PREVALENCE OF AND RISK FACTORS FOR SURGICAL SITE INFECTIONS IN PATIENTS WITH MYELOMENINGOCELE

Prevalência e fatores de risco para infecção de sítio cirúrgico em mielomeningocele

Prevalencia y factores de riesgo para infección del sitio quirúrgico en mielomeningocele

Natalie Rosa Pires Neves[1], Marilene Evangelista Correa Noleto[2], Virgínia Sousa Ribeiro[3]

ABSTRACT: Objective: To determine the prevalence of and risk factors for surgical site infections (SSIs) in the treatment of children with myelomeningocele. **Methods:** The medical records of children who underwent the procedure were listed; only the cases that tested positive for SSI were analyzed. **Results:** From 2005 to 2010, 155 medical records were listed, 123 (79.35%) of which were found. Of these, 14 (9.03%) were discarded, and 109 (70.32%) remained for analysis. There was a 33.94% prevalence of SSIs; the lumbosacral localization (32.43%) and ruptured lesions (83.78%) are predominant. The majority (86.49%) of the children underwent surgical correction after 48 hours of life. In 11 (27.73%) cases, material from the surgical wound was cultured, all of them (100%) were positive; *Klebsiella pneumoniae* (46.66%) and *Pseudomonas aeruginosa* (26.67%) prevailed. **Conclusion:** The prevalence rate of SSIs in this study was high when compared to other types of surgery; for infected surgeries, however, the levels found are consistent with the literature, which reports from 7% to 40%.

Keywords: Myelomeningocele; infection; risk factors.

RESUMO: Objetivo: Determinar a prevalência e os fatores de risco para infecção de sítio cirúrgico (ISC) no tratamento de mielomeningocele infantil. **Métodos:** Foram listados os prontuários de crianças que se submeteram ao procedimento e analisados apenas os casos positivos para ISC. **Resultados:** De 2005 a 2010, foram listados 155 prontuários, dos quais 123 (79,35%) foram localizados. Destes, 14 (9,03%) foram descartados, restando 109 (70,32%) para análise. Houve 33,94% de prevalência da ISC, e predominaram a localização lombossacral (32,43%) e lesões rotas (83,78%). A maioria (86,49%) das crianças realizou correção cirúrgica após 48 horas de vida. Em 11 (27,73%) casos se fez cultura de material proveniente da ferida operatória, todas (100%) positivas; predominaram *Klebsiella pneumoniae* (46,66%) e *Pseudomonas aeruginosa* (26,67%). **Conclusão:** A taxa de prevalência de ISC neste estudo foi considerada alta quando comparada a outros tipos de cirurgia; no entanto, para cirurgias infectadas os níveis encontrados acordam com a literatura, que relata de 7 a 40%.

Palavras-chave: Mielomeningocele; Infecção; Fatores de risco.

RESUMEN: Objetivo: Determinar la prevalencia y los factores de riesgo para infección del sitio quirúrgico (ISQ) en el tratamiento de mielomeningocele infantil. **Método:** Fueron listados los históricos de niños que se sometieron al procedimiento y analizados apenas los casos positivos para ISC. **Resultados:** De 2005 a 2010, fueron listados 155 históricos, de los cuales 123 (79,35%) fueron ubicados. De estos, 14 (9,03%) fueron descartados, restando 109 (70,32%) para análisis. Hubo un 33,94% de prevalencia de la ISC, y predominaron la ubicación lumbosacra (32,43%) y lesiones rotas (83,78%). La mayoría (86,49%) de los niños realizó corrección quirúrgica tras 48 horas de vida. En 11 (27,73%) casos se hizo cultivo de material proveniente de la herida operatoria, todas (100%) positivas; predominaron Klebsiella pneumoniae (46,66%) y Pseudomonas aeruginosa (26,67%). **Conclusión:** La tasa de prevalencia de ISQ en este estudio fue considerada alta cuando comparada a otros tipos de cirugía; sin embargo, para cirugías infectadas los niveles encontrados acuerdan con la literatura, que relata de un 7 a un 40%.

Palabras clave: Mielomeningocele; Infección; Factores de Riesgo.

[1]Nurse. Specialist in Operation Rooms, Post-Anesthesia Recovery, and Central Sterile Supply Department. Professor. Operating room nurse at the Djalma Marques Municipal Hospital – São Luís (MA), Brazil. E-mail: natalierosaneves@gmail.com
Rua 3, Quadra 7, Casa 8, Araçagy, Zip Code: 65110-000, São José de Ribamar (MA), Brazil.
[2]Nurse. Specialist in Operation Rooms, Post-Anesthesia Recovery, and Central Sterile Supply Department – São Luís (MA), Brazil. E-mail: marilenenoletto@hotmail.com
[3]Nurse. Specialist in Operation Rooms, Post-Anesthesia Recovery, and Central Sterile Supply Department – São Luís (MA), Brazil. E-mail: vsr.enf@gmail.com
Received: 11 Sept. 2016 – Approved: 10 Jan. 2017
DOI: 10.5327/Z1414-4425201700010003

INTRODUCTION

Myelomeningocele is characterized by a failure in the closure of the neural tube that compromises the medulla, the vertebral arches, and the cutaneous mantle, is presented as a tumor with variable volume and extension. It is in the midline, at any level of the vertebral column, with a predisposition for the lumbosacral region, where 75% of the cases occur, as ruptured, intact, or epithelial lesions[1].

The cause of the disease is still unknown, but there is evidence that factors such as radiation, drugs like valproic acid, malnutrition, and the use of chemical substance may be associated with it. There is strong proof that the maternal folic acid intake reduces the incidence of neural tube defects in at-risk pregnancies. The diagnosis is based on clinical manifestations and meningeal sac examination[2].

Nevertheless, surgery is inevitable. It is performed to close the lesion and recommended up to 48 hours after birth as it is believed that this can minimize the risk of infections and new spinal cord injuries to which the patient is susceptible. It consists of an update on microsurgical techniques for the anatomical reconstitution of the spinal cord, the preservation of the largest possible amount of functioning nervous tissue, and the prevention of infection and subsequent loss of function[3,4].

In the immediate postoperative period, the patient is vulnerable to several complications, usually associated with preoperative clinical conditions, the extent and type of surgery, surgical or anesthetic complications, and the efficacy of the therapeutic measures adopted. Surgical site infections (SSIs) are a relevant postoperative complication as it contributes to increased patient morbidity and mortality, causing physical or emotional disorders, and considerably increasing the cost of treatment and hospitalization, which indicates the epidemiological importance of the subject[5,6].

Two-thirds of SSIs are confined to superficial tissues (skin and subcutaneous tissues), and deep soft tissues (fascia and muscles), and a third involves organ, or space, penetrated during the surgical procedure. The Brazilian Health Surveillance Agency (ANVISA) establishes the superficial SSI is "an infection in the surgical incision, diagnosed up to 30 days after the procedure and involves only skin and subcutaneous tissue." It is characterized by one of the signs/symptoms: purulent drainage of the superficial incision, isolation of pathogen in the fluid culture or the incision tissue, presence of signs or symptoms of infection – pain or tenderness, localized edema, erythema or heat – if the incision is opened by the surgeon or the diagnosis made by the surgeon or attending physician. The ANVISA also believes deep SSIs include at least one of the following criteria: purulent drainage of deep soft tissue after incision, spontaneous dehiscence, or wound opening by the surgeon in the presence of hyperthermia or local pain, except for negative cultures, abscess, or other evidence of a deep status and/or diagnosis by the attending physician. Furthermore, the SSI in an organ or space that has been opened or manipulated during the occurrence of the surgical procedures if there is a positive culture of the local material, abscess, or other evidence of infection at that level and/or medical diagnosis[6].

There are several factors that interfere with the SSI pathogenesis, which may be related to the microorganism (microbial load, virulence), patient (underlying diagnosis, such as diabetes mellitus, obesity, hypertension, immune suppression, and age extremes) and perioperative period (prior use of antibiotics, previous length of hospitalization, trichotomy prior to surgical procedure, surgical technique, ventilation and perfusion, hemodynamic conditions, duration of the procedure, presence of devitalized tissues). Surgical contamination classification is very relevant, since "the contamination potential is an important variable because it estimates the bacterial inoculum in the surgical wound[8]." In the case of myelomeningocele, the following factors are added: the status of the spinal cord lesion at the time of surgery (ruptured, intact, or epithelial lesions), its location, the child's age at the time of correction, presence or absence of infectious complications before surgery (such as sepsis and ventriculitis)[9].

Since the beginning of infection control programs, epidemiological surveillance is important to identify problems of infection and the development of effective prevention measures. It is of the utmost importance that the entire health care service monitors SSI rates, with an active search of cases, surgical separation, and relation with the contamination potential of the procedure[8]. In the case of myelomeningocele surgery for correction, the relation between the procedure and the subsequent development of meningitis is still discussed if the time elapsed between birth and the correction is significant for the infection, and the adopted antibiotic therapy is effective in reducing the risk of infection[9].

Thus, health professionals must have knowledge of infections and their risk factors in order to implement a program to improve the quality of health care with effective prevention actions. In their daily practice, health care staffs should assess patients, the monitoring factors, proposing, and implementing preventive relevance measures, such as the use of the checklist that is part of the Safe Surgery Saves Lives Program, established by the World Health Organization (WHO) to improve the quality of global surgical care. The SSI ranks third among all infections related to health care in Brazil, which justifies its continued relevance in the hospital experience[5].

Therefore, this study is aimed at broadening the knowledge on myelomeningocele infections in children in the postoperative period, a procedure with an infection incidence much higher than all the other procedures performed in the central nervous system[4].

OBJECTIVES

To determine the prevalence of and risk factors for SSIs in the postoperative period of the surgical treatment of myelomeningocele, identify the microbial flora in SSIs, and show the sensitivity and resistance profile of microorganisms that cause SSIs in the postoperative myelomeningocele period.

METHODS

This is a transversal, descriptive, quantitative, and retrospective study carried out in a public, university and reference hospital for the treatment of children with meningomyelocele in the state of Maranhão. All medical records of children who underwent surgery for myelomeningocele correction from 2005 to 2010 – a period whose data were available at the time of collection – recorded in the pediatric operation room. Only the medical records of patients who were diagnosed with SSIs were analyzed, focusing on risk factors for their incidence. The length of hospitalization variable was tabulated for the total number of records available, described as a possible risk factor.

The project was approved by the Research Ethics Committee of the University Hospital of the Federal University of Maranhão (HUUFMA), Process No. 076/12. After approval, researchers began collecting the data, complying with all the ethical principles from Resolution No. 196/96 of the National Health Council (CNS).

The data were obtained from a documentary source, that is, from the medical records of the patients, in their totality – medical, nursing, and examination notes – in search of the SSI diagnosis. Infection risk factors were gathered using a data collection tool with the following information: identification, type of delivery, lesion topography, lesion status, previous infectious complications, length of hospitalization before and after the surgical procedure, details of antibiotic therapy, and microbial flora found.

The medical records were divided between the patients diagnosed with SSIs and those without the problem to discover the prevalence of SSIs in this case, using the prevalence formula shown in Figure 1. The data in the medical records of the patients who had an infection were categorized by question, and the relative frequencies were calculated. All data were tabulated in the Excel® software, presented in graphs and tables, analyzed according to the results, and discussed based on the existing literature.

RESULTS

There were 155 cases in the time interval studied. Of these, 32 (20.65%) medical records were not located by the Medical and Statistical Archive Service (SAME), 11 (7.1%) were discarded because they did not contain the minimum information for data collection, and three (1.93%) were not considered because the patients had died before 30 days, making it impossible to diagnose SSIs. Therefore, 109 (70.32%) records were analyzed for the presence or absence of SSIs. Of the records analyzed, 37 (33.94%) cases of SSI were found, resulting in a prevalence of 33.94% of SSIs in correction surgery for myelomeningocele from 2005 to 2010. Among the 37 SSIs, 22 (59.46%) were classified as deep, 10 (27.03%) as superficial and five (13.51%) as organ/space (Figure 2).

Of the SSI cases, 15 (40.54%) were caesarean sections and 14 (37.84%) were vaginal deliveries; in eight (21.62%) cases, the route of delivery was not informed in the medical records. Among these same 37 cases in which the SSI

$$\text{Prevalence of SSIs} = \frac{\text{number of SSI cases}}{\text{total of assessed cases}}$$

SSI: surgical site infection.

Figure 1. Calculation of the prevalence of surgical site infections in the study population.

was detected, we observed that the predominant localization of the lesion at the spinal level was lumbosacral, with 12 (32.43%) cases. In addition, nine (24.32%) cases were at the lumbar level, four (10.82%) cases were at the sacral level; two (5.40%) cases were in the cervical/occipital region; in 10 (27.03%) cases the medical records did not mention the location of the spinal cord lesion (Table 1).

Regarding the status of the lesion when the defect was corrected, 31 (83.78%) children had a ruptured lesion, four (10.82%) had an intact lesion, one (2.70%) had an epithelial lesion; one (2.70%) did not have their lesion status informed in the medical records (Table 1).

Concerning infectious complications prior to surgical correction, in 31 (83.78%) cases we considered the presence of an infected and ruptured lesion, even if the infectious process was not included in the medical records, due to a higher period than six hours after rupture (trauma) in all of them. In four (12.90%) of these cases, in addition to the local infection, sepsis was recorded; in five (13.52%) cases, there was no previous infection record; in another case (2.70%), the lesion status was not highlighted nor was there a record of an infectious complication prior to the procedure (Table 1).

The average length of hospitalization was 49.83 days, with an average of 10.11 days prior to surgery and 39.73 postoperative days for the cases in which there were SSIs. For the uninfected cases, the average was 9.67 days before the surgical procedure and 24.34 days in the hospital after the procedure.

Only five (13.51%) children underwent correction of myelomeningocele within 48 hours after birth and after the first 48 hours of life for the other 32 (86.49%) children affected by SSIs.

Of the 37 patients who had SSIs, only three (8.11%) used an antimicrobial prophylactically. The others (91.89%) used the antibiotic for curative purposes before the surgical procedure because of an infectious process. The most commonly used antimicrobial, whether for preventive or curative purposes, was oxacillin, which was chosen as the starting drug in all patients; combinations were made with gentamicin, amikacin, ceftriaxone, meropenem, vancomycin, and cephalexin.

Table 2 establishes that in 11 (27.73%) cases the surgical wound was cultured using a lesion fragment in two (18.18%) samples and swabbed secretion in the other nine (81.82%). From the total of cultures, all (100%) samples were positive; in four (36.36%) cases more than one predominant microorganism

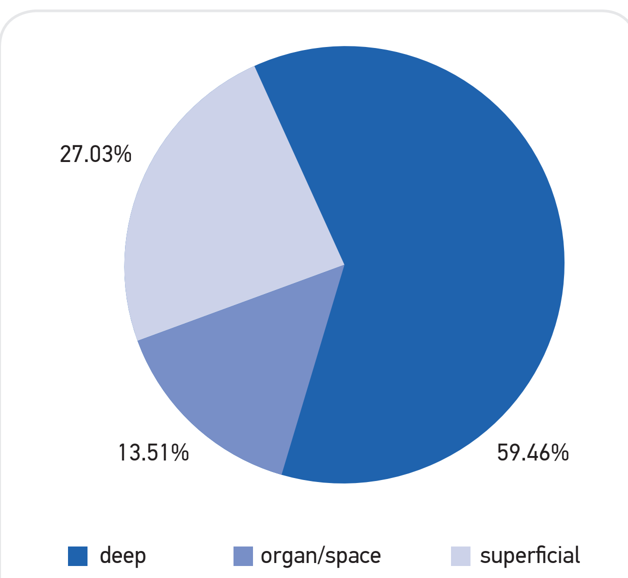

Figure 2. Classification of the found surgical site infections according to the subtypes determined by the Brazilian Health Surveillance Agency (ANVISA).

Table 1. Characteristics of meningomyelocele in children assisted by a public pediatric hospital, São Luís, Maranhão, 2005–2010.

Variables	Frequency	Percentage (%)
Location of the lesion		
Lumbosacral	12	32.43
Lumbar	9	24.32
Sacral	4	10.82
Cervical	2	5.40
Not informed	10	27.03
Total	37	100
Lesion status		
Ruptured	31	83.78
Intact	4	10.82
Epithelial	1	2.70
Not informed	1	2.70
Total	37	100
Presence of infectious complications prior to surgery		
Presence of infected ruptured lesion	31	83.78
No infection	5	13.52
Not informed	1	2.70
Total	37	100

Source: Data from the Medical and Statistical Archive Service (SAME) of the *Hospital Universitário Materno-Infantil* (University Maternal and Child Hospital), 2012.

was found. The microbial flora found comprised *Klebsiella pneumoniae* in seven cases (46.66%), *Pseudomonas aeruginosa* in four cases (26.67%), *Escherichia coli* in two cases (13.34%), coagulase-negative *Staphylococcus*in one case (6.66%), and *Enterobacter*sp. in one case (6.67%).

The sensitivity profile of *Klebsiella* sp. was 71.42% to ciprofloxacin and meropenem and 42.86% to imipenem and piperacillin + tazobactam; it is mainly resistant to amikacin and gentamicin (57.14% each), 42.86% to ampicillin and amikacin as well as 28.57% to ampicillin with sulbactam, cefotaxime, and ceftazidime. *P. aeruginosa*, however, was sensitive to piperacillinin 75% and amikacin in 50% of cases with predominant resistance to ampicillin and gentamicin (50%).

DISCUSSION

The prevalence of SSIs in myelomeningocele correction found in this study was high (33.94%) when compared to the results of other similar studies, which indicate 22.8% of postoperative complications associated with SSIs[10]. We found 11.7% of infectious complications after surgical treatment in a Brazilian study[11]. These authors[12,13] conclude SSIs are an important and frequent complication in this type of surgical procedure, given the conditions it is usually performed, its surgical classification and the other risk factors that will be discussed next. The result found here is superior, but compatible, with the expected SSI rate in infected surgeries, which is from 30% to 40%[7].

Table 2. Microbial flora found in culture of material from the surgical wound after surgical treatment of myelomeningocele in children assisted at *Hospital Público Infantil*, São Luís, Maranhão, 2005-2010.

Variables	n	%
Surgical site culture performed		
Yes	11	27.73
No	26	72.27
Total	37	100.00
Material used for culture		
Lesion fragment	2	18.18
Secretion through swab	9	81.82
Total	11	100.00
Microbial flora found*		
Klebsiella pneumoniae	7	46.66
Pseudomonas aeruginosa	4	26.67
Eschericcia coli	2	13.34
Negative *Sthaphylococcus coagulase*	1	6.66
Enterobacter sp.	1	6.67
Total	37	–

*In some cases, more than one microorganism was found per sample.
Data obtained from the Medical File Service (acronym in Portuguese – SAME) of *Hospital Universitário Materno Infantil*, 2012.

There are reports in the literature about the type of delivery as a risk factor for this type of SSI[10], but the findings of this study did not show a significant difference between the caesarean section, with 15 (40.54%) of the positive cases, and the vaginal delivery, with 14 (37.84%), corroborating other authors[14], who reported there is no conclusive evidence that the caesarean section improves the outcome in children with myelomeningocele in relation to the vaginal delivery.

The lesion topography is more frequent in the lower vertebral column, while the lumbosacral localization (32,43%) predominates in this study; however, most of the findings do not establish that this is a significant factor for surgical wound infection[3,13,15]. Other authors[11] find different predominant lesion topographies in their publications, reinforcing the possibility that this factor does not have as much influence on SSI incidence. In the present study, the result was compromised by the absence of data in 27.03% of the records studied, impairing a deeper analysis of the condition.

Regarding the lesion status, most were ruptured (83.78%), following the tendency described in the literature on lesions found in patients with myelomeningocele. In these cases, surgical treatment is characterized as a procedure with prior microbial contamination[7]. Several authors[17,13] state in their studies that the probability of SSIs is directly affected by potential surgery contamination, which is also suggested by this research findings.

About length of hospitalization, we observed that the average before surgery was 10.1 days in the positive infection cases against 9.67 days in negative cases, indicating an irrelevant difference, which counters investigators[8,12] that referred to a prolonged preoperative hospitalization period as a risk factor for surgical wound infections. However, analyzing the length of postoperative hospitalization, the indexes found (average of 39.7 days for positive cases vs. 24.14 days for negative cases) coincide with reports[18] that state SSIs increase the length of hospitalization.

Most authors[3,9]concur that a surgical closure longer than 48 hours is an important risk factor for SSIs and other complications as evidenced by other studies regarding the lower rate of dehiscence when the surgical correction happened at the optimum time[19]. In the present study, the value of such risk factor in the SSI etiology is suggestive, with 86.49% of the children who developed surgical wound infection having the defect corrected after 48 hours of life.

The majority of patients with SSIs (83.78%) had infectious complications prior to surgery, which justified the use of antibiotic therapy. Conversely, the antibiotic prophylaxis was not included in any medical records, which is the use of antibiotics without any evidence of established infections at the time of surgery[6]. In addition, antimicrobial prophylaxis is not indicated in clean surgeries, as it is the case of intact meningomyelocele, nor in infected ones[17] (ruptured lesion), thus justifying the lack of practice in this type of surgery.

Regarding the antibiotic usually prescribed, the physician must analyze if it comprehends the spectrum of pathogens that most commonly cause SSIs on the location undergoing surgery, always preferring first-generation antibiotics, such as cefazolin, since the use of antibiotics, although adequate, can lead to the selection of resistant pathogens[20].

All cultures collected from the surgical wound were positive for microorganisms, confirming a local infectious process. The presence of *P. aeruginosa*is confirmed by other studies[6,19] in class-III wounds – contaminated and infected – as one of the most frequently isolated in surgical wound cultures, proving one of this study findings, of 26.67% for this microorganism.

The *K. pneumoniae* specimen was the most prevalent microorganism in global nosocomial infections in investigations carried out in different locations and at different times; *P. aeruginosa* is also a major specimen in SSIs, a result also found in this study. The major challenge nowadays is developing multi-drug-resistant bacteria, making known microorganisms virtually insurmountable obstacles, as antimicrobial sensitivity is severely reduced[6,20].

The surgical wound culture and antibiogram are important to determine the patient's therapeutic plan to thwart the present infection. Few of the SSI cases in this study were cultured, but they became a significant sample due to the predominance of two microorganisms and the resistance and sensitivity profiles compatible with a large percentage. Analyzing the clinical features of the SSI cases, we detected that the most commonly used antibiotic, oxacillin, was not included in the resistance profiles nor in the sensitivity profiles; there were two widely used antibiotics (gentamicin and amikacin) that were quite resistant; however, of the others – ceftriaxone, meropenem, vancomycin, and cephalexin – meropenem was the only one listed for sensitivity and as predominant. Therefore, it is necessary to systematically collect and analyze surgical wound cultures for antimicrobial prescription to optimize the use of sensitive antimicrobials, leading to clinical improvement and the cure of infection, thus avoiding the selection of multi-resistant strains and other complications, such as death.

Some of the limitations of this study include those imposed by the use of secondary data, not collected by the authors, besides the incompleteness of medical records and insufficient information that damage the quality of data. In addition, the final sample was small, and it was not possible to proceed with statistical data tests.

CONCLUSION

This study concludes that the prevalence rate of SSIs is high in myelomeningocele correction. The most prevalent variables in the occurrence of SSIs were lesion status, infectious complications prior to surgery, length of postoperative hospitalization, and lesion correction more than 48 hours after birth. Type of delivery, location of the lesion, and length of preoperative hospitalization were not prevalent variables for SSIs.

The most prevalent microorganism in cases of infection was *K. pneumoniae*, sensitive to ciprofloxacin, meropenem, imipenem, and piperacillin + tazobactam and resistant to amikacin, gentamicin e ampicillin. Despite advances in control and prevention practices, SSIs still are a substantial cause of morbidity and mortality among patients undergoing surgical procedures, prolonging length of hospitalization and burdening health care services. Due to the constant change in this pattern of surgical infection, periodic studies (aimed at documenting the epidemiological profile of infections in these patients), the reassessment of risk factors for infection and, especially, the evaluation of the antimicrobial resistance profile are essential. It is necessary to implement he assessment of the epidemiological surveillance system of SSIs to minimize issues that limit the achievements of such studies, such as failure to provide information due to incomplete data or even absence of medical records.

REFERENCES

1. Baghdadi T, Abdi R, Bashi RZ, Aslani H. Surgical management of hip problems in myelomeningocele: a review article. Arch Bone Jt Surg. 2016;4(3):197-203.

2. Di Rocco C, Trevisi G, Massimi, L. Myelomeningocele: an overview. World Neurosurg. 2014;81(2):294-5. Disponível em: http://www.worldneurosurgery.org/article/S1878-8750(13)00325-2/abstract

3. Marreiros, H, Loff, C, Calado, E. Who needs surgery for pediatric myelomeningocele? A retrospective study and literature review. J Spinal Cord Med. 2015;38(5):626-40.

4. Bao N, Lazareff J. How I do it: management of spina bifida in a hospital in The People's Republic of China. Surg Neurol Int. 2015;6(Suppl 11):337-45.

5. Roscani ANCP, Ferraz EM, Oliveira Filho AG, Freitas MIP. Validação de checklist cirúrgico para prevenção de infecção de sítio cirúrgico. Acta Paul Enferm. 2015;28(6):553-65.

6. Nogueira PSF, Moura ERF, Costa MMF, Monteiro WMS, Brondi L. Perfil da infecção hospitalar em um hospital universitário. Rev Enferm UERJ. 2009;17(1):96-101.

7. Agência Nacional de Vigilância Sanitária (ANVISA). Critérios diagnósticos de infecção relacionada à assistência à saúde - Série Segurança do Paciente e Qualidade em Serviços de Saúde. 2013. 80p. Disponível em: <www20.anvisa.gov.br/segurancadopaciente/index.php/publicacoes/category/livros>

8. Oliveira AC, Ciosak SI. Infecção de sítio cirúrgico em hospital universitário: vigilância pós-alta e fatores de risco. Rev Esc Enferm USP. 2007;41(2):258-63.

9. Demir N, Peker E, Gülsen I, Agengin K, Tuncer O. Factors affecting infection development after meningomyelocele repair in newborns and the efficacy of antibiotic prophylaxis. Childs Nerv Syst. 2015;31(8):1355-9.

10. Salomão JF, Pinheiro JAB, Carvalho JGS, Leibinger RD, Lucchesi G, Bomfim V. Mielomeningocele: tratamento cirúrgico e resultados. Jornal de Pediatria. 1995;317-21. Disponível em: http://www.jped.com.br/conteudo/95-71-06-317/port.pdf.

11. Schroeder HK, Nunes JC, Madeira L, Moritz JLW, Walz R, Linhares MN. Postsurgical infection after myelomeningocele repair: a multivariate analysis of 60 consecutive cases. Clinical Neurology and Neurosurgery. 2012;114(7):981-5.

12. Bellusse GC, Ribeiro JC, Campos FR, Poveda VB, Galvão CM. Fatores de risco de infecção da ferida operatória em neurocirurgia. Acta Paul Enferm. 2015;28(1):66-73.

13. Pinto NC, Pinto FCG, Alho EJL, Yoshimura EM, Krebs VLJ, Teixeira MJ, et al. Estudo piloto em neonatos utilizando o laser de baixa intensidade no pós-operatório imediato de mielomeningocele. Einstein (São Paulo). 2010;8(1):5-9.

14. Anteby EY, Yagel S. Route of delivery of fetuses with structural anomalies. Eur J Obstet Gynecol Reprod Biol. 2003;106:5-9.

15. Faraji M, Ashrafzadeh F, Ariamanesh A, Faraji S. Surgical outcome of patients with meningomyelocele treated with a team approach. Neurosurgery Q. 2006;16(2):160-7.

16. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, Bolon MK, et al. Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm. 2013;70(3):195-283.

17. Olson MM, Lee JT. Continuous, 10-year wound infection surveillance. Ann Surg. 1990;60:27-40.

18. Kshettry VRI, Kelly ML, Rosenbaum BP, Seicean A, Hwang L, Weil RJ. Myelomeningocele: surgical trends and predictors of outcome in the United States, 1988-2010. J Neurosurg Pediatrics. 2014;13(6):666-78.

19. Radcliff E, Cassell CH, Laditka SB, Thibadeau JK, Correia J, Grosse SD, et al. Factors associated with the timeliness of postnatal surgical repair of spina bifida. Childs Nerv Syst. 2016;32(8):1479-87.

20. Garcia LM, César ICO, Braga CA, Souza GAAD, Mota EC. Perfil epidemiológico das infecções hospitalares por bactérias multidrogarresistentes em um hospital do norte de Minas Gerais. Rev Epidemiol Control Infect. 2013;3(2):45-9.