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Adalberto Lima, Christiane Barbosa, Alberto Sobrinho, Robisom Calado, Ana
Sobral

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Capacity Management as a tool for improving infrastructure in the Lean Healthcare: a systematic review

Adalberto Lima¹[0000-0001-7666-4581], Christiane Barbosa²[0000-0002-8303-9263],
Alberto Sobrinho²[0000-0003-3092-2703], Robisom Calado³[0000-0003-3349-0344],
and Ana Paula Sobral³[0000-0001-9214-7605]

¹ Universidade Federal do Pará, Abaetetuba, Brasil
aclima57@hotmail.com

² Universidade Federal do Pará, Belém, Brasil
cllima@ufpa.br, aclsobrinho@gmail.com

³ Instituto de Ciência e Tecnologia, Universidade Federal Fluminense, Rio das
Ostras, Brasil
robisomcalado@gmail.com, ana.sobral@id.uff.br

Abstract. The objective of this paper is to identify ways of managing capacity in healthcare settings and apply them to Emergency Care Units. The methodology used is based on three pillars: 1. lexical and content analysis of existing scientific articles in the Scopus database; 2. quantify and qualify the existence of publications by identifying the correlations between authors using VOSviewer; 3. proposed application of capacity management in 50 Emergency Care Units. The results showed that with Capacity Management it is possible to generate activities that add more value to the infrastructure and control service delivery, eliminating queues and bottlenecks in the healthcare environment, thus contributing to effective service through continuous flow in the urgency and emergency of 24h ECUs.

Keywords: Capacity Management · Capacity Control · Lean Healthcare.

1 Introduction

The production of goods and services requires the dimensioning of resources that include machinery, equipment, human resources, space required for installations, and the definition of flows (material, information, and financial). The intention is to generate productivity to obtain quality and sustainability in the organizational environment.

In healthcare service delivery, the measurement of performance and the determination of capacity is unclear or no viable methods for such measurement are indicated in the literature. In hospitals where customer service saves lives or decrees deaths it is necessary to establish a set of measures or indicators to

assess the operational efficiency of processes, the degree of capacity utilization, the availability of productive resources, and the quality of operations.

The Unified Health System is composed of several units, with different care objectives and that complement each other. This was the way to assign responsibilities to the Union, States, Federal District, and Municipalities through the management of health actions and services in a solidary and participatory manner.

In Brazil, the SUS brings together a network structure of basic care, hospital, home care, mobile emergency and emergency care units (ECU 24h) - whose goal is to meet the needs of the population. Otherwise, the scenario of uncertainty will be detrimental to the efficiency of health service delivery.

Therefore, it is essential to measure, evaluate performance and capacity to direct management and decision-making actions. Thus, this study aims to identify the measurement of capacity in the healthcare environment and propose an application in Emergency Care Units (ECU)

2 Theoretical Reference

2.1 Lean Healthcare

The dynamics that exist in the hospital environment offer opportunities for intervention that currently focuses on applying the principles and tools of Lean Thinking to adjust processes, streamline patient care, organize the work environment, and motivate employees.

Production capacity and operational efficiency are two improvements sought by healthcare executives and managers. They are concepts that require care when measured, as they vary with the local economy, over time due to resource scarcity [12, 3] and decentralized management [5, 10]. Therefore, it is necessary to plan, verify the availability of resources, define performance indicators and service level [3].

For hospital capacity planning, Ettelt et al. [5] stress investment in facilities, equipment, and technology. The number of hospitals varies with level of care and most countries define only the number and location of facilities for an existing infrastructure within a coverage area. Each differentiation of resources defines a capacity and the sum of all will determine the capacity of the system as a whole. Inadequate measurements or comparisons between the various capacities can result in inefficiency and non-accuracy of the system.

The hospital dynamic has variable demand, different pathologies and time periods. The service structure must offer an adequate infrastructure, personal and material resources, and a level of service to the patient.

In emergency areas it is important to have a specialized team to assist patients, ensure effective management of bed flow and capacity 24/7 [12, 3, 10, 7]. Capacity management in hospitals allows for the correction of errors such as lost revenue, delays, operational inefficiency and patient dissatisfaction. The lack of an adequate model and reliable database can make it difficult to plan service delivery or to make resources available for internal activities.

3 Method

The research strategy was action research with a qualitative and quantitative approach, data collection with interviews, questionnaires, and official documents. The method is divided into phases: 1. lexical and content analysis of existing scientific articles in the Scopus database; 2. quantify and qualify the existence of publications by identifying the correlations between authors using VOSviewer; 3. proposed application of capacity management in 50 Emergency Care Units.

The purpose of this proposal is to provide employees with practical tools to use in their daily lives and to improve their activities, eliminating waste of time and improving the quality of patient service. The study presents a systematic application of the Lean Healthcare system in the 50 ECUs participating in the project.

4 Development

4.1 Study Of The Process

The Scopus base (Elsevier) aggregated 473 articles (35.5%), three authors with three papers each, 240 in the medical field (29.9%), 126 in management, business and accounting (15.7%) and 73 in engineering (9.1%). The largest number of publications came from the United States of America and were affiliated with Harvard Medical School. In Brazil, 58.8% of the papers were published as articles in 2018 and 2019, two authors and two publications each - Augusto, B.P. and Tortella, G.L.

Using VOSviewer in the Scopus base (Elsevier) was observed that the word network is composed of seven clusters differentiated by colors (Figure 1), each of them has a central word that connects the others through links, interrelating them, being "Human" the central link.

One of the branches in red ends in "total quality management" from which other terminologies emerge, loosely, without direct connection to the others, however, with some degree of importance. Implying that although there is no direct link such concepts are pertinent or have been studied in some context, which illuminates the originality and generates the need to deepen and fill the research gaps, gains of this article. The terms Lean and Lean Production stand out in isolation and surrounded by terminology such as "performance measurement", "operations management" and "six sigma", which allows us to conclude that there is a concern to measure and determine through metrics, the variables that can interfere or improve the capacity of the entire system, especially in healthcare.

Authors' analysis, applying the VOSviewer to at least one publication per author identified the existence of 38 authors divided into three clusters that are related to each other by means of two central ones, Hooper, L. and Cederholm, T.. There is a little variation in relation to the number of publications in this area of interest, as there is not one author who has published more than three papers. However, Cederholm, T. stands out in the number of citations from his

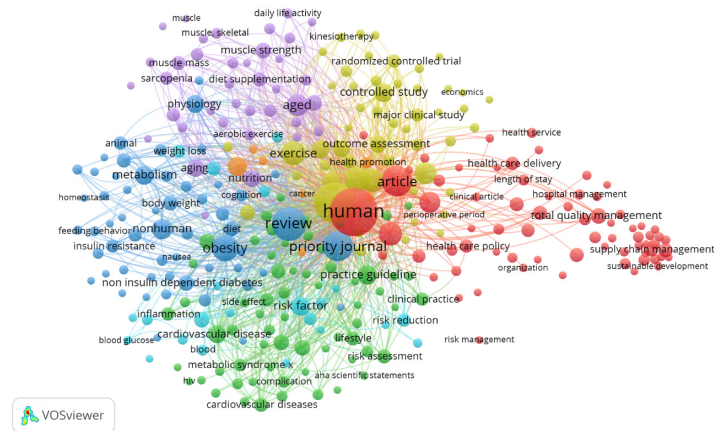


Fig. 1. Occurrence of key words in publications.

research in years prior to 2016, while Hooper, L. obtained more citations than works published from 2014 onwards, the most relevant succeeding 2018.

The analysis of the authors with the largest number of papers identified three clusters, one author in each. Individually, they have three publications, the most important and the most cited is Radnor, Z.

There is no consensus in the understanding and establishment of the relationship between Capacity Control, Capacity Measure, Effective Capacity, Lean Healthcare either by keyword or authorship or co-authorship. The publications do not treat the subject in a direct way or establish a concrete way of evaluation of capacity in health environments, especially among the authors on the largest number of published works.

Publications address the topic related to queuing concepts [8], discrete event simulation and operational research [13] applicable to healthcare, and with expressive results when combined with Lean to manage patient flow in hospital settings, especially with Value Stream Map (VSM), the implementation of 5S [4] and dynamic capacity measurement instruments (DC) [2].

The study by Leite et al. [9] identified 21 barriers to lean implementation and among them, the measurement and performance management system. This barrier shows that professionals and the SUS are limited to the service provided, i.e., non-urgent cases that reach the system create an unexpected demand, can make the process difficult and affect the capacity of that health unit. Similarly, the unavailability of resources for correct care can limit SUS processes, affect the performance of the technical team, and imply in its capacity.

During the application of the lean project in the ECUs, the monitoring of activities and the definition of indicators such as the average length of stay started in three units (Figure 2). The capacity of the units needs control, quality, and statistics. The u-chart, applied in the ECUs, was used to monitor indicators

such as the length of stay of patients as well as the average number of non-conformities per unit.

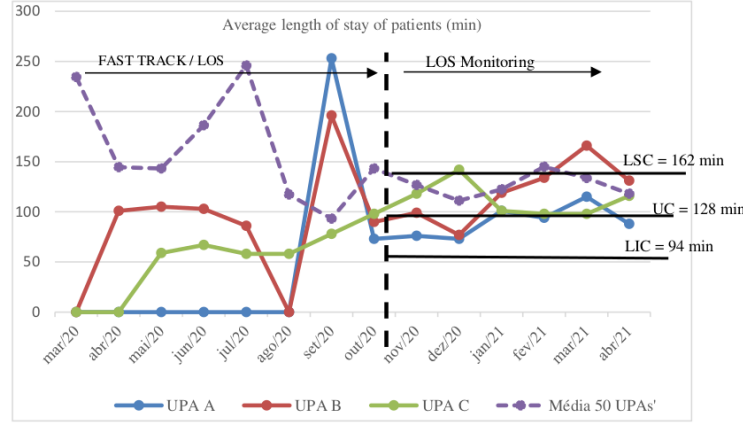


Fig. 2. Average length of stay patients (min).

The project brought to light the need to establish some measurement and representation parameters for the internal control of the activities, namely: Data collection by sampling, recording the times by service and patient; Point the data in the form and or system by patient; Compile the cycle times by patient in spreadsheet; Check and understand the outliers of the cycle times of services by patient; Visual management of the average time (LOS -Length of stay), present graph or Dashboard (Power BI).

In healthcare, Fast Track is a form of resource planning and control sequencing, such as "Shortest operation time first (SOT), where small tasks are processed quickly, and thus a green rating, for example, is accomplished more quickly. The performance of care in the shortest time can be improved with Fast Track, achieving more productivity and a shorter Average Dwell Time for patients in the Urgent and Emergency care.

The concept of capability helps managers and policy makers identify the capabilities needed to increase change: organizational culture; data and performance; employee engagement; leadership engagement; process improvement and learning; service user focus; stakeholder and supplier focus; strategy and governance [6]. However, volatility, uncertainty, complexity and ambiguity in the organizational environment are barriers to performance effectiveness. Therefore, there must be a rapid change at the strategic, tactical and operational levels [1].

Decision making is based on the collection of information and the functioning of the chain and its environment. Thus it is possible to align, adapt and streamline the chain for environments of high uncertainty and risk to promote agility and responsiveness [11].

To calculate the patient journey, the following procedures were determined: random sample of 80 patients per month, 20 per week (preferably 10 in the morning shift and 10 in the afternoon shift) and in all the stages in the ECU - Reception, Triage, Consultation, Medications and Exams. The data should be entered into the standardized spreadsheet. The data collection worksheet has 4 tabs, which are "Data", "Dashboard", "Graphical Dashboard" and "Action Plan". An example is shown in Table 1 of part of the standard spreadsheet available on ECUs.

Table 1. Example of a log sheet used in ECU's

(5) Check-in time at reception	(6) Check-out time at reception	(7) Screening start time	(8) End time of screening
1:00	1:02	1:03	1:05
3:10	3:13	3:16	3:18
5:52	5:53	5:54	5:55
6:05	6:10	6:13	6:15

Capacity measurement requires prior monitoring, the provision of standard information via remote systems and the creation of a big data to analyze the data received and establish service priorities according to the emergency. Therefore, it is essential to establish monitoring and control mechanisms linked to an information and communication system integrating the entire Unified Health System (SUS).

The definition of indicators, the use of methods for monitoring data such as DMAIC and A3 reporting in the ECUs have benefited patient care by more than 1Mi in reception, 5Mi in risk classification, 22Mi in orthopedics, and 5Mi in physicians. Each unit is able to identify needs and establish its indicators. However it is necessary to have standardized parameters that can guarantee a service level standard in the ECUs, the great benefit of the Lean application.

5 Conclusions

In the literature there are several management models, but not specific to the service in healthcare. The research points out some solutions to be applied in capacity management, but leaves gaps that need to be filled in order to improve the process of care in urgency and emergency in healthcare.

Another point that makes capacity management difficult is the human factor and its uncoordinated actions, generating overload or idleness. A method is needed to adjust capacity through overtime allocation or value chain balancing to eliminate idleness, varying, if possible, the size of the workforce, adjusting the infrastructure to new demand, or even subcontracting is an alternative.

The main barriers to Lean implementation are: a performance measurement and management system that is closely linked to capacity management; the

unavailability of resources that affects the performance of the entire technical team (doctors and nurses).

Thus, the application of Lean Six Sigma in Emergency Departments is recommended, as well as the definition of indicators and their monitoring. Orienting the organizational culture and the management for data collection was one of the benefits of the Lean implementation in the 50 UPAs and the next step is the definition of a method for capacity management in this universe.

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