

Research Article

Calculation of Costs based on Time-driven Activities (TDABC) during Hospital Nutritional Care in High-cost Pathologies such as Stomach, Colon and Rectal Cancer with Malnutrition

Pinzón-Espitia OL^{1,2,3*} and González-Rodríguez JL¹

¹Universidad del Rosario, School of Management, Bogotá, Colombia

²Universidad Nacional de Colombia, Bogotá, Colombia

³Méderi- Hospital Universitario Mayor, Bogotá, Colombia

***Address for Correspondence:** Pinzón-Espitia OL, Universidad del Rosario. Calle 200 entre Autopista Norte y Cra 7ma. Site of Entrepreneurship and Innovation. Bogotá DC, Colombia, E-mail: olga.pinzon@urosario.edu.co

Received: 01 October 2018; **Accepted:** 13 November 2018; **Published:** 16 November 2018

Citation of this article: Pinzón-Espitia, OL, González-Rodríguez, JL. (2018) Calculation of Costs based on Time-driven Activities (TDABC) during Hospital Nutritional Care in High-cost Pathologies such as Stomach, Colon and Rectal Cancer with Malnutrition. J Clin Nutr Food Sci, 1(2): 050-055.

Copyright: © 2018 Pinzón-Espitia, OL, et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background & Aim: An optimal nutritional care process with costs that contribute to the sustainability of hospitals, contributes to reduce the complications associated with states of malnutrition in oncological pathologies.

Methods: We analyzed the nutritional care costs of 471 patients with stomach cancer pathologies 39.5%, followed by colon cancer 37.98%, and rectal cancer 23.79%, in order to know the real cost caused by applying the methodology of cost based on time invested per activity (TDABC).

Results: In the ADHD analysis, it was shown that a nutritional intervention model favors the control of costs and opportunities for improvement, actively involving physicians, clinical teams and administrative staff in charge of the cycle of care, allowing a net profit of 3.7% to be established.

Conclusions: It was found that a nutritional care process based on time-driven activities optimizes care times and generates a positive net profit as part of comprehensive care.

Keywords: Analysis, Cost, Health care costs, Hospitalization, Clinical oncology, Malnutrition

Introduction

Malnutrition in hospitalized patients is a problem that requires attention in the health sector in order to improve outcomes, requiring research and evaluation of the costs and large-scale effectiveness of the use of therapeutic interventions, especially in cases of malnutrition [1,2].

Malnutrition requires adequate and timely nutritional intervention, as it is connected to a wide range of functional

alterations, medical complications and mental health problems, as well as increased risk of health complications such as pressure ulcers, surgical site infections, urinary tract infections, adverse impact on mental health, depression and reduced quality of life [3].

Therefore, an optimal nutritional care process with costs that contribute to the sustainability of hospitals, contributes to reduce the complications associated with states of malnutrition in oncological pathologies, such as infections, increased hospital stay and costs of care.

One of the main tools to carry out the administrative and managerial management for the decision making related to the products or services of a hospital institution, as far as its costs, profit margins, volumes, analysis of tariffs (prices), is to implement a costing system. An example is the case of the methodology of the Activity Based Costing (ABC) system, which has taken on a great deal of importance in recent times, and which since the 1980s has been known in the United States as an administrative and managerial tool that made it possible to solve many of the problems presented with traditional cost methodologies, mainly the distribution of indirect costs, which suggested having a much more effective mechanism for their distribution [4,5].

However, since any methodology has certain limitations for its implementation, such as the collection of statistical information and information provided by employees, and issues of organizational culture, the methodology defined as Time Driven Activity Based Costing (TDABC) emerged, which is proposed as an alternative to facilitate the incorporation of data in a costing system, using formulas that allow to easily establish the time that people dedicate to the activities and taking into account the number of activities they carry out, for which equations are configured associated to the information available in the information systems of the institution, which facilitate its continuity and analysis.

This methodology was presented by Robert Kaplan and Steven Anderson in 2003, they published the book in which an alternative is proposed to facilitate the distribution of costs using the practical capacity and not the theoretical capacity of the ABC, using formulas that allow to establish easily the time that people dedicate to the activities and taking into account the number of activities that they carry out, for which equations associated to the available information are configured [6].

This new model, according to its authors, is proposed as a tool that is much simpler, cheaper and more far-reaching than the ABC methodology, with a greater vision of costs, since it helps to determine unused capacity to allocate more activities to employees with underused time, and to increase the productivity of care services, as a contribution to the present study object of a nutrition service, which could become a reference for the other services of hospital institutions.

The TDABC model includes the costs of providing capacity and the time needed to carry out an activity, making it possible to determine unused capacity in care processes, considering practical capacity [7], and is a useful tool for health service delivery institutions [8].

Methods

Study population

The objective pursued in the present study was to know the real cost of hospital nutritional care process in high cost pathologies such as stomach, colon and rectal cancer, applying the methodology of cost based on time invested per activity (TDABC).

The steps for carrying out the partial economic assessment using the TDABC methodology in this research were as follows:

- Preparation of the model, included the description of direct costs of care of patients over 18 years, with diagnosis of stomach, colon and rectal cancer attended in 2015.

- The research question was as follows: What is the estimated total cost of the inpatient nutritional care process in stomach, colon, and rectal cancer?
- The population included 471 patients, which corresponds to the total number of patients treated by the nutrition team with a diagnosis of stomach, colon and rectal cancer in the HSPI during the months of January to December 2015.

The CIE-10 codes that were the subject of this study were as follows:

Stomach cancer:

C161 Malignant tumour of the gastric fundus

C165 Malignant tumour of the minor curvature of the stomach, no other specification

C166 Malignant tumour of the major curvature of the stomach, no other specification

C 169 Malignant tumour of the stomach, unspecified part

D002 Carcinoma in situ of the stomach

D131 Benign tumour of the stomach

D371 Tumour of uncertain or unknown behaviour of the stomach

C162 Malignant tumour of the body of the stomach

Colon cancer:

C184 Transverse colon malignant tumour

C186 Malignant tumour of the descending colon

C187 Sigmoid colon malignant tumor

C189 Malignant tumour of the colon, unspecified part

D010 Carcinoma in situ of the colon

D122 Benign tumour of the ascending colon

D123 Benign tumour of the transverse colon

D124 Benign tumour of the descending colon

D125 Benign sigmoid colon tumor

D126 Benign tumour of the colon, unspecified part

D374 Tumour of uncertain or unknown behaviour of the colon

Rectal cancer:

C20X Malignant tumour of the rectum

C785 Secondary malignant tumour of the large intestine and rectum

D011 Carcinoma in situ of the rectosigmoid junction

D011 Carcinoma in situ of the rectum

D127 Benign tumour of the rectosigmoid junction

D128 Benign tumor of the rectum

D375 Tumour of uncertain or unknown behaviour of the rectum

Cost analyses

The implementation of the model, for the present study, included

the review of the clinical histories of patients with stomach, colon and rectal cancer, and the respective invoices generated during the process of attention to the insurer, in order to classify costs from a descriptive point of view, based on production volume. For this, the costs directly related to the nutritional care of the disease that generated the hospitalization were collected, including 6 steps [6,9,10]:

1. Estimation of the practical capacity of the activities and resources of the nutrition process. Descriptive statistical analyses were carried out (univariate and bivariate analyses), with the respective measures of central tendency and dispersion, to subsequently generate a research report that included the calculation of practical capacity, the unit cost of the activities of the nutritional care process, and the state of results.
2. Calculation of the cost per unit of time it took the nutrition process to provide services in hospital care.
3. Computation of the approximate time of execution for each of the activities, by means of work of direct observation of the workers to establish the times and movements.
4. Obtaining the costs of the activities, and calculating the coefficient of costs by capacity.
5. Calculation of the cost of production.
6. Calculation of the profitability of the nutritional care process.

Statistical methods

This research included methods of Exploratory Analysis or Descriptive Statistics, with the objective of understanding the structure of the data.

The data was processed in the Software for Statistics and Data Science: Stata 15.

Results

Characteristics of the study populations

Next, the results are described according to the characterization of the target population, to later describe the results of the total cost of the process of hospital care using the ADHD method, in this case, a university hospital of high level of complexity of private character in Latin America, during the year 2015.

The population is made up of 471 patients with diagnoses of stomach, colon and rectal cancer, whose distribution by gender is 52% male and 48% female. As can be seen in Table 1, 53.5% of patients were in the 60 to 80 year range, and the proportion of young patients under 30 years of age was relatively low (1.5%).

The combination of several different types of cancer using ICD-10 codes was done taking into account the hospital's own cost structure and codification. Within the clinical diagnosis, a greater proportion of patients with stomach cancer was observed: 39.5 %, followed by colon cancer 37.98 %, and rectal cancer 23.79 %. In stomach cancer the most prevalent is the malignant tumour of the stomach, an unspecified part with 19.32%, being the male population the most affected. In colon cancer, the proportion of patients with the highest proportion of involvement was the malignant tumor of the colon, an unspecified portion of which was 9.34%, and in rectal cancer, the

Table 1: Distribution of participants by gender and age ranges.

Age (years)	F	M	Total (n)	%
18-20	0	1	1	0,2
20-30	3	3	6	1,3
30-40	7	6	13	2,8
40-50	22	19	41	8,7
50-60	38	36	74	15,7
60-70	51	72	123	26,1
70-80	59	70	129	27,4
80-90	37	35	72	15,3
90-100	6	5	11	2,3
100-110	1	0	1	0,2
General total	224	247	471	100

Source: Own elaboration.

most frequent diagnosis was malignant tumor of the rectum with 14.65% (Table 2).

Calculation of costs based on time-driven activities (TDABC)

After characterization of the population, in order to establish the total cost of the hospital care process, it was necessary to calculate the practical capacity in minutes. The practical capacity of the person who carries out the activities described in table 3, and who, for the sake of implementing the ADHD model, established the operations described and carried out by a team made up of 23 workers hired with a daily working day of 6 hours, so that their theoretical annual capacity amounted to 2,664,900 minutes.

By reviewing the variable costs, the total cost of the nutritional care process was established, calculating a capacity cost per minute coefficient of \$539 (Table 4).

On the other hand, a calculation was made of the cost per unit of time it takes to carry out the activities that can be invoiced for the nutritional care process, with a used capacity of 1%. The above taking into account findings such as failures in billable activities such as interconsultations, and which were reported to the central billing of the institution. It is important to clarify that the total unused capacity, equivalent to 99%, refers to non-billable care support activities, included in the hospitalization and that tend towards a better quality of service (Table 5).

With respect to the time-invested costs per activity (TDABC) system, this research allowed for the breakdown of costs per hospital care unit, which yields a net profit of 3.7% for the organization (Table 6).

Discussion

Cancer patients usually suffer from associated malnutrition resulting from local tumor effects, host response to tumor therapies, and contributing factors such as decreased food intake and alterations in nutrient metabolism that can lead to impairment of immune functions, functional status, muscle function, and quality of life; requiring intervention by an in-hospital nutritional support team, which can help improve prognosis, and reduce the consequences of deterioration of cancer-associated nutritional status [11],

In the comprehensive care of cancer patients, interventions related to prevention and treatment can generate improvements in quality of life and survival, although they imply an increase in care costs, affecting payment policies, the global economy and the incentive structures of oncological care [12-14].

It is imperative to carry out studies of the national costs of patient treatment, given the implications for decision-makers in planning and allocating resources for care, both at the health system and system levels, and in hospitals [15].

Table 2: List of patients according to clinical diagnosis.

Diagnosis	F	M	Total	Percentage
Carcinoma in situ of the rectosigmoid junction	2	1	3	0,64
Carcinoma in situ of the colon	1	3	4	0,85
Carcinoma in situ of the stomach	5	2	7	1,49
Carcinoma in situ of the rectum		4	4	0,85
Injury to contiguous sites of the anus, anal canal	1	10	11	2,34
Injury to contiguous sites of the colon	1	1	2	0,42
Tumor of uncertain or unknown behavior of the colon	17	15	32	7,00
Tumor of uncertain or unknown behavior of the stomach	21	14	35	7,43
Uncertain or Unknown Behavioral Tumor of the Rectum	5	6	11	2,34
Malignant tumor of the major curvature of the stomach	1	1	2	0,42
Malignant tumor of the minor curvature of the stomach		2	2	0,42
Malignant tumor of the rectosigmoid junction	4	4	8	1,70
Malignant tumor of the pyloric antrum		3	3	0,64
Malignant Tumor of the Blind	8	10	18	3,82
Malignant tumour of the ascending colon	18	11	29	6,16
Descending Colon Malignant Tumor	5	3	8	1,70
Sigmoid Colon Malignant Tumor	20	14	34	7,22
Transverse Colon Malignant Tumor	1	5	6	1,27
Malignant tumor of the colon, unspecified part	24	20	44	9,34
Malignant tumour of the body of the stomach	2	10	12	2,55
Malignant tumour of the duodenum	3	1	4	0,85
Malignant tumour of the stomach, unspecified part	39	52	91	19,32
Malignant tumour of the gastric fundus	6	18	24	5,10
Malignant pylorus tumor	1	2	3	0,64
Malignant tumor of the rectum	37	32	69	14,65
Secondary malignant tumor of the large intestine and rectum	2	2	4	0,85
General total	224	247	471	100,00

Source: Own elaboration.

Table 3: Calculation of practical capacity in minutes.

Practical capacity in minutes	Potential Days/Year	Hours /day	Minutes /hour	Number of employees	Total minutes /year (12months) Practical capacity
	365- (52+52+18+15+3)	6	60	23	2.664.900

Source: Own elaboration.

Table 4: Cost of the process.

Variable unit cost	Total cost	Capacity Cost Coefficient
Direct fixed cost	\$693.181.849	Minute value \$ 260
Indirect costs	\$743.864.076	Minute value \$ 279
Total Fixed Direct	\$1.437.045.925	Minute value \$ 539

Source: Own elaboration.

In Colombia, hospitals are classified by level of care, from level I to level IV, the latter being the most complex hospital, understood from the point of view of the activities, interventions and procedures carried out. Hospitals treat patients from different insurers in the country who require specialized care.

Taking into account the above, this study presents a costing methodology that can be replicated in the nutrition processes of hospitals in the region, in order to generate data to compare and establish strategies between institutions to include activities to improve hospital nutritional care processes in the country.

The results of this phase of research, which included a population of 471 patients with diagnoses of stomach, colon and rectal cancer, whose gender distribution was 52% men and 48% women, hospitalized in an Health Services Provider Institution (HSPI) of high level of complexity. It is important to emphasize that the clinical diagnosis identified with the highest proportion of patients was stomach cancer 39.5%, which according to Colombia is an increasing public health problem, representing great social and economic repercussions imposing a challenge to the health system [16].

Within the framework of economic evaluations of health interventions, it is necessary to estimate the costs of such health care in order to determine the value of health care, defined from the perspective of unit costs based on activity by time (TDABC) to determine the cost of care. Although nutritional intervention appears as a recommendation in major clinical practice guidelines [17,18], nutritional interventions can increase costs of care, sometimes shifting financial risk to insurers, and understanding the costs of care is relevant.

The costing process involved estimating the capacity of each resource, and calculating the capacity cost rate, determining the practical capacity for the 23 employees required for care and intervention in nutritional support, hired with a daily workday of 6 hours, with a theoretical annual capacity of 2,664,900, with a capacity per minute cost coefficient of \$539.

With respect to the system of costs based on time invested per activity (TDABC), the present investigation allowed the breakdown of costs per hospital unit of attention, allowing to establish a net profit of 3.7%. The literature on revenue management through actual

Citation: Pinzón-Espitia, OL., González-Rodríguez, JL. (2018) Calculation of Costs based on Time-driven Activities (TDABC) during Hospital Nutritional Care in High-cost Pathologies such as Stomach, Colon and Rectal Cancer with Malnutrition. *J Clin Nutr Food Sci*, 1(2): 050-055.

Table 5: Cost and percentage of participation in activities.

Activity	Attention time	Unit cost	Services	Total time	Cost	Participation
					Total	
Daily Care and Handling	18	\$9.706	1038	18.684	\$10.075.337	0,67%
First time consultation for nutrition and dietetics	36	\$19.413	173	6.228	\$3.358.446	0,22%
Nasogastric tube passage first time x head nurse	24	\$12.942	42	1.008	\$543.563	0,04%
Determination of oral nutritional regime	2,4	\$1.294	98	235	\$126.501	0,01%
Nutritional Screening	12	\$6.471	133	1.596	\$860.642	0,06%
Total capacity used				26.155	\$14.964.489	1,00%
Total unused capacity				2.638.745	\$1.422.942.077	99,00%
Total capacity				2.664.900	\$1.437.906.566	100,00%

Value 1 Euro = \$ COL 3.437

Source: Own elaboration

Table 6: Net profit from the nutritional care process.

Concept (value in Colombian pesos)	HCPI Ambulatory	HCPI 1	HCPI 2	Total Nutrition and Dietetics	%
Operating Income	12.694.592	1.159.005.918	6.331.749.195	7.503.449.705	100%
Operational Costs	35.942.609	865.214.464	5.700.346.965	6.601.504.037	88,0%
Gross Profit	23.248.017	293.791.454	631.402.231	901.945.668	12,0%
Operating Expenses	69.396	14.041.233	742.426.282	756.536.911	10,1%
Operating Income	23.317.413	279.750.220	111.024.051	145.408.756	1,9%
Non-Operating Income	-	9.011.026	124.806.671	133.817.697	1,8%
Non-Operating Expenses	-	2.634	1.437.794	1.440.428	0,0%
Net Income	23.317.413	288.758.613	12.344.826	277.786.025	3,7%

Value 1 Euro = \$ COL 3.437

Source Ownelaboration.

operating decisions, using methodologies to establish net profit, refers to values below 2.9% [19,20].

With precision the costs and results of this measurement, it constitutes a leverage for the transformation of concepts into health care economics and nutrition. To the extent that managers of health organizations and leaders of nutrition processes obtain accurate measurements of the costs of their services, favoring politically difficult decisions at lower costs while improving clinical outcomes [21,22].

The TDABC analysis became an information platform that demonstrated how a nutritional intervention model is an innovation in the care process, favoring the control of costs and opportunities for improvement, actively involving physicians, clinical teams and administrative staff in charge of the care cycle, allowing evidence that this nutritional intervention closes the gap between comprehensive health care and the reduction of care costs including innovative technologies, such as nutritional support to promote positive outcomes.

This research is the first time that the TDABC methodology is

applied to a hospital nutrition process, carried out in Colombia, in the patient with stomach, colon and rectal cancer, generating a positive net utility.

Funding Sources

The present research was developed within the framework of the doctoral thesis "Management of Hospital Nutritional Care", of the doctoral program in Sciences of the Management of Universidad del Rosario - Colombia.

Conflicts of Interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

References

1. Philipson, T., Linthicum, MT., Snider, JT. (2014) Tutorial on health economics and outcomes research in nutrition. *JPEN J Parenter Enteral Nutr*, 38(2): 5S-16S.
2. Philipson, TJ., Snider, JT., Lakdawalla, DN., Stryckman, B., Goldman, DP. (2013) Impact of oral nutritional supplementation on hospital outcomes. *Am J Manag Care*, 19(2): 121-128.

Citation: Pinzón-Espitia, OL., González-Rodríguez, JL. (2018) Calculation of Costs based on Time-driven Activities (TDABC) during Hospital Nutritional Care in High-cost Pathologies such as Stomach, Colon and Rectal Cancer with Malnutrition. *J Clin Nutr Food Sci*, 1(2): 050-055.

3. Löser, C. (2010) Malnutrition in hospital: the clinical and economic implications. *Dtsch Arztebl Int*, 107(51-52): 911-917.
4. Cooper, R., Kaplan, RS. (1991) Profit priorities from activity-based costing. *Harvard business review*. 1991;69(3): 130-135.
5. Udpa, S. (1996) Activity-based costing for hospitals. *Health Care Manage Rev*, 21(3): 83-96.
6. Kaplan, R., Anderson, S. (2003) Time-driven activity-based costing.
7. Öker, F., Özyapici, H. (2013) A new costing model in hospital management: time-driven activity-based costing system. *Health Care Manag (Frederick)*, 32(1): 23-36.
8. Gosselin, M. (2006) A review of activity-based costing: technique, implementation, and consequences. *Handbooks of management accounting research*, 2: 641-671.
9. Kaplan, RS., Witkowski, M., Abbott, M., Guzman, AB., Higgins, LD., Meara, JG., et al. (2014) Using time-driven activity-based costing to identify value improvement opportunities in healthcare. *Journal of Healthcare Management*, 9(6): 399-412.
10. Siguenza-Guzman, L., Van den Abbeele, A., Vandewalle, J., Verhaaren, H., Cattrysse, D. (2014) Using Time-Driven Activity-Based Costing to support library management decisions: A case study for lending and returning processes. *The Library Quarterly*, 84(1): 76-98.
11. Van Cutsem, E., Arends, J. (2005) The causes and consequences of cancer-associated malnutrition. *Eur J Oncol Nurs*, 9(Supplement 2): S51-S63.
12. Bach, PB. (2007) Costs of cancer care: a view from the centers for Medicare and Medicaid services. *J Clin Oncol*, 25(2): 187-190.
13. Silver, JK. (2015) Cancer Prehabilitation and its Role in Improving Health Outcomes and Reducing Health Care Costs. *Semin Oncol Nurs*, 31(1): 13-30.
14. Meropol, NJ., Schulman, KA. (2007) Cost of cancer care: Issues and implications. *J Clin Oncol*, 25(2): 180-186.
15. Mariotto, AB., Yabroff, KR., Shao, YW., Feuer, EJ., Brown, ML. (2011) Projections of the Cost of Cancer Care in the United States: 2010-2020. *J Natl Cancer Inst*, 103(2): 117-128.
16. Carreño Dueñas, A., Rojas, MP., Lucio-Arias, D., Serrano, ML., Piñeros, M. (2015) Cancer Research in Colombia, 2000-2010. *rev.colomb. cancerol*, 19(1): 39-46.
17. Huhmann, MB., August, DA. (2008) Review of American Society for Parenteral and Enteral Nutrition (ASPEN) clinical guidelines for nutrition support in cancer patients: nutrition screening and assessment. *Nutr Clin Prac*, 23(2): 182-188.
18. Arends, J., Bodoky, G., Bozzetti, F., Fearon, K., Muscaritoli, M., Selga, G., et al. (2006) ESPEN guidelines on enteral nutrition: non-surgical oncology. *Clin Nutr*, 25(2): 245-259.
19. Eldenburg, LG., Gunny, KA., Hee, KW., Soderstrom, N. (2011) Earnings Management Using Real Activities: Evidence from Nonprofit Hospitals. *Accounting Review*, 86(5): 1605-1630.
20. Newswire PR. (2016) Kaiser Foundation Health Plan and Hospitals Report Annual and Fourth Quarter 2015 Financial Results. KAISER-Q4-Earnings.
21. Kaplan, RS., Porter, ME. (2011) The big idea: How to solve the cost crisis in health care. *Harv Bus Rev*, 89(9): 46-52.
22. Herzlinger, RE. (2011) How to solve the cost crisis in health care. *Harv Bus Rev*. 89(11): 22, discussion 23.