



USE OF THE COSTING SYSTEM BASED ON ACTIVITIES TO MANAGE MATERIAL STERILIZATION

USO DO SISTEMA DE CUSTO BASEADO EM ATIVIDADES PARA GERENCIAR A ESTERILIZAÇÃO DE MATERIAIS

USO DEL SISTEMA DE COSTO BASADO EN ACTIVIDADES PARA ADMINISTRAR LA ESTERILIZACIÓN DE MATERIALES

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ABSTRACT

Objectives: to compare the direct costs involved in Low-Temperature Sterilization (EBT) technologies used in the CME of a University Hospital as well as to evaluate the cost-benefit relationship involved in the use of this technology. **Method:** this is an exploratory, descriptive, observational, qualitative study with data obtained from a sterilization center (CE) of a university hospital. The methodology of Costs Based on Activities (ABC) was used for the analysis of the costs. **Results:** the values of R\$ 303.72 were obtained for the sterilization cycle of Low-Temperature Steam of Formaldehyde, R\$ 424.28 for the Ethylene Oxide cycle and R\$ 485.32 for the Peroxide cycle of Plasma Hydrogen Gas. **Conclusion:** formaldehyde vapor was the most economical technology in cost/cycle and cost/liter, and the ABC methodology was effective in managing, planning and controlling the volumes and costs of a CE. **Descriptors:** Costs; Costs Analysis; Sterilization; Health Expenditures.

RESUMO

Objetivos: comparar os custos diretos envolvidos nas tecnologias de Esterilização à Baixa Temperatura (EBT) utilizadas na CME de um Hospital Universitário, bem como avaliar a relação custo-benefício envolvida no emprego desta tecnologia. **Método:** estudo exploratório, descritivo, observacional, de abordagem qualitativa, com dados obtidos em uma Central de Esterilização (CE) de um hospital universitário. Para a análise dos custos, utilizou-se a metodologia de Custos Baseados em Atividades (ABC). **Resultados:** encontraram-se os valores de R\$ 303,72 para o ciclo de esterilização de Vapor de Baixa Temperatura de Formaldeído, R\$ 424, 28 para o ciclo de Óxido de Etileno e R\$ 485,32 para o ciclo de Peróxido de Hidrogênio de Plasma Gás. **Conclusão:** o vapor de formaldeído foi a tecnologia mais econômica em custo/ciclo e custo/litro e a metodologia ABC se mostrou eficaz para gerenciar, planejar e controlar os volumes e custos de uma CE. **Descritores:** Custos; Análise de Custos; Esterilização; Gastos em Saúde.

RESUMEN

Objetivos: comparar los costos directos envueltos en las tecnologías de Esterilización a la Baja Temperatura (EBT) utilizadas en la CME de un Hospital Universitario, así como evaluar la relación costo-beneficio envueltos en el empleo de esta tecnología. **Método:** estudio exploratorio, descriptivo, observacional, de enfoque cualitativo, con datos obtenidos en una Central de Esterilización (CE) de un hospital universitario. Para el análisis de los costos fue utilizada la metodología de Costos Basados en Actividades (ABC). **Resultados:** se encontraron los valores de R\$ 303,72 para el ciclo de esterilización de Vapor de Baja Temperatura de Formaldehído, R\$ 424, 28 para el ciclo de Óxido de Etileno y R\$ 485,32 para el ciclo de Peróxido de Hidrogeno de Plasma Gas. **Conclusión:** el vapor de formaldehído fue la tecnología más económica en costo/ciclo y costo/litro y la metodología ABC se mostró eficaz para administrar, planear y controlar los volúmenes y costos de una CE. **Descriptores:** Costos; Análisis de Costos; Esterilización; Gastos en Salud.

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INTRODUCTION

Technological advances are becoming more and more present in several areas of knowledge. In the health area, in particular, all the technology employed aims to increase the comfort, safety, and quality of the care provided.¹ In the hospital context, several units use state-of-the-art technologies to ensure patient survival¹, also using a strategy for its survival and institutional growth.²

The Center for Sterilizable Materials (CME) has the purpose of providing adequately processed medical and hospital articles, its dynamics being marked by a set of elements for the reception and purging, preparation and sterilization, storage and distribution of materials for hospital units.^{3,4}

Thus, the CME plays a key role in combating hospital infections. To do so, the appropriate operation of this sector is necessary to ensure the quality of the indirect care provided to the patient. Also, it has the relevant role in the use of material, human and technological resources. Their daily decisions require the use of information that involves to a greater or lesser extent of the cost that it reflects the performance of the service.⁴ However, the implantation of these technologies has contributed to the increase of the hospital costs⁵ in both public and private institutions.

There is a concern by these institutions to offer high-quality products/services, preserving the safety of their patients, but at a lower cost.^{6,7} This is the challenge for the nurses of these units since management is the main activity in the CME, who must know and evaluate the expenses involved in a judicious way.^{8,9}

It can be noticed in the literature that the costs of operating high-temperature sterilization equipment have been evaluated.¹⁰ However, investigations regarding the costs of cold sterilization are still scarce, as well as a comparison of the cost/benefit of this technology.⁵

Thus, it is necessary to know the process of sterilization at low temperature and to evaluate the costs and benefits involved in an economically efficient management. A suitable way to do this is the use of the Activity-Based Costing System (ABC) that has been identified as adequate for hospital organizations, since this tool seeks to track the expenses of a company to analyze and monitor the various paths of resource consumption directly identifiable through the most relevant activities and those for products and services.¹¹

The objectives of this study are to compare the direct costs involved in Low-Temperature Sterilization (EBT) technologies used in the CME of a University Hospital, as well as to evaluate the cost-benefit relationship involved in the use of this technology.

METHOD

This is an exploratory-descriptive study, non-experimental, observational, with a qualitative approach.

For a better understanding of this study, it is worth characterizing the hospital studied, since the production of CME and the amount of sterilized material are directly related to the number of beds, surgical rooms and services of high complexity offered.¹² Thus, this institution has 600 beds, 18 beds in the Intensive Care Unit (ICU), 26 operating rooms and does not have a high inventory of material. The CME of this hospital has a nursing supervisor, four nurses, one secretary and thirteen nursing assistants. The professionals work forty hours a week, eight hours a day from Monday to Friday. The sterilization at low temperature is performed exclusively by nurses because the institution understands that it is a work that requires a greater technical/scientific knowledge and knowing that each failure implies a high burden on the institution's budget.

Thus, the ABC system was used to know the costs of each technology used in this CME, which is indicated by the literature¹³ as superior to other costing systems, since it can generate accurate information for managerial decision making¹³, organizational behavior and increasing focus on activities rather than volumes.

The technologies analyzed in this study were: Low-Temperature Steam of Formaldehyde (VBTF); Hydrogen Peroxide in the form of Plasma Gas (PHPG) and Ethylene Oxide (OE).

The results found here are expressed in costs per liter per cycle, since each sterilization equipment has its capacity, in liters, specific. For this, the following variables were considered: the cost of labor, the cost of disposables (chemical, biological controls, bags, and sterilizing agent) and equipment costs (replacement value, years of amortization, the number of cycles, 90% of actual capacity). This optimal load was established to compare costs across all technologies used.

To calculate the cost of sterilization at low temperature, it was necessary to know the amount spent to sterilize all the material that

is usually processed and sterilized. Therefore, weekly observations of the analyzed variables were performed, considering sterilized volumes in each week (Week A: from March 16 to 20, 2015; Week B: from April 20 to 24, 2015 and Week C: from September 14 to 18, 2015).

To choose the weeks of data collection, it was necessary to count on the memory of the sterilization cycles of each technology analyzed from years before 2015. Thus, it was concluded that in the months of March to June, the hospital processed the highest volumes of Sterilization of the year suffering a discrete variation between them. In December and January, holiday months, the number of patients declined sharply and with that, the volume of material processed as well. Therefore, to know how the costs per cycle and per liter are carried out in the months when high and low volumes of material are sterilized, the mentioned months were chosen.

Comparing the weeks of the same month of years before 2015, it was observed that the volume of material to be sterilized did not change significantly, so the choice of the week of each month was made randomly. Thus, during each week of sampling, the volume of all the material received for sterilization at low temperature was observed daily, aiming to know the optimal maximum load of each technology found in this CME.

The data was tabulated using the Excel program (version 2010) of Microsoft® indicating: the type of technology; the values and quantity of the disposables used in each sterilization cycle; the value of the nurse's work time; the time spent, in seconds, for the preparation of a load of material (measured in seconds - timed); the average number of cycles per year and the average number of packages/bags used per cycle. The capacity corresponds to the maximum optimum load of each equipment, in liters and bag per size, known by the measurement of the amount of water placed in each of them that allowed the perfect sealing. Then, with the help of a scale, the weights of these pockets in liquid were compared with those with materials to check for weight equality.

RESULTS

The results obtained were: R\$ 303.72 for the cost of the VBTF cycle, R\$ 434.28 for the OE cycle and R\$ 485.32 for the PHPG cycle.

Regarding the costs per liter of each technology, the values of R\$ 3.32 for VBTF technology, R\$ 5.08 for OE and R\$ 7.68 for PHPG were found. Thus, it was noted that

VBTF technology has the most cost-per-cycle and cost-per-liter, followed by OE and PHPG.

The results referring to the costs of sterilization at low temperature were performed based on the calculations of the costs of each available technology (OE, PHPG, and VBTF) taking into consideration all the sterilized material per week observed and the optimal maximum load of each technology.

When comparing the three technologies studied weekly, it was possible to verify that the most economical costs per liter and those per cycle were VBTF. Thus, the costs per OE cycle were the highest. When comparing the costs per liter of OE and PHPG in the three weeks, it was possible to show that the cost related to the first technology was more economical compared to the second technology. However, when comparing the costs per cycle of each technology, in each week studied, VBTF technology was the one with the lowest cost difference per cycle. VBTF was the technology that kept its costs per cycle more balanced when compared to the three weeks.

Thus, even if the volumes sterilized by VBTF are quite different, this technology has similar values. Regarding the costs per liter, the sterilization method by PHPG proved to be the most costly in all studied weeks, but the same did not occur with VBTF, which remained the most economical during the studied period.

The costs per cycle of OE during the three weeks studied were more expensive than those of PHPG in the same period. This probably occurred because they were processed weekly because of the high time spent per cycle, and, annually, fewer cycles were counted in the first one compared to the second technology. Thus, when calculating the amortization of the equipment per cycle, the wear of the sterilizer that is a result obtained by dividing the annual amortization by the annual number of cycles, caused OE to suffer a disadvantage since it was little used annually when compared to PHPG. Thus, the equipment wear and cycle number per year directly influenced the final price of the cost per cycle.

DISCUSSION

No failure was observed in this CME in any sterilization cycle at low temperature during the execution of this study. This reinforces that this technology must be handled by nurses or a team very well trained to work with technology at low temperature since it requires a greater technical-scientific knowledge.

This study evidenced the importance of the maximum optimum load so that the sterilization process is efficient and can justify the importance of making the load of each of the sterilizers profitable, because of the higher the load, the optimum maximum load, the cheaper the cost per liter and the cost per cycle. For this reason, VBTF has been identified as the most economical technology for low-temperature sterilization, which is an alternative to ethylene oxide.

Regarding the costs per cycle and per liter, in each case, the maximum optimum load of 90% (ninety percent) of the actual capacity of equipment was considered to compare each technology studied. Thus, it has been observed that the cost per liter is a result that is always conditioned by the volume of the sterilizer load. Therefore, it is an indicator of use and, consequently, of efficient use of the equipment.

It was observed that the amount of material sterilized in VBTF added the second highest volume of all material processed at low temperature, and the fact that VBTF is the most economical sterilizing agent technology (R\$ 30.44/cycle) to be the most economically viable. The maximum optimum load of the VBTF equipment (91.35 L) is the greater volume when compared to other EBT equipment, so the sterilizer of this technology has more capacity, in liters, to sterilize, per cycle, a greater quantity of materials than the rest. With this, it can be ensured that the more material is sterilized per cycle, the more economical will be because there are savings of sterilizing agent.

With all data, it was possible to prove that the sterilization process using PHPG was the one that presented the highest cost per cycle, due to 1) self-cost of the sterilizing agent, R\$ 161.48/liter, of disposable products totaling R\$ 154.08/cycle; 2) the volume of material processed weekly was higher in this technology compared to the others, since this hospital has a small inventory and needs a fast method of sterilization; 3) the time spent by the employees in this technology was higher when compared to the others, because the sterilization of more materials by this method caused them to spend more time in preparing, supplying, removing the materials from the sterilizer and storing them; 4) the disposable material used in this technology is manufactured exclusively by the same manufacturer of the sterilizer of this CME, which has the power to freely work its prices; 5) PHPG sterilizer was on loan, until the end of this study, and therefore, the price of the disposables practiced for this technology were

at that moment more expensive than the market price. Thus, the price of sterilization by PHPG has become higher and, consequently, it is suggested to repeat this study with this technology when the equipment is removed.

In the three weeks in which the technologies of EBT were studied, the variation of costs per liter and per cycle was observed. Regarding the values referring to the VBTF and OE methods, they remained practically unchanged. However, the same has not happened with PHPG technology, as there are opposite inflection points in costs per cycle and per liter that correspond to the same ratio. In week A of sampling the highest volume of PHPG was processed, when compared to the other weeks, and this implied in the increase of the number of disposables and, consequently, a cost per final cycle higher. On the other hand, it can be seen that by having a better use of the sterilizer, a higher percentage of maximum optimum load, the final cost per liter is reduced. In week C, the cost per cycle of OE increased, while the costs of other technologies in the same week declined. This is because this week has been a holiday month and, therefore, the number of procedures and hospitalizations has decreased considerably. Thus, the decrease in the number of procedures allowed the accumulation of materials to be sterilized by OE (technology used only once a week in this CME) and, consequently, the weekly volume of material to be sterilized by other technologies, has been reduced. The fact that the hospital had a small number of patients allowed the material to wait for a slow OE aeration process.

An important point that deserves to be highlighted was when comparing the value of the cost per liter of PHPG between Weeks A and C. In the first week; the cost was R\$ 5.4/L, and in the third week, it was R\$ 7.8/L. This fact explains why the average use of PHPG in Week A was 67.14L and in C of 43.68L. This average utilization factor is very important in determining the cost per cycle of the sterilization process. Another important factor was when, in the same weeks, the optimal maximum load of PHPG was compared. This load was in Week A of 95.91% and C of 47.40%. With this, it can be concluded that the maximum optimum load directly influences the price of the final cost per liter. Thus, the higher the optimum maximum load, the lower the final value of cost per liter.

Therefore, the routine of this CME and the results found in this study show that plasma gas sterilization just does not become even more expensive, because this technology is the most used in this service. The VBTF technology has the cost-per-liter and lower-cycle values in the three weeks of sampling when compared to other technologies. This is explained by the fact that the VBTF has disposables at much more attractive prices, used with high frequency and maintaining the maximum optimum load in the three weeks studied.

In a study¹⁰ that also knew and analyzed the costs of a CME using the ABC system, concluded the importance of analyzing the cost-benefit of activities for sterilization. This system enabled the study to know the advantages from the information obtained at the managerial level, identifying how the activities and materials used to influence the cost, allowing monitoring the performance of the processes from financial data, and allowing to improve management practice.

It can be seen that the ABC instrument was efficient^{14,15} when it came to knowing, analyzing and comparing health costs, and especially in CMEs, where expenditures are very high and difficult to visualize.

CONCLUSION

As a result of CMEs being essential to the operation of the hospital and the need to maintain excellence in the quality of sterilized products, it should be emphasized that the costs related to them must be known and analyzed in depth so the financial health of the institution investments can be done whenever necessary without putting it at risk.

Each institution must first study the costs of its CME, as well as the need to acquire a certain technology, since it often requires changes in the infrastructure to be used and, consequently, to be paid quickly, it is necessary to be used in high frequency.

It is not interesting to acquire a certain technology if there is not enough material that justifies its acquisition and also, they must master the technology before using it so that expenses from ignorance are avoided.

Thus, it can be considered that the formaldehyde vapor (VBTF) was the one that presented the costs per cycle and per liter more attractive of all the technologies of sterilization studied at low temperature.

In the case of this CME, gas plasma sterilization (PHPG) was a good choice for processing thermosensitive materials.

The information found by using the ABC methodology was relevant in the management, planning, and control of volumes and costs of a CME. The closer the optimum load is of the material to be sterilized, the lower the cost of the sterilization process, as it was found that the cost per liter is an indicator of efficient use of a sterilization method.

The fact that the nurse of this CME dominates the technologies of EBT made that the number of failure cycles was null, avoiding unnecessary costs.

The values found in this investigation exclusively reflect the reality of this CME, since each sterilization center has its characteristics and routine. The methodology used proved to be of great importance for the nursing management, any CME and any and all health services.

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