Research Article

Multivariate Logistic Regression Analysis for the Significant Neonatal and Maternal Risk Factors Related to Neonatal Sepsis

Hisham Medhat,[1] Abdelmoneim Khashana,[1,2,*] and Mohamed El Kalioby[1]

[1]Department of Pediatrics, Faculty of Medicine, Suez Canal University, Ismailia, Egypt
[2]PEDEGO Research Center, Medical Research Center Oulu, University of Oulu, Oulu, Finland

Corresponding author: Abdelmoneim Khashana, Department of Pediatrics, Faculty of Medicine, Suez Canal University, Ismailia, Egypt. Tel: +2-01200411588, E-mail: Abdelmoneim_khashana@hotmail.com

Abstract

Background: It is known that risk factors related to neonatal bacterial sepsis are complex.

Objectives: The current study aimed to determine the risk factors of neonatal sepsis.

Materials and Methods: This study was conducted on 1023 neonates admitted to neonatal intensive care units (NICUs) in South Sinai governorate hospitals from January 2010 till September 2014. Demographic data of the neonates and the potential risk factors for neonatal septicemia were collected and analyzed.

Results: The incidence of septicemia in the NICUs of South Sinai governorate hospitals was 8.6% and a mortality rate among sepsis cases (sepsis fatality rate) was about 25%. The percentage of cases with late-onset sepsis (68.2%) was predominant than early-onset sepsis (31.8%). Hospital acquired infections represented 30.7% of the sepsis cases. A multivariate logistic regression analysis for the significant neonatal and maternal risk factors related to neonatal sepsis was performed to explain the interaction between these risk factors and order these risk factors regarding statistical significance. The results showed that the highest effect on sepsis was for rupture of membranes >18 hours then the presence of twin deliveries came next, followed by multipara mothers then normal vaginal delivery came 4th in order followed by male gender, low birth weight babies and preterm neonates which became nonsignificant in this multivariate logistic regression analysis.

Conclusions: Rupture of membranes > 18 hours, the presence of twin deliveries came next, multipara mothers, normal vaginal delivery came 4th in order, followed by male gender are the most common risk factors for neonatal sepsis in Sinai governorate hospitals, Egypt.

Keywords: Sepsis, Risk Factors, Neonates

1. Background

The world health organization (WHO) estimates that 130 million neonates are born each year. Of these, eight million do not live till the 1st year of life, and more than 10 million pass away before the age of 5 years (1). Every year, four million infants die during the first month of life. Developing countries give 98% of reported worldwide neonatal deaths (2). Neonatal septicemia cause about 1.6 million deaths per year in the developing world, and the major cause of neonatal mortality is neonatal infections (3, 4). Bacterial sepsis is considered to be an important cause of neonatal mortality in the first month of life) (5, 6). It occurs in a range of 1 - 10/1000 live births and despite advances in perinatal care, neonatal sepsis is still a significant cause of morbidity and mortality in neonates (7). The incidence of sepsis in the neonate is greater than at any other period of life and varies from center to center.

Studies from developed countries demonstrated that the incidence of neonatal sepsis has been reported to be less than five cases per 1000 live births; some other population-based studies from developing countries have reported clinical sepsis rates ranging from 49 - 170 per 1000 live births (8). Neonatal mortality is about 34 per 1000 live births in Asia, 42 per 1000 live births in Africa and 17 per 1000 live births in Latin America and the Caribbean (4). The incidence of neonatal bacterial infections depends on geographic area and may vary from country to country as well as within the same country. Furthermore, neonatal mortality for different African countries ranges from 68 per 1000 live births in Liberia to 11 per 1000 live births in South Africa (9). Reported infection rates in the neonatal intensive care units (NICUs) vary from 3.2 to 30 per 100 admissions or discharges, illustrating the wide variability among centers. The neonatal intensive care units that admit surgery patients may have higher rates (10).

2. Objectives

There are a lot of risk factors that increase the risk of neonatal sepsis; so, we tried to find the risk factors of neonatal infections in this remote area in Asia.

3. Materials and Methods

3.1. Study Design

Descriptive design was used in the study.

3.2. Setting and Sample

This study was a retrospective cross-sectional descriptive study, which was conducted in six hospitals all-over South Sinai Governorate throughout scanning of 1023 files of the patients admitted to NICUs in these hospitals from January 2010 till September 2014.

3.3. Data Collection/Procedure

Scanning patient's records was done for demographic data and potential risk factors including gender, gestational age, birth weight, mode of delivery, site of delivery, presence of twins, presence of congenital anomalies, maternal age, maternal parity, presence of sepsis, age at onset of sepsis, symptoms and signs, perinatal risk factors, and outcome.

A multivariate logistic regression analysis for the significant neonatal and maternal risk factors related to neonatal sepsis was performed to explain the interaction between these risk factors and order these risk factors regarding statistical significance.

3.4. Data Analysis

Data were analyzed using descriptive statistics (percentages, frequencies, also mean and standard deviations), student's t-tests and Mann-Whitney U tests with the SPSS software version 18.0 (SPSS Inc, Chicago, Illinois, USA).

3.5. Ethical Consideration

Ethical approval which agreed with the principles in the declaration of Helsinki was obtained from the local university ethical council prior to the study. The patients gave their written informed consent to participate in this study.

Table 1. Distribution of the Study Population According to the Type of Sepsis

Parameter	No. (%)
No sepsis	935 (91.4)
Early onset sepsis	28 (2.7)
Late onset sepsis	60 (5.9)
Total	1023 (100)

4. Results

The current study aimed to measure the prevalence of septicemia in the NICUs of South Sinai governorate hospitals, and elicit the risk factors that may be linked to neonatal sepsis in this area.

The number of sepsis cases was 88 (8.6%) and late onset sepsis (5.9%) was more frequent than early onset sepsis (2.7%) (Table 1).

A multivariate logistic regression analysis for the significant risk factors related to neonatal sepsis showed that the highest effect on sepsis was for rupture of membranes > 18 hours then the presence of twin deliveries came next, followed by multipara mothers then normal vaginal delivery came 4th in order followed by male gender, low birth weight babies and preterm neonates which became non-significant in this multivariate logistic regression analysis (Table 2).

5. Discussion

Egypt is a developing country where the problem of infection is more evident due to lack of health services and infection control practices. Also, infection control practices are also underdeveloped and are known to contribute to the risk of antibiotic resistance (11). The diagnosis of neonatal infections is difficult because of the similarity between clinical signs associated with physiological disturbances and those of sepsis, bacteremia or fungemia. Earlier diagnosis of neonatal sepsis in critically ill infants would improve timely administration of antibiotics and discontinuation of management in infants with a low probability of sepsis (12).

In the current study, the prevalence rate of septicemia in the NICUs of South Sinai governorate hospitals was 8.6%. The incidence of neonatal sepsis varies greatly between different continents, countries, regions, and hospitals. The reported incidence of neonatal sepsis has recently been reviewed and it varies from 7 to 38 per 1000 live births in Asia and from 6 to 23 per 1000 live births in Africa (4). By comparison, culture proven sepsis in USA and Europe was about two to four per 1000 live births (13). Thapa

Table 2. Multivariate Logistic Regression Analysis for the Significant Neonatal and Maternal Risk Factors Related to Neonatal Sepsis

Parameter/Variables	Suspected Sepsis, No. (%)	Total Cases	Statistical Significance		
			P Value	OR	CI
Gender			0.2101	1.394	0.8292 -2.3435
Male	55 (11.6)	473			
Female	33 (6.9)	550			
Gestational age			0.8885	1.0572	0.4856 - 2.3018
Full term	44 (6.9)	638			
Preterm[a]	44 (11.4)	385			
Birth weight			0.4106	1.3388	0.6681 - 2.6830
Normal	39 (6.3)	616			
Low[b]	49 (12)	407			
Mode of delivery			< 0.00001[c]	0.2333	0.1341 - 0.4057
Normal	44 (11.6)	380			
Caesarean	44 (6.8)	643			
Twin deliveries			< 0.00001[c]	7.8585	3.6708 - 16.8235
Yes	17 (16.2)	105			
No	71 (7.7)	918			
Maternal parity			0.0448[d]	2.0622	1.0169 - 4.1821
Multipara	77 (9.6)	803			
Primipara	11 (5)	220			
ROM > 18 h			< 0.00001[c]	44.4451	23.4700 - 84.165
Yes	49 (47.1)	104			
No	39 (4.2)	919			

Abbreviations: CI, 95% confidence interval; OR, odds ratio.
[a] < 2.5 kg.
[b] < 37 weeks.
[c] P < 0.01: highly significant.
[d] P < 0.05: Significant.

et al. found that the NICU prevalence rate of sepsis was 37.12% in their cross-sectional study conducted in a NICU of Paropakar Maternity and Women's Hospital in Kathmandu (14). Wu et al. found that the incidence of sepsis was 4.06% among all NICU admissions in a Taiwanese medical center (15).

Results of the current study showed that ROM > 18 hours has a significant effect on sepsis incidence (ROM > 18 hours was highly significant associated with more incidence with sepsis among study population), ROM > 18 hours was the most significant risk factor in a multivariate logistic regression analysis for the significant risk factors related to neonatal sepsis among the study population (odds ratio = 44.4451, 95% confidence interval from 23.4700 to 84.165). Similar to our results, it was found that history of prolonged rupture of membrane (PROM) was common

among neonates with sepsis (16). Other studies showed that the duration of PROM ≥ 18 hrs was associated with an increased risk of neonatal sepsis (17). However, in a study conducted in Saudi Arabia no significant role was reported for the duration of premature rupture membranes in the incidence of neonatal sepsis (18).

Results of the current study showed a highly statistical significant difference (P < 0.01) between sepsis and non-sepsis cases regarding the twin deliveries as twin deliveries was significantly associated with more incidence of sepsis among the study population, it came in the 2nd place after ROM > 18 hours as a strong risk factor in a multivariate logistic regression analysis for the significant risk factors related to neonatal sepsis among the study population (odds ratio = 7.8585, 95% confidence interval from 3.6708 to 16.8235). The rate of multifetal pregnancies, specifically

twin gestations has risen in recent years, most likely as a result of fertility treatments and delayed childbearing (19). Unlike our results, Boghossian et al. found that the incidence of sepsis among singletons and multiples were similar (20).

5.1. Conclusions

In light of the previously mentioned results the following conclusions were drawn from the study: Prevalence of septicemia in NICUs in South Sinai governorate was about 8.6%. The multivariate logistic regression analysis for the significant risk factors related to neonatal sepsis showed that the highest effect on sepsis was for rupture of membranes > 18 hours then the presence of twin deliveries came next, followed by multipara mothers then normal vaginal delivery came 4th in order followed by male gender, low birth weight babies and preterm neonates, which became nonsignificant in this multivariate logistic regression analysis.

Acknowledgments

Footnote

Authors' Contribution: Mohamed El Kalioby: concept and design of the study, revision and interpretation of the results; Abdelmoneim Khashana: concept and design of the study, data collection and interpretation, and drafting of the manuscript; Hisham Medhat: data collection and interpretation

References

1. World Health Organization . World health report 2006: make every mother and child count. ; 2006.
2. Zupan J. Perinatal mortality in developing countries. *N Engl J Med.* 2005;**352**(20):2047–8. doi: 10.1056/NEJMp058032. [PubMed: 15901857].
3. Lawn JE, Cousens S, Darmstadt GL, Paul V, Martines J. Why are 4 million newborn babies dying every year?. *Lancet.* 2004;**364**(9450):2020. doi: 10.1016/S0140-6736(04)17511-9. [PubMed: 15582058].
4. Vergnano S, Sharland M, Kazembe P, Mwansambo C, Heath PT. Neonatal sepsis: an international perspective. *Arch Dis Child Fetal Neonatal Ed.* 2005;**90**(3):F220–4. doi: 10.1136/adc.2002.022863. [PubMed: 15846011].
5. Motara F, Ballot DE, Perovic O. Epidemiology of neonatal sepsis at Johannesburg Hospital. *South Afr J Epidemiol Infect.* 2005;**20**(3):90–3.
6. Movahedian AH, Moniri R, Mosayebi Z. Bacterial culture of neonatal sepsis. *Iran J Publ Health.* 2006;**35**(4):84–9.
7. Shim GH, Kim SD, Kim HS, Kim ES, Lee HJ, Lee JA, et al. Trends in epidemiology of neonatal sepsis in a tertiary center in Korea: a 26-year longitudinal analysis, 1980-2005. *J Korean Med Sci.* 2011;**26**(2):284–9. doi: 10.3346/jkms.2011.26.2.284. [PubMed: 21286023].
8. Thaver D, Zaidi AK. Burden of neonatal infections in developing countries: a review of evidence from community-based studies. *Pediatr Infect Dis J.* 2009;**28**(1 Suppl):S3–9. doi: 10.1097/INF.0b013e3181958755. [PubMed: 19106760].
9. Costello A, White H. Reducing global inequalities in child health. *Arch Dis Child.* 2001;**84**(2):98–102. [PubMed: 11159279].
10. Moore D. . Nosocomial infections in newborn nurseries and neonatal intensive care units. In: Mayhall CG, editor. Hospital epidemiology and infection control. USA: Lippincott Williams & Wilkins; 2004. .
11. Fahmey SS. Early-onset sepsis in a neonatal intensive care unit in Beni Suef, Egypt: bacterial isolates and antibiotic resistance pattern. *Korean J Pediatr.* 2013;**56**(8):332–7. doi: 10.3345/kjp.2013.56.8.332. [PubMed: 24019843].
12. Polin RA, Randis TM. Biomarkers for late-onset neonatal sepsis. *Genome Med.* 2010;**2**(9):58. doi: 10.1186/gm179. [PubMed: 20828428].
13. Anderson-Berry AL, Bellig LL, Ohning BL. Neonatal sepsis (e medicine specialties pediatrics: cardiac disease and critical care medicine neonatology) 2009. Available from: http:// emedicine.medscape.com/article/ 978352_overview.
14. Thapa B, Thapa A, Aryal DR, Thapa K, Pun A, Khanal S, et al. Neonatal sepsis as a major cause of morbidity in a tertiary center in Kathmandu. *JNMA J Nepal Med Assoc.* 2013;**52**(192):549–56. [PubMed: 25327225].
15. Wu JH, Chen CY, Tsao PN, Hsieh WS, Chou HC. Neonatal sepsis: a 6-year analysis in a neonatal care unit in Taiwan. *Pediatr Neonatol.* 2009;**50**(3):88–95. doi: 10.1016/S1875-9572(09)60042-5. [PubMed: 19579754].
16. Jumah DS, Hassan MK. Predictors of mortality outcome in neonatal sepsis. *Med J Basrah Univ.* 2007;**25**:11–8.
17. Schuchat A, Zywicki SS, Dinsmoor MJ, Mercer B, Romaguera J, O'Sullivan MJ, et al. Risk factors and opportunities for prevention of early-onset neonatal sepsis: a multicenter case-control study. *Pediatrics.* 2000;**105**(1 Pt 1):21–6. [PubMed: 10617699].
18. Asindi AA, Archibong EI, Mannan NB. Mother-infant colonization and neonatal sepsis in prelabor rupture of membranes. *Saudi Med J.* 2002;**23**(10):1270–4. [PubMed: 12436136].
19. Shamshirsaz AA, Ravangard SF, Ozhand A, Haeri S, Shamshirsaz AA, Hussain N, et al. Short-term neonatal outcomes in diamniotic twin pregnancies delivered after 32 weeks and indications of late preterm deliveries. *Am J Perinatol.* 2014;**31**(5):365–72. doi: 10.1055/s-0033-1334458. [PubMed: 24166683].
20. Boghossian NS, Page GP, Bell EF, Stoll BJ, Murray JC, Cotten CM, et al. Late-onset sepsis in very low birth weight infants from singleton and multiple-gestation births. *J Pediatr.* 2013;**162**(6):1120–4. doi: 10.1016/j.jpeds.2012.11.089. [PubMed: 23324523] 1124 e1.