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Antibiotic therapy costs at a Neonatal Intensive Care Unit at a philanthropic hospital

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Abstract

Objective: To evaluate the costs of antibacterials dispensed to patients admitted in a Neonatal Intensive Care Unit (UTIN) of a philanthropic hospital, over a one-year period. The total and unitary costs were analysed and the antibacterials were classified according to the ABC curve method. **Methods:** Study of direct analysis of therapy costs with injectable antibiotics for intravenous use, carried out from the assessment of dispensing data obtained from the institution managing software used for the hospital's central pharmacy (SALUX System). The study comprised the period from January to December 2020. **Results:** A total of 191 patients were hospitalized throughout 2020 and 2.214 ampoules of various antibacterials were distributed, generating a total price of US$ 1.113.25. The drug cefepime, with a total cost of US$ 394.45 and 67 ampoules dispensed (35.4% of the total cost in antibacterials) reached the highest unit value. Ampicillin 500 mg and gentamicin 20 mg were the most dispensed drugs with 915 and 575 ampoules, respectively. According to the ABC curve classification, four antibacterials are grouped in category A and add up to 79.75% of the accumulated percentage (AP) of total costs. Another four items are in category B (AP of 93.99%), while category C represented less than 10% of the total cost. **Conclusion:** The evidence from the study suggests that the prescription and dispensing of antibiotics for the NICU appear to be by the Pediatric Society guidelines since ampicillin and gentamicin were the most prescribed antibiotics with low cost for the economic administration of the hospital. Also, according to the global use of antibiotics, they do not show a high economic impact on the total costs of hospitalization and treatment of patients.

Palavras-chave: pharmacoeconomics, antibacterials, neonatal intensive care unit, costs, cost analysis

Custos da terapia com medicamentos antibacterianos em uma Unidade de Terapia Intensiva Neonatal de um hospital filantrópico

Resumo

Objetivo: Avaliar os custos com o tratamento antibacteriano em pacientes internados na Unidade de Terapia Intensiva Neonatal (UTIN) de um hospital filantrópico, pelo período de um ano. Foram analisados os custos unitários e totais e, utilizando-se o método da curva ABC, foi feita a classificação dos antibacterianos. Métodos: Estudo de análise direta de custos da terapêutica com antibióticos injetáveis de uso intravenoso, realizado a partir da avaliação dos dados de dispensação obtidos do software de gestão da instituição (Sistema SALUX) na Farmácia Central do hospital. O estudo compreendeu o período de janeiro a dezembro de 2020. **Resultados:** Estiveram internados 191 pacientes ao longo de 2020 e foram distribuídas 2.214 ampolas de diversos antibacterianos, a um custo total de US$ 1.113,25. O medicamento cefepime (67 ampolas) representou um custo de US$ 394,45 (35,4% do custo total em antibacterianos), alcançando o maior valor unitário. Ampicilina 500 mg e gentamicina 20 mg foram os mais dispensados com 915 e 575 ampolas, respectivamente. Pela classificação da curva ABC, quatro antibacterianos foram agrupados na categoria A e somaram 79,75% do percentual acumulado (AP) dos custos totais. Outros quatro itens estão na categoria B (AP de 93,99%); enquanto a categoria C representou menos de 10% do custo total. **Conclusão:** As evidências do estudo sugerem que a prescrição e a dispensação de antibióticos para a UTIN parecem estar de acordo com as orientações da Sociedade Brasileira de Pediatria, uma vez que ampicilina e gentamicina foram os antibióticos mais prescritos com baixo custo para a administração econômica do hospital. Ainda, de acordo com o uso global de antibióticos, estes não demonstram ter impacto econômico alto frente aos custos totais de internação e tratamento dos pacientes.

Keywords: farmacoeconomia, antibacterianos, unidade de terapia intensiva neonatal, custos, análise de custos.

Introduction

Application of health economy has proved to be a relevant tool to meet the need to rationalize resources in today's world, allowing for a reduction in expenditures and maintaining drug quality through the contribution of physicians, nurses and pharmacists, contributing benefits to the health services[1,2,3].

In hospitals, Intensive Care Units (ICUs) and Neonatal Intensive Care Units (NICUs) require an economic analysis, as they are hospital areas for the care of critically-ill patients who need a large number of medications and interventions, where their costs represent an important percentage of the hospital budget[4,5].

Use of antimicrobials stands out at the hospital level, especially in NICUs[6]. Antibiotics are often prescribed to neonates, regardless of whether they are affected by proven infections, and this pattern is maintained due to the high risk of neonatal sepsis, considered the main cause of morbidity and mortality among newborns[7]. However, incorrect use of these medications can be detrimental to the patients' clinical condition[5]. In this sense, it becomes essential to identify the etiological agent to choose the right antibiotic, thus avoiding therapeutic failures, empirical treatments with various therapeutic regimens and increased hospital costs[8,9-10].

The correct indication needs to be performed precisely, as it is fundamental to try and minimize the risk of bacterial resistance induction and the emergence of multidrug-resistant species, as well as reducing the number of adverse events[12].

In order to have greater knowledge of the costs, consumption and movements, the ABC Curve, also known as Pareto Curve or 80-20 Curve, becomes a good strategy, being possible through it to sort the items in stock according to their importance or impact, with the amount used and their unit value[11,14]. The result of this classification is stratified into three categories: A, B and C. Curve A represents 80% of the financial cost and 20% of the items in stock; Curve B is considered the intermediate zone between A and C; while Curve C represents 70% of the items and only 20% of the total cost[12]. Thus, with the possibility of summarizing as follows: A items are the most important in financial terms and require greater care, items classified as B are intermediate and C items are less important[13].

In view of the scarcity of studies comparing the costs regarding antibiotics and the importance of implementing cost reduction protocols, it becomes relevant to know their consumption, which directly or indirectly affects the institution and the health system by increasing hospitalization times and treatment costs. Therefore, the objective of the study was to evaluate the cost of the antibiotics distributed to the patients admitted to the NICU of a philanthropic hospital, during a one-year period, aiming at identifying the most frequently prescribed antibiotics, analyzing the unit and total costs generated for the institution, by using the ABC Curve.

Methods

This is a study involving direct analysis of the costs of the therapy with intravenous antibiotics dispensed to a NICU of a philanthropic hospital on the West border of Rio Grande do Sul, which has nearly 230 beds, of which eight are destined to the NICU. The study locus was the Central Pharmacy of the hospital, where the medications dispensed to the NICU from January to December 2020 were evaluated through SALUX System, a hospital management program used by the institution. The associations described in protocols and most frequently used in the NICUs were also evaluated based on the available antibiotics.

The data were recorded and organized in a Microsoft Office Excel 2013® electronic spreadsheet and later on analyzed by means of tables and graphs. For calculation of the hospital's expenditure on antibiotics during this period, the amounts obtained in the SALUX System were added up, where it provides the values of the medication purchases by the hospital, in which open quotations are made, every fifteen days. The monetary values were converted into US dollars through a mean quotation from January to December 2020 (US$ 5,383.93).

The data were analyzed by means of the macro-costing or top-down method, which aims at evaluating aggregated data, providing a notion of the values as a whole.

The ABC Curve was drawn from the data of antibiotic dispensations; therefore, the medications were classified into classes A, B and C. The classification was based on their cost, taking into account the unit and total costs, as well as the individual and accrued percentage, so that the classification could be obtained.

The project was submitted to the Information System for Research, Teaching and Extension Projects of the Federal University of Pampa (*Universidade Federal do Pampa*, UNIPAMPA), under registration number 202021208160046. In accordance with Resolution No. 510/2016[15], as this is a research study conducted with a database whose information is grouped, without the possibility of individual identification, it waived evaluation by the Research Ethics Committee (*Comitê de Ética em Pesquisa*, CEP). Authorization of the institution to access the system data was previously deliberated and documented.

Results

In total, 191 patients were hospitalized and 2,214 ampoules of antibiotics were dispensed between January and December 2020, accounting for a total cost of US$ 1,113.25. Table 1 displays the medications, therapeutic classes, total of ampoules administered, the unit values and their totals.

The most expensive medication was cefepime, which generated a total cost of US$ 394.45, with 67 ampoules dispensed, representing 35.4% of the total costs in antibiotics during the period analyzed. On the other hand, it was observed that the most frequently consumed medications often do not represent the highest costs, such as ampicillin 500 mg and gentamicin 20 mg, which totaled 915 ampoules with a cost of US$ 362.37 (32.5%) and 575 ampoules with a cost of US$ 73.79 (6.62%), respectively (Figure 1).

As for the different therapeutic classes, it was noticed that a set of six different classes were dispensed during this period (Figure 2), especially the penicillin class (33.3%), followed by the aminoglycoside class (25%).

Table 2 presents the classification of the antibiotics, according to the ABC Curve. It was possible to notice that only four items were classified in category A and that, together, they account for 79.75% of the total expense on antibiotics during the period. Adding the percentage spent on items from categories A and B, more than 90% of the cost is concentrated in eight items (66.6%) of the total in stock, while category C accounted for less than 10% of the total cost.

Table 1. Antibiotics used in the NICU between January and December 2020. Uruguaiana, RS, 2021.

Medication	Therapeutic class	Total of ampoules	Unit cost (US$)	Total cost (US$)
Amikacin (100 mg)	Aminoglycoside	195	0.12	23.94
Ampicillin (1 g)	Penicillin	27	1.06	28.79
Ampicillin (500 mg)	Penicillin	915	0.39	362.37
Benzylpenicillin (5,000,000 UI)	Penicillin	24	1.09	26.34
Cephazolin (1 g)	Cephalosporin*	10	1.61	16.13
Cefepime (1 g)	Cephalosporin**	67	5.88	394.45
Gentamicin (20 mg)	Aminoglycoside	575	0.12	73.79
Gentamicin (80 mg)	Aminoglycoside	7	0.06	0.45
Meropenem (500 mg)	Carbapenem	39	1.46	57.25
Metronidazole (500 mg)	Nitroimidazole	60	0.80	48.42
Oxacillin (500 mg)	Penicillin	147	0.21	31.64
Vancomycin (500 mg)	Glycopeptide	148	0.33	49.67

*First generation; **Fourth generation.

Figure 1. Percentage individual cost of the antibiotics dispensed between January and December 2020. Uruguaiana, RS, 2021.

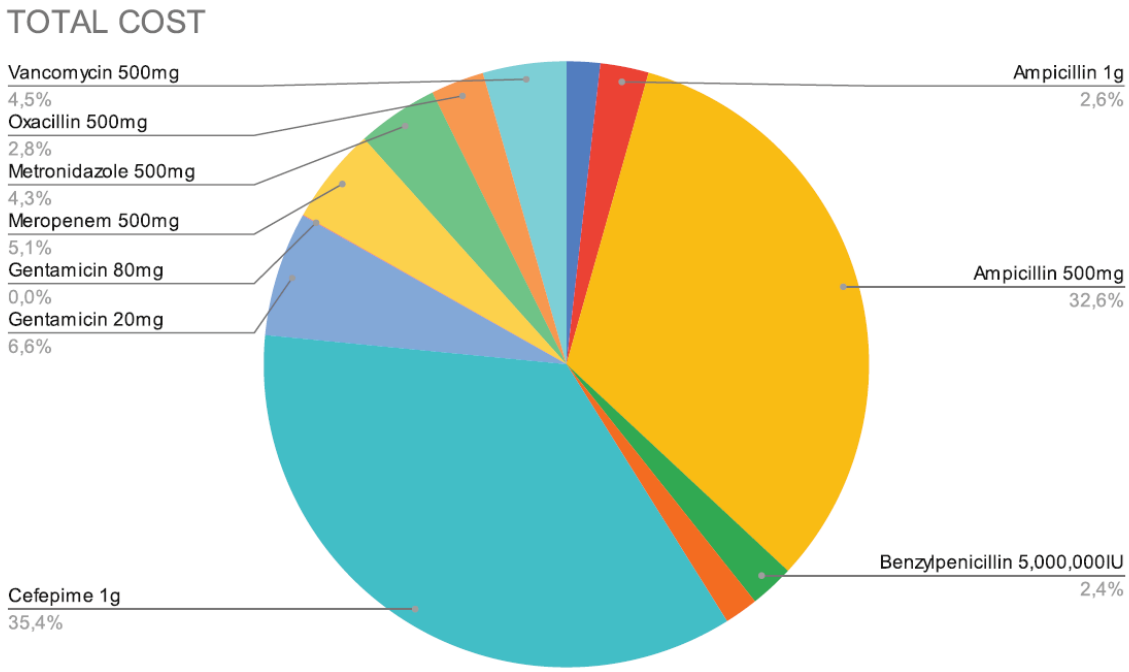

Figure 2. Therapeutic classes of the antibiotics dispensed between January and December 2020. Uruguaiana, RS, 2021.

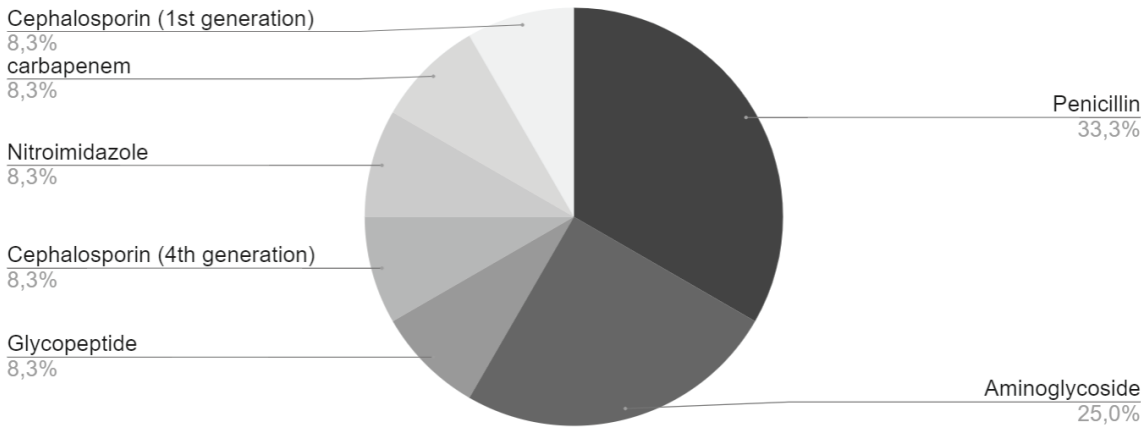

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Table 2. Classification of the antibiotics used in the NICU between January and December 2020, according to the ABC Curve. Uruguaiana, RS, 2021.

Medication	Total of ampoules	Unit cost (US$)	Total cost (US$)	Individual percentage (%)	Accrued percentage (%)	Classification
Cefepime (1 g)	67	5.88	394.45	35.44	35.44	A
Ampicillin (500 mg)	915	0.39	362.37	32.53	67.97	A
Gentamicin (20 mg)	575	0.12	73.79	6.62	74.59	A
Meropenem (500 mg)	39	1.46	57.25	5.15	79.75	A
Vancomycin (500 mg)	148	0.33	49.67	4.47	84.21	B
Metronidazole (500 mg)	60	0.80	48.42	4.35	88.56	B
Oxacillin (500 mg)	147	0.21	31.61	2.84	91.41	B
Ampicillin (1 g)	27	1.06	28.76	2.58	93.99	B
Benzylpenicillin (5,000,000 UI)	24	1.09	26.34	2.37	96.36	A
Amikacin (100 mg)	195	0.12	23.94	2.15	98.51	A
Cephazolin (1 g)	10	1.61	16.13	1.45	99.96	A
Gentamicin (80 mg)	7	0.06	0.45	0.04	100.00	A

Discussion

Hospitalizations of neonates in the NICU are due to several reasons, with early or late neonatal sepsis being the most prevalent problem[16]. In this scenario, therapy with antibiotic use becomes essential, where treatment and correct management can significantly reduce morbidity and mortality due to neonatal sepsis[17]. In view of the importance of these treatments, the evaluation of antibiotics becomes of great value from the biological and also economic point of view.

In the current study it was possible to notice that ampicillin, amikacin and gentamicin presented a higher number of dispensations. This is because they are the antibiotics of choice for early sepsis and use in empirical treatments[18,19]. Our data are similar to those of a study conducted by Oliveira *et al.* at a philanthropic hospital in Bahia[18], in which the prescriptions of 56 patients who were admitted to the NICU were analyzed during six months, where these medications were also the most frequently prescribed, with frequency in prescriptions of 33 (58.9%), 32 (57.1%) and 27 (48.2%) for gentamicin, ampicillin and amikacin, respectively.

In the cases of late infections in neonates, the first option is commonly related to an association, where the first choice is oxacillin and amikacin, which have a recommendation for use due to low induction of resistance and to high sensitivity of gram-negative rod-shaped bacteria, also offering low cost; while the second choice in these cases is using vancomycin associated with cefotaxime or cefepime[19,20]. It can then be assumed that part of the patients admitted to the NICU may have undergone treatments for late sepsis, due to the amount of these antibiotics dispensed.

According to the protocols set forth by the Brazilian Society of Pediatrics (*Sociedade Brasileira de Pediatria*, SBP), these antibiotics are the most used due to their low resistance profile, high availability and reduced costs[18]. In agreement with the SBP, our study observed reduced unit values, with a mean cost of US$ 0.39 for ampicillin 500 mg and US$ 0.12 for gentamicin 20 mg. Based on this analysis, it is concluded that, in addition to being effective, these medications do not represent high costs for the treatments.

In general, cefepime was the antibiotic that generated the highest costs for the hospital, even if it was one of the least dispensed. This may justify why it is considered the second treatment option for infections, when there is no response in the first-choice drugs; it is understood that they may present resistance to the other antibiotics.

By classifying antibiotics according to the ABC Curve it is possible to observe the medications with the highest and lowest consumption and their costs[21,22]. The ABC classification indicated that the medications that represented category A were cefepime, ampicillin, gentamicin and meropenem, which are represented by higher costs, accounting for almost 80% of the financial cost. However, ampicillin and gentamicin were the most dispensed and their unit costs are low. In this sense, it is believed that they only fall into category A due to the high number of dispensations, as they represent a large percentage of the items in stock, when compared to cefepime and meropenem.

For the purpose of evaluating the economic impact generated by the antibiotics in the treatment process of patients hospitalized in the NICU, the mean values of the daily expenses and hospitalization time, US$ 92.93 and 20 days respectively, were obtained from a direct survey with the hospital's inpatient sector. Thus, it is possible to observe that the costs generated by the antibiotics dispensed for this unit do not contribute significantly to the increase in the total amount of the expenses related to the treatment of patients because, on average, US$ 1,879.20 are spent for the 20 hospitalization daily expenses and the total amount spent for the most costly antibiotics, which belong to category A (cefepime, ampicillin, gentamicin and meropenem), in the period of 1 year, reaches a value of US$ 917.10. Thus, for a period of 20 hospitalization days, the estimated cost for these antibiotics reaches US$ 50.25, which represents 2.67% of the total hospitalization cost.

Conclusion

According to the survey of costs generated by the use of antibiotics in the NICU, it can be concluded that they do not contribute significantly to the total cost of hospitalization and treatment of the patients in this unit.

The most frequently dispensed antibiotics are amikacin, ampicillin and gentamicin, with low purchase values. The antibiotic with the highest value found was cefepime, which represented the highest purchase expenditure.

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Collaborators

MNM, FRJ and PAG took part in elaboration of the article, including conception of the project, data analysis and interpretation, writing of the article and review of the final paper to be published.

Conflict of interest statement

The authors declare that there are no conflicts of interest in relation to this article.

References

1. Packeiser PB, Resta DG. Farmacoeconomia: uma ferramenta para a gestão dos gastos com medicamentos em hospitais públicos. Infarma Ciências Farmacêuticas. 2014; 26(4): 215-223.
2. Tonom LM, Tomo TT, Secoli SR. Farmacoeconomia: Análise de uma perspectiva inovadora. Contexto Enferm. 2008; 17(1): 177- 82. DOI: 10.1590/s0104-07072008000100020
3. Drummond MF, O'Brien BJ, Stoddart GL & Torrance GW. Métodos para a avaliação econômica de programas de saúde Oxford University Press, Oxford;1997.
4. Gomes AM. Enfermagem na unidade de terapia intensiva. São Paulo: EPU; 1998.
5. Papadoulos J, Rebuck JA, Lober C, et al. The critical care pharmacist: an essential intensive care practitioner. Pharmacotherapy: The Journal of Human Pharmacology and Drug Therapy. 2002; 22(11):1484-1488. DOI: 10.1592/phco.22.16.1484.33694
6. Silva CDR, Junior MS. Estratégias para uso adequado de antibioticoterapia em unidade de terapia intensiva.Einstein. 2015; 13(3): 448-453.
7. Andrikopoulou M, Huang Y, Duffy CR, et al. Uso de antibióticos sem indicação durante hospitalizações de parto nos Estados Unidos. Obstet Gynecol. 2019; 134 (4): 718 – 725. DOI: 10.1097 / AOG.0000000000003485
8. Paterson DL. O papel dos programas de gerenciamento de antimicrobianos na otimização da prescrição de antibióticos em hospitais. Clin Infect Dis. 2006; 42 (2): S90-5.
9. Cabral LG, de Meneses JP, de Carvalho Pinto PF, et al .Racionalização de antimicrobianos em ambiente hospitalar. Rev da Soc Bras de Clin Med. 2018;16 (1): 59-63.
10. Ting JY , Roberts A, Sherlock R, et al. Duração da antibioticoterapia empírica inicial e resultados em bebês de muito baixo peso ao nascer. Pediatrics. 2019; 143 (3): 2018-2289. DOI:10.1542/peds.2018-2286
11. Ferranti E. Gestão de estoque de medicamentos utilizando classificação ABC em um hospital público [trabalho de conclusão de curso].Universidade Federal do Rio Grande do SUL – UFRGS, Porto Alegre, 2015.
12. Calil R, Caldas JPS- Uso Racional e Seguro de Antibióticos em Neonatologia. Universidade Estadual de Campinas UNICAMP. 2012
13. Popesko B, Novák P. Application of ABC method in hospital management. Recent Researches in Economics and Management Transformation. 2011; 11 (1): 17-19.
14. Almeida, JCA, Allevato, RCG. Planejamento de compras em rede hospitalar pública: estudo de caso da rede hospitalar federal no Rio de Janeiro [trabalho de conclusão de curso]. Universidade Federal Fluminense, Niterói- RJ, 2011.
15. Brasil. Resolução nº 510, de 07 de abril de 2016. Dispõe sobre as normas aplicáveis a pesquisas em Ciências Humanas e Sociais. Diário Oficial da República Federativa do Brasil, Brasília, DF, 24 maio de 2016.
16. 16. Dos Santos PN, Silva GA, Coelho TS et al. Análise farmacoeconômica dos antimicrobianos na unidade de terapia intensiva em um hospital terciário. Research, Society and Development. 2020; 9 (7): 1-15. DOI: https://doi.org/10.33448/rsd-v9i5.3179
17. Jucá FL. O uso de antimicrobianos em Unidade de Terapia Intensiva Pediátrica [Tese de doutorado]. Universidade de São Paulo, São Paulo, 2016.
18. Castro RSAPD. Análise da sepse neonatal tardia em prematuros de muito baixo peso após a implantação do protocolo de sepse na unidade [dissertação de mestrado]. Faculdade de Medicina Universidade Estadual Paulista, Botucatu, 2017.
19. Oliveira CRV, Macedo NM, Bendicho MT, et al. Utilização de antimicrobianos em uma Unidade de Terapia Intensiva Neonatal: um estudo transversal retrospectivo.Research, Society and Development. 2021;10 (1): 1-09. DOI: https://doi.org/10.33448/rsd-v10i1.11794
20. Calil R, Caldas JPS. Uso racional e seguro de antibióticos em neonatologia. Sociedade Brasileira de Pediatria, 2012.
21. Procianoy RS, Silveira RC. The challenges of neonatal sepsis management. Jornal de pediatria. 2020; 96 (1): 80-86.
22. Bassoli HM, Pierre FC, de Oliveira, PA. Aplicação da curva ABC como ferramenta para a gestão de estoques de uma indústria madeireira de botucatu/SP. In IV JORNACITEC. 2015; (7): 82-97.