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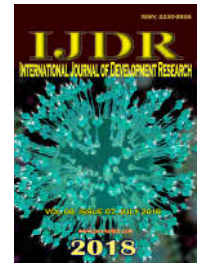
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ANALYSIS OF PERFORMANCE INDICATORS APPLIED IN A UNIVERSITY HOSPITAL CONVENIATED TO THE BRAZILIAN HOSPITAL SERVICES COMPANY

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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.

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INTRODUCTION

Key performance indicators, with the purpose of increasing the performance in organizations, have been an international

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theme that is increasingly of interest to academics and professionals working in companies (Hill, 1995; Zaffron, 2009; Buckingham, 2015 and Cappeli, 2016). Particularly in the segment of hospital organizations, key performance indicators have been used as a tool to boost performance in their essential functions (Pastinen, 2010; Ferry, 2015; Steve,

2013; Botje, 2016 and Trotta, 2013). Although the hospital organization has among its functions to understand value, create value and deliver value to its clients (Pink, 2001; Chow, 1998 and Dejong, 2009), according to Drucker (Anderson, 2009 and Drucker, 1985), 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 research (Trotta, 2013). 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 population (Barata, 2010). 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 strategies (Langaber, 2000). 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 (Oliveira, 2014 and Palhares, 2014). 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 country (Melo, 2014). 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 EBSERH (<http://www.ebserh.gov.br>). Among the university hospitals that joined EBSERH, in Brazil, the Federal University of Rio Grande do Norte (UFRN) signed an adhesion 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 Churilov (Gospodarevskaya, 2011). argue that the performance indicator is important to ensure government 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 EBSERH, 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 (N°) or fact (Bittar, 2001). 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 Donabedian (Donabedian, 1986) - 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. (2012), Bittar (2004), Brizola, Gil and Junior (2011), Basu, Howell and Gopinath (2010), Careta (2013), Cunha and Corrêa (2013), Lins et al. (2007), Lobo et al. (2006), Marinho and Façanha (Marinho, 2001), Marinho, (Marinho, 2001), Mohammadkarim et al. (Mohammadkarim, 2011), Nasiripour, Gohari and Moradi (2010), Nikjoo, Beyrami and Jannati (2013), Sadeghifar et al. (Sadeghifar, 2011), Trotta et al. (2013) and Zaboli, Seyedin and Khosravi (2011). 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. (2014), studies on indicators for hospital performance evaluation using different methodologies to evaluate performance, such as: Data Envelopment Analysis (DEA), Balanced Scorecard (BSC), 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. (Lobo, 2010), 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.

MATERIALS AND 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

Table 1. Hospital Performance Indicators

Perspectives	Indicators	Perspectives	Indicators
Innovation and Growth	<ul style="list-style-type: none"> • Absenteeism rate • Incentive plan • Number of communication projects for Access to hospital services • Employee satisfaction score • Number of meetings for planning activities • Hours of training per employee • % Employees involved in development plans • % Technology investment 	Installations	<ul style="list-style-type: none"> • Number of operational beds • Number of beds installed • Number of clinics • Number of emergency rooms • Number of operating rooms
Human Resources	<ul style="list-style-type: none"> • Number of teachers • Number of administrative technical servers • Hours of training / employee / year • Absenteeism rate • Churn rate 	Financial	<ul style="list-style-type: none"> • Liquidity Ratio • Average collection period • Average payment period • Operating margin • Asset Turnover • Return on Investment • Return on equity
Production	<ul style="list-style-type: none"> • Number of hospitalizations • Number of outpatient procedures • Patients-days • Total number of consultations • Number of outpatient visits • Number of emergency and emergency calls • Number of surgeries • Number of exams • Number of births 	Productivity	<ul style="list-style-type: none"> • Hospital Occupancy Rate • Adult ICU occupancy rate • Pediatric ICU occupancy rate • Neonatal ICU Rate • Rotation Turn • Replacement range index • Consultation / Practice / Day • Surgery / Ward • Donation rate of organs per approach • Average stay • Server / operational bed
Teaching and research	<ul style="list-style-type: none"> • Number of medical residency programs • Number of medical residents • Number of other residence programs • Number of residents of other programs • Number of inmates • Number of students in the health science center • Number of searches performed • Residents / Operational beds or Teaching Intensity • Residents / Physicians or Teaching Dedication 	Quality	<ul style="list-style-type: none"> • Hospital Infection Rate • Mortality rate • Necropsy rate • Patient Satisfaction • Number of accreditations issued • Prevalence rate of hospital accidents • Success for hospitals in obtaining quality management certificates
Cost and Revenue	<ul style="list-style-type: none"> • Average cost of hospitalization day • Average cost of outpatient care • Average Cost Attendance • Average value per AIH • Average value per outpatient procedure • SUS Revenue Started 	Process	<ul style="list-style-type: none"> • The percentage of appropriate written nursing documents • Percentage of students in nursing training courses • Percentage of students passing through medical training • The percentage of appropriate prescriptions • Percentage of antibacterial prescription • Clinical Chemistry Lab Score • Hematology laboratory score • Immunology laboratory score • Bacteriological laboratory score
Input	<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 	Output	<ul style="list-style-type: none"> • 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

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 Junior (2011), 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

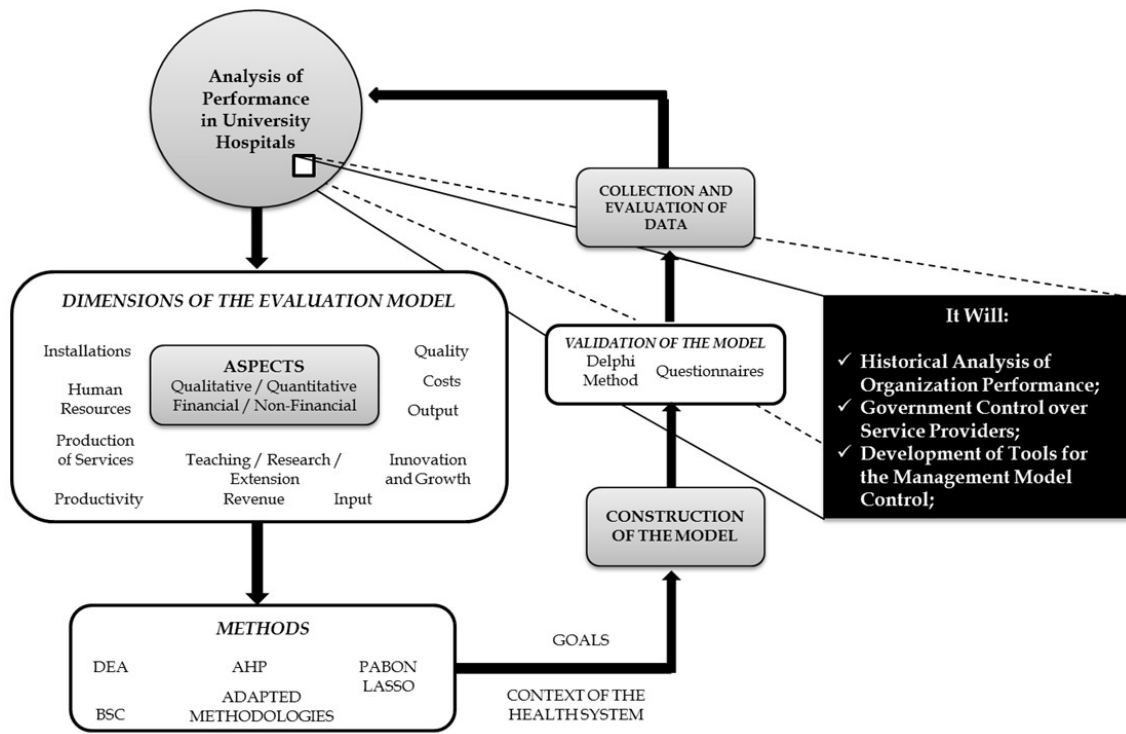


Fig. 1. Framework of the performance analysis model in university hospitals

around the adhesion to the OLUH management contract with EBSEH. 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 values [28]. As a result, it was possible to evaluate the results for bienniums, with biennium 1 (2011-2012) related to the period prior to EBSEH 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)/EBSEH, 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 EBSEH (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, physical space, among others (Bittar, 2001). 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 Education (Ministry of Education , 2012), according to the relation made by this 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

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

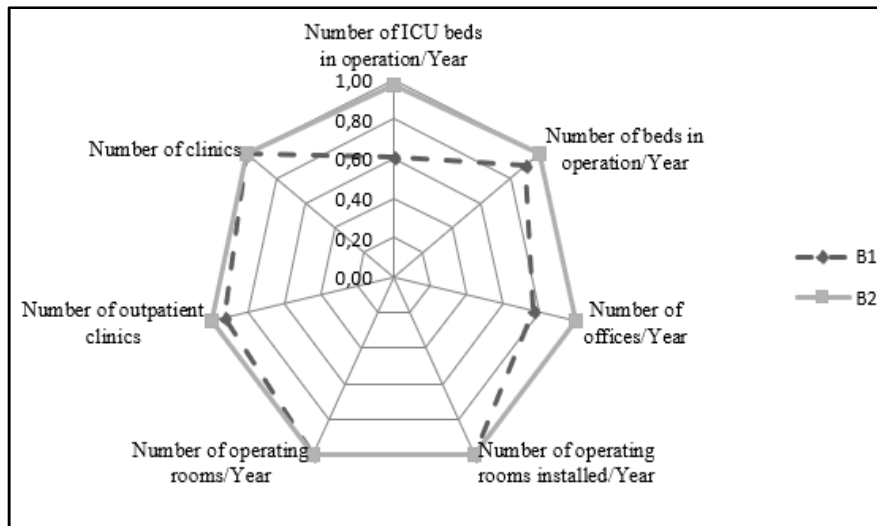
		Dimensions									
		Structure				Result					
Categories	Indicators	Biennium 1		Biênio 2		Categories	Indicators	Biennium 1		Biênio 2	
		2011	2012	2014	2015			2011	2012	2014	2015
installations	Number of ICU beds in operation	13	10	18	19	Production of Services	Number of hospitalizations	4.685	5.288	6.265	8.624
	Number of beds in operation	204	231	239	241		Number of Hospitalizations of High Complexity	767	1.018	1.279	2.149
	% of ICU beds over total operational beds (%)	6,37	4,32	7,53	7,88		Number of Ambulatory Care	133.503	131.817	172.834	218.687
	Number of offices	81	81	106	106	Productivity	Number of Surgeries	6.735	6.966	7.582	8.831
	Number of Installed Surgery rooms	12	12	12	12		Number of Exams	332.031	263.907	480.072	610.409
	Number of surgery rooms in operation	12	12	12	12		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 Quality	Average Cost Patient per day Internship	253,13	264,99	287,09	324,13
	Number of Technical-Administrative Servers / Year	-	-	1.913	1.607		General Mortality Rate	5,26%	4,95%	4,25%	3,76%
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 hospital admission	2.409,62	2.473,55	2.755,04	2.563,90		Number of students Graduates of the Medicine course	92	92	91	91
	Average Ambulatory Procedure	10,43	9,46	10,6	10,14		Number of students Graduates of the Medicine course	29	29	29	29
							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.

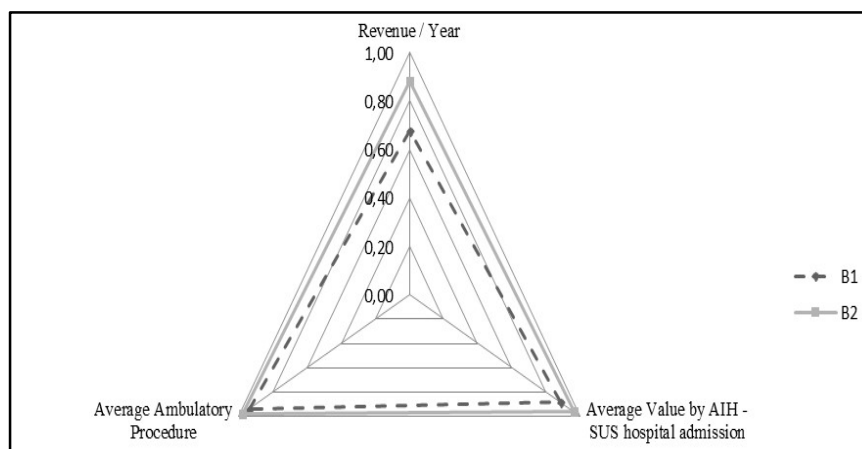
Table 3. Matrix of accumulated indices of performance of the indicators by analytical categories - biennium B1-B2

Dimensions					
Structure			Result		
Category	Biennium		Category	Biennium	
	B1	B2		B1	B2
Installations	6,19	6,97	Production of Services	2,86	4,38
Human Resources	Insufficient data for analysis		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.



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



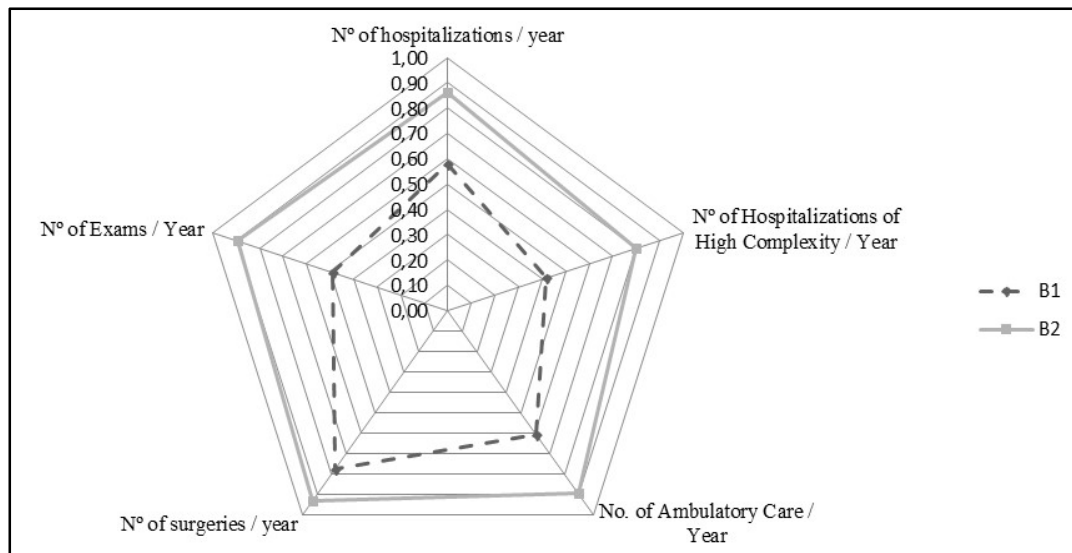
Graph 2. Performance indicators in the revenue category in biennia 1 and 2 in HUOL

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 EBSEHR 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.

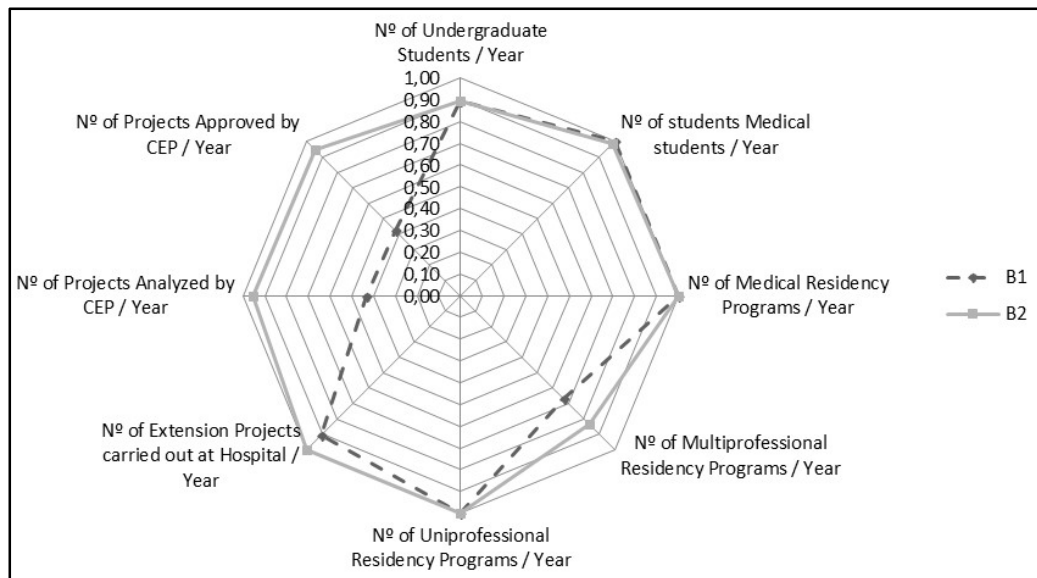
To analyze the performance of the indicators shown in Graph 1 and Graph 2, it is important to consider that this type of Radar Graph shows that the best results are the most external, given the proximity of the highest performance values. Therefore, for the most part, performance indicators showed better 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 organization (Bittar, 2001). 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 scorecard (Bittar, 2001). 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



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



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

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 Education (Ministry of Education, 2012), 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 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 profile

(<http://www.ans.gov.br/images/stories/prestadores/E-EFT-02.pdf>). 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 Health (<ftp://www.ans.gov.br/images/stories/prestadores/E-EFI-01.pdf>) 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 Health (<ftp://www.ans.gov.br/images/stories/prestadores/E-EFI-01.pdf>), 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 accurately (Rahimi, 2014).

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, Tiemann and Schreyögg [46] 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.

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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.

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