, settlement documents, reimbursement invoices, signed contract annexes) between the NHF Provincial Branch and healthcare providers. Thanks to this system, for a selected period, we have access to information on:

1. the number of settlement points and their values in the current contract plan;
2. the number of points actually performed and their values under the contract;
3. the number of points completed beyond the limit and their values;
4. the amounts of invoices issued.

The National Health Fund (NHF) provides medical institutions (service providers) with which it has contracts for the public financing of healthcare services, an IT system designed for submitting settlement data, namely IFMS. Using the functionalities available in IFMS, it is possible to obtain information and generate reports regarding the current status of contract fulfillment. However, this process is very time-consuming, especially when there is a need to generate more detailed reports presenting data for individual modules of the service financing agreement – including real-time information on the current utilization of the funding limit for each contract point. For the purpose of automatically retrieving data necessary for further analysis from IFMS, the module called the ‘Provider’s Assistant’ (Pol. *Pomocnik Świadczeniodawcy*) was used. A key component of this tool is the ‘Monit’ module, which allows the retrieval of information regarding the fulfillment of all contracts conceded with the National Health Fund. The ‘Monit’ module automatically retrieves data from IFMS and saves it in an editable Microsoft Excel file. The main benefits of using the ‘Provider’s Assistant’ software include: saving time by eliminating manual data entry, clarity that enables quick analysis, organization of data sets, and high reliability and consistency with the payer’s data. During the analytical work on creating by MRS the personalized report, the first step was to define the scope of information and types of analyses that meet the needs of the hospital management. Additionally, an inventory of the IT systems and the data structure available within the institution’s resources was conducted.

The next stage in creating by MRS the final report involved developing a method for presenting data necessary to obtain the desired management information, and defining parameters that enable the basic configuration of the report. At the same time, a user interface was designed to provide easy and intuitive navigation between the available reports. The construction of a personalized, interactive report—generated in real time based on all available data sources—was made possible by developing calculation mechanisms and algorithms for data verification. It was also essential to create report templates and define components that allow exporting results in both

graphical and textual formats. The analytical tool used for effective monitoring of healthcare service delivery and proper settlement integrates data from the medical institution’s IT systems and processes it automatically.

The detailed report obtained shows the areas of information retrieval (data from the Hospital Information System, designated as the ‘Eskulap’ and ‘Monit’ modules) and includes information about the most recent database update dates, which form the basis for creating the report. The degree of contract fulfillment within individual contract groups is displayed on the main screen of the report (Fig. 1).

The report of a first-level BHCS healthcare provider presents in the first column the types of contracts concluded with the NHF Provincial Branch, grouped into three sections:

- 1) lump sum, along with QI (Quality Index, i.e., quality coefficients).
- 2) Contracts within Separately Financed Services – SFS (Pol. *ŚOF*), including:
 - hospital treatment – services provided in the oncology package (unlimited scope);
 - hospital treatment – services provided outside the oncology package (limited scope);
 - Outpatient Specialist Care – OSC (Pol. *Ambulatoryjna Opieka Specjalistyczna – AOS*) – including services in the oncology package;
 - costly Outpatient Diagnostic Services – CODS (Pol. *Ambulatoryjne Świadczenia Diagnostyczne Kosztochłonne – ASDK*) – computed tomography;
 - eotherapy – services;
 - motherapy – drugs; rehabilitation.
- 3) Contracts outside the BHCS network (newly contracted agreements):
 - drug programmes – services;
 - drug programmes – drugs;
 - CODS (pol. – *ASDK*) – endoscopic examinations;
 - plastic surgery;
 - oncology;
 - nutritious meal (Pol. *dobry posiłek*);
 - prevention;
 - emergency room;
 - night and holiday care (Pol. *nocna i świąteczna opieka zdrowotna*);
 - remunerations increase.

In each of the mentioned sections, within a dropdown list, detailed data is available concerning specific scopes and contract points, along with the following information presented in subsequent columns:

- ‘Financial and Material Plan’ (IFMS) – the value of the financial and material plan proposed by the NHF Provincial Branch in the IFMS; data is retrieved using the ‘Provider’s Assistant’ software.
- ‘HIS Execution’ – the value of performed services; data is collected directly from the Hospital Information System (HIS), based on completed, coded, and properly settled health services.
- ‘IFMS Execution’ – the value of services (in settlement points or in PLN) that have been submitted and accepted by NHF Provincial Branch in the IFMS.
- ‘Execution minus Plan’ – the value of services performed and coded in the hospital HIS system, but not reported to IFMS, and therefore not financed by NHF Provincial Branch.

- Percentage share of reported and financed services – an important management indicator enabling assessment of the level of overperformance or underperformance; it compares the value of services performed to the value of the financial and material plan.
- Un-invoiced amount – a key piece of information placed in the last column, defining the value of services to be realized by the entity in a given settlement period.

The report derived by the MRS includes a field allowing the selection of a specific time range. After selecting the month, the report displays the current values of data in respective columns, and additionally—on the right side—displays cumulative data from January to the end of the selected month. The user can also choose the data presentation format—in settlement points or in values expressed in PLN (Polish currency – złoty).

Besides ongoing monitoring of revenues from NHF for the assessment of the hospital’s and individual departments’ financial results, it is also extremely important to constantly monitor the execution of services within the BHCS lump sum. According to the rule, the amount of the lump sum for the next settlement period (quarter, half-year, or year) depends on the level of health services performed in the current period (Tab. 1).

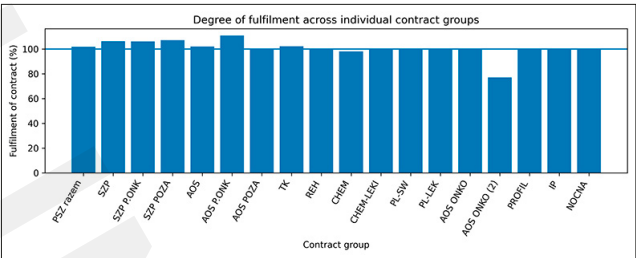


Figure 1. View of the main screen of the report derived by the MRS

The presented tool enables analysis of lump-sum contract fulfilment for individual months, both with and without the inclusion of quality indices. The data is sourced from the IFMS (Information Flow Management System) and the hospital’s HIS (Hospital Information System). The management team receives complete, real-time information on the current contract

fulfilment rate (97.1%) and a forecast of monthly performance through to the end of the year. This enables fully informed and appropriate managerial decisions, ensuring that the provision of services remains within the applicable limits and at a safe level.

The lump-sum amount allocated to a healthcare provider can be increased if the hospital meets specific quality criteria. Thus, the lump-sum financing model an incentive for improvements in the quality of services provided and encourages better control over their volume. The healthcare provider should continuously monitor the provision of medical services within the granted lump-sum amount (ranging from 98% – 100%). This requires daily and systematic oversight from the management team. In this regard, precise, dynamic, automated, and needs-based analytical tools provide essential support (Tab. 3).

The MRS derived report monitoring Quality Index (QI) amounts by month (Fig. 3), demonstrates that the healthcare provider benefits from an increased contract value due to holding an accreditation certificate, a certificate issued by the Central Centre for Quality Research in Microbiological Diagnostics, and a certificate issued by the Central Centre for Quality Research in Laboratory Diagnostics. The data obtained from this analytical tool support managerial decision-making related to monitoring the amounts increasing the contract value, and implementing appropriate quality measures within the healthcare entity.

Aggregated data obtained from customized, dynamic, and automated analytical tools enable the visualization of revenues generated from contracts with the National Health Fund between 2018 -2023, across selected organizational units of the hospital. These data also demonstrate the positive impact of analytical tool utilization on the financial performance of the healthcare provider.

The value of healthcare services provided under the lump-sum payment system (Pol. *ryczałt*) between 2018–2023 is presented in Figure 2.

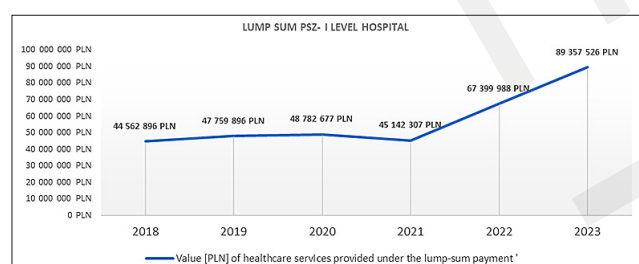
Thanks to the reliable data reported by the analytical tool, the hospital’s management team was able to monitor an area that showed an upward trend between 2018–2021. The slight decline recorded in 2021 was the result of objective factors, namely, the ongoing COVID-19 pandemic. This situation was immediately processed and reported to the management team by the analytical tool. As a result,

Table 1. Detailed report on monitoring the fulfilment of lump-sum contracted services by scope

Category	January	February	March	April	May	June	July	August	September	October	November	December	SUM 2022
Accreditation certificate coefficient	34 701	35 426	35 706	58 017	46 145	46 145	97 396	60 792	54 382	57 027	55 719	79 328	660 784
Coefficient for certificate issued by the National Centre for Quality Assessment in Microbiological Diagnostics	17 351	17 713	17 853	29 008	23 073	23 073	48 698	30 396	27 191	28 513	27 859	39 664	330 392
Coefficient for certificate issued by the National Centre for Quality Assessment in Laboratory Diagnostics	17 351	17 713	17 853	29 008	23 073	23 073	48 698	30 396	27 191	28 513	27 859	39 664	330 392
QI Adjustment Coefficient [PLN]	69 403	70 852	71 413	116 033	92 290	92 290	194 792	121 584	108 765	114 054	111 437	158 655	1 321 568

Table 2 View of the main screen of the report derived by the MRS.

Category	Financial and material plan (SZOI)	Execution HIS	Execution SZOI	No reported	% of reported	Invoices SZOI	Execution HIS minus PLAN (SZOI)	Unfulfilled	Above limit	% of fulfilment vs limit	Invoicable amount
Hospital treatment – PSZ		67 551 093	67 551 093	0	100.0%						0
LUMP SUM, with QI	67 399 988	67 551 093	67 551 093	0	100.0%	67 399 988	151 104	0	151 104	100.2%	0
LUMP SUM without QI	66 078 420	67 551 093	67 551 093	0	100.0%	67 399 988	151 104	0	1 472 673	102.2%	0
Hospital treatment	5 154 060	5 509 685	5 509 685	0	100.0%	5 509 685	355 625	-3 360	358 985	106.9%	-358 985
Hospital treatment ONKOLOGY PACKAGE	1 434 601	1 543 857	1 543 857	0	100.0%	1 543 857	109 256	0	109 256	107.6%	-109 256
Hospital treatment OUTSIDE ONKOLOGY PACKAGE	523 488	562 890	562 890	0	100.0%	562 890	39 402	0	39 402	107.5%	-39 402
Outpatient Specialist Care	2 242 068	2 294 313	2 294 167	145	100.0%	2 294 167	52 244	-241	52 486	102.3%	-52 339
Outpatient Specialist Care ONKOLOGY PACKAGE	157 171	176 537	176 537	0	100.0%	176 537	19 366	-4	19 371	112.3%	-19 371
Outpatient Specialist Care OUTSIDE ONKOLOGY PACKAGE	124 621	125 087	121 147	3 939	96.9%	121 147	466	-2 549	3 014	100.4%	0
Computed tomography	560 914	574 235	574 640	-405	100.1%	574 640	13 321	0	13 321	102.4%	-13 726
Rehabilitation	6 826 474	6 844 248	6 844 248	0	100.0%	6 844 248	17 774	-6 647	24 422	100.3%	-24 422
SEPARATELY FINANCED SERVICES (SFS)	17 023 397	17 630 851	17 627 172	3 679	100.0%	17 627 172	607 454	-12 801	620 256	103.6%	-617 500
SUM OF CONTRACTS (LUMP SUM without QI + SFS)	83 101 817	85 181 944	85 178 265	3 679	100.0%	85 027 161	2 080 127	-12 801	2 092 928	102.5%	-617 500
Chemotherapy HOSPITAL TREATMENT	1 074 041	1 051 064	1 051 064	0	100.0%	1 051 064	-22 977	-22 977	0	97.9%	0
Chemotherapy DRUGS	268 930	269 771	269 771	0	100.0%	269 771	841	-3 737	4 579	100.3%	-4 579
DRUG PROGRAMS – services	50 733	50 733	50 733	0	100.0%	50 733	0	0	0	100.0%	0
DRUG PROGRAMS – drugs	650 452	650 448	650 448	0	100.0%	650 448	-4	-4	0	100.0%	0
Outpatient oncology	382 916	382 953	381 562	1 391	99.6%	381 297	37	-68	105	100.0%	265
Ambulatory endoscopy	117 014	90 241	90 241	0	100.0%	90 241	-26 773	-26 773	0	77.1%	0
Prevention	45 996	45 996	45 996	0	100.0%	45 996	0	0	0	100.0%	0
Emergency room	2 450 277	2 450 277	2 452 474	-2 197	100.1%	2 452 474	0	0	2 197	100.0%	-2 197
Night and holiday care	2 934 507	2 934 507	2 935 007	-500	100.0%	2 935 007	0	0	500	100.0%	-500
Covid	3 376 155	3 376 155	3 376 155	0	100.0%	3 368 122	0	0	0	100.0%	8 032
Costs (remuneration increase on all contracts)	5 490 541	5 369 517	5 369 517	0	100.0%	5 369 517	-121 024	-121 024	0	97.8%	0
ALL CONTRACTS	99 943 380	101 853 606	101 851 233	2 373	100.0%	101 691 831	1 910 226	-187 385	2 100 308		-616 478

**Figure 2.** Value [PLN] of healthcare services provided under the lump-sum payment (Pol. *ryczalt*) between 2018–2023

corrective management actions were undertaken, leading to a significant increase already in 2022 (PLN 67,399,988), followed by another substantial rise in 2023 (PLN 89,357,526). It can be reasonably stated that the reliable insights provided by the analytical tool enabled the hospital to navigate the

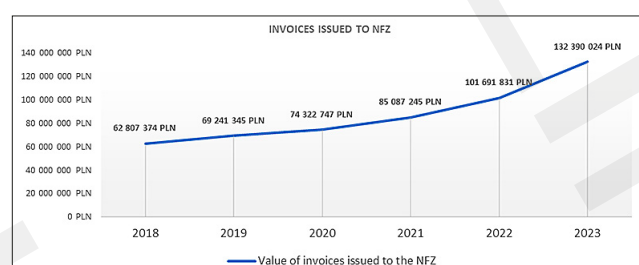
financial challenges of the pandemic period without major risks or strategic threats.

The value of invoices issued to the National Health Fund for completed and settled healthcare services in the years 2018–2023 (Fig. 3).

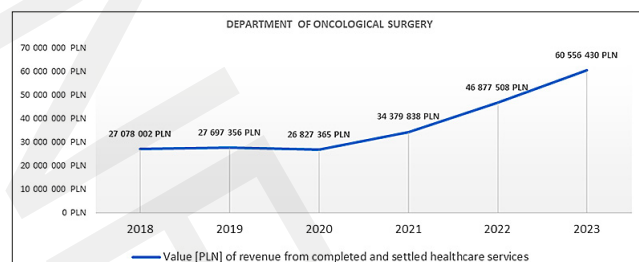
In the presented area, over the six-year period analysed, no downward trends were observed. Constant supervision of this issue, made possible through ongoing and reliable reporting by analytical tools, resulted in a steadily increasing value of invoices issued to the NHF. A systematic upward trend can be seen from 2018 – PLN 62,807,374; 2019 – PLN to 2023 – PLN 132,390,024. Thanks to the implementation of the analytical tool, invoice management proved financially beneficial and efficient for the hospital. A correctly issued invoice is the basis for the payer (NHF) to transfer funds to the hospital. From a financial standpoint, this is a strategically advantageous situation for the healthcare provider.

Table 3. Report Screen of the MRS – Monitoring of Quality Indicator (QI) amounts by month.

Monitoring of Quality Indicator (QI) amounts by months January–December 2022 [PLN]													
Category	January	February	March	April	May	June	July	August	September	October	November	December	SUM 2022
Accreditation certificate coefficient	34 701	35 426	35 706	58 017	46 145	46 145	97 396	60 792	54 382	57 027	55 719	79 328	660 784
Coefficient for certificate issued by the National Centre for Quality Assessment in Microbiological Diagnostics	17 351	17 713	17 853	29 008	23 073	23 073	48 698	30 396	27 191	28 513	27 859	39 664	330 392
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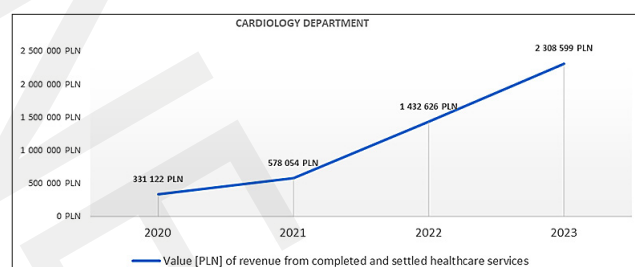
**Figure 3.** Value of invoices issued to the NHF for healthcare services provided and settled in 2018–2023

Revenue from completed and settled healthcare services in 2018–2023 in the Oncological Surgery Department of the first-level hospital under the basic hospital care network (Figure 4).

**Figure 4.** Value [PLN] of revenue from completed and settled healthcare services in 2018–2023 in the Oncological Surgery Department of a first-level hospital under BHCS

In 2018–2019, the value of the completed contract remained at a similar level (PLN 27,078,002 in 2018 and PLN 27,697,356 in 2019). In 2020, a slight decrease to PLN 26,827,365 was observed, caused by the ongoing COVID-19 pandemic. This situation was automatically identified, processed, and reported to the management by the analytical tool. Equipped with reliable information, the management undertook appropriate actions. As a result, there was a significant increase in the value of the completed contract in 2021 (PLN 34,379,838), followed by further growth in 2022 (PLN 46,877,508) and 2023 (PLN 60,556,430). The availability of real-time, reliable data made it possible to swiftly implement actions that led to a substantial improvement in the value of the completed contract in the Oncological Surgery Department.

Value [PLN] of revenue from completed and settled healthcare services in 2020–2022 in the Cardiology Department of a first-level hospital under the basic hospital care network (BHCS) (Figure 5).

**Figure 5.** Value [PLN] of revenue from completed and settled healthcare services in 2020–2023 in the Cardiology Department of a first-level hospital under BHCS

Thanks to the use of aggregated reports generated by the analytical tool, it was possible to make appropriate management decisions between 2020–2023, which allowed for maintaining a consistent upward trend in the value of the completed contract with the NHF in the Cardiology Department. The significant increase in recent years resulted from a higher number of completed healthcare services in the field of invasive cardiology.

The value of the realized contract over the six-year period showed an upward trend, except for the year 2020. The decrease in 2020 to PLN 6,050,344 was caused by the coronavirus pandemic. This situation was promptly detected by the analytical tool, processed, and reported to the management staff of the healthcare entity. This allowed for appropriate decisions to be made, which ultimately led to a significant increase in the value of the realized contract with the NHF—to PLN 10,052,067 in 2022 and PLN 12,018,249 in 2023.

The aggregated data presented in the chart indicate that the dynamics of contract fulfillment with the NHF in the area of internal medicine were not uniform. A significant decline in revenue was recorded in 2020, followed by an even larger drop in 2021. This was the result of the ongoing coronavirus pandemic, which prevented the contract from being fulfilled at a satisfactory level. This situation was promptly detected by the analytical tool, properly processed, and reported to the management team. Thanks to the information obtained, appropriate corrective actions were taken, which

in the following years translated into an improvement in the financial situation of the healthcare entity.

The significant increase in the value of the contract fulfilled with the NHF (PLN 6,844,248 in 2022 and PLN 11,173,771 in 2023) was the result of management actions aimed at increasing the delivery of healthcare services in the field of gastroenterology. In this case as well, it can be stated with full confidence that thanks to the rapid and automated response of the analytical tool, the hospital's financial situation has noticeably improved.

The presented data indicate that the value of the contract realized with the NHF during the analyzed period showed an upward trend, except for the year 2020, which recorded a decline caused by the ongoing coronavirus pandemic. The revenue drop in 2020 was immediately analyzed by the analytical tool and reported to the management team, who then implemented a series of managerial actions. These actions resulted in a clear increase in contract realization values in 2021, 2022, and 2023. The upward trend is consistently visible in the subsequent years. In this case, the analytical tool effectively fulfilled its role, positively impacting the hospital's financial situation and economic efficiency.

The aggregated data processed by the analytical tools indicate that, thanks to the use of customized solutions and well-informed managerial decisions based on generated information, the value of the executed contract during the analyzed period showed a consistent upward trend. Importantly, this growth was not disrupted even by the coronavirus pandemic in 2020 and 2021.

The creation and practical use of individualized analytical tools—as direct support for decision-making at the operational level—lead to further improvements [16]. One such improvement is the ability to present data visually – interactive, dynamic charts and diagrams assist in understanding the processes of handling complex data, and facilitate drawing specific conclusions. Analysis of data contained in analytical reports can also help identify areas where patient care quality raises concerns, enabling rapid corrective actions. Another undeniable advantage of analytical tools is automated reporting — instead of manual report creation, the process is fully automated, saving time and minimizing the risk of errors. The most important argument for developing and using customized analytical tools is undoubtedly their accuracy, lack of additional costs, and ability to present data in real time. This is crucial for the quality of the entire healthcare facility's operations and its overall operational effectiveness.

DISCUSSION

Despite advances in science and IT technology, hospitals still face challenges in effectively integrating operational and financial data to optimize performance [20, 21, 22]. Barriers existing in Polish legal regulations and in economic transactions, primarily related to the current IT infrastructure and concerning the low efficiency of publicly operated IT solutions, limit the ability to use BI (Business Intelligence) tools [23, 24, 25]. This results in difficulties in collecting data from incompatible systems functioning across various healthcare entities throughout the country. Such a situation necessitates the implementation of proprietary, local solutions that enable the analysis of statistical data regarding healthcare services provided to patients, used to improve the operational

efficiency of the healthcare entity (accurate reporting), and consequently, to secure a specific level of funding.

Creating effective, individualized, personalized, and dynamic analytical tools based on internal resources enables easy access to information gathered within the healthcare entity and efficient management of that information. It also allows for the flexible exploration of medical, business, and especially financial data of the unit. Proper integration and processing of this information becomes a source of knowledge that plays a crucial role in the sale of medical services, assessment of market opportunities, improvement of financial efficiency, risk minimization, and planning of future actions – such as optimizing bed utilization, shaping hospital medication policy, or planning staffing norms. The ability to use this knowledge in daily operations provides a competitive advantage and enables more effective acquisition of new, profitable contracts with the National Health Fund. Daily work with personalized analytical tools thus becomes essential for every manager, allowing faster and more effective responses to medical and economic events occurring within the healthcare entity. This directly impacts financial efficiency, which in turn translates into strategic clinical effectiveness.

Development and implementation of a Medical Reporting System. An MRS aimed at supporting management processes in a healthcare facility is technically feasible to accomplish in a relatively short time – especially by utilizing modern open-source technologies. With licenses for operational software, the hospital can acquire data generated by these systems and process it locally according to its own needs. The development of such a reporting system requires at minimum:

- analysis of user requirements and needs;
- designing interfaces and operational logic;
- implementation (software development);
- tests;
- integration with an existing Hospital Information System.

Work with the system can begin with simple modules that can be implemented in a very short time. Their purpose is to quickly provide basic reporting functionality for the hospital management staff, enabling data-driven decision-making.

Systems base functions are:

- data import;
- management panel displaying key indicators;
- ability to generate reports based on data filtering;
- responsive interface enabling work in all conditions.

If the system is to analyze data such as performance indicators, patient information, or resource utilization, two elements are crucial: high data quality and appropriate analytical algorithms. The data must be complete, consistent, up-to-date, and accurate. Proper preparation is essential, including cleaning, standardizing formats, filling in gaps, and eliminating errors. Analytical algorithms should be tailored to the nature of the data (e.g., medical data, which is often sensitive and heterogeneous) and take into account privacy and security issues. The choice of specific algorithms depends on the purpose of the analysis, and appropriate statistical models are selected accordingly. In the near future, it will also be possible to use more advanced analytical techniques based on artificial intelligence.

Automating controlling methods improves the quality of verification and optimization of healthcare service

settlements. This is achieved because automated systems can compare data from multiple sources (e.g., medical documentation, invoices, contracts with the NHF), faster and more accurately than a human. They are also used to detect inconsistencies, coding errors in procedures, or incorrect assignment of services by utilizing control algorithms. Thanks to real-time access to automated analyses, faster operational and strategic decision-making is possible. Reports are generated automatically and can include real-time data. These systems eliminate many common human errors, such as mistakes in ICD-10/ICD-9 codes, incomplete data, or non-compliance with NHF guidelines. More advanced solutions analyze costs and revenues, identifying areas with the greatest savings potential. They can also indicate unprofitable or incorrectly settled procedures, enabling corrections before reports are sent to the payer. The automation of analytical tools in healthcare significantly improves the quality, effectiveness, and safety of settlement processes, and consequently enhances the efficiency of the entire healthcare entity. The use of analytical tools therefore promotes making accurate and appropriate management decisions, which directly impacts the financial efficiency of healthcare facilities.

Key analytical tools in managing healthcare entities include operational and financial controlling. Implementing these tools allows for the division of responsibility for the financial situation between the management board and the heads of individual organizational units. This enables middle management, such as department heads, to make more informed decisions, positively impacting the financial efficiency of the facility. Another useful analytical tool is ratio analysis, which uses financial indicators such as profitability, liquidity, and debt levels to precisely assess the financial condition of the entity. This analysis helps identify areas requiring improvement and implement corrective actions, which is crucial for maintaining financial stability. Personalized analytical tools allow, among other things, better budget planning, identification of costs and revenues related to specific services, optimization of resource utilization, and making informed investment decisions based on reliable data analysis. This leads to increased financial transparency, which can facilitate obtaining additional sources of funding. The integration of local, customized analytical tools in the management process forms a foundation for making accurate decisions that directly translate into improving the financial efficiency of healthcare facilities.

CONCLUSIONS

- 1) The creation of an innovative analytical tool, namely a Medical Reporting System (MRS) for the hospital, which supports and streamlines the management process of the entity, is immediately feasible and does not generate additional costs.
- 2) Automation of controlling methods significantly improves the quality of verification and the effectiveness of optimizing the processes of health service settlements.
- 3) The operation of analytical tools has a direct impact on the financial efficiency of the healthcare entity.
- 4) The creation and implementation of individualized, automated, dynamic analytical tools enables efficient management of the healthcare entity.
- 5) The use of aggregated data through analytical tools increases the level of knowledge and awareness regarding

the current condition of individual organizational units within the entity.

- 6) The use of analytical tools supports making accurate and appropriate management decisions, which have a significant impact on the financial efficiency of the facility.

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