

Analysis of Performance Indicators Applied in A University Hospital Conveniated to the Brazilian Hospital Services Company

Júlia Lorena Marques Gurgel¹, Hélio Roberto Hékis¹, Rafael Monteiro de Vasconcelos¹, Ricardo Alexsandro de Medeiros Valentim², Custódio Leopoldino de Brito Guerra Neto², Amália Cinthia Meneses Rêgo³, Irami Araújo-Filho^{2*}.

¹Federal University of Rio Grande do Norte – UFRN, Graduate Program in Production Engineering – PPGEP/UFRN, Natal, RN, Brazil;

²Federal University of Rio Grande do Norte – UFRN, Graduate Program in Management and Innovation in Health – PPGGIS/UFRN, Natal, RN, Brazil;

³Postgraduate Program in Biotechnology at Potiguar University / UnP - Laureate International Universities; Brazil

Available Online: 25th September, 2018

ABSTRACT

Introduction: In Brazil, university hospitals have fundamental importance in the evolution of the Unified Health System (SUS) and in several areas that favor the improvement of the health conditions of the population. Thus, this article aims to analyze performance indicators of the Onofre Lopes University Hospital, located in the northeast region of the country, before and after joining the management contract with the Brazilian Hospital Services Company (EBSERH). **Methods:** In order to perform this study, the authors selected performance indicators in hospital organizations and analyzed the comparative of the bienniums 2011-2012 and 2014-2015, based on the performance index matrix. The 32 indicators are organized in terms of structure and results, and in the categories: installations, human resources, revenue, production, productivity, quality, costs and teaching/research/extension. **Results:** The results show better performance of the indicators in the biennium 2014-2015. The authors attribute this evolution of the performance indexes to the expansion and reorganization of the work team, to the increase in revenue, to structural reforms and to the provision of new services to the population. **Conclusion:** The small number of studies that relate the results of the indicators in a periodic comparison of the same hospital is noticeable. Therefore, is essential the monitoring, analysis and dissemination of these indicators.

Keywords: Hospitals, University; Quality Indicators, Health Care; Health Impact Assessment; Process Assessments (Health Care).

INTRODUCTION

Key performance indicators, with the purpose of increasing the performance in organizations, have been an international theme that is increasingly of interest to academics and professionals working in companies¹⁻⁴. Particularly in the segment of hospital organizations, key performance indicators have been used as a tool to boost performance in their essential functions⁵⁻⁹. Although the hospital organization has among its functions to understand value, create value and deliver value to its clients¹⁰⁻¹², according to Drucker^{15,16}, innovation is the only essential function of the twenty-first century organization that permeates all the value chain in the organization.

Due to the need to develop treatments for various diseases, health professionals are expected to overcome the limitations and to make innovations in techniques and therapeutic approaches. In this sense, university and teaching hospitals linked to the public sector have at least three different roles involving the provision of medical

treatment, teaching of future physicians and incentives to research⁹.

In Brazil, the teaching hospitals have a fundamental importance in the evolution of the Unified Health System (SUS), in several areas that favor the improvement of the health conditions of the population¹⁷. Despite the high social relevance of these organizations, this did not prevent them from going through several operational crises. Precarious physical installations, underutilization of installed capacity for high complexity, and insufficient servers are factors that restrict the offer of services to the community.

The administration of Brazilian University Hospitals (HU's) is historically linked to the Federal Universities related to the Brazilian Ministry of Education (MEC), which provide assistance services to SUS clients, through public agreements with municipal and state managers. Consequently, the effectiveness of these organizations depends on the level at which management establishes a unifying purpose, given the variety of professionals

cooperating with each other, defining and implementing appropriate business and clinical strategies¹⁸. As a way of equating the problem of the precariousness of the labor force in irregular contracts, allowing financial autonomy and glimpsing the perspective of raising of own

resources, was created, through Federal Law 12.550 of December 15 of 2011, the Brazilian Hospital Services Company (EBSERH), with a new legal proposal to manage university hospitals, preferably federal, setting performance targets, deadlines and indicators^{19,20}.

Table 1: Hospital Performance Indicators.

Perspectives	Indicators	Perspectives	Indicators
Innovation and Growth	• Absenteeism rate	Installations	• Number of operational beds
	• Incentive plan		• Number of beds installed
	• Number of communication projects for Access to hospital services		• Number of clinics
	• Employee satisfaction score		• Number of emergency rooms
	• Number of meetings for planning activities		• Number of operating rooms
	• Hours of training per employee		
	• % Employees involved in development plans		
Human Resources	• % Technology investment	Financial	• Liquidity Ratio
	• Number of teachers		• Average collection period
	• Number of administrative technical servers		• Average payment period
	• Hours of training / employee / year		• Operating margin
Production	• Absenteeism rate	Productivity	• Asset Turnover
	• Churn rate		• Return on Investment
	• Number of hospitalizations		• Return on equity
	• Number of outpatient procedures		• Hospital Occupancy Rate
	• Patients-days		• Adult ICU occupancy rate
	• Total number of consultations		• Pediatric ICU occupancy rate
	• Number of outpatient visits		• Neonatal ICU Rate
	• Number of emergency and emergency calls		• Rotation Turn
	• Number of surgeries		• Replacement range index
	• Number of exams		• Consultation / Practice / Day
Teaching and research	• Number of births	Quality	• Surgery / Ward
	• Number of medical residency programs		• Donation rate of organs per approach
	• Number of medical residents		• Average stay
	• Number of other residence programs		• Server / operational bed
	• Number of residents of other programs		• Hospital Infection Rate
	• Number of inmates		• Mortality rate
	• Number of students in the health science center		• Necropsy rate
	• Number of searches performed		• Patient Satisfaction
	• Residents / Operational beds or Teaching Intensity		• Number of accreditations issued
	• Residents / Physicians or Teaching Dedication		• Prevalence rate of hospital accidents
Cost and Revenue	• Average cost of hospitalization day	Process	• Success for hospitals in obtaining quality management certificates
	• Average cost of outpatient care		• The percentage of appropriate written nursing documents
	• Average Cost Attendance		• Percentage of students in nursing training courses
	• Average value per AIH		• Percentage of students passing through medical training
	• Average value per outpatient procedure		• The percentage of appropriate prescriptions
• SUS Revenue Started	• Percentage of antibacterial prescription	• Clinical Chemistry Lab Score	

<p>Input</p> <ul style="list-style-type: none"> ▸ Number of beds ▸ Number of doctors ▸ Number of other medical professionals ▸ Number of nurses ▸ Total full-time equivalent employees ▸ Number of hospital beds ▸ Labor costs ▸ Length of stay ▸ Number of health professionals ▸ Number of other employees 	<p>Output</p> <ul style="list-style-type: none"> ▸ Hematology laboratory score ▸ Immunology laboratory score ▸ Bacteriological laboratory score ▸ Number of days of hospitalization ▸ Number of outpatient / emergency visits ▸ Number of person-time using expensive medical devices ▸ In-hospital survival rate ▸ Interruption of the adjusted price mix index ▸ Total non-emergency outpatient visits ▸ Outpatient visits ▸ Emergency ▸ Diagnosis ▸ Operations ▸ Number of patient's days ▸ Number of minor operations ▸ Number of main operations ▸ Admissions ▸ Assistance to the Department of Ambulances ▸ Deliveries
---	--

Source: Own authorship.

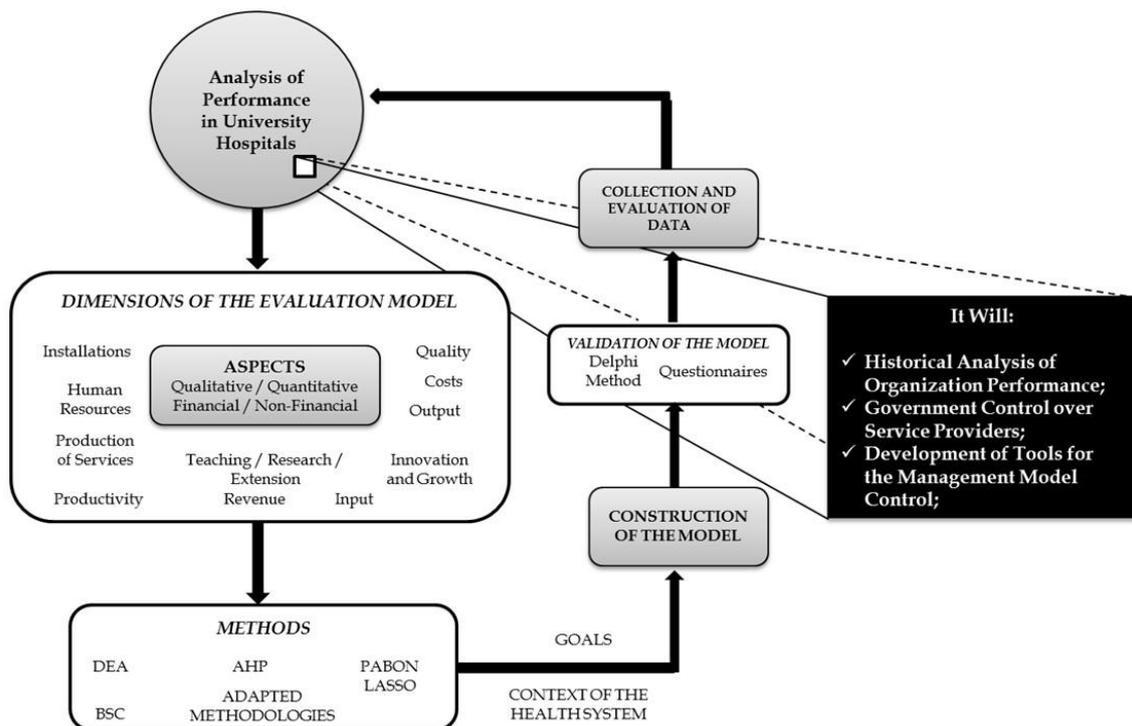


Figure 1: framework of the performance analysis model in university hospitals.

This model of management adds to the existing public structure the creation of a public company of private law through legislation constituted by the Brazilian federal government for administrative management of university hospitals in the country²¹. The network of federal university hospitals is comprised of 50 assistance units linked to 35 federal universities. Of these hospitals, 39

(78%) chose to sign the management contract with EBSEH²².

Among the university hospitals that joined EBSEH, in Brazil, the Federal University of Rio Grande do Norte (UFRN) signed an adherence agreement on August 29 of 2013, to partner in the administration of its 3 hospital units, namely: Onofre Lopes University, Januário Cicco

maternity school and Ana Bezerra University Hospital, the latter located in the interior of the state of Rio Grande do Norte (RN).

With all these significant changes for the improvement of the management, it is relevant that there is monitoring of

performance indicators of these hospitals. In this sense, Gospodarevskaya and Churilov²³ argue that the performance indicator is important to ensure government

Table 2: Data collected for the measurement of performance indicators of the Onofre Lopes University Hospital, Natal-RN-Brazil

Structure		Dimensions				Result						
Categories	Indicators	Biennium 1		Biênio 2		Categories	Indicators	Biennium 1		Biênio 2		
		2011	2012	2014	2015			2011	2012	2014	2015	
installations	Number of ICU beds in operation	13	10	18	19	Production of Services	Number of hospitalizations	4.6	5.2	6.2	8.6	
	Number of beds in operation	204	231	239	241		Number of Hospitalizations of High Complexity	767	1.0	1.2	2.1	
	% of ICU beds over total operational beds (%)	6,37	4,32	7,53	7,88	Number of Ambulatory Care	133	131	172	218		
	Number of offices	81	81	106	106	Number of Surgeries	35	66	82	31		
	Number of Installed Surgery rooms	12	12	12	12	Number of Exams	332	263	480	610		
	Number of surgery rooms in operation	12	12	12	12	Productivity	Hospital Occupancy Rate	70,18	73,47	75,23	78,13	
	Number of Outpatient Clinics	12	12	13	13		Adult ICU occupancy rate	80,22	85,87	92,13	87,99	
	Number of Clinical and Pathology Laboratories	2	2	2	2	Average Permanence	10,13	10,83	10,3	8,59		
	Human Resources	Number of Teachers	-	-	289	433	Costs	Average Cost Patient per day Internship	253,13	264,99	287,09	324,13
		Number of Technical-Administrative Servers / Year	-	-	1.913	1.607		Quality	General Mortality Rate	5,26%	4,95%	4,25%
Incoming	Revenue / Year	30.976.055,24	35.032.603,69	37.116.486,04	48.818.345,48	Teaching, Research and Extension	Number of undergraduate students	2154	2317	2500	1968	
	Average Value by AIH - SUS	2.409,62	2.473,55	2.755,04	2.563,90		Number of Graduates of the	92	92	91	91	

hospital admission					Medicine course				
Average	10,43	9,46	10,6	10,14	Number of students	29	29	29	29
Ambulatory Procedure					Graduates of the Medicine course				
					Number of Medical Residents	117	124	-	216
					Number of Multiprofessional Residency Programs	2	2	2	3
					Number of Uniprofessional Residency Programs	1	1	1	1
					Nº of Extension Projects carried out at the Hospital	48	50	54	54
					Number of Projects Analyzed by CEP	136	297	501	454
					Number of Projects Approved by CEP	112	155	316	283

Source: Own authorship.

control over service providers, in order to guarantee quality in a system that has efficiency, effectiveness and equity as objectives. From this, it is possible for management to understand the historical analysis of its performance, establish tools that contribute to the control of the new managerial model and conduct in a supported manner its actions.

Taking into account the relevance of this subject for the management of the University Hospitals and the EBSEH, we accomplished an analysis of performance indicators at Onofre Lopes University Hospital before and after joining the management contract with the Brazilian Hospital Services Company.

Preliminary research

In the design of health organizations, an indicator is considered as a call that identifies or directs attention to specific outcome issues that should be the subject of a review. Thus, they are considered as indicators: rate or coefficient, index, absolute number (Nº) or fact²⁴. That is, to be an indicator, it is not necessary to perform a calculation through data and/or information of the organization, being able of measure quantitative and qualitative aspects.

Through the triad of factors presented by Donabedian²⁵ - structure, process and results - it is possible to form groups or perspectives of different indicators that are used in evaluations through the objective of the evaluation model. In order to broaden the understanding of these dimensions included in the measurement of hospital performance, a list of performance indicators based on Arzamani et al.²⁶, Bittar²⁷, Brizola, Gil and Junior²⁸, Basu, Howell and Gopinath²⁹, Careta³⁰, Cunha and Corrêa³¹, Lins et al.³², Lobo et al.³³, Marinho and Façanha³⁴, Marinho³⁵, Mohammadkarim et al.³⁶, Nasiripour, Gohari and Moradi³⁷, Nikjoo, Beyrami and Jannati³⁸, Sadeguiifar et al.³⁹, Trotta et al.⁹ and Zaboli, Seyedin and Khosravi⁴⁰.

The Framework, Fig. 1, considers that to the development of a model of Performance Analysis in University Hospitals, are observed certain dimensions and aspects. Some methodologies are already consolidated and others are adapted in accordance with the objectives and context of the Health System, in which the organization is inserted. According to Rahimi et al.⁴¹ studies on indicators for hospital performance evaluation using different methodologies to evaluate performance, such as: Data Envelopment Analysis (DEA), Balanced Scorecard (BSC),

Table 3: Matrix of accumulated indices of performance of the indicators by analytical categories - biennium B1-B2

Structure	Dimensions				
	Biennium		Result	Biennium	
Category	B1	B2	Category	B1	B2
Installations	6,19	6,97	Production of Services	2,86	4,38
Human Resources	Insufficient analysis	data for	Productivity	2,64	2,88
Incoming	2,50	2,82	Costs	0,98	0,83
			Quality	0,74	0,94
			Teaching, Research and Extension	6,32	7,62

Source: Own authorship.

Process Technique of Analytical Hierarchy (AHP) and the Pabon Lasso Model.

With the construction of the model, the validation is fulfilled by specialists in the area, requiring constant revision and updating of the model criteria. After the collection, it is made the analysis that will allow the visualization of the historical performance and the development of tools and policies for the improvement of the management.

Lobo et al.⁴² report that the main indicators and the policy impact measures to improve the performance of these hospitals and the efficiency in the management of resources passed through the goal contract have been debated. Therefore, the great problem involves precisely the relationship between quantity and quality of indicators.

METHODS

A study was carried out at the Onofre Lopes University Hospital (OLUH), which has a history of more than 107 years in the training of professionals in the health and related areas, as well as in the provision of health services to the population in more than 30 specialties. It is a medium-sized hospital, given the number of beds available, 245 in total, being its installed capacity bigger than the other university hospitals in the state of Rio Grande do Norte.

The study that most approached the characteristics and objectives of this research was the Brizola, Gil and Junior²⁸, which consisted in the performance analysis of a teaching hospital before and after contracting SUS. In an adapted manner, the research methodology was carried out around the adhesion to the OLUH management contract with EBSERH.

With the choice of method, was defined the indicators that would be grouped in two dimensions: Structure and Result, distributed in 8 (eight) analytical categories: facilities, human resources, revenue, production, productivity, costs, quality, teaching/research/extension.

With this, some professionals with experience in the management of health organizations identified and suggested the most relevant indicators for performance analysis. After that, the data were collected at the hospital to measure the indicators per year.

The research project was approved by the Research Ethics Committee of the Onofre Lopes University Hospital (OLUH), registered with CAAE (Certificate of

Presentation for Ethical Appreciation) N°. 53277816.4.0000.5292, and the collection was made after the letter of agreement was issued and appreciation of CEP/OLUH.

Performance Index Matrix: Overview

For the comparative analysis of performance, the Performance Index Matrix was elaborated, so that each indicator was classified in a range from zero to one, for which, in view of the best expected situation, the value 1 was assigned and for the others, proportional values²⁸. As a result, it was possible to evaluate the results for bienniums, with biennium 1 (2011-2012) related to the period prior to EBSERH accession, and biennium 2 (2014-2015) corresponding to the later period.

The data were collected from October 2015 to April 2016, through information provided by the planning sector and through the Management Application for University Hospitals (AGHU)/EBSERH, MV2000[®] system used until then as OLUH hospital computer system, as well as information collected in the Teaching and Research Management. Parametric and non-parametric statistical tests were not performed considering that the sample size is insufficient to perform them.

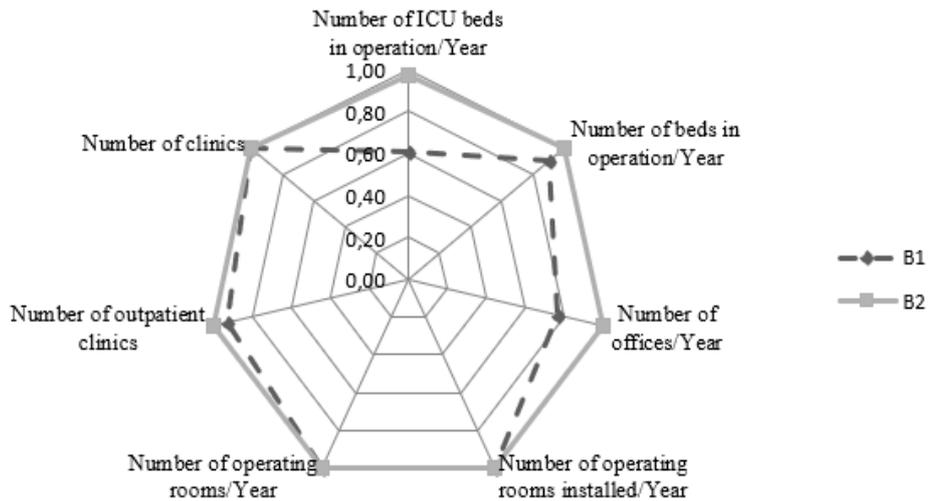
The organization and structuring of the matrix of performance indices were performed in Excel[®] Software, as well as elaborated graphs and tables that enabled the best visualization and understanding of the analysis in the two biennia. In order to subsidize the results found, the search for information in the OLUH regarding changes and/or events that implied in the improvement or the decline in the performance of the indicators.

RESULTS

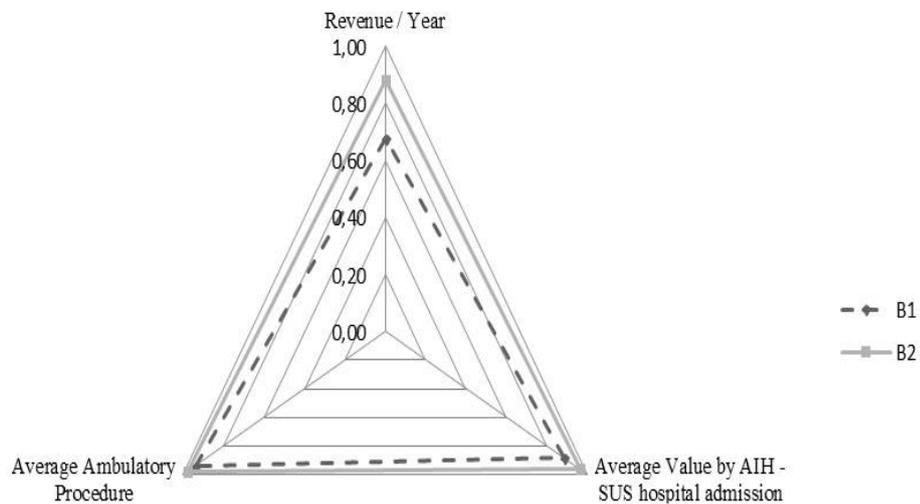
The performances of the categories will be presented, in which it was possible to collect the data in the two biennia for the analysis. The two years prior to joining the management contract with EBSERH (2011-2012) are called Biennium 1 or B1 and the two subsequent years (2014-2015), Biennium 2 or B2. The analyzes presented below were taken from the annual quantitative data obtained from each indicator analyzed, as shown in Table 2.

Structure Indicators

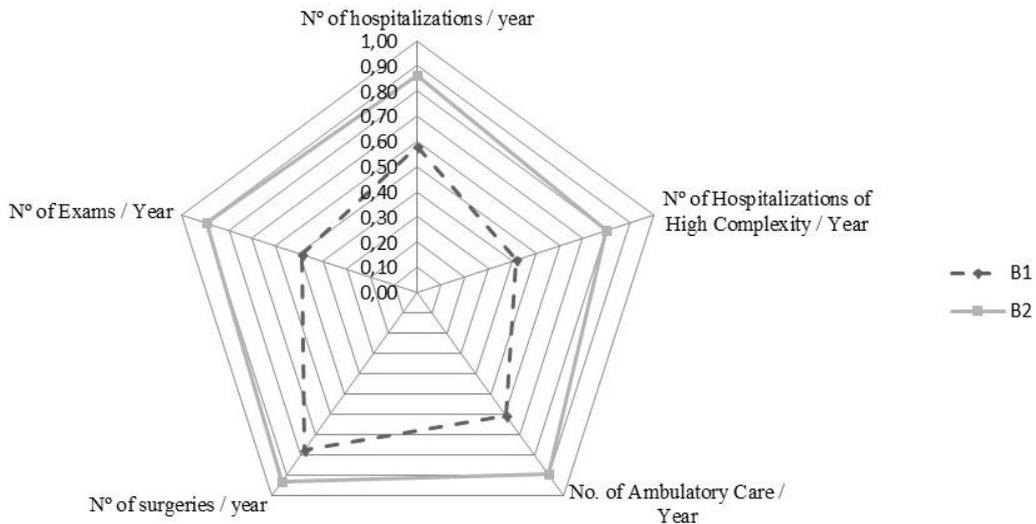
The structure is established as the physical part of an institution, corresponding to its employees, instruments, equipment, furniture, aspects related to the organization,



Graph 1: Performance of the structure indicators referring to the facilities category in biennia 1-2 in OLUH.



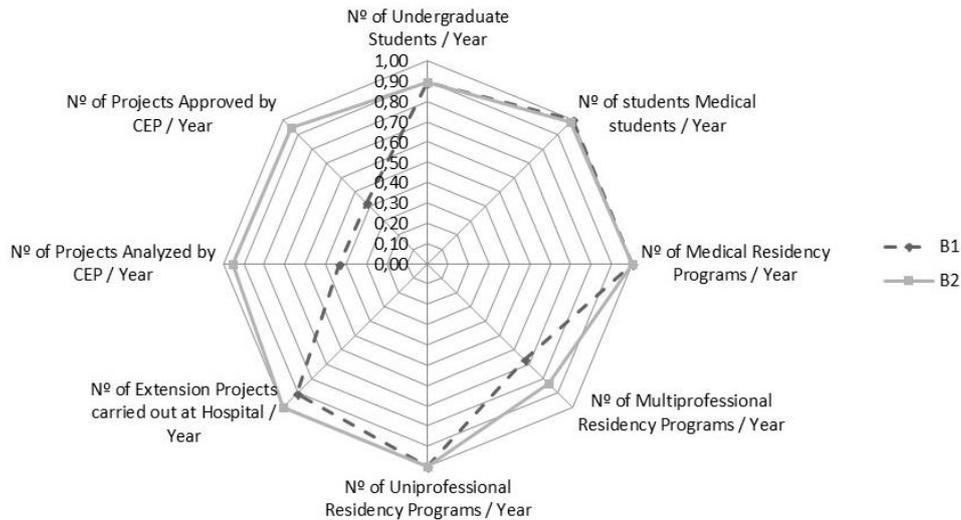
Graph 2: Performance indicators in the revenue category in biennia 1 and 2 in HUOL.



Graph 3: Performance indicators of the category production of services in biennia 1 and 2 in HUOL.

physical space, among others²⁴. It includes factors that delimit the organization's ability to function, corroborating with the organization's production variation.

The matrix of distribution of financial resources to federal university hospitals is instituted by the Brazilian Ministry of Education⁴³, according to the relation made by this



Graph 4: Performance indicators of the teaching/ research/ extension category in biennia 1 and 2 in HUOL.

among some indicators with the respective results expected by number of active beds in HUs. In this case, the results of the OLUH indicators related to the structure, that is, the size and profile of the HU, score punctuation, considering that in the analyzed years the indicators are within the corresponding range of values with respect to the number of Intensive Care Unit (ICU) beds, 10 to 29, with the number of active beds, 150 to 299 and operating rooms, 5-7 rooms.

Regarding Human Resources, the data collected were insufficient to accomplish the analysis and comparison of performance, being possible only access to the data of the Biennium 2. It was estimated the arrival of more than 1,100 employees among teachers and administrative technicians, through public tender, after joining the OLUH /EBSERH management agreement.

The referenced values of the revenue category in Table 2 represent the revenue entered, corresponding to the budget revenue per year; the average amount paid for hospital admission in the SUS AIH (Hospital Inpatient Authorization); and the average amount paid for hospital admission and outpatient procedure. For the most part, the indicators of the categories of the structure dimension had an increase in the valuation. In order to prove the performance improvement, the matrix of performance indices was elaborated, which is represented in Table 3, through of indexes accumulated by biennium in the categories analyzed in the study. It is important to note that when there is an increase in the value of the Biennium 1 to the Biennium 2, it is indicated that there was an improvement in the performance in the indicators.

In a visual way, some graphs will be shown by categories. The performance of the installation indicators in the two bienniums, before and after joining the EBSEH management contract, is represented in Graph 1. The dashed line refers to the performance of the Biennium 1, and the continuous line, the performance of the Biennium 2.

To analyze the performance of the indicators shown in Graph 1 and Graph 2, it is important to consider that this type of Radar Graph shows that the best results are the

most external, given the proximity of the highest performance values. Therefore, for the most part, performance indicators showed better results in the biennium 2.

Outcome Indicators

Results are evidence of the consequent effects of the combination of factors of the environment, structure and processes that happened to the patient after something is done to him or the consequence of technical and administrative operations between the areas and subareas of an organization²⁴. In this way, this information is related to and has implications for the performance of the structure indicators. Also shown in Table 3 are the accumulated indices of the results indicators per categories.

The indicators that measure production are considerable for the different types of benchmarking, as well as for the internal business perspective, in the use of the balanced scorecard²⁴.

The increase in the number of attendance was a result of the expansion and reorganization of the work team, and due to the increase in the capacity of the offer, more patients were taken care of, allowing the creation of specific outpatient clinics. Thus, the quality of patient care increased, which is of fundamental importance for the training of qualified personnel in health, since the residents, besides a larger number of cases for discussion, have gained access to a more specialized perception.

The performance of service production indicators in the two biennium is shown in Graph 3. It is also possible to visualize the impact of the growth of this category, considering the distance shown in the graph between the lines representing the bienniums.

Regarding the productivity category, it is also essential for several types of benchmarking, being considered as classic indicators, such as the hospital occupancy rate, which is sensitive for the evaluation of hospital beds management, indicating aspects of the management of the care process. According to the Brazilian Ministry of Education⁴³, hospitals are punctuated from a 60% occupancy rate, with a higher score having occupancy equal to or greater than 70% of the hospital rate. In the OLUH, this rate increased

Table 4: SWOT analysis for the development of improvements for university hospitals.

		Forces	Opportunities		
Internal environment		Quality of care provided by the Hospitals of Education (HE) are superior to those provided in non-HEs; Capable of providing atypical or particularly severe treatment for complex, highly specialized and innovative diseases; Provide professionals and researchers to improve their Skills; Promotes and incorporates new technologies; Promotes teacher-care integration.	Establishment of staff training courses to improve relationships Ensure self-sustainability; Optimization of funding sources; Be able to innovate, with the objective of reaching levels of excellence; Integration of HUs functions to achieve a joint service; Implementation of external communication activities; Structuring and constant revision of the performance indicators framework; Be able to articulate politics with society.	External Environment	
		Weaknesses HEs are less efficient than non-HEs; It is difficult to allocate costs for HE functions; HEs have higher costs than non-HEs; In general, the calculation of indicators and reports for external accountability are not tied to internal quality management processes.	Threats The current lack and need for efficiency, which seriously threatens the prospects for survival and development of these organizations; An increasing need to reconcile the improvement of service quality with economic sustainability and fair financial systems.		

Source: Based on Botje et al. [8], Trotta et al. [9] and Rahimi et al.⁴¹

from 70.18% to 78.13%, showing a better performance in the second biennium. These rates are within the average of the hospitals evaluated by the Hospital Quality Commitment Program (CQH) in 2008, which was 72%.

Some factors differentiate the average hospital stay, such as the complexity of the hospital, the role of hospital admission via the emergency room and the patients' clinical profile⁴⁴. It is important to highlight that, for the valuation of this indicator, the lower the value, better the performance.

Regarding the ICU occupancy rate, the Brazilian Ministry of Health⁴⁵ recommends a minimum rate of 90%. Thus, it was verified that both the Occupancy Rate of ICU and the average of stay in the OLUH had a considerable improvement after the EBSEH management, being possible to verify the increase of the accumulated indices, as shown in Table 3.

Considering the costs category, the data collected allowed only the measurement of the average cost patient/day hospitalized indicator. It is necessary to emphasize that these values must be updated for the last month of the year 2015. After the analysis, this indicator showed that there was an increase in the average cost per day of hospitalization in the second biennium. This result is explained by the increase in high complexity care, which, as a consequence, increased hospital costs. For a more effective evaluation of costs, it is necessary to carry out an investigation by economic-financial indicators, in which the decision-makers observe the cost-benefit of the resources that are being used.

Among the indicators of the quality category, only the general mortality rate indicator, shown in Tables 2 and 3, was measured, in which the performance of the biennium

2 was improved. The Brazilian Ministry of Health⁴⁵ pointed out that teaching hospitals and high complexity had institutional mortality rates ranging from 3.4% to 6.8%, with OLUH being within these recommended parameters.

In the category of teaching/research/extension indicators, the OLUH performance analysis, presented in Table 3, is related to the indicators that could be collected for measurement and a posteriori analysis.

It was found that, for all the teaching/research/extension indicators, there was an increase in the average indices of the biennium analyzed. Among the indicators that performed best, are those related to the research. The increase in the number of research was due to a restructuring of the Ethics Committee of OLUH, with the adhesion of new component members, allied to the use of the Brazil Platform for the submission of research projects in a computerized way, making the submission and follow-up of the procedures more agile.

In the medical residency programs, the vacancies granted to OLUH were extended after approval by the National Medical Residency Commission. The performance of the teaching/research/extension indicators in the two bienniums, before and after joining the EBSEH management contract, are represented in Graph 4.

DISCUSSION

Innovative contributions and practical implications

The results of this research have several practical implications. Only three implications will be presented. The first practical implication is the strategic leadership of hospitals that can use research results to encourage the culture of key performance indicators among all hospital

staff. In the second practical implication, coordinators of undergraduate courses in the health area may insert new disciplines or extracurricular activities that promote the learning of key performance indicators in hospital organizations aimed at improving performance.

With regard to these implications, in Brazil, the UFRN started the activities of the Postgraduate Program in Health Management and Innovation (PPGGIS) in the second half of 2017, in order to contribute to the scientific and technological development and professional training in health, in consonance with the policies of Education, Health and Science, Technology and Innovation. It is important to note that this postgraduate course is held in order to encourage the participation of employees who are in direct contact with the procedural rules and unfolding possible strategic innovations of procedural rules, as well as in the construction and diffusion of knowledge and development of tactics for the occupation of spaces in the care network, requiring pedagogical projects that integrate with the services and of the teaching - care work.

Still in relation to the supporters of the hospital indicators measurement and monitoring initiative, the Laboratory of Technological Innovation in Health (LTIH) was created in March 2011, which is based on a combination of health knowledge, engineering and information technologies and communication. The LTIH is located in OLUH and constitutes the first laboratory installed in a Brazilian hospital with the proposal to promote technological innovation in health.

The third practical implication is the managers of public health policies at the federal, state and municipal level. Public policy managers will be able to formulate structuring programs that foster the insertion of culture of key performance indicators into public hospital organizations, with a focus on performance enhancement. With respect to the last inference, EBSEH manages the Management Application for University Hospitals (AGHU), which aims to support the standardization of healthcare and administrative practices of Federal University Hospitals and allow the creation of national indicators, which facilitates adoption of common improvement projects for these hospitals. Therefore, it is essential to discourse the main performance indicators and their results among hospitals, so that exchanges of experiences and best practices are made. All these measures potentiate the formulation of culture and public policies for the development and improvement of HUs.

Table 4 presents the SWOT analysis for the development of improvements for university hospitals, highlighting the main strengths and weaknesses in the perspectives of the internal and external environment of these organizations. These aspects are essential for the construction of a model for evaluation and development of innovation in university and teaching hospitals. In this context, several indicators are available for evaluation of hospital performance, and their use depends on the models, the goals of the executive managers and the evaluators' point of view, so that the hospital managers select a combination of quantitative and qualitative indicators to monitor their performance accurately⁴¹.

CONCLUSIONS

From the understanding evaluation/analysis models of indicators in university teaching hospitals, it was possible to notice the small number of studies that relate the results of the indicators in a periodic comparison within the same hospital environment, in the form of an earlier and posterior analysis (crossover). Most of the studies are performed to classify positions or rank, as to the efficiency of the analyzed hospitals, in a separate and comparative way between different health units.

In the case of the performed study, it was possible to observe that the indicators of the Result dimension had a more significant improvement than those of the Structure dimension. There was an increase in the number of hospitalizations of high complexity, laboratory, pathological and ambulatory visits. The improvement of six categories analyzed is attributed to the expansion and reorganization of the work team, increase of revenue, structural reforms and the provision of new services to the population. Therefore, monitoring, analysis and dissemination of these indicators is essential.

After OLUH joined the EBSEH network, changes were made to the technological restructuring, the recovery of the human resources framework, the progressive increase of the institutional budget and the improvement of activities related to teaching, research, extension and assistance. The improvement of the management processes is evident, in view of the access to the information after joining the management contract is better structured and organized, even for the realization of the present study.

The activities of the Graduate Program in Management and Innovation in Health, from the Laboratory of Technological Innovation in Health, and the use of the management application for university hospitals in conjunction with the network administration by the Brazilian Hospital Services Company, inserted in the reality of the Onofre Lopes University Hospital are important factors in establishing improvements for hospital development.

In this sense, Tiemam and Schreyögg report that the governments of western industrialized countries, identifying the inefficiencies and financial risks of public hospitals, have tried to improve the performance of health organizations through privatizations in the expectation that the shifting from public to private ownership would lead to gains in organizational performance. This kind of change in the management of university hospitals is something that has already been happening in other countries, making it almost obligatory for the improvement of these organizations.

The detailing and the investigation of aspects related to the perception of the actors involved in this organizational change were outside the scope of the present study. Therefore, it is inferred that these factors should be analyzed in future studies. Finally, it is important to highlight that this organizational change is still recent and that it should trigger several other impacts in the different analyzed categories of Onofre Lopes University Hospital.

DECLARATIONS SECTIONS

List of Abbreviations

AGHU: Management Application for University Hospitals; AHP: Process Technique of Analytical Hierarchy; AIH: Hospital Inpatient Authorization; BSC: Balanced Scorecard; CAAE: Certificate of Presentation for Ethical Appreciation; CQH: Hospital Quality Commitment Program; DEA: Data Envelopment Analysis; EBSEH: Brazilian Hospital Services Company; HE: Hospitals of Education; HU: University Hospitals; OLUH: Onofre Lopes University Hospital; ICU: Intensive Care Unit; LTIH: Laboratory of Technological Innovation in Health; MEC: Brazilian Ministry of Education; PPGGIS: Postgraduate Program in Health Management and Innovation; RN: Rio Grande do Norte; SUS: Unified Health System; UFRN - Federal University of Rio Grande do Norte.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The research project was approved by the Research Ethics Committee of the Onofre Lopes University Hospital (OLUH), registered with CAAE (Certificate of Presentation for Ethical Appreciation) N°. 53277816.4.0000.5292, and the collection was made after the letter of agreement was issued and appreciation of CEP/OLUH.

COMPETING INTERESTS

The authors declare that they have no competing interests.

FUNDING

The study was funded by authors' resources.

AUTHORS' CONTRIBUTIONS

JG and HH designed the study. IAF contributed to the collection of data. RV, CN, and RV conducted data analysis. JG, ACMR, IAF wrote the first draft of the manuscript. All authors contributed to the interpretation of the conclusions and approved the final draft of the manuscript.

AVAILABILITY OF DATA AND MATERIAL

The data were collected from October 2015 to April 2016, through information provided by the planning sector and through the Management Application for University Hospitals (AGHU)/EBSEH, MV 2000® system used until then as OLUH hospital computer system, as well as information collected in the Teaching and Research Management.

ACKNOWLEDGEMENT

We are grateful to OLUH employees for giving their time and energy to respond to interview questions and assist in collecting survey data.

REFERENCES

1. Hill L. High Performance Management. Boston: Harvard Business School Publishing. Electronic; 1995.

2. Zaffron L, Steve D. Performance Management: The Three Laws of Performance: Rewriting the Future of Your Organization and Your Life (1st ed.) São Francisco: Jossey-Bass; 2009.
3. Buckingham M, Goodall A. Reinventing performance management. *Havard Business Review*. 2015; 93(4):40-50.
4. Cappeli P, Tavis A. The performance management revolution. *Havard Business Review*. 2016; 94(10):58-67.
5. Pastinen M High-Performance process improvement. Springer Science & Business Media; 2010.
6. Ferry L, Murphy P, Zakaria Z, & Zakaria Z. Implementing Key Performance Indicators in a government agency: a typical story? *Journal of Finance and Management in the Public Services*. 2015; 14(2):1-15.
7. Steve R. Developing and Using Key Performance Indicators A Toolkit for Health Sector Managers. Bethesda, MD, Health Finance & Governance Project, Abt Associates Inc. 2013.
8. Botje D, Asbroek G, Plochg T, Anema H, Kringos D, Fischer C, Wagner C, Klazinga N. Are performance indicators used for hospital quality management: a qualitative interview study amongst health professional and quality managers in the Netherlands. *BMC Health Services Research*. 2016; 16(1):574.
9. Trotta A, Cardamone E, Cavallaro G, Mauro M. Applying the balanced scorecard approach in teaching hospitals: a literature review and conceptual framework. *The international journal of health planning and management*. 2013; 28(2):181-201.
10. Pink G, Mckillop I, Schara E, Preyra C, Montgomery C, Baker G. Creating a balanced scorecard for a hospital system. *Journal of Health Care Finance*. 2001; 27(3):1-20.
11. Chow C, Ganulin D, Haddad K, & Williamson J. The balanced scorecard: a potent tool for energizing and focusing healthcare organization management. *Journal of Healthcare Management*. 1998; 43(3):263-280.
12. Dejong D. Quality improvement using the Baldrige criteria for organizational performance excellence. *American Journal of Health-System Pharmacy*. 2009; 66(11):1031-1034.
13. Gibberd R, Hancock S, Howley P, Richards K. Using indicators to quantify the potential to improve the quality of health care. *International Journal of Quality in Health Care*. 2004; 16(1):37-43.
14. Lee S, Alexander J, Wang V, Margolin F, Combes J. An Empirical taxonomy of hospital governing board roles. *Health Services Research*. 2008; 43(4):1223-1243.
15. Anderson JC, Narus JA, & Narayandas D. Business Market Management: Understanding, Creating and Delivering Value, 3^a ed. Pearson Prentice Hall, 2009.
16. Drucker P. Innovation and Entrepreneurship-Practices and Principles, Butterworth-Heinemann, 1985.
17. Barata L, Mendes J, Bittar O. Hospitals of teaching and the unique health system. *Rev. adm. Saúde*. 2010; 12(46):7-14.

18. Langaber J, Napiewocki J. *Competitive Business Strategy for Teaching Hospitals*. Quorum Books, London, 2000.
19. Oliveira G. The compatibility of the principles and model of State that underlies SUS and EBSEPH (Brazilian Company of Hospital Services). Dissertation (Master in Social Sciences) - Faculty of Philosophy, Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, Brazil. 2014.
20. Palhares D, Cunha A. Bioethical reflections on the Brazilian company of hospital services (EBSEPH). *Latin American Journal of Bioethics* [online]. 2014; 14(1):122-129.
21. Melo T, Almeida M. Public-Private Partnership: private management in university hospitals in the Great Northern River. *Revista Saúde Pública Santa Catarina*. 2014; 7(3):46-62.
22. Brazilian Company of Hospital Services. *University Hospitals / EBSEPH Branches*. [http://http://www.ebserh.gov.br](http://www.ebserh.gov.br). Accessed 05 July 2017.
23. Gospodarevskaya E, Churilov L. Process performance indicators in redesigning the patient care process. *Business Process Management Journal*. 2011; 17(6):1012–1038.
24. Bittar O. Indicators of quality and quantity in health. *Revista de Administração em Saúde – RAS*. 2001; 3(12):21-22.
25. Donabedian A. Quality Assurance in Our Health Care System. *American Journal of Medical Quality*. 1986; 1(1):6-12.
26. Arzamani M, Pournaghi S, Katooli S, Moghadam A. The comparison of performance indicators in educational hospitals of North Khorasan Universities of Medical Sciences with the standards of the country in 2011-2012. *J North Khorasan U Med Sci*. 2012; 4(4):513-21.
27. Bittar O. Indicators of quality and quantity in health. *Revista de Administração em Saúde – RAS*. 2004; 6(22):15-18.
28. Brizola J, Gil C, Junior L. Analysis of performance of a teaching hospital before and after contracting with the Unified Health System. *Revista de Administração em Saúde – RAS*. 2011; 13(50):7-22.
29. Basu A, Howell R, Gopinath D. Clinical performance indicators: intolerance for variety? *Int J Health Care Qual. Assur*. 2010; 23(4):436-49.
30. Careta C. Measurement of performance of logistics activities: multiple case study in university teaching hospitals. Thesis of Doctorate. University of São Paulo. 2013.
31. Cunha J, Corrêa H. Organizational Performance Assessment: An Applied Study in Philanthropic Hospitals. *Journal of Business Administration*. 2013; 53(5):485-499.
32. Lins M, Lobo M, Silva A, Fiszman R, Ribeiro V. The use of data envelopment analysis (DEA) for the evaluation of Brazilian university hospitals. *Rev. Ciência & Saúde Coletiva* [on line]. 2007; 12(4):985-98.
33. Lobo M, Bloch K, Fiszman R, Oliveira M, Ribeiro. University Hospitals Information System (SIHUF / MEC): an administrative database. *Caderno Saúde Coletiva*. 2006; 14(1):149-62.
34. Marinho A. *University Hospitals: indicators of utilization and efficiency analysis*. Rio de Janeiro: Institute of Applied Economic Research. 2001.
35. Marinho A, Façanha L. *The University Hospitals: comparative evaluation of technical efficiency*. Rio de Janeiro: Institute of Applied Economic Research. 2001.
36. Mohammadkarim B, Jamil S, Pejman H, Seyyed M, Mostafa N. Combining multiple indicators to assess hospital performance in Iran using the Pabon Lasso Model *The Australasian medical journal*. 2011; 4(4):175-9.
37. Nasiripour A, Gohari M, Moradi S. The Relationship of centralization, organizational culture and performance indexes in teaching hospitals affiliated to Tehran University of Medical Sciences. *Acta Medica Iran*. 2010; 48(5):326-31.
38. Nikjoo R, Beyrami H, Jannati A. Selecting hospital's key performance indicators, using analytic hierarchy process technique *Journal of Community Health Research*. 2013; 2(1):30-38.
39. Sadeghifar J, Ashrafrezaei N, Hamoozadeh P, Taghavi Shahri M, Shams L. The relationship between performance indicators and degree evaluation of hospitals affiliated to Oromia University of Medical Sciences. *J Nurs Midwif*. 2011; 9(4):270-6.
40. Zabolli R, Seyedin S, Khosravi S. Effect of per – case reimbursement on performance indicators of a military hospital's wards. *J Mil Med*. 2011; 13(3):155-8.
41. Rahimi H, Khammar-nia M, Kavosi Z, Eslahi M. Indicators of Hospital Performance Evaluation: A Systematic Review. *International Journal of Hospital Research*. 2014; 3(4):199-208.
42. Lobo M, Lins M, Silva A, Fiszman R. Performance evaluation and teacher-care integration in university hospitals. *Revista Saúde Pública* [online]. 2010; 44(4):581-590.
43. Ministry of Education. Establishes the matrix of distribution of financial resources to federal university hospitals. (2012) Ordinance n. 1.256, of October 17, 2012. Brazil, Official Gazette of the Union.
44. Ministry of Health. Technical file: Institutional Mortality Rate. National Agency of Supplementary Health, Brazil <ftp://www.ans.gov.br/images/stories/prestadores/E-EFT-02.pdf>. (2012) Accessed 27 October 2016.
45. Ministry of Health. Technical Data Sheet: General Operational Occupancy Rate. National Agency of Supplementary Health, Brazil <ftp://www.ans.gov.br/images/stories/prestadores/E-EFI-01.pdf>. (2012) Accessed 27 October 2016.
46. Tiemann O, Schreyögg J. Changes in hospital efficiency after privatization. *Health care management science*. 2012; 15(4):310-326.