Instituto Nacional de Neurología y Neurocirugía Manuel Velasco Suárez | Revista de Enfermería Neurológica

Original article

Intervenciones de prevención y tratamiento en recién nacidos con defectos del tubo neural

Interventions of prevention and treatment on newborn with neural tube defects

Ariela Vázquez Hernández[1] 0000-0003-0381-8660 Laura Álvarez Gallardo[2] 0000-0003-2820-5027

Resumen

Introducción: los defectos de tubo neural son anomalías congénitas del sistema nervioso central; estas malformaciones elevan el grado de morbimortalidad en los recién nacidos durante los diez primeros años de vida.

Objetivo: definir las intervenciones que el profesional de enfermería puede realizar en el recién nacido con defectos del tubo neural tomando en cuenta aspectos de prevención y tratamiento.

Material y métodos: se realizó una búsqueda sistematizada en las bases de datos de PudMed y BVS de julio-septiembre 2021, que incluyo artículos completos relacionados con intervenciones de enfermería a recién nacidos con defectos del tubo neural publicados entre 2016-2021 y artículos médicos de revisión literaria.

Resultados: se seleccionaron 41 artículos para definir las intervenciones, a saber: **a.** intervenciones preventivas con el consumo de ácido fólico, control prenatal y educación sanitaria, **b.** intervenciones relacionadas al tratamiento enfocadas al cuidado de las derivaciones ventriculoperitoneales y cuidado de heridas quirúrgicas, **c.** intervenciones ante complicaciones.

Discusión: las tasas de mortalidad y discapacidad infantil han incrementado en los últimos años a pesar de los avances en la medicina preventiva, por lo que toma relevancia el consumo de ácido fólico, educación sanitaria y métodos de cuidado hospitalarios.

Conclusiones: la enfermera neonatal puede participar con cuidados estandarizados en beneficio de los recién nacidos considerando intervenciones para evitar retraso en el crecimiento y desarrollo de los hitos motores y cognitivos, reducir complicaciones y mejorar las posibilidades de una óptima condición de vida.

Palabras clave: defectos del tubo neural, cuidados de enfermería, prevención, ácido fólico, hidrocefalia, derivación ventriculoperitoneal, mielomeningocele.

Citation: Vázquez Hernández A., Álvarez Gallardo L. Interventions of prevention and treatment on newborns with neural tube defects Rev Enferm Neurol.2021;20(3):pp. 179-188.

Addres for correspondence: Ariela Vázquez Hernández
[1]División de Estudios de Posgrado de Enfermería, Instituto Nacional de Pediatría, Escuela Nacional de Enfermería y Obstetricia, Universidad Nacional Autónoma de México, México
[2]Instituto Nacional de Pediatría, Ciudad de México, México
E-mail: ary.ela21v@gmail.com.

Received: November 5 2021
Accepted: November 29 2021

Abstract

Introduction: neural tube defects are congenital anomalies of the central nervous system; These malformations increase the degree of morbidity and mortality in newborns during the first ten years of life.
Objective: define the interventions that the nursing professional can be carried out in newborns with neural tube defects, considering aspects of prevention and treatment.
Material and methods: systematized search was carried out in the databases of PudMed and BVS during July-September 2021, which included complete articles related to nursing interventions for newborns with neural tube defects published between 2016-2021 and medical literature review articles.
Results: forty-one articles were selected to define the interventions: a. Preventive interventions in the consumption of folic acid, prenatal control and health education, b. Interventions related to treatment focused on the care of ventriculoperitoneal shunt and surgical wound care, c. interventions for complications.
Discussion: infant mortality and disability rates have increased in recent years despite advances in preventive medicine, which is why the consumption of folic acid, health education and hospital care methods are relevant.
Conclusions: neonatal nurse can participate with standardized care for the benefit of newborns, considering interventions to avoid delayed growth and development of motor and cognitive milestones, reduce complications and improve the chances of an optimal life condition.

Key words: neural tube defects, nursing care, prevention, folic acid, hydrocephalus, ventriculoperitoneal shunt, myelomeningocele.

Introduction

Congenital malformations are structural or functional anomalies that develop during intrauterine life and are detected during pregnancy, delivery or after the birth,[1,2] according to estimates from the World Health Organization, on a world-wide scale, every year over 303.000 newborns die.[3]

The neural tube develops after the third week of pregancy and closes around the twenty-eighth day. Neural tube defects (NTDs) are part of birth defects (CBI), these are produced by an alteration in the process of neurulation, which can affect the brain and/or the spinal cord; in addition to entailing meningeal, osseous, muscular or integumentary tissues, that is to say, they affect the structures that give protection to the central nervous system (CNS). Neural tube anomalies produce damage to the nervous system, learning difficulties, paralysis, and death. Frequently reported congenital malformations in Mexico are anencephaly, encephalocele and spina bifida; however, the epidemiological surveillance system (Sistema de vigiancia Epidemiológica) reports a decrease on the two firsts[3-5] Statistically, something similar takes place in other countries where prevalent neural tube defects are: anencephaly, spina bifida, encephalocele and congenital hydrocephalus[6] These are caused by different environmental factors, epigenomics and/or sociocultural.[7,8]

Objective: to define the interventions that the professional nurse can perform on the newborn with neural tube defects, taking into account aspects of prevention and treatment.

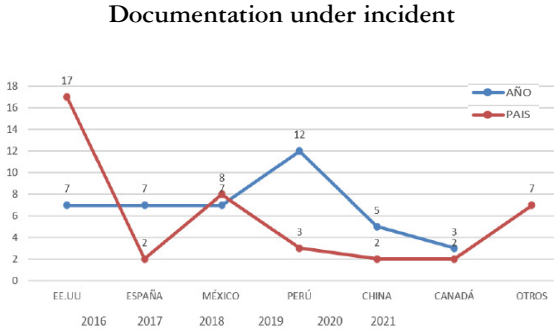
Materials and methods

A systematic search was carried out in the digital databases of PudMed and BVS from July to September 2021. The search terms MeSH included neural tube defects, nursing, prevention, folic acid, hydrocephalus, ventriculoperitoneal shunt, myelomeningocele. Whole articles related to nursing interventions on newborns with neural tube defects published between 2016-2021 and medical review articles of renown were included. Incomplete articles and those published before 2015 were excluded. The obtained data was condensed into a spreadsheet and a critical analysis of the information answering the following questions: *what were the results?, are these results valid?*, are these results applicable in the professional

Results

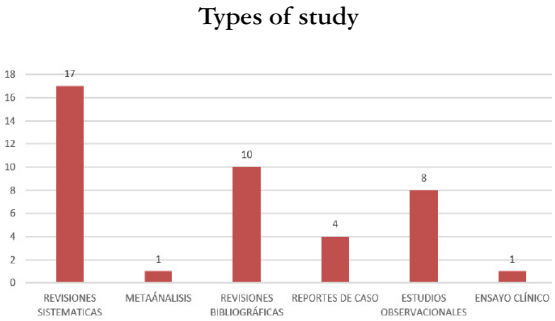
I. Graphical analisis

Forty-one articles were analyzed, 2019 yielded remarkable results about the topic. The countries with more scientific documentation were The United States of America (17), followed by Mexico (8), classified among others, we can find: Costa Rica, Cuba, Argentina, Jordan, Turkey and Germany.



1st chart. Relation between the year of publication and countries with more documentation.

The studies found during the search were systematical revisions (17); bibliographic revisions (10); observational studies (8), file reports (4), meta-analysis (1) and clinical papers (1).



2nd chart. Articles found during the literary revision.

Due to the prevalence of congenital malformations in Mexico, on basis with the revision, the interventions of professional nurses must be focused in:

Prevention interventions	• Folid acid intake • Prenatal care checkups • Prenatal education
Caring interventions	• Ventriculoperitoneal shunts care • Placoda care (open spina bifida) • Surgical wound care • Enteral feeding
Interventions for complications	• Care of external ventricular drains • Care of contaminated surgical wounds • Prevention of latex allergy

Table 1. Nursing interventions on newborns with neural tube defectsdefectos del tubo neural.

II. Prevention interventions

a. Folid Acid Intake

The consumption of folic acid (4 mg/day) is essential to prevent failures during neural tube closure (open and closed), this was grounded by

fifteen authors who mentioned what can be done to decrease infant morbitality rates, on another note, it is preponderant to mention the fortification of wheat and corn flours, which have acquired notoriety in the prevention of these malformations especially in developing countries.[3, 9-28]

b. Prenatal care checkups

Preconceptual counseling is important to identify possible risk factors on an early phase of the pregnancy and to establish preventive measures to give adequate treatment with minimal adverse reactions and for the satisfactory evolution of both, the mother and their fetus.[1,2]

c. Prenatal education

Education is a fundamental pillar in the population to prevent unintended pregnancies and pregnancy at early ages, with the objective to adhere to a therapeutic regime; [8,10,11] to avoid exposure to toxins like tobacco consumption[29], contaminated food[30] and teratogenic drugs that could increase the risks of defects in the development of the neural tube.[1]

III. Treatment interventions for hydrocephalus and myelomeningocele

a. Ventriculoperitoneal shunt care

A primordial step towards the handling of patients with hydrocephalus-related neurological disorders, is to prepare the nursing staff of the neonatal intensive care units, in most cases, newborns get a ventriculoperitoneal shunt (VP shunt) surgically placed to drain extra cerebrospinal fluid (CSF), in such a way that the boarding would be routed to the practice of specific interventions such as intracranial pressure monitoring (ICP), median arterial pressure, vomit, letargy, neurological reflexes (Babinski, suction, deglutition, palmar grasp reflex, plantar pressure assessment, ...), photophobic response reflexes, bleeding, cephalic perimeter, etc. [31, 32]

b. Placode care (open spina bifida)

Neural tube closure defects of the open type, are characterized for a protrusion on the skin due to an unfused portion of the vertebrae in the spinal column, while waiting for surgery, the myelomeningocele must be protected from damage for excoriation and contamination through the usage of a sterile occlusive dressing soaked in saline solution and in a prone decubitus position, no less relevant the take of eutermic measures against temperature loss for humidity. [33]

c. Surgical wounds care

Postsurgical treatment on wounds to prevent infections and favor their healing process is a specific intervention to perform on newborns with myelomeningocele; the degree of damage on the skin must be evaluated, if the defect is broken and/or intact, a treatment on the lesion must be performed through an aseptic technique coupled with a warm sterile physiological solution to avoid desiccation, a sterile dressing must be applied, and the condition of the meningeal(epithelial) sac inspected to verify the presence of cerebrospinal fluid drainage, quantify the quantity and color of the drainage in the course of each dressing change, realize changes in the position from prone to lateral decubitus every two to three hours according to the stability of the newborn, avoid injuries for pressure, bring protection against infections and regulate the temperature.[5]

d. Enteral feeding

Mothers can breastfeed their newborns with myelomeningocele, in the intensive care units, mothers must be encouraged to give human milk due to the multiple benefits that these give in relation to the supplying of nutrients and hydration, strengthening of the immune system, to develop the mother-child link and reduce the risk of death during the first month of life. Milk must be pumped early, frequently and with the adequate sanitary measures for it to be innocuous, it has been described that up to 80% of newborns can be breastfeed directly or with the help of a bottle/probe in accordance with their clinical conditions. [34]

IV. Interventions for complications

a. Care of external ventricular drains

A ventriculoperitoneal shunt malfunction is often caused by the accumulation of proteins in the cerebrospinal fluid that obstruct the catheter in any part of the system or due to an infection colonized by the skin microflora generating an abcess. Some signs and sympthoms of infection that must be observed are: erythema, edema over the incision site or through where the catheter is situated, fever, lethargy or irritability, abdominal pain, ascites, anorexia, nape stiffness, febricula and elevated white blood cell count. [32]

Drainage of cerebrospinal fluid with a ventriculoperitoneal shunt is not an option on patients with meningitis or ventriculitis, an alternative is the usage of an external ventricular drain (EVD), which often are regarded as secure for the treatment and have a low rate of infection. [35] The intervention of nursing in EVD drainage include the monitoring and maintenance of these from the moment of insertion to the conclusion of the procedure realized by the interdisciplinary team.[36]

On infections of the central nervous system by multidrug-resistant pathogens, when medication capable of reaching adequate concentrations of cerebrospinal fluid (CSF) through systemic therapy are lacking, intrathecal administration of anti-infective agents is indicated. Indispensable antibacterials include aminoglycosides, colistin, daptomycin, tigecycline, vancomycin and amikacin these can be used on newborns with a dosage of 50/100 mg/day to treat post-surgical refractory meningitis caused by bacteria resistant to gentamicin (Klebsiella pneumoniae and staphylococcus epidermidis). The professional nurse must observe adverse effects like hearing impairments to high tones and transitory vomitting.[38]

b. Care of contaminated surgical wounds

The plasia of a myelomeningocele interrupts the integrity of the skin, this remains exposed to infections, mainly gram-negative bacteria resistant to antibiotics, an effective way to treat them, is the application of a therapy coupled with chlorhexidine gluconate at 2% on the healthy skin around the wound and saline solution at 0.9% over open wounds to support healing of the epithelial tissue and keep it free from microorganisms.[39]

c. Latex allergy prevention

A latex allergy is an immune system reaction to proteins found in natural rubber latex, this substance is found on some instruments utilized during the caring of newborns in the intensive care unit, even though these do not manifest symptoms commonly recognized on later stages of development (sneezes, nasal congestion, coryza,

pruritus, urticaria, conjunctivitis, pharyngitis, sinusitis, otitis, dyspnea or cough) it must be taken into account that patients, especially those with myelomeningocele, are more susceptible due to the frequent and early contact to these products, because of that, when bringing nursing essential supplies the professional must opt for latex-free implements and keep track of available allergy data.[40]

Discussion

Despite advances in preventive medicine, infant mortality and disability rates have increased over the last few years, which emphasizes the relevance of folic acid intake, prenatal education and methods of hospital caring.

As a preventive framework in relation to neural tube defects, many countries have shown interest in research regarding the importance of folic acid intake and the fortification of wheat and maize flour to minimize the incidence rates. Kancherla in 2018, indentified 71 countries with an immediate potential to compulsory fortification of 145 millions of metric tons of wheat flour with folic acid, this would avoid 57.000 newborns with spina bifida and anencephaly on average, furthermore it would increase the global prevention rates from 13% to 34%.[18] Later in 2021, estimates from their prevention model determined that 65.380 cases of spina bifida were prevented in 2019 through the fortification of folic acid of wheat and maize flour, they also appraised the proportion of world-wide prevention at 23%.[19] In 2019, Centeno assessed health and security benefits of fortification with folic acid in maize and wheat flours, they found that the later one fortified with folic acid and other micro-nutrients was associated with a significantly lower incidence of neural tube defects, spina bifida and encephalocele, but not anencephaly, in comparison with non-fortified flour.[14] On the other hand, Shlobin points out in 2020 that compulsory fortification based on folic acid is effective to reduce neural tube defects sensitive to folate deficiency, decreases the hospitalization rates, deaths after hospital discharge and increases survival during the first year of life.[12]

Another way to prevent neural tube defects besides folic acid consumption is through comprehensive sexual education, knowledge, prenatal care checkups and the establishment of politics that reinforce this initiative. In 2018, Toivonen observed a higher prevalence of supplementation with folic acid on patients with a higher educational level, the prevalence of intake before conception was bigger in Europe with a 98% and null in Africa with 0%.[10] Later in 2020, Lassi found that educative interventions to delay the age of the first pregnancy and spacing interpregnancy intervals, exponentially improved contraceptive acceptance; besides, preconceptional iron-folic acid supplementation decreased the incidence of neural tube defects and improved the rates of anemia when supplemented in a school setting. [11]

Some policies that encourage this initiative in Mexico can be found in the NOM-034-SSA2-2013, Para la prevención y control de los defectos al nacimiento (regarding the prevention and control of birth defects); and in the NOM-007-SSA2-2016, Para la atención de la mujer durante el embarazo, parto, puerperio y de la persona recién nacida (regarding the caring of the woman during pregnancy, childbirth, puerperium and the newborn person); where an adequate nutrition with a prescription of folic acid (4 mg), multivitamins, and the avoiding of abuse and usage of toxic and addictive substances is promoted to prevent low birthweight and damage on the fetus. On top of emphasizing the advantages of breastfeeding and the spacing between pregnancies through

the adoption of a postpartum contraceptive method without limiting their universal rights to reproductive and sexual health.[41]

If neural tube defects overcome the prevention measures it is important to bring newborns an opportune treatment through high-quality healthcare, on this revision 11 of the studies describe nursing care in relation to ventriculoperitoneal shunts and their encompassed systems (neurological, gastrointestinal, integumentary); in 2017 Joseph, mentions that nursing staff in neonatal intensive care units (NICU) must be capacitated to take care of babys with hydrocephalus and those who are subjected to ventriculoperitoneal shunting procedures (VP shunt), since monitoring the first signs of an increase in the intracranial pressure (ICP) eases a timely diagnostic and promts an inmediate surgical intervention.[31] In 2018, Vacca analized if nursing personnel can look after patients that have been subjected to lodging or amendment of a shunt, they found that immediate post-operative care must include: 30° tilt position, pain handling, adequate functioning of the ventriculoperitoneal shunt, neurological assessment, evaluation towards complications, care of the proximal (head) and distal (abdominal) surgical site of the catheter to take notice of possible bleeding, drainage and signs of infection.[32]

On the eventuality of any complications in response to the initial treatment a second surgical intervention or another therapeutic method like the installation of an external ventricular drain will be required, as a consequence the professional must have knowledge about the handling of these and about the caring of wounds, even those that are contaminated: In 2019, George evaluates the security and efficacy of long-tunneled external ventricular drains (long-tunneled EVD) as a temporary measure on patients with ventriculitis and meningitis that require a derivation of cerebrospinal fluid (CSF). Out of 16 long-tunneled EVDs that were inserted, two developed a new infection between 44 and 17 days of continuous CSF drainage, concluding that these systems have low associated morbidity and infection rates, which shapes it as a good option for the treatment of neurosurgical conditions.[35] In 2016, Hepburn provided a nursing guide with better practices for the insertion, care and maintenance of ventriculostomies; the hair around the external ventricular drain (EVD) must be shaved, the skin must be prepared with chlorhexidine, adequate maximal barrier precautions, minimize the number of personnel present during the procedure, utilize antimicrobial-impregnated catheters, verification list; for the sampling and maintenance of CSF; employ an aseptic technique for the maneuver, tag the EVD tubes, CSF sampling from the distal port; gather samplings only when clinicaly indicated, minimize contact with the EVD and keep the catheter in place; specific recommendations for the dressing over EVD connections; usage of a bio-occlusive dressing with antiseptic agents (chlorhexidine gluconate), change the dressing on a weekly basis or if it detaches, this process can only be performed by doctors or nurses adept on changing dressings. [37]

Conclussions

With the subsequent analysis, interventions that the professional nurse must perform on the newborn with neural tube defects, while taking into account aspects of prevention, treatment and complications are defined.

Every care provided by professionals directly influence the health of the newborns, hence essential nursing interventions must be considered by neonatal nurses to avoid delayed growth and setbacks in the

development of motor and cognitive milestones, minimize complications, decrease hospital length of stay, medical costs and to improve the possibilities of optimal life conditions, without forgetting that the purpose of interventions is to always take heed with knowledge, warm and humanity.

Declaration of conflicitng interests policy. The authors declare that there is no conflict of interest.

Declaration of financial support. None.

References

1. **Santos-Hernández S.** Espina bífida: prevención y abordaje actual de este trastorno. (tesis) España Universidad de Valladolid, Facultad de Enfermería de Valladolid, España 2016. https://bit.ly/3sQ9dzk
2. **Zegarra-Hidalgo GC.** Factores maternos asociados a malformaciones congénitas en recién nacidos del Hospital Regional Honorio Delgado durante el año 2017.(tesis) Universidad Católica de Santa María, Perú, 2019. https://bit.ly/3HkkEp1
3. **Manual de procedimientos estandarizados para la vigilancia epidemiológica de los defectos del tubo neural y craneofaciales.** México: Secretaría de Salud, 2021. https://bit.ly/3wwP2sc
4. **García-Méndez JA.** Aspectos epidemiológicos y clínicos de la hidrocefalia en el hospital pediátrico de Legaria. (tesis) Universidad Nacional Autónoma de México, Facultad de Medicina. 2019. https://bit.ly/3zi2hyS
5. **Guzmán-Caridad I, Landin-Guerra RC, Rico-Aguilar MT.** Caso clínico de enfermería: mujer embarazada y recién nacido con defecto del tubo neural. Rev Enferm Inst Mex Seguro Soc. 2016; 24(1):65-74. https://bit.ly/3zcUsuk
6. **Zhang TN, Gong TT, Chen YL, Wu QJ, Zhang Y, Jiang CZ, et al.** Time trends in the prevalence and epidemiological characteristics of neural tube defects in Liaoning Province, China, 2006-2015: a population-based study. Oncotarget. 2017;8(10): 17092-104. doi: 10.18632/oncotarget.15060. https://bit.ly/38LrqHk
7. **Robles-Serrano P.** Características poblacionales de pacientes con mielomeningocele y consumo de ácido fólico prenatal en el Hospital General de México del 2017-2018. (tesis) Universidad Nacional Autónoma de México, Facultad de Medicina. 2019. https://bit.ly/3GKZcJs
8. **Flores-Sandi G.** Defectos del tubo neural: factores de riesgo etiológico. Rev Clín Escuela de Medicina UCR-HSJD. 2019;9(1):65-71. https://bit.ly/3x5snm2
9. **Viswanathan M, Treiman KA, Kish-Doto J, Middleton JC, Coker-Schwimmer EJ, Nicholson WK.** Folic acid supplementation for the prevention of neural tube defects: an updated evidence report and systematic review for the US Preventive Services Task Force. JAMA. 2017;317(2):190-203. doi:10.1001/jama.2016.19193 https://bit.ly/3mveU29
10. **Toivonen KI, Lacroix E, Flynn M, Ronksley PE, Oinonen KA, Metcalfe A, et al.** Folic acid supplementation during the preconception period: a systematic review and meta-analysis. Prev Med. 2018;114:1-17. doi: 10.1016/j.ypmed.2018.05.023 https://bit.ly/3wYXxv6
11. **Lassi ZS, Kedzior SG, Tariq W, Jadoon Y, Das JK, Bhutta ZA.** Effects of preconception care and periconception interventions on maternal nutritional status and birth outcomes in low- and middle-income countries: a systematic review. Nutrients. 2020; 12(3):606. doi:10.3390/nu12030606 https://bit.ly/3mi853u
12. **Shlobin NA, LoPresti MA, Du RY, Lam S.** Folate fortification and supplementation in prevention of folate-sensitive neural tube defects: a systematic review of policy. J Neurosurg Pediatr. 2020:1-17. doi:10.3171/2020.7.PEDS20442 https://bit.ly/3x9UHDX
13. **Crider KS, Qi YP, Devine O, Tinker SC, Berry RJ.** Modeling the impact of folic acid fortification and supplementation on red blood cell folate concentrations and predicted neural tube defect risk in the United States: have we reached optimal prevention? Am J Clin Nutr. 2018;107(6):1027-34. doi: https://bit.ly/3xLuPQ7

14. **Centeno Tablante E, Pachón H, Guetterman HM, Finkelstein JL.** Fortification of wheat and maize flour with folic acid for population health outcomes. Cochrane Database Syst Rev. 2019;7(7):CD012150. doi: 10.1002/14651858.CD012150.pub2 https://bit.ly/3mb57Oj
15. **Wang A, Rose CE, Qi YP, Williams JL, Pfeiffer CM, Crider KS.** Impact of voluntary folic acid fortification of corn masa flour on RBC folate concentrations in the U.S. (NHANES 2011-2018). Nutrients. 2021;13(4):1325. doi: 10.3390/nu13041325 https://bit.ly/3ma8027
16. **Lowry RB, Bedard T, MacFarlane AJ, Crawford S, Sibbald B, Agborsangaya BC.** Prevalence rates of spina bifida in Alberta, Canada: 2001-2015. Can we achieve more prevention? Birth Defects Res. 2019;111(3):151-8. doi: 10.1002/bdr2.1438 https://bit.ly/3tg7fIx
17. **Atta CA, Fiest KM, Frolkis AD, Jette N, Pringsheim T, St Germaine-Smith C, Rajapakse T, et al.** Global birth prevalence of spina bifida by folic acid fortification status: a systematic review and meta-analysis. Am J Public Health. 2016;106(1):e24-34. doi:10.2105/AJPH.2015.302902 https://bit.ly/3mb5N6j
18. **Kancherla V.** Countries with an immediate potential for primary prevention of spina bifida and anencephaly: mandatory fortification of wheat flour with folic acid. Birth Defects Res. 2018;110(11):956-65. doi: 10.1002/bdr2.1222 https://bit.ly/3NTKG4e
19. **Kancherla V, Wagh K, Pachón H, Oakley GP Jr.** A 2019 global update on folic acid-preventable spina bifida and anencephaly. Birth Defects Res. 2021;113(1):77-89. doi: 10.1002/bdr2.1835 https://bit.ly/3NN1ee8
20. **Dixon M, Kancherla V, Magana T, Mulugeta A, Oakley GP Jr.** High potential for reducing folic acid-preventable spina bifida and anencephaly, and related stillbirth and child mortality, in Ethiopia. Birth Defects Res. 2019;111(19):1513-9. doi: 10.1002/bdr2.1584 https://bit.ly/3GMFv3I
21. **Kancherla V, Redpath B, Oakley GP Jr.** Reductions in child mortality by preventing spina bifida and anencephaly: implications in achieving target 3.2 of the sustainable development goals in developing countries. Birth Defects Res. 2019;111(14): 958-66. doi: 10.1002/bdr2.1362 https://bit.ly/3zcYzGD
22. **Yanes-Calderón M, Mesa-Suárez M, Marrero-Escobedo D.** Defecto del tubo neural. Rev Cubana Obstet Ginecol. 2017;43(1). https://bit.ly/3tcQopW
23. **Jamous MA, Daoud SS, Abu-Aqoulah AM.** Multiple neural tube defects: a case report. Am J Case Rep. 2020;21:e922312. doi: 10.12659/AJCR.922312 https://bit.ly/3xg1Qni
24. **Moreno Oliveras L, Llácer Ortega JL, Leidinger A, Ali Haji M, Chisbert Genovés MP, Piquer Belloch J.** Infant hydrocephalus in sub-Saharan Africa: impact of perioperative care in the Zanzibar archipelago. Neurocirugia (Astur: Engl Ed). 2020;31(5):223-30. doi: 10.1016/j.neucir.2020.01.002 https://bit.ly/3teZ4fv
25. **Miranda-Flores MLC.** Experiencia en el manejo y evolución en niños con mielomeningocele en el Hospital Infantil del Estado de Sonora. (tesis) Universidad Nacional Autónoma de México, 2018. https://bit.ly/3NlRmsi
26. **Caramantin-Toledo FC.** Cuidados de enfermería en pacientes con mielomeningocele en el servicio de pediatría del Hospital III José Cayetano Heredia Essalud-Piura 2013-2016. (tesis) Universidad Nacional de Callao-Bellavista-Callao, Perú 2017. https://bit.ly/3PYToA2
27. **Jiménez-Guerra R, Coronado-Zarco IA, Zamora-Escudero R, García-May PK, Yescas-Buendía G, González-Gómez LA, et al.** Live births with neural tube defects at National Institute of Perinatology in Mexico City: demographic and epidemiological characteristics. Science Direct. 2018:32(1);27-32. https://bit.ly/3amQR2m
28. **Reyes-Vega MC.** Intervenciones del licenciado en enfermería y obstetricia en lactantes con hidrocefalia (tesis) Universidad Nacional Autónoma de México, Escuela Nacional de Enfermería y Obstetricia. México, 2016. https://bit.ly/3anMCDU
29. **Luo L, Diao J, Li J, Li Y, Wang T, Chen L, et al.** Association of paternal smoking with the risk of neural tube defects in offspring: A systematic review and meta-analysis of observational studies. Birth Defects Res. 2021;113(12):883-93. doi: 10.1002/bdr2.1823 https://bit.ly/3xfxMbl

30. **Du RY, LoPresti MA, Hadley CC, Lam S.** Systematic review of clinician awareness of mycotoxin impact in neural tube defects and best practices for pediatric neurosurgeons: implications for public health and policy. Childs Nerv Syst. 2019;35 (4):637-44. doi: 10.1007/s00381-018-4023-3 https://bit.ly/3Nn1zVd
31. **Joseph RA, Killian MR, Brady EE.** Nursing care of infants with a ventriculoperitoneal Shunt. Adv Neonatal Care. 2017;17(6):430-9. doi: 10.1097/ANC.0000000000000439
32. **Vacca VM Jr.** Ventriculoperitoneal shunts: What nurses need to know. Nursing. 2018; 48(12):20-6. doi: 10.1097/01.NURSE.0000547719.39116.84 https://bit.ly/3MhyIQE
33. **Cartwright CC, Igbaseimokumo U, Olsen S.** A comparison of dressing techniques for presurgical closure of myelomeningocele in the neonate. J Neurosci Nurs. 2019;51 (5):217-20. doi: 10.1097/JNN.0000000000000461 https://bit.ly/3MgWyMv
34. **Spatz DL, Froh EB.** Human milk and breastfeeding outcomes in infants with myelomeningocele. Adv Neonatal Care. 2019;19(5):376-82. doi: 10.1097/ANC.0000000000000653 https://bit.ly/3PZTR4Z
35. **George T, Moorthy RK, Rajshekhar V.** Long tunnel external ventricular drain: an adjunct in the management of patients with infection associated hydrocephalus. Br J Neurosurg. 2019;33(6):659-63. doi: 10.1080/02688697.2019.1667483 https://bit.ly/38Lw4oH
36. **Álvarez-Rossi PG, Quintano Tutos ML.** Efectividad del manejo adecuado del drenaje ventricular externo para prevenir el riesgo de infección del sistema nervioso central en recién nacidos con hidrocefalia. (tesis) Universidad Norbert Wiener, Facultad de Ciencias de la Salud. Perú 2018. https://bit.ly/3tBEyWX
37. **Hepburn-Smith M, Dynkevich I, Spektor M, Lord A, Czeisler B, Lewis A.** Establishment of an external ventricular drain best practice guideline: the quest for a comprehensive, universal standard for external ventricular drain care. J Neurosci Nurs. 2016;48(1): 54-65. doi: 10.1097/JNN.0000000000000174 https://bit.ly/3GL7YqT
38. **Nau R, Blei C, Eiffert H.** Intrathecal antibacterial and antifungal therapies. Clin Microbiol Rev. 2020;33(3):e00190-19. doi: 10.1128/CMR.00190-19 https://bit.ly/3Q1Wy62
39. **Tekgündüz KŞ, Kepenekli E, Demirelli Y, Caner İ, Kara M.** Combined treatment with chlorhexidine and 0·9% saline in a newborn infant with an infected surgical wound. Int Wound J. 2016;13(5):1000-2. doi: 10.1111/iwj.12381 https://bit.ly/3GUTq8c
40. **Bihurriet A.** Cuidados de enfermería libres de látex. Rev Enferm Neonat. 2017;23:10-3. https://bit.ly/3MioK1s
41. **Norma Oficial Mexicana NOM-007-SSA2-2016, para la atención de la mujer durante el embarazo, parto y puerperio y de la persona recién nacida**. México: Secretaría de Salud, 2016. https://bit.ly/3mid5VO