Research Paper
Impact Factor: 3.657
Refereed Monthly Journal

AIJRRR
ISSN - 2456-205X

EPIDEMIOLOGY OF THE NEONATAL DEATHS

Dr. G. Nagarjuna* Dr. R. Ramakrishnan Dr.C.N. KamalaRatnam*****
**Research Scholar, National Institute of Epidemiology.*
***Scientist G, National Institute of Epidemiology, Chennai*
****Prof & HoD, ICH & HC, Egmore,Chennai*

Abstract
Scientific, systematic and data driven, Epidemiology probes the causes, pattern, frequency, prevalence, effects and prevention of diseases and disease related issues on larger populations. It is a quantitative discipline that relies on probability, statistics, and sound research methods. The global decline in the neonatal mortality implies that the on-going research in studying cause-specific neonatal mortality has created an increase in the awareness, care and prevention of neonatal deaths. Verbal Autopsy records help to minimize the cause-specific neonatal mortality.

Abbreviations used NM – Neonatal mortality, NMR – Neonatal mortality rate, VA –Verbal autopsy, ICD 10 – International Classification of Diseases, 10th edition

Neonate refers to a baby during the first 28 days after birth[1]. This label is applied to premature, post mature, and full term babies. Following are the terms that are discussed here: i) Preterm, ii) Term and iii) Post term[2]. Gestational age starts from the first day of the woman's last menstrual period which will be around two weeks before fertilization. Starting from 37th week and ending in 42nd week in gestation, a woman is said to be "at term" and normal delivery takes place during this time. Anything happening before this period is termed "preterm". Preterm is usually from 24 to 36 weeks. Happenings after the 42nd week of pregnancy are "post term."[3]

Live Birth: The complete expulsion or extraction from the mother of a product of human conception, irrespective of the duration of pregnancy, which, after such expulsion or extraction, breathes or shows any other evidence of life, such as beating of the heart, pulsations of the umbilical chord[4].

Foetal Death is the complete expulsion or extraction from the mother of a product of human conception, irrespective of the duration of Pregnancy. It is not an induced termination of pregnancy. For statistical purposes, foetal deaths are further subdivided as "early" (20–27 weeks' gestation) or "late" (28 weeks' gestation). Foetal deaths can be still births or miscarriages[5].

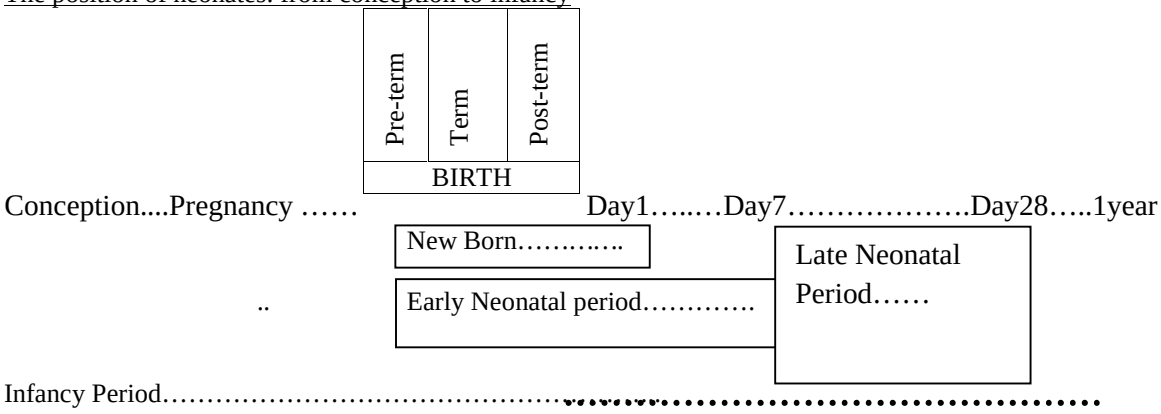
Still Birth: The term "stillbirth" is also used to describe fetal deaths at 20 weeks 'gestation or more[6]. Still birth should be certified by a Registered Physician. **Miscarriage:** Fetuses that die in utero before 20 weeks' gestation are categorized specifically as miscarriages[7].

Infant Death A live birth that results in death within the first year (365 Days) is defined as an infant death. Infant deaths are divided into 1. Neo – natal death which means death of alive born infant during the first 28 days. The term Neo-natal death is sub divided in to early neonatal (7 days), late neonatal (7–27 days), and 2. Post neonatal death which means Deaths occurring from 29 days of life to less than one year[8].

Perinatal Death Perinatal death, definition I, includes infant deaths that occur at less than 7 days of age and fetaldeaths with a stated or presumed period of gestation of 28 weeks or more. Perinatal death, definition II, includes infant deaths that occur at less than28 days of age and fetal deaths with a stated or presumed period of gestation of 20 weeks or more. Perinatal death, definition III, includes infant deaths that occur at less than 7 days of age and fetal deaths with presumed gestation of 20 weeks or more. However, definition II is more inclusive and, hence, is more appropriate for monitoring perinatal deaths throughout gestation, because the majority of fetal deaths occur before 28 weeks' gestation[9].

Neonatal Deaths: Neonatal deaths are deaths occurring during the Neonatal period, commencing at birth and ending 28 completed days after birth. Neonatal deaths Neonatal deaths are those that occur among live born infants during the first 28 completed days of life. The certification of perinatal death normally requires information about both the mother and the neonate. Sometimes difficulties arise in distinguishing between stillbirth and New born death. If there is evidence in the medical records of life after birth, with death occurring later, such a death is classified as a neonatal death. In many cases it is difficult to ascertain from those being interviewed whether the baby was alive after birth and died shortly thereafter or was stillborn. This causes many neonatal deaths to be labelled as stillbirths. If the neonatal death can be attributed to a particular cause, the cause of death should be classified and recorded as "Neonatal death due to" whatever is the appropriate cause[10].

The position of neonates: from conception to infancy



Neonatal deaths account for 40% of deaths under the age of 5 years worldwide. Two thirds of the world's neonatal deaths occur in just 10 countries, mostly in Asia. Almost 66 percent of Infants' death occurs in the first month of life. Among those who die in the first month, over 66 percent die in the 1st week of life. Of those who die in the first Week, over 66 percent die in the first 24 hours of life[11]. Globally, 90% of Neonatal deaths occur in developing countries where the vital registration is wanting and moreover, 70% of the causes of death are not well understood. Interestingly enough, a large number of these deaths are preventable. Hence, a focus on mortality in the first week of life is important in order to accelerate the millennium goal[12]. Of the estimated 130 million infants born each year Worldwide, 4 million die in the first 28 days of life[13]. The first 28 days of life – the neonatal period – is the most vulnerable time for a baby's survival. During the last 25 years, the worldwide NM rate fell by 47 per cent: from 36 to 19 deaths per 1,000 births. During the same period, the number of deaths of new-born Babies within the first 28 days of coming into existence declined from 5.1 million to 2.7 Million. Of these, nearly 1 million neonatal deaths occur on the day of birth, and almost 2 million die during the first week of life. In India, NMR fell down from 57 to 28 per 1000[14].

Determining cause of death in neonates by verbal autopsy is particularly challenging given the non-specific and overlapping clinical symptoms of several major causes of neonatal deaths. Neonatal mortality is not only a health problem of child and mother but also a social problem. Globally it has been estimated that ninety percent of neonatal deaths occur in developing countries where the vital registration is limited. Existing programme could not minimize the proportion of neonatal mortality to a considerable size and 70% of causes of death are not well understood. Interestingly enough, a large number of these deaths are preventable. Hence, a focus on mortality in the first week of life is important in order to accelerate the millennium goal[15].

Changing Patterns Deaths due to prematurity, congenital malformation, respiratory distress syndrome, neonatal pneumonia, post-natal aspiration were more common during first seven days of life. Deaths due to birth injury/asphyxia, neonatal sepsis, neonatal tetanus and sudden deaths were more common during 8-28 days of life. Deaths due to diarrhoea, dysentery and sudden death were recorded only in the late neonatal period[16]. According to Hafizur Rahman Chowdry, et al, (2010)[17] thirty-seven percent of the neonatal deaths occurred within 24 hours, 76% within 0-3 days, 84% within 0-7 days, and the remaining 16% within 8-28 days. Asphyxia Neonatorum (52.8%) was the single largest category of cause of death in the early neonatal period, while meningitis / sepsis (48.3%) were the single largest category in the late neonatal period. The high proportion of deaths during the early neonatal period and the far-higher proportion of neonatal deaths caused by Asphyxia neonatorum compared to the global average (45% vs 23-29%) indicate the lack of skilled birth attendance and new-born care for the large majority of births.

Neonatal deaths are broadly classified into two: 1. Early Neonatal deaths (1st week deaths, 84% of Neonatal deaths occur within first week and in this 37% deaths take place within first 24hours. The common causes for these deaths are i) Preterm (born between 24-36 weeks): ii) Asphyxia Neonatorum iii) Birth injury and Birth Trauma; iv) Low birth weight v) Pneumonia; vi) Hypoglycaemia; vii) Meconium Aspiration syndrome; and viii) Congenital malformations.2. Late Neonatal deaths (between the 8th and the 28th day) 16% dies during this period. The common causes for these deaths are i) Bacterial Sepsis of new born; ii) Congenital heart diseases, iii) Diarrheal diseases; iv) Feeding Problems of New born[18].

Premature Baby: Babies born between 24 and 36 weeks of gestation:
Classification of Premature babies based on duration of gestation[19]**:**
Premature baby born before 37 weeks
Preterm baby born between 32-36 weeks
Very Preterm baby born between 28-31 weeks
Common major cause of death in this condition is Hyaline membrane disease or Respiratory distress syndrome, Intraventricular Haemorrhage, Necrotising Enterocolitis and Infection.

Pneumonia
The following are the signs of respiratory distress: tachypnea, laboured breathing, with chest wall recession (particularly sternal and subcostal in drawing) and nasal flaring, expiratory grunting and cyanosis if severe. The common causes are (1) Bronchiolitis from RSV (respiratory syncytial virus) infection. (2) Meconium aspiration (3) Neonatal Pneumonia (4) Milk aspiration (5) Broncho pulmonary dysplasia

Birth Asphyxia commonly due to Prolonged or difficult labour. A**sphyxia Neonatorum: Poor** breathing at the time of birth or convulsions during the first 72 hours of birth may cause NM. Rule out preterm and low birth weight.
Grading of Birth Asphyxia based on Apgar score
Normal Apgar score ----------0-10
Mild Asphyxia Neonatorum --------5-6
Moderate Asphyxia Neonatorum --3-5
Severe Asphyxia Neonatorum------0-2

Birth trauma is commonly caused by complicated deliveries. The common causes are Chronic / acute maternal illness resulting in uteroplacental dysfunction**,** Macrosomia / dystocia**,** Prematurity**,** IUGR**,** Prolonged labour**,** Breech presentation.
Soft tissue Birth injuries These include: Caput succedaneum, bruising and edema of the presenting part extending beyond the margins of the skull bones; resolves in a few days Cephalhaematoma hematoma from bleeding below the periosteum, confined within the margins of the skull sutures. It usually involves the parietal bone. The centre of the hematoma feels soft. It resolves over several weeks**.** Chignon edema and bruising from Ventouse delivery. Bruising to the face after a face presentation and to the genitalia and buttocks after breech delivery. Examination, blood loss may be severe and lead to hypovolemic shock and coagulopathy.

Nerve palsies Birth injuries: Brachial nerve palsy, facial nerve palsy, Fractures. Clavicle**,** Humerus / femur…
Low Birth Weight Before labelling LBW confirm it is Full term pregnancy
Classification of LBW based on the weight
Low birth weight……Infants less than 2500gms
Very Low birth weight……...Infants less than 1500gms
Extremely Low birth weight. Infants less than 1000gms

Classification based on percentile
Appropriate for gestational age--New-borns whose birth weight is between 10th and the 90th percentile for gestational age
Small for gestational age-- New-borns whose birth weight is usually below the 10th percentile for gestational age
Large for gestational age--New-borns whose birth weight is usually above the 90th percentile for gestational age
There is a high incidence of low birth weight reported in developing countries like India with 26% of all live births[20]. LBW is generally associated with increased morbidity and mortality, impaired immune function, and poor cognitive development for neonates and infants. Infants, who are low birth weight, risk contracting pneumonia or acute lower respiratory infections (ALRI) at a rate almost twice that of infants with normal birth weight and more than three times greater if their weight is less than 2000 gm.[21, 22, 23].The risk of neonatal deaths for infants who are LBW weighing 2000-2499 gm at birth is estimated to be 4 times higher than for infants weighing 2500-2999 gm, and 10 times higher than for infants weighing 3000-3499 gm. LBW accounted for 69% of the ALRI in India, and it is estimated that in Bangladesh, almost half of the infant deaths from pneumonia or ALRI and diarrhoea could be prevented if LBW could be eliminated[24,25]. The algorithm used in the present study –baby was very small or smaller than usual at birth" had high sensitivity (89%) and good specificity (85%) in a validation study in Bangladesh [26]

Common problems of death in very low birthweight babies are Respiratory distress syndrome, Hypotension,Patent ductus arteriosus, Hypothermia, Necrotizing enterocolitis, Infections, Brain injury and Haemorrhage.

Bacterial sepsis of new-born: The time of highest risk in childhood acquiring a serious invasive bacterial infection is the neonatal period. Clinical features of neonatal sepsis. Temperature instability, Poor feeding, Apnea, Vomiting, bradycardia, Respiratory distress, Abdominal distension Jaundice, Neutropenia, Hypo or hyperglycaemia Shock, Irritability, Seizures, Lethargy, drowsiness Infections fall into two broad categories, early-and late-onset sepsis. (1) Early-onset infection In early onset sepsis (less than 48 h after birth), bacteria have ascended from the birth canal and invaded the amniotic fluid. The fetus is secondarily infected because the fetal lungs are in direct contact with infected amniotic fluid. These infants have pneumonia and secondary bacteraemia / septicaemia. In contrast, congenital viral infections and early-onset infection with Listeria monocytogenes, fetal infection is acquired via the placenta following maternal infection. The risk of early-onset infection is increased if there has been prolonged or premature rupture of the amniotic membranes, and when chorioamnionitis is clinically evident such as when the mother has fever during labour.

(2) Late-onset infection in late-onset infection (after 48 h after birth), the Source of infection is often the infant's environment. The presentation is usually non-specific. Nosocomial acquired infections are an inherent risk in a neonatal unit and all staff must adhere strictly to effective hand hygiene measures to prevent cross-infection. In neonatal intensive care, the main sources of infection are indwelling central venous catheters for parenteral nutrition, invasive procedures which break the protective barrier of the skin, and tracheal tubes. Coagulase negative staphylococcus (Staphylococcus epidermidis) is the most common pathogen, organisms include Gram-positive bacteria (Staphylococcus aureus and Enterococcus faecalis) and Gram-negative bacteria (Escherichia coli and Pseudomonas, Klebsiella and Serratia species). Initial therapy (e.g. with flucloxacillin and gentamicin) is aimed to cover most staphylococci and Gram-negative bacilli. If the organism is resistant to these antibiotics or the infant's condition does not improve, specific antibiotics (e.g. vancomycin for coagulase-negative staphylococci or enterococci) or broad-spectrum antibiotics (e.g. meropenem) may be indicated. Use of prolonged or broad-spectrum antibiotics predisposes to invasive fungal infections (e.g. Candida albicans) in premature babies.

Neonatal meningitis, around 10-30% of pregnant women have faecal or vaginal carriage of group B streptococci.
Major neonatal gastrointestinal problems are (1) oesophageal atresia is commonly associated with a trachea-oesophageal fistula. It occurs in 1 in 3500 live births and can be associated with polyhydramnios during pregnancy. **(2) Small bowel obstruction** This can be recognised ultrasound scanning antenatally. Small bowel obstruction presents with persistent vomiting. Commonest cause is cystic fibrosis **and** Meconium plug. A meconium plug will usually pass spontaneously. Meconium ileus may be dislodged using Gastrografin contrast medium. **(3) Large bowel obstruction** The common causes are: Hirsch sprung disease, rectal atresia. and Exomphalos / gastroschisis . In Hirsch sprung disease. There is absence of the myenteric nerve plexus in the rectum. The baby often does not pass meconium within 48 h of birth and subsequently the abdomen distends. Rectal atresia. is absence of the anus at the normal site. Treatment is surgical….. Exomphalos/gastroschisis Againthese lesions can be diagnosed antenatally. In omphalos (also called omphalocele), the abdominal contents protrude through the umbilical ring, covered with a transparent sac formed by the amniotic membrane and peritoneum. There may be associated major congenital abnormalities. In gastroschisis, the bowel protrudes through a defect in the anterior abdominal wall. Gastroschisis carries a much greater risk of dehydration and protein loss, so the abdomen of affected infants should be wrapped in several layers of clingfilm to minimise fluid and heat loss.
Hypothermia: Central part of the baby's body turns cold; baby becomes lethargic**,** stops taking the feed. This leads to the death of the neonate. **Prevention of heat loss in new-born infants** (1) Cover baby with Clothe, including covering heat (2) Dry and wrap at birth; (3) Humidify incubator.

Neonatal tetanus: Baby will be able to suck after birth**,** but it stops sucking after 3 days. The **b**aby's body becomes rigid with or without convulsions. **Tetanus:** Neonates only: Only Bangladesh had enough cases of neonatal tetanus for analysis.

Congenital malformations: The types ofcongenital malformations are
(1) Malformationsis a morphological defect of an organ, part of an organ, or larger region of the body that results from an intrinsically abnormal developmental process. Ex: - Congenital heart diseases, Anencephaly(2) Disruptions are secondary destructions of previously normal organs, arise from extrinsic disturbance in morphogenesis, The classical examples Rupture of amnion causing Amniotic bands and encircle or compressing fetal parts .It can repeat in subsequent pregnancy.(3)Deformations are also due to extrinsic disturbance in morphogenesis, mainly due to compression of fetus by Biomechanical forces. During 35^{th} – 38wksfetalgrowth outpaces uterine size. These can be broadly classified into (a) Maternal due to Primi mother, abnormal uterus. (b) Fetal can be due to Oligohydramnios, multiple fetuses (4)Syndrome is a constellation of congenital anomalies causing complex symptoms and due to multiple factors.

Ill – defined / unspecified: Apart from all these classifications, there may still be some unspecified causes for NM. Please note, for the unspecified neonatal cause of death, P96 (Other perinatal conditions) instead of R99, has got to be used.

Major causes of Neonatal death list with VA code and corresponding ICD-10 codes

Verbal autopsy Code	**VA Title**	**ICD-10**
VA-10.01	Tetanus Neonatorum	A33
VA-10.02	Prematurity	P07-P011
VA-10.03	Low birth weight	P059
VA- 10.04	Birth trauma	P109-159
VA- 10.05	Birth Asphyxia	P021-90
VA-10.06	Neonatal pneumonia	P239
VA-10.07	Viral diseases	P359
VA-10.08	Bacterial Sepsis	P369
VA-10.09	Congenital malformations of the Nervous system	Q00-79
VA-10.10	Congenital malformations unspecified	Q899-999
VA-10.97	Still birth	P95
VA-11	External causes of death	V,W,X
VA-98	Other specified causes of death	
VA-99	Unspecified causes of death	R99

Coding of Neonatal diseases Neonatal deaths are included in chapter 16, 17 and 18 as in major categories P00-P96……Q00-Q99……R00-R99. Each category grouped under blocks. Again under each blocks there are CODES like P00.0, P00.1. Most of the VA instruments are mainly oriented towards determining common diseases of great public importance. ICD 17coding (1) Exclusively Neonatal (2) Infections (B) (3) External Injuries (VWXY).In ICD 10 theNeonatal deaths are included in chapter 16, 17 and 18 as in major categories P00-P96……Q00-Q99……R00-R99. Each category grouped under blocks. Again under each blocks there are CODES like P00.0, P00.1. Most of the VA instruments are mainly oriented towards determining common diseases of great public importance.

Neonatal care and Interventions: The following are some of the suggested care and interventions for the neonates: i) Prenatal care; ii) Proper delivery; iii) Post-natal care; and iv) Communication and counseling. Prenatal care includes immunizations and inoculations, proper dietary advice, periodic health check-ups, and counseling. Post-natal care includes creating awareness on regular breast feeding, hygiene, cord care, immunization, nutritious food for mother, etc. Communication and counseling may encompass inputs on hygiene, health care, life style changes, nutrition, etc. NM can be minimized by improving antenatal health care, skilled obstetric care, new-born and neonatal care. In order to have these interventions on time, this field tested and validated tool could be incorporated into the existing child health programs, which would lead to improved evidences on neo natal death causes and relevant interventions.

Conclusions: It is pertinent to note that the use of secondary data for any research has its own intrinsic limitations and difficulties. It is important to note, it provides a picture of care at antenatal health level, delivery and Neonatal unit, at birth for preterm infants with very low weight and other NM causes which contribute to the neonates' mortality. This might prove helpful if the research findings are taken up seriously, and measures are taken up in right earnestness to address these concerns and alleviate them. More focus is needed to achieve the UN Millennium Development Goal 4 of reducing Neonatal mortality by two-thirds in high-mortality countries.

References

1. https://medlineplus.gov/ency/article/002271.html.
2. Wood, A (2013). Preterm, Full Term & Post-term Babies: What Do They Mean?
3. February 20, 2013. http://www.thebabycorner.com/page/2952/.
4. Khan M.Z., et al (2016). Preterm and PosttermLabour.*Health & Medicine.Published* on Feb 7, 2016.
5. http://medical-dictionary.thefreedictionary.com/live+birth
6. http://www.obfocus.com/reference/glossary/S/Stillbirth.htm
7. http://americanpregnancy.org/pregnancy-complications/miscarriage/
8. Cates W. Epidemiology: Applying principles to clinical practice. Contemp Ob/Gyn 1982;20:147–61.
9. https://en.wikipedia.org/wiki/Sudden_infant_death_syndrome
10. http://medical-dictionary.thefreedictionary.com/perinatal+death
11. www.who.int/gho/child_health/mortality/neonatal/en/
12. Hill (1999) .The Infant mortality: 'Two-thirds Rule'. *Save the children, 2001.*

13. Costello, A., et al (2001). State of the World' Newborns: A Report from Saving Newborn Lives. Save the Children, ISBN-1-888393-05-X 2001. Web site: http://www.savethechildren.org.
14. 13.Jehan, I., et al (2009). "Neonatal mortality, risk factors and causes: a prospective population-based cohort study in urban Pakistan." *Bulletin of the World Health Organization* 2009;87:130-138. Doi: 10.2471/BLT.08.050963.
15. http://data.worldbank.org/indicator/SH.DYN.NMRT.
16. Costello, A., et al (2001). State of the World' Newborns: A Report from Saving Newborn Lives. Save the Children, ISBN-1-888393-05-X 2001. Web site: http://www.savethechildren.org.
17. Shrivatsava, S. P., et al (2001). Verbal Autopsy Determined Causes of Neonatal Deaths. *Indian Pediatrics* 2001; 38: 1022-1025.
18. Chowdhury, H.R., et al (2010). Causes of Neonatal Deaths in a Rural Subdistrict of Bangladesh: Implications for Intervention. *J Health PopulNutr*. 2010 Aug; 28(4): 375–382.
19. 18.Jehan, I., et al (2009). "Neonatal mortality, risk factors and causes: a prospective population-based cohort study in urban Pakistan." *Bulletin of the World Health Organization* 2009;87:130-138. Doi: 10.2471/ BLT. 08. 050963.
20. http://bestpractice.bmj.com/best-practice/monograph/671/basics/classification.html
21. https://en.wikipedia.org/wiki/World_Health_Report.
22. Victoria CG, Smith PG, Vaughan JP, Nobre LC, Lombardi C, Teixeira AM et al. (1989) Infant feeding and deaths due to diarrhea. American Journal of Epidemiology 129(5):1032-1041. 18.
23. Victora CG, Barros FC, Kirkwood BR, Vaughan JP (1990) Pneumonia, diarrhea, and growth in the first 4 y of life: a longitudinal study of 5914 urban Brazilian children. American Journal of Clinical Nutrition 52:391-396.
24. Fonseca W, Kirkwood BR, Victoria CG, Fuchs SR, Flores JA, Misago C (1996) Risk factors for childhood pneumonia among the urban poor in Fortaleza, Brazil: a casecontrol study. Bulletin of the World Health Organization 74:199-208.
25. Datta N, Kumar V, Kumar L, Singhi S (1987) Application of case management to the control of acute respiratory infections in low-birth-weight 35 References Nutrition Policy Paper # 18 infants: a feasibility study. Bulletin of the World Health Organization 65:77-82.
26. Arifeen SE (1997) Birth weight, intrauterine growth retardation and prematurity: a prospective study of infant growth and survival in the slums of Dhaka, Bangladesh Doctor of Public Health dissertation, Johns Hopkins University, Baltimore MD.
27. WHO (1999). International Symposium on LBW. Bangladesh. June 1999.