Clinical outcome and risk factors of neonatal sepsis among neonates in Felege Hiwot referral Hospital, Bahir Dar, Amhara Regional State, North West Ethiopia 2016: a retrospective chart review

Tilahun Tewabe*, Seida Mohammed, Yibeltal Tilahun, Birhanie Melaku, Mequanint Fenta, Tsigiereda Dagnaw, Amare Belachew, Ashagre Molla and Habte Belete

Abstract

Background: Sepsis remains a major cause of morbidity and mortality among neonates. The risk factors and clinical outcomes of sepsis are poorly understood. Most cases of sepsis occurred mostly within the first week of newborn life related to perinatal risk factors. Late onset sepsis is related to hospital acquired infections which is seen after seven days of age. The purpose of this study was to assess clinical outcome and risk factors of neonatal sepsis in Felege Hiwot referral hospital Bahir Dar, North West Ethiopia.

Results: Among the total 225 neonatal charts reviewed; 164 (72.9%) were age less than or equal to 7 days, and 144 (64%) were males. About 29 (12.9%) neonates were with irregular respiratory signs and 40 (17.8%) had meconium aspiration syndrome. Regarding the clinical outcome of neonatal sepsis: 189 (84%) were improved after treatment, 9 (4%) were died and 13 (5.8%) referred to other organizations for further treatment. Respiratory distress syndrome [AOR = 0.258 (0.072–0.930)] and meconium aspiration syndrome [AOR = 0.1989 (0.059–0.664)] were the determinant factors for poor outcome of neonatal sepsis.

Conclusion: The clinical outcome of neonatal sepsis in Felege Hiwot referral hospital was not satisfactory. The significant risk factors for poor outcome of neonatal sepsis were respiratory distress syndrome and meconium aspiration syndrome. Recommendations to improve neonatal outcome are: performing essential newborn care for all newborns and arranging appropriate follow up until the end of neonatal period, increasing antenatal care and early detection and management of neonatal infections or problems.

Keywords: Clinical outcome, Risk factors, Neonatal sepsis, Felege Hiwot referral hospital, Bahir Dar, North west Ethiopia

Background

Neonatal sepsis is a systemic infection occurring in infants within 28 days of life and is a major cause of morbidity and mortality in newborns [1]. According to the international pediatric consensus conference of 2001, neonatal sepsis was defined as systemic inflammatory response syndrome in the presence of or as a result of suspected or proven infection with or without accompanying bacteremia, documented by a positive blood culture in the first 28 days of life [2].

Sepsis encompasses various systemic infections of the new born such as: septicemia, meningitis, pneumonia, arthritis, osteomyelitis and urinary tract infections [3]. Neonatal sepsis is caused by both gram-positive and gram negative bacteria's [4, 5].

Neonatal sepsis is classified into two major categories based on the time of onset: early-onset neonatal sepsis...
(EONS) and late onset neonatal sepsis (LONS). Early-onset neonatal sepsis appears within the first seven days of life and most cases appear within 24 h of birth. While late onset neonatal sepsis occurs after 8 days of infants life and is mostly acquired after delivery [5, 6].

Sepsis is diagnosed by: a complete white blood cell count with differential, blood culture, urine cultures, and a lumbar puncture for cell count and culture. To clear the diagnosis of early onset sepsis factors that predispose the neonate for sepsis such as maternal infection and prolonged rupture of membranes, and prematurity are also considered [1, 6].

Signs and symptoms of infection in neonates are subtle and non-specific, may present with or more of the following: hypothermia or fever, lethargy, poor cry, refusal to suck, poor perfusion, prolonged capillary refill time, hypotonia, absent neonatal reflexes, bulging fontanel, brady/tachycardia, respiratory distress, apnea and gasping respiration, hypo/hyperglycemia, and metabolic acidosis [3, 6, 7].

Risk factors for early onset of sepsis includes premature rupture of membrane (PROM), fever, chorioamnionitis, repeated vaginal examination, meconium stained amniotic fluid, dietary intake of contaminated foods, cervical cerclage, place of birth, prematurity, low birth weight, complications and instrument-assisted delivery, and low appearance pulse grimace activity respiration (APGAR) scores. Late onset of sepsis acquiring nosocomial infections and invasive procedures during hospital admission [1, 6, 8].

Antimicrobials used to treat sepsis are combinations and in most units are penicillin (Benzyl penicillin, Ampicillin, or Cloxacillin) together with an aminoglycoside, most commonly Gentamicin and is largely preventable by timely recognition, rational antimicrobial therapy and aggressive supportive care [3, 9].

Globally, sepsis is one of the major causes of morbidity and mortality among neonates [4], according to WHO sepsis caused approximately 12% of the 2.9 million neonatal deaths in 2012 [10]. Out these deaths 99% occur in developing countries [11].

In Africa sepsis accounts 28% neonatal deaths [12] and infectious causes accounts 68 deaths per 1000 live births [13]. In Ethiopia from prenatal mortalities sepsis covers 5% [14]. In Debrezeyt, Ethiopia the overall poor outcomes of NS were 26% including deaths [8].

Therefore the purpose of this study was to assess clinical outcomes and risk factors of neonatal sepsis in Felege Hiwot referral hospital, Bahir Dar, North West Ethiopia.

Methods
Study settings and period
An institution based quantitative retrospective chart review was conducted from April 30 to May 30, 2016 in Felege Hiwot referral hospital. It is located in Amhara regional state, Bahir Dar, Ethiopia. It is 565 km away from Addis Ababa. The hospital was established in April 1963 in collaboration with the Ethiopian people and the German government. The hospital has different departments that provide specialized services in outpatient, inpatient and operation theatre departments. It provides services for approximately for 130,000 populations and has more than 415 beds and gives services for the western part of Amhara region as a Referral hospital. Annually nearly 550 neonates with sepsis were admitted at Felege Hiwot referral hospital. The neonatal intensive care unit has 30 beds and there were five pediatricians and 11 nurses.

The sample size of the study was calculated using single population proportion formula by considering the following assumptions: prevalence (P) = 50%, confidence level (CI) = 95%, margin of error (W) = 5% and by using correction formula since the total population is below 10,000 the final calculated sample size became 225.

Measurement
Data was collected and registered by using structured check list. The check list was prepared by reviewing different literatures done on similar topics. The check list consists of socio demographic information of mother and neonate, maternal and neonatal risk factors, and health service related factors for poor outcome of sepsis. The data were collected by four data collectors and one supervisor and finally submitted to the investigator as scheduled. Before the data collection period data collectors and supervisors were oriented and trained for a day on how to record and collect data.

Operational definitions of the variables
Early onset of sepsis: If sepsis is occurred from birth to 7 days of age.
Late onset of sepsis: If sepsis is occurred between 8 and 28 days of age.
Good outcome: If neonate is improved after completing the treatment without any complications like: seizure, meningitis, shock, deafness and blindness.
Poor outcome: If neonate is not improved after completing the treatment, presented with complications, referred to other health institutions, died and refused against medical treatment.

Results
Socio demographic data
A total of 225 neonatal charts with sepsis were studied. From total 144 (64%) were males, 164 (72.9%) were age less than 7 days, 115 (51.1%) mothers were between 19 and 29 years old, and 133 (59.1%) were rural residents (Tables 1, 2).
Neonatal related risk factors for sepsis
From 225 neonates 169 (75.1%) were admitted with early onset of sepsis. From total 71 (31.6%) were low birth weight, 173 (76.9%) were term (37–42 weeks), 8 (3.6%) were presented with meningitis, 8 (3.6%) had history of birth asphyxia, and 73 (32.4%) neonates were with APGAR score less than six. Most, 203 (90.2%) neonates were treated with Ampicillin and Gentamycin. About 89 (84%) were improved after completing the treatment but 9 (14%) were died (Table 1).

Maternal related risk factor for neonatal sepsis
More than half of the mothers 124 (55.1%) were multi-gravida. Majority (95.1%) of mothers received ANC follow up and 9 (4%) mothers had history of urinary tract infection during their pregnancy. About 47 (20.9%) mothers were febrile, 12 (5.3%) mothers were twin delivered, 2 (0.9%) were having history of cervical cerclage and 4 (1.8%) were mothers with history medical problem during pregnancy.

One hundred and thirty-three (59.1%) mothers delivered their newborn in hospital and 61 (27.1%) mothers delivered by caesarean section. With regard to rupture of membrane, 47 (20.9%) had history of PROM and out of them 29 (12.9%) were for more than 12 h duration. Out of all mothers with PROM, antibiotic was given for 43 (19.1%) mothers. About 46 (20.4%) mothers has history of prolonged duration of labor. While 28 (12.4%), 34 (15.1%), 40 (17.8%) mothers faced obstructed labor, history of chorioamnionitis and meconium aspiration syndrome, respectively (Table 2).

| Variables | Frequency | Percent |
|-----------|-----------|---------|
| Sex | | |
| M | 144 | 64 |
| F | 81 | 36 |
| Age of infant | | |
| 0–7 days | 164 | 72.9 |
| 8–28 | 61 | 27.1 |
| Birth weight (g) | | |
| <1500 | 7 | 3.1 |
| <2500 | 71 | 31.6 |
| 2500–4000 | 143 | 63.6 |
| >4000 | 4 | 1.8 |
| Prematurity (weeks) | | |
| <37 | 46 | 20.4 |
| 37–42 | 173 | 76.9 |
| >42 | 6 | 2.7 |
| Birth asphyxia | | |
| Yes | 8 | 3.6 |
| No | 217 | 96.4 |
| Associated infection (n = 10) (4.5%) | | |
| Meningitis | 8 | 3.6 |
| Hydrocephalus | 2 | 0.9 |
| Had resuscitation | | |
| Yes | 8 | 3.6 |
| No | 217 | 96.4 |
| Mode of ventilation (n = 8) (3.6%) | | |
| Ambubag | 4 | 1.8 |
| Suction machine | 2 | 0.9 |
| Ambubag and suction machine | 2 | 0.9 |
| APGAR score | | |
| <3 | 4 | 1.8 |
| 4–6 | 69 | 30.7 |
| >7 | 152 | 67.6 |
| Birth injury | | |
| Yes | 4 | 1.8 |
| No | 221 | 98.2 |
| BCG and polio vaccinated | | |
| Yes | 132 | 58.7 |
| No | 93 | 41.3 |
| Immune suppressant drug | | |
| Yes | 1 | 0.4 |
| No | 224 | 99.6 |
| Prophylaxis of Hiv infection | | |
| Yes | 9 | 4 |
| No | 216 | 96 |
| Any skin infection/umbilical stump | | |
| Yes | 6 | 2.7 |
| No | 219 | 97.3 |
One hundred and fifty-eight neonates (70.2%) had history of fever, and 29 (12.9%), 15 (6.7%) were history of irregular respiration and tachypnea, respectively. Majority of neonates 74 (32.9%) had poor feeding and about 43 (19.1%) had cold and clammy skin (Table 3).

Diagnostic/laboratory results of neonates with sepsis
Of the total 39 samples tested for culture 39 (17.3%) were gram negative. While the CSF result showed; white blood cell (WBC) count >5 cells/µL was in 15 (6.7%) cases, 10 (4.4%) were glucose <40 mg/dL, 6 (2.7%) were protein >45 mg/dL and WBC count in CBC profile were 142 (63.1%) (Table 4).

Factors associated with clinical outcome of neonatal sepsis
First variables were tested by using bivariate analysis. Variables which were associated (p < 0.05) in the bivariate analysis were tested in the final multivariate analysis to see their significant association with poor outcome of neonatal sepsis. The independent predictor of poor outcome of neonatal sepsis were; respiratory distress syndrome and history of meconium aspiration syndrome.

Respiratory distress syndrome was significantly associated with poor outcome of neonatal sepsis. Those neonates with respiratory distress syndrome were 74.2% more likely to develop poor outcome (AOR 0.258: 0.072, 0.930) than neonates without respiratory distress syndrome.

### Table 2 Maternal related risk factors that predisposed to neonatal sepsis during pregnancy in Felege-Hiwot referral hospital, North West Bahir Dar, Ethiopia, 2016

| Variables                                      | Frequency | Percentage |
|------------------------------------------------|-----------|------------|
| Age of the mother (years)                      |           |            |
| <18                                            | 14        | 6.2        |
| 19–29                                          | 115       | 51.1       |
| 30–34                                          | 67        | 29.8       |
| >35                                            | 29        | 12.9       |
| Residence                                      |           |            |
| Rural                                          | 133       | 59.1       |
| Urban                                          | 92        | 40.9       |
| No. of pregnancy                               |           |            |
| Primi gravid                                   | 97        | 43.1       |
| Multi gravid                                   | 124       | 55.1       |
| Grand multi Para                              | 4         | 1.8        |
| >24 h                                          | 8         | 3.6        |
| ANC follow up                                  |           |            |
| Yes                                            | 214       | 95.1       |
| No                                             | 11        | 4.9        |
| TT vaccination                                 |           |            |
| Yes                                            | 214       | 95.1       |
| No                                             | 11        | 4.9        |
| UTI during pregnancy (n = 183)                 |           |            |
| Yes                                            | 9         | 4          |
| No                                             | 174       | 77.3       |
| Febrile Hx of mother (n = 205)                 |           |            |
| Yes                                            | 47        | 20.9       |
| No                                             | 158       | 70.2       |
| Twin pregnancy                                 |           |            |
| Yes                                            | 12        | 5.3        |
| No                                             | 213       | 94.7       |
| Cervical cerclage (n = 191)                    |           |            |
| Yes                                            | 2         | 0.9        |
| No                                             | 189       | 84         |
| Maternal infection hx (n = 205)                |           |            |
| Yes                                            | 4         | 1.8        |
| No                                             | 201       | 89.3       |
| Place of birth                                 |           |            |
| Hospital                                       | 133       | 59.1       |
| Health center                                  | 81        | 36         |
| Home                                           | 11        | 4.9        |
| Mode of delivery                               |           |            |
| SVD                                            | 147       | 65.3       |
| Instrumental                                   | 17        | 7.6        |
| C/S                                           | 61        | 27.1       |
| PROM (217)                                     |           |            |
| Yes                                            | 47        | 20.9       |
| No                                             | 170       | 75.6       |
| PROM > 12 h (n = 207)                          |           |            |
| Yes                                            | 29        | 12.9       |
| No                                             | 178       | 79.1       |

### Table 2 continued

| Variables                                      | Frequency | Percentage |
|------------------------------------------------|-----------|------------|
| PROM intrapartum antibiotic (n = 203)          |           |            |
| Yes                                            | 43        | 19.1       |
| No                                             | 160       | 71.1       |
| Duration of labor (n = 174) (h)                |           |            |
| <8                                             | 51        | 22.7       |
| 8–18                                           | 69        | 30.7       |
| 18–24                                          | 46        | 20.4       |
| Obstructed labor hx (n = 222)                  |           |            |
| Yes                                            | 28        | 12.4       |
| No                                             | 194       | 86.2       |
| Chorioamnionitis hx (n = 186)                  |           |            |
| Yes                                            | 34        | 15.1       |
| No                                             | 152       | 67.6       |
| Meconium hx (n = 183)                          |           |            |
| Yes                                            | 40        | 17.8       |
| No                                             | 143       | 63.6       |
| Foul lochia (n = 180)                          |           |            |
| Yes                                            | 10        | 4.4        |
| No                                             | 170       | 75.6       |

### Clinical presentation of neonates with sepsis
One hundred and fifty-eight neonates (70.2%) had history of fever, and 29 (12.9%), 15 (6.7%) were history of irregular respiration and tachypnea, respectively. Majority of neonates 74 (32.9%) had poor feeding and about 43 (19.1%) had cold and clammy skin (Table 3).
Meconium aspiration syndrome was significantly associated with poor outcome of sepsis. Neonates with meconium aspiration syndrome were 80.2% more likely to develop poor neonatal outcome (AOR 0.198: 0.059, 0.664) than neonates without history of meconium aspiration syndrome (Table 5).

Discussion
Neonatal sepsis is a systemic infection occurring in infants at less than 28 days of life and is an important cause of morbidity and mortality of newborns [1]. It encompasses various systemic infections of the new born such as septicemia, meningitis, pneumonia, arthritis, osteomyelitis and urinary tract infections [3].

Risk factors for early onset of sepsis includes: premature rupture of membrane, fever, chorioamnionitis, repeated vaginal examination, meconium stained amniotic fluid, dietary intake of contaminated foods, cervical cerclage, place of birth, prematurity, low birth weight, complicated or instrument assisted delivery, and low appearance pulse grimace activity respiration (APGAR) scores. Late onset of sepsis acquiring nosocomial infections and invasive procedures during hospital admission [1, 6, 8].

In this study 84% of neonates had good outcome after treatment. This result comparable with a study done in Debrezeyt, Ethiopia favorable outcome of neonatal sepsis were 74% [8] and in Jimma neonatal death due to infections was 34.3% [15], in other studies done in Ethiopia mortalities due to sepsis accounts 5% a hospital based data [14], in Uganda death rates associated with sepsis was 18.1% [16], in Sudan neonatal mortality due to sepsis was found to be 14.5% [13], Egypt mortality rate of neonatal sepsis were 51% for early onset sepsis and 42.9% for
late onset sepsis [4], Iran neonatal sepsis was estimated at 27.4% [17], and Latin America: Brazil, Colombia and Mexico mortality rate of neonatal sepsis were 56, 36 and 28% respectively [18].

In this study respiratory distress syndrome was identified as the determinant factor for poor clinical outcome neonatal sepsis. Neonates with history of respiratory distress syndrome were 74.2% more likely to develop poor neonatal outcome. This result comparable with studies done Uganda [16] in which tachypnea (AOR 1.07: 0.65, 1.77) was the determinant factor for poor outcome of sepsis, and in Sudan [19] where tachypnea results 69.4% for poor outcome of sepsis. This was due to health workers ignorance the syndromes, poor early detection of signs and due to the mothers delay to come in health institution.

Meconium aspiration syndrome history was significantly associated with clinical outcome of sepsis. Neonates with meconium aspiration syndrome history were 80.2% more likely to develop poor outcome. Which is similar with a study in Uganda [16] where neonates with meconium aspiration syndrome were 2.5 times more likely to develop poor outcome than neonates without history of meconium aspiration. This is showed that after

| Variables                        | Good         | Poor         | COR          | AOR          | P value      |
|----------------------------------|--------------|--------------|--------------|--------------|--------------|
| Birth weight (g)                 |              |              |              |              |              |
| <2500                            | 60 (76.9%)   | 18 (23.1%)   | 0.465 (0.226–0.957) |              |              |
| >2500                            | 129 (87.8%)  | 18 (12.2%)   | 1            |              |              |
| Asphyxia                         |              |              |              |              |              |
| Yes                              | 3 (37.5%)    | 5 (62.5%)    | 1 (0.023–0.440)    |              |              |
| Respiratory distress             |              |              |              |              |              |
| No                               | 186 (85.7%)  | 31 (14.3%)   | 1            |              |              |
| Yes                              | 129 (90.2%)  | 14 (9.8%)    | 0.296 (0.142–0.618)  | 0.258 (0.072–0.930)  | 0.038         |
| Skin color                       |              |              |              |              |              |
| Good                             | 153 (87.9%)  | 21 (12.1%)   | 0.329 (0.155–0.701) |              |              |
| Poor                             | 36 (70.6%)   | 15 (29.4%)   | 1            |              |              |
| APGAR score                      |              |              |              |              |              |
| <6                               | 61 (83.6%)   | 12 (16.4%)   | 0.953 (0.447–2.032) |              |              |
| >7                               | 128 (84.2%)  | 24 (15.8%)   | 1            |              |              |
| Onset of illness                 |              |              |              |              |              |
| Early                            | 147 (87%)    | 22 (13%)     | 2.227 (1.049–4.728) |              |              |
| Late                             | 42 (75%)     | 14 (25%)     | 1            |              |              |
| Iv line medications              |              |              |              |              |              |
| Gentamycin + ampicillin          | 175 (86.2%)  | 28 (13.8%)   | 3.571 (1.373–9.289) |              |              |
| Ceftriaxone + Gentamycin         | 14 (63.6%)   | 8 (36.4%)    | 1            |              |              |
| Place of birth                   |              |              |              |              |              |
| Health institution               | 182 (85%)    | 32 (15%)     | 0.308 (0.085–1.112) |              |              |
| Home                             | 7 (63.6%)    | 4 (36.4%)    | 1            |              |              |
| Maternal fever                   |              |              |              |              |              |
| Yes                              | 45 (95.7%)   | 2 (4.3%)     | 4.846 (1.110–21.163) |              |              |
| No                               | 130 (82.3%)  | 28 (17.7%)   | 1            |              |              |
| NG tube feeding                  |              |              |              |              |              |
| Yes                              | 53 (98.1%)   | 1 (1.9%)     | 13.862 (1.850–103.87) |              |              |
| No                               | 130 (79.3%)  | 34 (20.7%)   | 1            |              |              |
| Meconium aspiration              |              |              |              |              |              |
| Yes                              | 27 (67.5%)   | 13 (32.5%)   | 0.299 (0.131–0.683) | 0.198 (0.059–0.664) | 0.009        |
| No                               | 125 (87.4%)  | 18 (12.6%)   | 1            |              |              |

Italic value indicates p value less than <.05
meconium aspiration strict follow up is needed. This may be due to health workers poor neonatal performance skill and ignorance of meconium aspiration signs.

Conclusion
In this study the favorable outcomes of neonatal sepsis was 189 (84%). The determinant factors for poor outcome of neonatal sepsis were respiratory distress syndromes and meconium aspiration syndrome. Recommendations to improve neonatal outcome are: performing essential newborn care for all newborns and arranging appropriate follow up until the end of neonatal period and early detection and management of neonatal infections or problems.

Abbreviations
ANC: antenatal care; APGAR: appearance pulse grimace activity respiration; AOR: adjust odd ratio; CI: confidence interval; CS: cesarean section; EONS: early onset neonatal sepsis; FHR: Felege Hiwot referral hospital; LBW: low birth weight; LONS: late onset neonatal sepsis; NGO: non governmental organization; PROM: premature rupture of membrane; SPSS: statistical Package for social science; WHO: World Health Organization.

Authors' contributions
All authors TT, SM, YT, BM, MF, TD, AB, AM and HB contributed to the design of this study. Authors conceived and designed study, collected, analyzed and interpreted data. TT drafted the manuscript for important intellectual content. All authors read and approved the final manuscript.

Acknowledgements
Our first deepest gratitude to Bahir Dar University College of Medicine and Health Science, Nursing School to give the chance for attending Bachelor science program and conducting this research. We also thank to Felege Hiwot referral Hospital human resource for their permission and pediatric ward staffs for their participation and also giving patient charts. Finally, we would like to acknowledge our friends who were very interested, encouraged and helped us to do these research project.

Competing interests
The authors declare that they have no competing interests.

Availability of data and materials
The date of this study can’t be shared publically due to presence of sensitive [confidential] participants’ information.

Ethics approval and consent to participate
Ethical approval of the study was obtained from Bahir Dar University, college of medicine and health science department of nursing ethical review committee. The ethical letter was submitted to Felege Hiwot Referral Hospital administrators and permission was obtained to use the data. To ensure confidentiality of patient’s information was kept and was not exposed to third body. On the questionnaire the name of the patient and any identification of patients were not recorded. After collection of the data charts were returned into the card room.

Publisher’s Note
Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Received: 17 October 2016 Accepted: 28 June 2017 Published online: 11 July 2017

References
1. Simonsen KA, Anderson-Berry AL, Delair SF, Davies HD. Early-onset neonatal sepsis. Clin Microbiol Rev. 2014;27(1):21–47.
2. Goldstein B, Giroir B, Randolph A. International pediatric sepsis consensus conference: definitions for sepsis and organ dysfunction in pediatrics. Pediatric Crit Care Med. 2005;6(1):2–8.
3. Wolde MA, Guta MB, Lenjisa JL, Tegegne GT, Tesafe G. Assessment of the incidence of neonatal sepsis, its risk factors, antimicrobials use and clinical outcomes in bishoftu general hospital, neonatal intensive care unit, Debreznet-Ethiopia. Pediat Therapeut. 2014;4(4):1–7.
4. Neonatal sepsis in newborn, AlIMs protocol in India, 2014. http://www.newbornwhcc.org/2014_pdf/Neonatal%20sepsis%202014.pdf.
5. Milka B. To determine the bacterial aetiological agents Of neonatal sepsis, risks associated with acquisition and the susceptibility of these organisms to commonly used antimicrobial agents at kenyatta national hospital, Nairobi, Kenya, 2013 thesis of masters.
6. El-Din EM, El-Sokkary MM, Bassoony MR, Hassan R. Epidemiology of neonatal sepsis and implicated pathogens, Egypt. BioMed Res Int. 2015;5094848:11. doi:10.1155/2015/5094848.
7. Hoogen AV, Gerards LJ, Verboon-Maciolek MA, Fleer A, Krediet TG. Long-term trends in the epidemiology of neonatal sepsis and antibiotic susceptibility of causative, Netherlands. Pall Med Life Sci Neonatol. 2009;97:22–8.
8. Setawwan C. Background paper 6.23 neonatal conditions.
9. Shah BA, Padbury JF. Neonatal sepsis an old problem with new insights USA. Landes Biosci. 2014;15(1):170–8.
10. Vergnano S, Sharland M, Kazembe P, Mwansambo C, Heat PT. Neonatal sepsis: an international perspective, London. Arch Dis Child Fetal Neonatal Ed. 2005;90:F220–4. doi:10.1136/adc.2002.022863.
11. Waters D, Jawad I, Ahmad A, Lukisc I, Nair H, Zgaga L, Theodoratou E, Rudan I, Zaidi AKM, Campbell H. Aetiology of community-acquired neonatal sepsis in low- and middle-income countries Scotland, UK. J Glob Health. 2011;1(2):154–70.
12. Aggarwal R, Sarker N, Deorari AK, Paul VK. Sepsis in the newborn, New Delhi. 2014;110029
13. Lawn JE, Mongi P, Couessen S. Africa’s newborns-counting them and making them count. Opportunities for Africa’s newborns: practical data, policy and programmatic support for newborn care in Africa, 2006.
14. Lawn J.4 million neonatal deaths, London. Thesis of doctrate.
15. Kebede B, Gebeyehu A, Rai Sharma H, Yifru S. Prevalence and associated factors of neonatal mortality in North Gondar Zone, Northwest Ethiopia. Ethiop J Health Dev. 2015;26(2):66–71.
16. Mugalu J, Nakakete MK, Kiguli S, Kaddu-Mulindwa DH. Aetiology, risk factors and immediate outcome of bacteriologically confirmed neonatal septicemia in Mulago Hospital, Uganda. J Afr Health Sci. 2009;97:22–8.
18. Fjalstad JW, Neonatal sepsis and the adverse effects of antibiotic treatment—a systematic review, Thesis. 2015. p. 1–53.
19. Kheir AE, Khair RA. Neonatal sepsis; prevalence and outcome in a tertiary neonatal unit in Sudan. Time J Med Sci Rep. 2014;2(1):21–5.