ISSN 2077 - 7469 (PRINT)
ISSN 2309 - 1320 (ONLINE)
Index in Bangla JOL
BMDC Recognized

• Volume 11 • Number 1 & 2 • January - July 2020

JPSB

Journal of Paediatric Surgeons of Bangladesh

The Official Journal of the
ASSOCIATION OF PAEDIATRIC SURGEONS OF BANGLADESH (APSB)
www.apsb-bd.org

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Published : March 2025

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● Volume 11 ● Number 1 & 2 ● January - July 2020

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www.apsb-bd.org

Journal of Paediatric Surgeons of Bangladesh (2020) Vol. 11 (1 & 2):24-32
Official Journal of the Association of Paediatric Surgeons of Bangladesh

Journal of Paediatric Surgeons of Bangladesh

Original Article

Neonatal Surgical Situation in Bangladesh: Challenges and Way Forward

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Abstract

The neonatal period is the most vulnerable time for a child. Although neonatal morbidity and mortality have declined over the last few decades, the outcome of neonatal surgery is still relatively poor in Bangladesh compared to other low- and middle-income countries. Still, neonatal surgery is not getting its due attention in the national health policy. Here, challenges are multifactorial. In developed countries, intrauterine diagnosis, planned delivery, better pediatric anesthetic support, improved neonatal intensive care, and prompt surgical management have been shown to significantly improve neonatal surgical outcomes. This article addresses various problems of delivering neonatal surgical services in Bangladesh and proposes solutions. It is crucial that prompt surgical management be a key focus in improving neonatal and infant health indices.

Keywords: Neonatal surgery, Manpower, Neonatal transport, Neonatal intensive care unit, Minimally invasive surgery, Challenges, Follow-up, Research

Introduction

Neonatal surgery is delicate and sophisticated in every aspect. Most neonatal surgeries are performed during the first ten days of life.[1] For successful survival, neonatal surgeries require surgical management by pediatric surgeons in medical centers with facilities for pediatric anesthesia, radiology, and specialized nursing care.[2] Prolonged duration of surgery, perioperative blood loss, and hypothermia adversely affect the outcome.[3]

The average global rate of neonatal deaths was 16.8 per 1,000 live births in 2023.[4] The neonatal mortality rate for Bangladesh in 2023 was 21.56 deaths per 1000 live births, which declined from 27/1000 to 21/1000 live births between 2017 and 2023.[5] Congenital anomaly is currently the fifth leading cause of neonatal mortality worldwide.[2] Congenital anomaly comprises 7% of neonatal deaths, and most of these are curable.[6,7,8] The most common surgical conditions in the newborn involve the gastrointestinal tract.[2] Complications related to birth defects are responsible for around 12.7% of neonatal deaths in Bangladesh, making it an emerging public health concern.[6,7]

This paper addresses the burden and outcome of neonatal surgical conditions in Bangladesh to plan and implement strategies to improve outcomes.

Health Care System of Bangladesh

Bangladesh has a well-structured health care system with three tiers of primary health care – Upazila Health Complexes (UHC) at the sub-district level, Union Health and Family Welfare Centers (UHFWC) at the Union (collection of few villages) level, and Community Clinics (CC) at the village level.[10] The provision of surgical services starts at the Upazila (sub-district) level and goes upward.[11] Upazila Health Complexes provides limited surgical services depending on specialist doctors, skilled staff, and proper equipment availability. Pediatric and neonatal surgery is often

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Published: March 2025

performed at district and general hospitals, and nowadays, limited Special Care Newborn Unit (SCANU) facilities are available in some places here.[11,12]

At the tertiary level, health facilities are delivered through the specialized surgical specialty and sub-specialty care.[11] A SCANU and a Pediatric Intensive Care Unit (PICU) are vital components of hospital care for critically ill children, significantly reducing morbidity and mortality rates. According to the DGHS Health Bulletin 2023, there are currently 59 functional SCANUs across 50 district hospitals in Bangladesh. Additionally, the country has about 22 hospitals equipped with PICUs, highlighting the widespread availability of these essential life-saving facilities.[12] Among the prominent institutions offering these vital services are the renowned Dhaka Shishu (Children) Hospital, Bangabandhu Sheikh Mujib Medical University (BSMMU), Chattogram Maa-o-Shishu Hospital Medical College, Institute of Child and Mother Health, Combined Military Hospital, Square Hospital, Bangladesh Specialized Hospital, United Hospital Limited, Dr. MR Khan Shishu Hospital & Institute of Child Health, BIRDEM General Hospital 2 (Child and Mother), Women's and Children's General Hospital, Central Hospital, Dhaka Pediatric-Neonatal & General Hospitals for Children, Labaid Hospital, and Delta Hospital.[12] These hospitals have a strong track record of successfully performing operations on neonates and children. Collectively, these institutions represent a beacon of hope and excellence in pediatric and neonatal healthcare within Bangladesh. These hospitals regularly operate on neonates and children and are equipped with NICU and PICU facilities.[11,12]

Bangladesh has a shortage of doctors, nurses, midwives, and health technicians of various kinds. 68% of Bangladesh's medical doctors work in the private sector.[9,10] In 2021, the health workforce is bent towards doctors, with a doctor-to-nurse ratio of 1:0.77 and a doctor-to-technologist ratio of 1:0.35, highlighting the limited number of technologists available in relation to their medical counterparts.[9] Meanwhile, in 2014, the healthcare landscape reflected a different balance, with a composite ratio of doctors to nurses to technologists at 1:0.4:0.24, illustrating a more diversified workforce distribution that included a stronger emphasis on nursing and technological roles.[10] The inadequate number of appropriately trained human resources for health in Bangladesh is a decisive limiting factor.

Antenatal Checkup

According to "the WHO antenatal care (ANC) model (2016)", there are four timely ANC visits that aim to reduce maternal and child mortality.[13] During 2007–2014, globally, only 64% of pregnant women attended the WHO-recommended minimum of four contacts for ANC.[13] Bangladesh Demographic and Health Survey (BDHS) data 2019-20 shows that the four ANC coverage rates rose to 47% from 31% in 2010.[14] In 2022, 88% of pregnant women received at least one ANC from a trained provider.[5]

In most countries, one ultrasound scan before 24 weeks of gestation (mid-trimester scan) is recommended as part of standard prenatal care for pregnant women to estimate gestational age, rule out structural abnormalities or congenital anomalies, improve detection of fetal anomalies and multiple pregnancies, and improve a woman's pregnancy experience.[13] In the Salomon study, over one-half (56%) of malformations and significant anomalies were identified before 24 weeks of gestation.[15] Parveen (2018) conducted a study in the Gynecology Department of Bangabandhu Sheikh Mujib Medical University, where (125/705) 17.7% of women had congenital anomalies in their babies.[16]

Newborn Care

Essential newborn care (ENC) includes hygienic care, thermal control, eye and cord care, early and exclusive breastfeeding support, immunization, early identification of danger signs, and resuscitation with a bag and mask if needed.[17,18] ENC should be applied after the baby is born and continued for the first seven days after birth.[13]

The Burden of Disease

The most common congenital anomalies encountered at Dhaka Medical College Hospital were anorectal malformation (ARM), Hirschsprung's disease, gastroschisis, omphalocele, intestinal atresia, meconium ileus, volvulus with malrotation, infantile pyloric stenosis, prune belly syndrome, neonatal injury, congenital diaphragmatic hernia, posterior urethral valve, ectopia vesicae, oesophageal atresia, tracheoesophageal fistula, and conjoint twin.[2] Similarly, at Dhaka Shishu Hospital, Hasan et al. (2022) noted that anorectal malformations and gastroschisis were the most prevalent anomalies.[3] This information provides a comprehensive understanding of the landscape of congenital anomalies in our country.

Time of Presentation

According to a study by Ekwunife et al. (2022), the duration of presentation from the onset of symptoms ranged from 1 hour to 26 days (mean 34.7 ±21.1 hours).[19]

Hanif et al. (2020) observed early presentation in ARM, gastroschisis, omphalocele major, and meconium ileus.[2] Early onset of symptoms, rapid deterioration of patients' condition in intestinal obstruction, and straightforward approach to diagnosis were probably the causes of early presentation. On the other hand, the presentation was late in Hirschsprung disease and malrotation because of variability in the onset of symptoms and lack of specificity.[2,20]

One of the most pressing issues in neonatal surgical services in Bangladesh is the late presentation of cases.[2,3] These babies often arrive at referral centers in critical condition, with hypothermia, sepsis, and hemodynamic instability. This late presentation not only complicates the surgical intervention but also significantly increases the postoperative morbidity and mortality rates.[2,21,22] This underscores the urgent need for strategies to address this challenge.

Neonatal Birth Trauma

Several factors contribute to the occurrence of birth trauma, with instrumental delivery, fetal presentation (vertex presentation), early preterm birth, high birth weight (>4000 g), and male sex being the primary predisposing factors.[23,24,25] These factors, when present, significantly increase the risk of birth trauma. In fact, scalp injuries alone account for 80% of all birth traumas.[25] Other prevalent birth traumas include clavicular fractures, brachial plexus injuries, and intracranial hemorrhage.[25] This knowledge can help us identify and manage these cases more effectively.

Surgical Procedures

Ekwunife et al. (2022) recommended that the most common procedures were intestinal resection and anastomosis in 29.6%, colostomy in 21.1%, primary repair of anterior abdominal wall defect in 12.7%, and silo or modified silo application in 6.9% neonates.[26] This finding was similar to other studies.[2,3,19] Here, various modalities of management were used.[2,3,26]

Minimally Invasive Surgery in Neonates

Minimally invasive surgery (MIS) has been increasingly accepted as a treatment modality for neonatal surgical conditions.[27] Neonatal MIS, which includes both laparoscopic and thoracoscopic procedures, is now used for a variety of surgeries such as laparoscopic pyloromyotomy, laparoscopic Ladd's procedure for malrotation, repair of diaphragmatic hernia, and complex biliary reconstructions in neonates.[27,28] The ability to visualize the opposite patent processus vaginalis in inguinal hernias makes MIS a superior option to open herniotomy.[29]

Challenges Faced in Neonatal Surgery in Bangladesh:

1. Shortage of Skilled Manpower

In Bangladesh, 6.78 registered Physicians and 0.058 anesthesiologists are available per 10,000 people0.[12] The Lancet Commission on Global Surgery recommended 20 specialist surgeons and anesthesiologists per 10,000 population.[30] However, in Bangladesh pediatric surgical workforce is exceptionally low. There was only one pediatric surgeon for two lakh children.[12] Nowadays, very few dedicated pediatric anesthesiologists are present in Bangladesh.

2. Urgent Need to Address Insufficient Infrastructure, Equipment, and Facilities

Modern technology plays a vital role in improving the outcomes of neonates in developed countries. Intravenous infusion pumps, radiant warmers, incubators, mechanical ventilators, and extracorporeal membrane oxygenators are commonly used in modern surgical NICU.[18,19,20] The need for such equipment poses a substantial challenge in achieving positive outcomes in neonatal surgery.

3. Inadequate Documentation and Research

More data and research are needed on neonatal surgical problems. Birth defects have not been included in Bangladesh's national census so far. The actual data regarding neonatal surgical patient load in Bangladesh is not available, but this burden is increasing and contributing significantly to the causal list of neonatal mortality.[3]

4. Lack of Awareness

In addition to the challenges mentioned above, there needs to be more awareness and understanding among the general population, especially among health policy planners in Bangladesh, regarding neonatal surgical issues. Many parents and caregivers may not recognize the early signs and symptoms of

neonatal surgical conditions, leading to delayed or inadequate care for affected infants. Increasing awareness about the importance and necessity of early detection and timely intervention for neonatal surgical problems is crucial for improving outcomes and reducing neonatal mortality in the country.

5. The Severe Impact of Low Budget Allocation in the Health Sector and Scarcity of Investment

The national budget is BDT 7,970 billion for the 2024-25 fiscal year. 41,4.07 billion Tk, or 5.27% of the proposed budget, has been allocated to the health sector.[31] This lack of critical public funding severely hampers access to surgical services. Governments and donor agencies must pay more attention to funding and supporting research studies in neonatal surgical diseases.

6. Out-of-Pocket Payment System

Government hospitals cannot provide completely free primary health care.[10,11] Patients bear the costs of medicine, laboratory investigations, and some additional unseen costs.[10,11] Insurance makes up a small share of the total source of healthcare financing in Bangladesh.[21] However, government expenditure on health is about 34% of the total health expenditure (THE), the remaining (66%) being out-of-pocket expenses.[10,32]

7. Gender Bias

Gender bias is prevalent among Bangladeshi societies, with a clear preference for baby boys over girls. In numerous instances, girls may not receive necessary medical and surgical treatment, or it may be discontinued altogether.

8. Fear, Beliefs & Superstitions

Fear of surgery is observed in many cases. Some believe that surgery will bring lots of complications and worse outcomes. Seeking treatment from traditional and spiritual healers is common in rural areas.[33] In Bangladesh, almost 87% of the mothers sought care for their newborns, of which 38% sought care from homeopaths, 37% from village doctors, 17% from trained providers, 5% from government health facilities, and 3% from herbalist/spiritual healer.[33]

9. Consanguineous marriage

Consanguineous marriage refers to marriage between first or second cousins.[35] Becker (2002) recommended that among the offspring of first-cousin parents, birth defects' prevalence increased from 3–4% to 5.7–6.8%.[34,35] In the Teknaf region of Bangladesh, 17.6% of marriages were consanguineous.[36]

10. Gestational Age and Birth Weight

Prematurity and low birth weight are two independent variables for neonatal surgical mortality.[2, 3, 37] A report by Puri et al. (2019) showed that prematurity and low birth weight increase the odds of neonatal surgical mortality by 3.38 and 3.41 times, respectively.[37] Hasan et al. (2022) demonstrated in their study that 54% of neonates were premature.[3]

11. Delivery at Home and Distance from Hospital

The practice of childbirth at home is widespread in Bangladesh; 57.2% of total births still take place at the household level, and among them, 70.3% of children are born with the help of Traditional Birth Attendants (TDA) in 2022.[38] Relative to other births, a medically trained provider is more likely to assist first-order births. Congenital anomalies in such children are not easily determined at birth.[16] It was to be shown that late presentation of neonates was a risk factor for surgical outcomes.[2]

12. Late Presentation and Poor Transportation

More than 60% of births are usually at home in many parts of the country.[39] Many of these neonates are brought to the hospital several days or sometimes weeks after the onset of illness with severe fluid and electrolyte deficits, anemia, sepsis, and malnourishment.[39]

On the other hand, the neonates who are delivered in the Upazila Health Complexes or Community Clinics are referred to specialist centers after significant delays, often not well resuscitated, and transported in suboptimal conditions from far locations on poorly maintained roads.[10,11] Besides, surgical intervention in such babies often leads to high postoperative morbidity and mortality.

13. Difficulty with Anesthesia

The lack of trained anesthesiologists in low- and middle-income countries is confirmed by a survey conducted by Dubowitz et al. (2010), and undergoing general anesthesia is a significant risk for patients (mainly infants and children) in developing countries.[20] General anesthesia for the sick newborn is often turbulent, prolonged, and practiced in a state of lack of appropriate anesthetic equipment and inappropriate drugs in most centers in Bangladesh.[40,41,42]

14. Challenges of MIS

Ergonomic problems cause surgeons discomfort and fatigue, leading to imprecise movements that may cause surrounding organ injury.[29] Market-driven

instrumentation limitations remain an essential issue in developing neonatal MIS.[27,28] The low volume of MIS procedures performed on neonates acts as a deterrent to attract manufacturing companies to develop smaller, more sophisticated instruments.[43]

15. Poor Follow-up

Follow-up of patients treated in the hospital is usually inferior.[2,3,33] Many of the neonates do not come back after initial surgery, which means that the long-term outcome of treatment is challenging to evaluate and document.

Proposed Solutions to Improving Neonatal Surgical Care in Bangladesh:

The average mortality from neonatal surgery in most centers of LMIC countries is 20%-30%.[3,21] Most of these neonatal surgical deaths are avoidable if the care providers take the necessary steps.

1. Community Awareness

Community awareness regarding neonatal complications and practices for care-seeking have the potential to bring about significant improvements in neonatal health. By leveraging the expertise of Traditional Birth Attendants (TBA) and Community Health Care Providers (CHCP), we can enhance facility-based delivery and improve newborn care practices in Bangladesh. Training the staff of rural hospitals to recognize life-threatening neonatal conditions and refer such cases early and adequately is a crucial step. The Association of Pediatric Surgeons of Bangladesh (APSB) could play a pivotal role in generating awareness across the continent through symposia, workshops, and meetings on neonatal surgical problems, instilling hope for a brighter future.

2. Data Collection, Aggregation & Dissemination

Neonatal surgical data should be collected from every level, and a national database should be established. The database should be open for all to access.

3. Research

Regular publication of research results in relevant journals, Web sites, and other communication media would go a long way in raising awareness of neonatal surgical problems. With proper documentation and published research, it may be easier to convince healthcare providers, the international community, and governments to pay particular attention to this important aspect of child health.

4. Equipment and Facilities

Each divisional city needs one dedicated children's hospital, which will have the budget for appropriate equipment and facilities for neonatal surgery. The provision of a well-equipped NICU with trained staff is mandatory for improved morbidity and mortality rates of neonatal surgery.

5. The role of government and healthcare planners

Neonatal surgical services are expensive and require a lot of capital expenditure, which is only feasible with active government involvement. Governments need to encourage the setting up of dedicated children's hospitals and provide funding for research into various aspects of child health. This would go a long way in improving the outcome of newborn babies with surgical diseases, which should be a right of every child born in Bangladesh and not a privilege.

6. Coordination and Collaboration between the Ministries

Coordination and collaboration between ministries could be an effective way to tackle the situation and devise strategic ways. Finding common goals with other ministries and executing collaborative programs will save time, money, and effort. Development and implementation of treatment protocols and guidelines and collaboration across centers are needed to ensure continuous neonatal surgical quality improvement for a sustained good outcome.

7. The Role of International Community

Regional and international collaboration is a crucial part of our strategy. It is important to note that international funding agencies have a significant role to play. By recognizing that neonatal surgical conditions also cause significant morbidity and mortality, these agencies can provide funding for neonatal surgical research and help train and incentivize pediatric surgeons and other support staff. Their support will be instrumental in our collective efforts to improve neonatal surgical care in Bangladesh.

8. Training

Neonatal surgical training, a crucial component of the pediatric surgical curriculum, should be emphasized. The Association of Pediatric Surgeons of Bangladesh (APSB) and the government should regularly organize training, symposia, and workshops to ensure the dissemination of this vital knowledge.

9. Ensure Four Antenatal Checkup and confirm Prenatal Diagnosis

Four ANC visits with one ultrasound scan before 24 weeks of gestation can reduce maternal and child mortality. Bangladesh still ensures a higher uptake rate of timely four ANC visits with its government and non-government organizational initiatives. Prenatal diagnosis of complex congenital anomalies allows planning for delivery and early post-natal treatment, which is associated with a better outcome.

10. Immediate Referral of Neonatal Surgical Emergencies

Immediate and appropriate surgical attention is not commonly available here due to illiteracy, ignorance, and poverty. Modernized sophisticated perioperative care significantly reduces morbidity and mortality in neonatal surgery.[39]

11. Transport

Infants under 1.8kg in weight are best transported in a portable incubator at a temperature of 40 °C and an oxygen concentration of 50%.[40,42] The infant should be transported lying flat on its side.[42] The accompanying nurse must be able to suck out the pharynx and clear the air passages at a moment's notice. However, postoperative mortality significantly varied with age and anomaly ($P < 0.001$) but not by distance traveled ($P = 0.565$).[44]

12. Dealing with Rare and Complex Diseases

Due to their rarity, neonatal surgical conditions are often challenging to manage.[26] A thorough understanding of congenital anomalies and neonatal pathophysiology is essential to the practicing pediatric surgeon. In addition, the surgeon must be conscious of functional abnormalities of the esophagus, stomach, intestines, diaphragm, and abdominal wall.[45]

13. Provision of Major Neonatal Surgery under Local Anesthesia

General anesthesia carries considerably higher mortality for the most critically ill neonates, where perioperative health resources are limited.[40] Hagander et al. (2015) observed that local infiltrative anesthesia has emerged as an alternative to general anesthesia for neonates.[46] Caudal anesthesia has also proven beneficial for neonatal surgery in the perineal region.[46] Evaluation of intraoperative monitoring of pain scores to ascertain the adequacy of analgesia.[42]

14. Advancement of Minimally Invasive Surgery (MIS) in Neonates

MIS in neonatal surgery has been safe and effective and provides the same benefits as its open counterparts. A newer concept of "gasless laparoscopy" eliminates the risks of pneumoperitoneum in neonates.[47] Two mm instruments are now available in many advanced centers, obviating the need for trocar insertion.[43]

15. Prevention and Treatment of Neonatal Birth Trauma

It is challenging to deliver a large baby via spontaneous vaginal delivery and is traumatized by instrumental devices during health workers' assistance. CS delivery reduces the risk in these cases from birth trauma.[23] Midwives must be trained and posted to maternity centers in our health facilities.

16. Other Solutions to be Ensured

- Gender Equity & Social Inclusion
- Parents Support Group
- Uninterrupted Electricity, Water, Oxygen, and Nitrous Oxide Supply in the Hospital
- Control of the Body Temperature
- Maintenance of hydration by Fluid and Electrolyte balance
- Prevention and Treatment of Infections
- Improvising newer surgical techniques
- Maintain Follow-up schedule

Conclusion

Neonatal surgery, a crucial tool in addressing congenital anomalies and birth defects in Bangladesh, is currently facing substantial challenges within the healthcare system. However, there is significant potential for improvement. Addressing these challenges requires a comprehensive approach, including improving antenatal care, raising awareness, ensuring timely referrals, and increasing the availability of skilled healthcare professionals, particularly in pediatric surgery. It's crucial that the government, healthcare providers, international organizations, and the community come together in collaborative efforts to enhance the survival and well-being of neonates with surgical conditions in Bangladesh. By implementing these solutions and addressing the multifaceted issues, Bangladesh can significantly improve neonatal surgical care, reduce neonatal mortality, and ensure a healthier future for its most vulnerable newborns.

References:

1. Broche-Candó, R. C., Sosa-Palacios, O., Morales-Mesa, E., et al. (2017). 'Neonatal Surgery Case Fatality and Associated Factors in a Cuban Pediatric Hospital, 2005-2015'. *MEDICC review*, 19(2-3), 18. doi: 10.37757/MR2017.V19.N2-3.4.
2. Hanif, A., Hasina, K., Rouf, M.A., et al. (2020). 'Neonatal surgery: Demand and survival both are on the increase- an experience of seventeen years in Dhaka Medical College Hospital, Bangladesh.' *Bangladesh Medical Research Council Bulletin*, 46(1), 5–11. doi:10.3329/bmrcb.v46i1.47462.
3. Hasan, M. S., Islam, N., & Mitul, A. R. (2022). 'Neonatal Surgical Morbidity and Mortality at a Single Tertiary Center in a Low- and Middle-Income Country: A Retrospective Study of Clinical Outcomes'. *Frontiers in Surgery*, 9, 817528. doi: 10.3389/fsurg.2022.817528.
4. Goalkeepers Report, 2024, p2-7.
5. ICDDRB; Bangladesh Demographic and Health Survey (BDHS) 2023 Preliminary Findings: Positive Trends in Maternal and Child Health, p13-22.
6. Rahman, A. E., Hossain, A. T., Siddique, A. B., et al. (2021). 'Child mortality in Bangladesh - why, when, where and how? A national survey-based analysis'. *Journal of Global Health*, 11, 04052. doi: 10.7189/jogh.11.04052.
7. UNICEF. Neonatal mortality rate. UNICEF global database. (2020) Available at https://data.unicef.or/wp-content/uploads/2017/10/Neonatal-mortality-rate_2020.xlsx.
8. WHO; Newborn Mortality, 2023, p2-12.
9. Bangladesh Health Workforce Strategy 2021, p42-52.
10. Islam, A., & Biswas, T. (2014). 'Health system in Bangladesh: Challenges and Opportunities'. *American Journal of Health Research*. 2(6): 366-374. doi: 10.11648/j.ajhr.20140206.18.
11. Ali, M.A. (2020). 'Healthcare Services in Bangladesh: Revisiting the Existing Regulatory Framework'. *Southeast University Journal of Arts and Social Sciences*, 3(2): 131-147.
12. DGHS Health Bulletin, 2023, p32-56.
13. WHO recommendations on antenatal care for a positive pregnancy experience: World Health Organization; 2016, p4-14.
14. Sarker, B.K., Rahman, M., Rahman T., et al. (2020). 'Status of the WHO recommended timing and frequency of antenatal care visits in Northern Bangladesh'. *PLoS One.*, 15(11): e0241185. doi: 10.1371/journal.pone.0241185.
15. Salomon, L. J., Alfirevic, Z., Berghella, V., et al. (2022). 'ISUOG Practice Guidelines (updated): performance of the routine mid-trimester fetal ultrasound scan'. *Ultrasound in obstetrics & gynecology: the official journal of the International Society of Ultrasound in Obstetrics and Gynecology*, 59(6), 840–856. doi:10.1002/uog.8831
16. Parveen, T., Hafiz, M.G., Akther, S., et al. (2018). 'Congenital Anomalies Attending at Fetomaternal Wing of Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh'. *Journal of Pediatrics & Neonatal Care*, 8(1): 00301. DOI: 10.15406/jpnc.2018.08.00301.
17. Berhan, D., & Gulema, H. (2018). 'Level of knowledge and associated factors of postnatal mothers' towards essential newborn care practices at governmental health centers in Addis Ababa, Ethiopia'. *Advances in Public Health*, 2018, Article ID 8921818, 10 pages. https://doi.org/10.1155/2018/8921818.
18. Singh, K., Brodish, P., Chowdhury, M. E., et al. (2017). 'Postnatal care for newborns in Bangladesh: The importance of health-related factors and location'. *Journal of Global Health*, 7(2), 020507. doi:10.7189/jogh.07.020 507.
19. Ekwunife, H. O., Ameh, E., Abdur-Rahman, L., et al. (2022). 'Burden and outcome of neonatal surgical conditions in Nigeria: A countrywide multicenter cohort study'. *Journal of Neonatal Surgery*, 11, 3. doi: 10.47338 /jns.v11.1029.
20. Sowande, O.A., Ogundoyin, O.O., & Adejuyigbe, O. (2007). 'Pattern and factors affecting management outcome of neonatal emergency surgery in Ile-Ife, Nigeria'. *Surgical Practice*, 11(2), 71–75. doi:10.1111/j.1744-1633.2007.00341.x.
21. Chirdan, L. B., Ngiloi, P. J., & Elhalaby, E. A. (2012). 'Neonatal surgery in Africa'. *Seminars in*

Pediatric Surgery, 21(2), 151–159. doi: 10.1053/j.sempedsurg.2012. 01.007.

22. Lam, G., Kuller, J., & McMahon, M. (2002). 'Use of Magnetic Resonance Imaging and Ultrasound in the Antenatal Diagnosis of Placenta Accreta'. *Journal of the Society for Gynecologic Investigation*, 9(1):37-40. doi:10.1177/107155760200900108.
23. Luca, A., Vinturache, A., Ilea, C., et al. (2022). 'Birth trauma in preterm spontaneous vaginal and cesarean section deliveries: A 10-years retrospective study'. *PloS one*, 17(10), e0275726. doi: 10.1371/journal.pone.0275726
24. Tolosa, G., Assefa, N., Keneni, M., et al. (2023). 'Neonatal Birth Trauma and Its Predisposing Factors Among Newborns Admitted to Public Hospitals in Eastern Ethiopia: A Cross-Sectional Study'. *Global pediatric health*, 10, 2333794X231183814. doi: 10.1177/2333794X231183814.
25. Gupta, R., & Cabacungan, E. T. (2021). 'Neonatal Birth Trauma: Analysis of Yearly Trends, Risk Factors, and Outcomes'. *The Journal of Pediatrics*, 238, 174–180.e3. doi: 10.1016/j.jpeds.2021.06.080.
26. Osifo, O.D., & Ovueni, M.E. (2009). 'The prevalence, patterns, and causes of deaths of surgical neonates at two African referral pediatric surgical centers'. *Annals of Pediatric Surgery*, 5, 194-199.
27. Mitul, A. R., & Sarin, Y. K. (2017). 'Minimal Access Surgery in Neonates'. *Journal of neonatal surgery*, 6(3), 59. doi 10.21699/jns.v6i3.614.
28. Jones, V. S., & Cohen, R. C. (2008). 'Two decades of minimally invasive pediatric surgery-taking stock'. *Journal of pediatric surgery*, 43(9), 1653–1659. doi: 10.1016/j.jpedsurg. 2008.01.006.
29. Blinman, T., & Ponsky, T. (2012). 'Pediatric minimally invasive surgery: laparoscopy and thoracoscopy in infants and children'. *Pediatrics*, 130(3), 539–549. doi:10.1542/peds.2011-2812.
30. Meara, J. G., Leather, A. J., Hagander, L., et al. (2016). 'Global Surgery 2030: evidence and solutions for achieving health, welfare, and economic development'. *International journal of obstetric anesthesia*, 25, 75–78. doi: 10.1016/j.ijoa.2015.09.006.
31. Ministry of Finance (MOF), Finance division, Bangladesh, 2024, p35-67.
32. Banu, T., Chowdhury, T. K., Aziz, T. T., et al. (2018). 'Cost Incurred by the Family for Surgery in Their Children: A Bangladesh Perspective'. *World journal of surgery*, 42(12), 3841–3848. doi:10.1007/s00268-018-4700-0.
33. Ahmed, S., Sobhan, F., Islam, A., et al. (2001). 'Neonatal morbidity and care-seeking behavior in rural Bangladesh'. *Journal of tropical pediatrics*, 47(2),98–105. doi: 10.1093/tropej/47.2.98.
34. Becker, S.M. (2002). 'Consanguinity and congenital birth defects'. *Journal of Genetic Counseling*, Vol. 11, No. 5.
35. Bennett, R.L., Motulsky, A.G., Bittles, A., et al. (2002). 'Genetic Counseling and Screening of Consanguineous Couples and Their Offspring: Recommendations of the National Society of Genetic Counselors'. *Journal of Genetic Counseling*, 11(2), 97–119. doi:10.1023/a:1014593404915.
36. Mobarak, A. M., Kuhn, R., & Peters, C. (2013). 'Consanguinity and Other Marriage Market Effects of a Wealth Shock in Bangladesh'. *Demography*, 50(5), 1845–1871. doi:10.1007/s13524-013-0208-2.
37. Puri, A., Lal, B., & Nangia, S. (2019). 'A Pilot Study on Neonatal Surgical Mortality: A Multivariable Analysis of Predictors of Mortality in a Resource-Limited Setting'. *Journal of Indian Association of Pediatric Surgeons*, 24(1), 36–44. doi: 10.4103/jiaps.JIAPS_30 _18.
38. Bangladesh Demographic and Health Survey 2022, p33-48.
39. Saha, M., & Odjidja, E.N. (2017). 'Access to a Skilled Birth Attendant in Bangladesh: What We Know and what Health System Framework Can Teach Us'. *Health Systems and Policy Research*, 4(4),66. Available from: doi:10.21767/2254-9137.100085.
40. Dubowitz, G., Detlefs, S., & McQueen, K. A. (2010). 'Global anesthesia workforce crisis: a

preliminary survey revealing shortages contributing to undesirable outcomes and unsafe practices'. *World journal of surgery*, 34(3), 438–444. doi: 10.1007/s00268-009-0229-6.

41. Tiret, L., Nivoche, Y., Hatton, F., et al. (1988). 'Complications related to anaesthesia in infants and children. A prospective survey of 40240 anaesthetics'. *British journal of anaesthesia*, 61(3), 263–269. doi: 10.1093/bja/61.3.263.
42. Walker, I. A., & Wilson, I. H. (2008). 'Anaesthesia in developing countries-a risk for patients'. *Lancet (London, England)*, 371(9617), 968–969. doi: 10.1016/S0140-6736(08) 60432-8.
43. Lopez, J., & Stringel, G. (2016). 'Minimally Invasive Surgery in Neonatal Patients: A Review'. *NeoReviews*, 17(5), *e242–e250*. doi:10.1542/neo.17-5-e242.
44. Ullrich, S. J., Kakembo, N., Grabski, D. F., et al. (2020). 'Burden and Outcomes of Neonatal Surgery in Uganda: Results of a Five-Year Prospective Study'. *The Journal of Surgical Research*, 246, 93–99. doi:10.1016/j.jss.2019.08.015.
45. Escobar, M. A., Jr, & Caty, M. G. (2016). 'Complications in neonatal surgery'. *Seminars in pediatric surgery*, 25(6), 347–370. doi:10.1053/j.sempedsurg.2016.10.005.
46. Hagander, L., Kabir, M., Chowdhury, M. Z., et al. (2015). 'Major neonatal surgery under local anesthesia: a cohort study from Bangladesh'. *World journal of surgery*, 39(4), 953–960. doi:10.1007/s00268-014-2895-2.
47. Gupta, R., & Singh, S. (2009). 'Challenges in paediatric laparoscopic surgeries'. *Indian journal of anaesthesia*, 53(5), 560–566.