

## **The Role of Neonatal Nurses in the Prevention of Retinopathy of Prematurity**

**GEETANJLI KALYAN AND \*SARAH MOXON**

*From National Institute of Nursing Education, PGIMER, Chandigarh, India and \*Maternal Adolescent, Reproductive and Child Health (MARCH) Centre, London School of Hygiene and Tropical Medicine, Keppel Street, London, WC1E 7HT, UK.*

*Correspondence to: Geetanjli Kalyan, Paediatric Nursing, PhD Candidate, Clinical Instructor, National Institute of Nursing Education, PGIMER, Chandigarh, India. geets2@gmail.com*

The main risk factors for preterm babies developing retinopathy of prematurity (ROP) are poorly administered supplemental oxygen, infections, poor weight gain and transfusion of blood products, meaning ROP is sensitive to the quality of neonatal inpatient care provided, especially the nursing care. Nurses are the primary caregivers in neonatal units and play a critical role in preventing ROP related blindness. We discuss the role of the neonatal nurse in prevention of ROP based on a framework of five dimensions of care: specialist knowledge, clinical advocacy, leadership and mentorship, service management and counselling. Developing the role in the prevention of ROP needs to be supported by a wider movement to develop core training competencies and national benchmarks for neonatal nurses. As part of the national newborn action plans, countries such as India have an opportunity to play a leading role in developing the nursing role in minimising the rates of visual impairments and blindness due to ROP.

**Keywords:** *Clinical advocacy, Counselling, Leadership, Specialist knowledge, Service management.*

**T**he highest rates of retinopathy of prematurity (ROP) are in low- and middle-income countries (LMIC), where common workforce challenges such as lack of access to safety equipment, and insufficient numbers of staff trained in the care of the preterm infant, may limit the ability of health workers, especially nurses, to provide quality care [1,2]

Nurses, as the primary medical care-givers in neonatal intensive care units (NICU) and special care newborn units (SCNU), play a critical role in the prevention and management of ROP. A set of studies on health system bottlenecks to the scale up of quality inpatient care for small and sick newborns highlighted a number of nursing workforce challenges in LMIC, such as a lack of mentorship, supervision and leadership to improve the quality of care [1,3] Qualitative work in India described need to increase competency-based training and improve pre-service and in-service nurse training curricula to include specialist content on newborn and preterm care, including ROP prevention [4]. Even in higher income countries where facilities are usually better resourced, Hamilton, *et al.* [5] demonstrated a positive correlation between newborn outcomes and the number of qualified nurses working on a given shift. Despite the fact that many of the risk factors for ROP are mediated by nursing interventions, the specific role of nurses in preventing and managing ROP has not been systematically described.

Davy, *et al.* [6] described five dimensions of the

nursing-role based on a framework developed at the International Conference for Neonatal Nursing hosted in 2010, with participation of over 80 participants from 13 countries. We have adapted and built on this framework to describe the role of nurses in prevention and management of ROP (**Box I**).

### **NURSING ROLE IN PREVENTION AND MANAGEMENT OF ROP**

We discuss five dimensions of the nursing-role and how these relate to the prevention and management of ROP; specialist knowledge, clinical advocacy, service management, leadership and mentorship, and finally, counselling and support. With due attention to these five dimensions of nursing care the principle risk factors - poorly administered supplemental oxygen, infections, poor weight-gain, and transfusion of blood products – can potentially be mitigated. We explore each dimension in the subsequent sections. Rates of ROP are an important indicator of a facility's ability, including the nursing component, to provide high-quality care to premature and LBW babies.

#### ***Specialist Knowledge***

Once admitted to a special care unit, specialist knowledge on the management of respiratory distress syndrome (RDS) and apneic episodes is a mainstay of neonatal nursing care and requires understanding of the sensitivity of the premature newborn to their

**BOX 1 DIMENSIONS OF THE NURSING ROLE IN PREVENTION AND MANAGEMENT OF RETINOPATHY OF PREMATUREITY**

- **Specialist knowledge on the risk factors for retinopathy of prematurity (ROP)**

Nurses develop specialist knowledge on the risk factors for ROP for preterm and low birth weight (LBW) babies to promote best practices; the rational use of oxygen (safe oxygen levels, use of pulse oximetry and management of apnoeic episodes and respiratory distress syndrome) support for adequate weight gain and prevention of infection, as part of comprehensive quality neonatal care.

- **Clinical advocacy to protect preterm babies from visual impairment due to ROP**

Nurses act as the clinical advocate for the preterm and LBW baby, protecting them from unnecessary interventions, pain and contact to minimise the risk factors for ROP and ensure adherence to clinical guidelines as part of comprehensive quality neonatal care.

- **Mentorship and leadership for education and training on prevention of ROP**

Nurses act as leaders of the multidisciplinary team caring for preterm and LBW babies, mentoring junior staff on protecting eyes from ROP. Prevention of ROP is included in neonatal nursing education and training programmes.

- **Service management for the prevention of ROP**

Nurses ensure optimal day-to-day organisation of inpatient care services for preterm babies to minimise risk of ROP, including adequate infrastructure, management of staffing numbers and skill mix, availability of safe oxygen delivery and monitoring equipment, and accurate documentation of care. Nurses ensure that services for preterm and LBW babies includes timely eye screening and organisation of follow up services.

- **Support and counsel families on ROP throughout the continuum of care**

Nurses provide support and counselling to parents and carers on ROP and the specific needs of preterm and LBW babies, including the need for quality, family care during inpatient stay, and on ROP screening and adherence to follow-up care post discharge.

*Adapted from Davy, et al. [12]*

environment, the function of oxygen, and its safe delivery. As oxygen supplementation is one of the major risk factors for ROP, the nursing role requires balancing the preterm newborns' need for oxygen to survive, while minimizing the damage caused to the immature vascular structure of the eye. The risk of ROP increases if partial pressure of oxygen in arterial blood of preterm baby is more than 80 mm Hg [7]. To ensure partial pressure of oxygen between 50 to 80 mm Hg, saturation levels need to be monitored with pulse oximetry and maintained between an optimal threshold of 90-93% [8]. The target for saturation in preterm neonates is 88-94% [9]. When desaturations do occur, confident nursing practice is needed to allow the infant time for spontaneous recovery accompanied by slow titration of oxygen levels when needed [10]. The clinical algorithm presented in **Fig. 1** shows the nursing action sequence for provision of safe oxygen therapy at the cot-side. Specific responsibilities may vary between settings, but clearly designated roles and protocols for nurses and midwives, supported with the appropriate competency-based training, can help to emphasise the nursing role.

Whilst the majority of the nursing role in preventing ROP occurs during care on the neonatal unit, there are also important nursing considerations during labour and birth

that can mitigate the risk of visual impairment in premature babies.

*Care for mothers with threatened preterm labour:* The World Health Organisation (WHO) recommends antenatal corticosteroids be given to mothers where preterm (<34 weeks) birth is threatened, to support fetal lung maturation and thereby reducing need for respiratory support [11]. In some settings, this intervention is administered by trained nurses (or midwives), but specialist training and knowledge on identifying circumstances for their appropriate and safe use as per WHO criteria are needed, including appropriate assessment of gestational age and adequate obstetric and newborn care [11-13].

*Care in the labour room: The "Golden Hour":* Once in the delivery room, the first hour of life of a preterm newborn, referred to as the "Golden Hour" requires effective communication, the application of evidence-based protocols, algorithms [14-15] and checklists to manage the complex decisions and tasks necessary in the first hour of life to maximise survival and minimise the exacerbation of morbidities [16,17]. Nurses and midwives require specialist knowledge on surfactant administration [11], delayed cord clamping [18], the appropriate level of

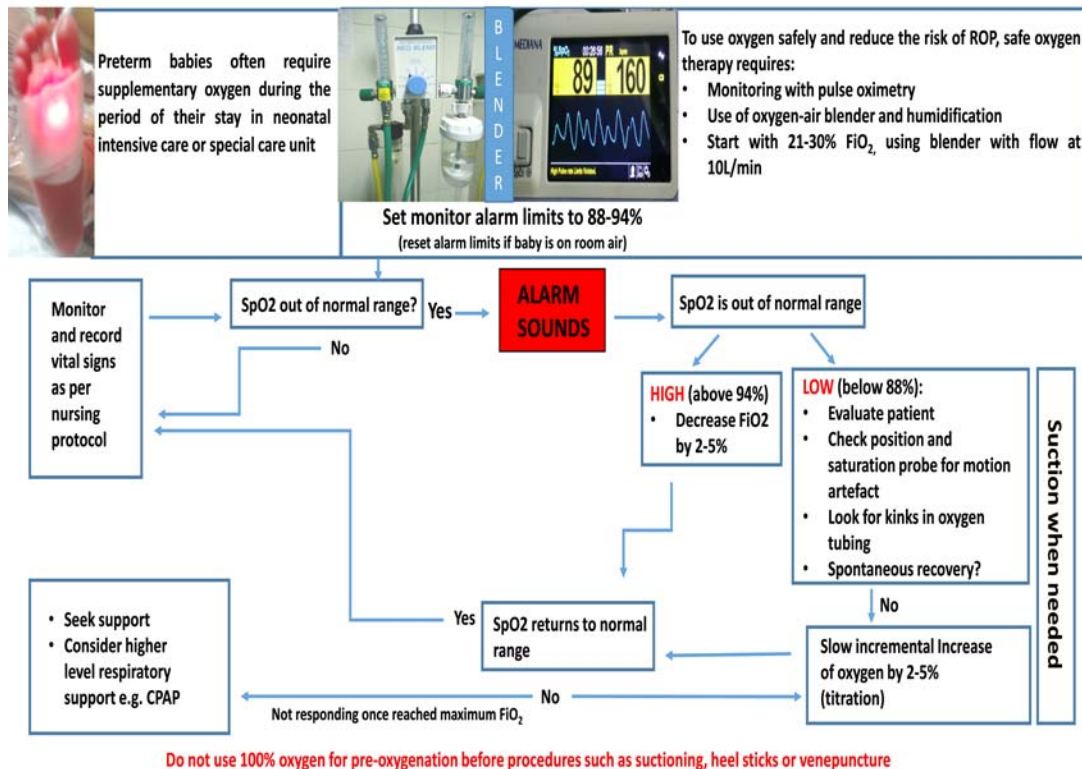


Fig. 1 Nursing action sequence for provision of safe oxygen therapy to preterm and LBW neonates at the cot side.

respiratory support for resuscitation when needed, judicious use of supplementary oxygen and use of continuous positive airway pressure (CPAP) instead of invasive mechanical ventilation wherever possible [8,11]. Strategies to stabilize the infant's temperature in the delivery room and during transport to the inpatient unit should also be considered [16].

### Clinical advocacy

Nurses, as the primary cot-side carers, act as the clinical advocates and their role is critical to protect these babies from unnecessary exposure to risk factors, including painful interventions that may increase need for oxygen supplementation. A qualitative study of neonatal nurse's in the NICU in Australia showed that nurses perceived their role as using their clinical knowledge and experience to advocate for the best interests of the infant and family [19]. This involves ensuring that preterm babies receive a comprehensive package of quality neonatal care that minimises the chance of poor outcomes.

Ensuring warmth (thermo-regulation), infection prevention measures and providing support allows adequate weight gain, and minimises the risk of infection. Poor weight gain and infections are major risks to newborn

survival, but are also independent risk factors for ROP [20-22]. Infection control procedures, such as hand-washing for all staff and visitors before contact with the newborn and practices such as keeping separate implements for each baby at the cot or incubator side (e.g. stethoscopes, thermometers, and swab containers) and regular cleaning of equipment helps to reduce rates of infection. Kangaroo mother care (KMC) involves direct and continuous skin to skin contact between the infant and mother. Alongside numerous other benefits, KMC helps to reduce many of the risk factors that are associated with ROP, specifically, improving weight gain and reducing the incidence of infection [23-25]. KMC is primarily a nurse-led intervention with medical support and forms a cornerstone of care for the preterm baby [1,6,26]; it can be delivered intermittently in intensive care units or as a mainstay of care for clinically stable LBW and/or premature newborns [21].

Extremely premature babies (<28 weeks) have increased risk of ROP and most will require intensive supportive nursing care with mechanical ventilation. These infants may not be stable enough for prolonged KMC with the mother or tolerate oral feeds, layering the risk factors for ROP. Advocating for the adjustment of environmental factors (minimal handling, noise and light)

and developmental care are core components of nursing role that will maximize the chances of healthier developmental outcomes in extremely preterm newborns, including vision, hearing and cognitive function [27,28]. Unnecessary painful interventions or failure to consider comfort and pain has clear ethical implications. Pain can lead to desaturations and unnecessary use of supplemental oxygen, increasing ROP risk. The use of charts and protocols for comfort and developmental positioning during procedures are critical considerations for nurses to minimise painful procedures and reduce unnecessary oxygenation. Evidence is emerging on the importance of involving parents, especially mothers, in optimizing comfort of the newborn, which has clear implications for the nursing role in both high and low income settings [29,30]. The specific role of pain and comfort management during ROP treatment has a substantial literature base [31] and neonatal units can develop context specific, evidence-based clinical guidelines.

### ***Leadership and Mentorship***

One of the greatest resources in neonatal units are experienced nurses. The demand of providing quality nursing care for premature newborns requires training and experience from within the nursing profession to mentor junior staff. Continuous learning and professional development cannot occur in a vacuum and leadership is required to create a multidisciplinary team and a workforce structure that provides supervision and mentorship. Recent qualitative work in India on educational barriers of nurses caring for sick newborns has shown that mentorship for nursing development needs to be incorporated into existing pre-service and in-service training programs [4], which could include components on safe oxygen use and ROP. Nurse leaders organize the sustainable systems [32] and obtain the necessary resources that can support the quality care needed to prevent ROP. In Latin America, educational workshops for nurses on the delivery and monitoring of oxygen have been shown to be effective in reducing the incidence of severe ROP [33]. The POINTS (Pain control, optimal oxygenation, infection control, nutrition interventions, temperature control, and supportive care) of care educational package focuses on six key areas of nursing practice and uses practical demonstrations as part of teaching workshops to help nurses identify areas of quality improvement on their unit [34]. A study in Brazil showed that a strong participatory approach was effective in improving nursing knowledge on oxygen saturations and increasing compliance on setting of alarm limits [35]. The pathway between knowledge and application of evidence-based actions is complex. Education programs need to be embedded in a supportive

system and often adapted and tailored to different levels of nurses, and made specific to different hospitals or neonatal units. Leadership from within the nursing profession to advocate for policies on educational opportunities and competency based training programs is needed to make sustainable change.

### ***Service Management***

Factors aside from knowledge clearly play a role in the provision of quality care [35] and when health systems are challenged by constraints such as staff shortages, lack of drugs and equipment and outdated policies and guidelines, the ability of health providers to provide high quality care is adversely affected [1,2]. Nurses play a key service management role, which involves coordinating the service to ensure environmental and structural conditions are in place. If rates of ROP are to be kept low, this service management role is a key, including consideration of the number of staff on each shift and appropriate skill-mix for the case load. Many settings do not have recommended staff to patient ratios (in the UK this is 1:1 care for NICU and 4:1 for special care baby units) [3,36, 37]. As part of the accreditation for neonatal nurses, this also need to be supported by policies that prevent nursing staff rotation to other wards and units [38]. Effective service management to prevent ROP involves ensuring the necessary supplies and processes in place, including safety checks on equipment (pulse oximetry, oxygen distribution systems and monitors with the correct alarm limits). Guidelines and protocols should be available on the ward (*eg.* algorithms on safe oxygen titration and alarm limits), and can be displayed as wall posters or kept in care plans for individual babies. As a minimum, running water and soap, disposable gloves, sterile linen and disinfectants should be present on all units caring for premature infants. Culturally appropriate, inclusive visitation policies (especially for mothers) that allow for KMC are important considerations for all nurse managers on neonatal units and need to be supported by the appropriate guidelines, pre-service and in-service training and updates. At a higher management level, nurse managers need to be involved in ROP policy and guideline review processes to ensure that they are appropriate and actionable at a ground level and can be disseminated to the appropriate levels of the health system. Checklists, registers and monitoring systems need to be part of management systems. Nursing care that babies receive should be carefully documented with limited numbers of core indicators that feed up to higher management levels, aligned with the national monitoring plan [39].

Maximizing the nursing role in prevention of ROP extends beyond day-to-day inpatient care and also

includes assisting in screening and treatment of ROP, if indicated. **Table I** illustrates the nursing role in eye screening and ablative therapy for ROP. The early identification (screening) of sight threatening ROP (*i.e.* stages requiring laser treatment, as defined by American Academy of Paediatrics) [40] followed by urgent treatment can improve the prognosis. Screening and treatment guidelines have been shown in high-income settings to contribute to minimising ROP related blindness and, given their role in managing ROP services, nurses should be involved in their development, dissemination and implementation [41].

There is potential for developing a cadre of specialist ROP nurses that can perform ROP screening in place of ophthalmologists, particularly in tertiary-level hospitals. Preliminary research has demonstrated that nurse-performance of ROP screening was as accurate as screening carried out by an expert pediatric ophthalmologist. In settings where this is feasible, particularly tertiary-level hospitals, this could be considered an area for developing a more specialist role and nursing leadership in the prevention of ROP, including use of technologies such as telemedicine [42-46].

### **Counselling**

Breastmilk has multiple benefits for preterm babies, including protection against ROP [47,48]. Nurses play a key role in supporting and counselling mothers on breastfeeding and breastmilk expression, including supporting KMC. Davy, *et al.* [6] described the importance of communication skills and treating families with respect, dignity and providing emotional support when needed, especially to mothers. Care of preterm infants extends beyond their stay on the unit and management of ROP requires support for families to adhere to screening and treatment programs, including attending follow-up visits.

Low cost nurse-led strategies of using 'Red and Green cards' given to mothers was found to be effective in enrolling unscreened infants into ROP screening in a study in Bangalore [49]. Mothers of infants weighing  $\geq 2000$  g were given red cards (signifying risk of ROP). Part of this card, with details on the infant's weight, date of birth and contact details were kept on, the unit to facilitate sending out reminders to the mothers to come for follow up and mothers were contacted when necessary. Once infants weight  $>2000$  grams, the mothers are given a green congratulations card that contains general pediatric eye education material. Such innovative strategies can be used by nursing teams to effectively manage ROP screening services and counsel and support families from inpatient care into ongoing follow-up care. A number of settings

have used mobile phone technology to strengthen adherence to follow up to manage complex neuro-developmental needs. Interventions to restore function and rehabilitation must be communicated effectively to parents. Nurses play an important counselling and supportive role to educate parents to keep in touch with the ophthalmologist and other support to prevent further complications and ensure seamless integration with the child health services.

### **FUTURE AGENDA**

Outside of high-income countries, there are very few formal training programs for neonatal nurses, despite the potential for this speciality cadre to improve neonatal survival and outcomes [32,38,50]. Given that direct complications of preterm birth are now the leading cause of child death, and a major contributor to child morbidity (including blindness), there is a global need to establish international standards for neonatal nursing [38], recognised by the global Every Newborn Action Plan [51]. Competency-based training should include the role of nurses in preventing and managing ROP. Some settings, including LMIC, may be able to explore the potential role of neonatal nurse practitioners in ROP prevention and management, using learning from experiences in settings where this is an established role [3, 52]. Accreditation for neonatal nurses is important to provide job satisfaction, but also to articulate the specialist role and responsibility in care of the preterm newborn. In order to retain these specialist nurses, appropriate remuneration is needed for experienced and specialist neonatal nurses [3,38] including job descriptions with competencies that allow potential for career development and understanding of the complex dimensions of their role [4]. Similar to policy investment for midwives and obstetric care, benchmarks need to be developed to monitor numbers of neonatal nurses. Service readiness metrics are being developed to aid monitoring quality of care for preterm newborns, which could include nursing levels and training [8,53,54].

### **CONCLUSION**

Nurses form the backbone of neonatal care and there is a need to develop and support this role so that nurses are empowered to act as clinical advocates, protecting preterm newborns from visual impairment. Nurses play a major role in counselling, guiding and mentoring junior staff and parents. As service managers, nurses play a key role in facilitation of specialist ROP screening and coordinating ophthalmology follow up as part of comprehensive child health services. Such a role needs to extend beyond preventing ROP and be supported by the appropriate management structures with leadership from

**TABLE I** NURSING ROLE IN EYE-SCREENING AND ABLATIVE THERAPY FOR RETINOPATHY OF PREMATUREITY

<i>Timing of care</i>	<i>Specific activities</i>
Prior to screening	Monitoring and documentation <ul style="list-style-type: none"> <li>• Ensure birthweight and gestational age at birth are recorded in patient notes</li> <li>• Accurate monitoring and documentation of weight gain during inpatient stay</li> <li>• Maintain accurate records and charts of inpatient care received, including oxygen therapy</li> <li>• Assist in selection of infants eligible for screening based on national criteria and clinical judgement</li> <li>• Counsel and prepare parents for eye procedures.</li> </ul>
Eye screening	Planning and preparation <ul style="list-style-type: none"> <li>• Calculate timing of first eye examination based on gestational age at birth</li> <li>• Dilate eyes 1 hour before just before examination using topical agent</li> <li>• To prevent aspiration keep infant nil by mouth one hour prior to the procedure</li> </ul> Support during eye screening procedure <ul style="list-style-type: none"> <li>• Infection control, ensure hand washing and availability of sterile articles</li> <li>• Remind physician to keep the examinations brief</li> <li>• Monitor and record vital signs during examination</li> <li>• Focus on comfort and minimising pain at all times</li> </ul>
Ablative therapy for ROP	Planning and preparation <ul style="list-style-type: none"> <li>• Prepare treatment schedule in consultation with physician</li> <li>• Ensure parental consent and understanding of procedure</li> <li>• Keep infant nil by mouth three hour prior to procedure</li> <li>• Start intravenous lines</li> <li>• Apply topical agent for dilation of eyes</li> <li>• Ensure emergency equipment is available</li> </ul> Support during ablative therapy <ul style="list-style-type: none"> <li>• Ensure correct positioning</li> <li>• Monitor and record vital signs, including SpO2 levels</li> <li>• Maintain temperature of baby during the procedure</li> <li>• Focus on comfort and minimising pain at all times</li> </ul>
Follow-up care	<ul style="list-style-type: none"> <li>• Accurate documenting of treatment received and outstanding appointments</li> <li>• Counsel parents on need for ablative therapy follow up (usually 5-7 days) and maintain contact for reminders if necessary</li> <li>• Ensure seamless transition to paediatric outpatient eye services.</li> </ul>

within the nursing profession. To empower neonatal nurses, this needs to be accompanied by opportunities for training and progression on a career pathway within the multi-disciplinary team, advanced nursing specialism and the potential for involvement in research and policy.

#### REFERENCES

1. Dickson KE, Kinney MV, Moxon SG, Ashton J, Zaka N, Simen-Kapeu A, *et al.* Scaling up quality care for mothers and newborns around the time of birth: an overview of methods and analyses of intervention-specific bottlenecks and solutions. *BMC Pregnancy Childbirth.* 2015;15:2.
2. Dickson KE, Simen-Kapeu A, Kinney MV, Huicho L, Vesel L, Lackritz E, *et al.* Every Newborn: health-systems bottlenecks and strategies to accelerate scale-up in countries. *Lancet.* 2014;384:438-54.
3. Moxon SG, Lawn JE, Dickson KE, Simen-Kapeu A, Gupta G, Deorari A, *et al.* Inpatient care of small and sick newborns: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth.* 2015;15:S7.
4. Campbell-Yeo M, Deorari A, McMillan DD, Singhal N, Vatsa M, Aylward D, *et al.* Educational barriers of nurses caring for sick and at-risk infants in India. *Int Nurs Rev.* 2014;61:398-405.
5. Hamilton KES, Redshaw ME, Tarnow Mordt W. Nurse staffing in relation to risk adjusted mortality in neonatal care. *Arch Dis Child Fetal Neonatal Ed.* 2007;92:99-103.
6. Davy KB, Bergh A-M, Van Rooyen E. The neonatal

- nurse's role in kangaroo mother care. *Prof Nurs Today*. 2011;15:32-7.
7. Good WV, Hardy RJ, Dobson V, Palmer EA, Phelps DL, Quintos M, *et al*. The incidence and course of retinopathy of prematurity: findings from the early treatment for retinopathy of prematurity study. *Pediatrics*. 2005;116:15-23.
  8. Blencowe H, Lawn JE, Vazquez T, Fielder A, Gilbert C. Preterm-associated visual impairment and estimates of retinopathy of prematurity at regional and global levels for 2010. *Pediatr Res*. 2013;74:35.
  9. Sola A, Golombek SG, Montes Bueno MT, Lemus-Varela L, Zuluaga C, Domínguez F, *et al*. Safe oxygen saturation targeting and monitoring in preterm infants: Can we avoid hypoxia and hyperoxia? *Acta Paediatr*. 2014;103:1009-18.
  10. Ellsbury DL, Ursprung R. Comprehensive Oxygen Management for the Prevention of Retinopathy of Prematurity: the pediatric experience. *Clin Perinatol*. 2010;37:203-15.
  11. WHO. WHO Recommendations on Interventions to Improve Preterm Birth Outcomes. 2015; Available from: <http://www.ncbi.nlm.nih.gov/books/NBK321160/>. Accessed February 29, 2016.
  12. Liu G, Segrè J, Gülmezoglu AM, Mathai M, Smith JM, Hermida J, *et al*. Antenatal corticosteroids for management of preterm birth: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth*. 2015;15:S3.
  13. Brownfoot FC, Gagliardi DI, Bain E, Middleton P, Crowther CA. Different corticosteroids and regimens for accelerating fetal lung maturation for women at risk of preterm birth. *Cochrane Database Syst Rev*. 2013; 8:CD006764.
  14. Kattwinkel J, Perlman JM, Aziz K, Colby C, Fairchild K, Gallagher J, *et al*. Neonatal resuscitation: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Pediatrics*. 2010;126:e1400-13.
  15. Wyckoff MH, Aziz K, Escobedo MB, Kapadia VS, Kattwinkel J, Perlman JM, *et al*. Part 13: Neonatal Resuscitation 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2015;132:S543-60.
  16. Wyckoff MH. Initial resuscitation and stabilization of the periviable neonate: the Golden-Hour approach. *Semin Perinatol*. 2014;38:12-6.
  17. Castrodale V, Rinehart S. The golden hour: improving the stabilization of the very low birth-weight infant. *Adv Neonatal Care*. 2014;14:9-14-16.
  18. Raju TNK. Timing of umbilical cord clamping after birth for optimizing placental transfusion. *Curr Opin Pediatr*. 2013;25:180-7.
  19. Monterosso L, Kristjanson L, Sly PD, Mulcahy M, Holland BG, Grimwood S, *et al*. The role of the neonatal intensive care nurse in decision-making: advocacy, involvement in ethical decisions and communication. *Int J Nurs Pract*. 2005;11:108-17.
  20. Kim J, Jin JY, Kim SS. Postnatal weight gain in the first two weeks as a predicting factor of severe retinopathy of prematurity requiring treatment. *Korean J Pediatr*. 2015;58:52-9.
  21. Kaempf JW, Kaempf AJ, Wu Y, Stawarz M, Niemeyer J, Grunkemeier G. Hyperglycemia, insulin and slower growth velocity may increase the risk of retinopathy of prematurity. *J Perinatol*. 2011;31:251-7.
  22. Garg R, Agthe AG, Donohue PK, Lehmann CU. Hyperglycemia and retinopathy of prematurity in very low birth weight infants. *J Perinatol*. 2003;23:186-94.
  23. Lawn JE, Mwansa-Kambafwile J, Horta BL, Barros FC, Cousens S. "Kangaroo mother care" to prevent neonatal deaths due to preterm birth complications. *Int J Epidemiol*. 2010;39:144-54.
  24. Charpak N, Ruiz-Pelaez JG, Figueroa de CZ, Charpak Y. A randomized, controlled trial of kangaroo mother care: results of follow-up at 1 year of corrected age. *Pediatrics*. 2001;108:1072-9.
  25. Conde-Agudelo A, Belizán JM, Diaz-Rossello J. Kangaroo mother care to reduce morbidity and mortality in low birthweight infants. *Cochrane Database Syst Rev*. 2011; 3:CD002771.
  26. Vesel L, Bergh AM, Kerber KJ, Valsangkar B, Mazia G, Moxon SG, *et al*. Kangaroo mother care: a multi-country analysis of health system bottlenecks and potential solutions. *BMC Pregnancy Childbirth*. 2015;15:S5.
  27. Blencowe H, Lee ACC, Cousens S, Bahalim A, Narwal R, Zhong N, *et al*. Preterm birth-associated neurodevelopmental impairment estimates at regional and global levels for 2010. *Pediatr Res*. 2013;74:17-34.
  28. Kleberg A, Warren I, Norman E, Mörelus E, Berg AC, Mat-Ali E, *et al*. Lower stress responses after newborn individualized developmental care and assessment program care during eye screening examinations for retinopathy of prematurity: A randomized study. *Pediatrics*. 2008; 121:e1267-78.
  29. Pediatrics AA of, Surgery C on F and N and S on, Medicine S on A and P, Society CP, Committee F and N. Prevention and management of pain in the neonate: An Update. *Pediatrics*. 2006;118:2231-41.
  30. Committee on Fetus and Newborn and Section on Anesthesiology and Pain Medicine. Prevention and Management of Procedural Pain in the Neonate: An Update. *Pediatrics*. 2016;137:1-13.
  31. Sun X, Lemyre B, Barrowman N, O'Connor M. Pain management during eye examinations for retinopathy of prematurity in preterm infants: a systematic review. *Acta Paediatr*. 2010;99:329-34.
  32. Lawn JE, Kinney MV, Belizan JM, Mason EM, McDougall L, Larson J, *et al*. Born too soon: Accelerating actions for prevention and care of 15 million newborns born too soon. *Reprod Health*. 2013;10:S6.
  33. Gordillo L, Villanueva AM, Quinn GE. A practical method for reducing blindness due to retinopathy of prematurity in a developing country. *J Perinat Med*. 2012;40:577-82.
  34. Darlow BA, Zin AA, Beecroft G, Moreira ME, Gilbert CE. Capacity building of nurses providing neonatal care in Rio de Janeiro, Brazil: methods for the POINTS of care project to enhance nursing education and reduce adverse neonatal

- outcomes. *BMC Nurs.* 2012;11:3.
35. Gilbert C, Darlow B, Zin A, Sivasubramaniam S, Shah S, Gianini N, *et al.* Educating neonatal nurses in Brazil: a before-and-after study with interrupted time series analysis. *Neonatology.* 2014;106:201-8.
  36. David Brunetti. Bliss baby-report 2015: Hanging in the balance. [Internet]. Available from: <http://www.cardiomyopathy.org/downloads/baby-reportfinallow.pdf>. Accessed August 04, 2016.
  37. Fenton AC, Turrill S, Davey C. Nurse staffing to patient ratios and mortality in neonatal intensive care. *Arch Dis Child - Fetal Neonatal Ed.* 2016;92:99-103.
  38. Premji SS, Spence K, Kenner C. Call for neonatal nursing specialization in developing countries. *MCN Am J Matern Child Nurs.* 2013;38:336-44.
  39. India Newborn Action Plan - Government of India [Internet]. [cited 2016 Apr 8]. Available from: <http://nrhm.gov.in/india-newborn-action-plan.html>. Accessed February 29, 2016.
  40. Fierson WM, Saunders RA, Good W, Palmer EA, Phelps D, Reynolds J, *et al.* Screening Examination of Premature Infants for Retinopathy of Prematurity. *Pediatrics.* 2013; 131:189-95.
  41. Wilson CM, Ells AL, Fielder AR. The challenge of screening for retinopathy of prematurity. *Clin Perinatol.* 2013;40:241-59.
  42. Azad RV, Manjunatha NP, Pal N, Deorari AK. Retinopathy of prematurity screening by non-retinologists. *Indian J Pediatr.* 2006;73:515-8.
  43. Shah SP, Wu Z, Iverson S, Dai S. Specialist nurse screening for retinopathy of prematurity-a pilot study. *Asia-Pac J Ophthalmol.* 2013;2:300-4.
  44. Saunders RA, Donahue ML, Berland JE, Roberts EL, Powers BV, Rust PF. Non-ophthalmologist screening for retinopathy of prematurity. *Br J Ophthalmol.* 2000;84:130-4.
  45. Silva RA, Murakami Y, Jain A, Gandhi J, Lad EM, Moshfeghi DM. Stanford University Network for Diagnosis of Retinopathy of Prematurity (SUNDRP): 18-month experience with telemedicine screening. *Arch Clin Exp Ophthalmol.* 2008;247:129-36.
  46. Skalet AH, Quinn GE, Ying G-S, Gordillo L, Dodobara L, Cocker K, *et al.* Telemedicine screening for retinopathy of prematurity in developing countries using digital retinal images: A feasibility project. *J Am Assoc Pediatr Ophthalmol Strabismus.* 2008;12:252-8.
  47. WHO | Guidelines on optimal feeding of low birth-weight infants in low- and middle-income countries [Internet]. WHO. Available from: [http://www.who.int/maternal\\_child\\_adolescent/documents/infant\\_feeding\\_low\\_bw/en/](http://www.who.int/maternal_child_adolescent/documents/infant_feeding_low_bw/en/). Accessed March 01, 2016.
  48. WHO. Essential interventions; commodities and Guidelines for Reproductive, Maternal, Newborn, and Child Health. A Global Review of Key Interventions related to RMNCH. [Internet]. Available from: [http://who.int/pmnch/topics/part\\_publications/essential\\_interventions\\_18\\_01\\_2012.pdf](http://who.int/pmnch/topics/part_publications/essential_interventions_18_01_2012.pdf). Accessed March 06, 2016.
  49. Vinekar A, Avadhani K, Dogra M, Sharma P, Gilbert C, Braganza S, *et al.* A novel, low-cost method of enrolling infants at risk for retinopathy of prematurity in centers with no screening program: the REDROP study. *Ophthalmic Epidemiol.* 2012;19:317-21.
  50. Lee ACC, Cousens S, Wall SN, Niermeyer S, Darmstadt GL, Carlo WA, *et al.* Neonatal resuscitation and immediate newborn assessment and stimulation for the prevention of neonatal deaths: A systematic review, meta-analysis and Delphi estimation of mortality effect. *BMC Public Health.* 2011;113:S12.
  51. WHO, UNICEF. Every Newborn: An Action Plan to End Preventable Deaths. The action plan [Internet]. [cited 2016 Apr 8]. Available from: <https://www.everynewborn.org/every-newborn-action-plan/>. Accessed March 08, 2016.
  52. Hall D, Wilkinson AR. Quality of care by neonatal nurse practitioners: a review of the Ashington experiment. *Arch Dis Child - Fetal Neonatal Ed.* 2005;90:F195-200.
  53. Moxon SG, Ruysen H, Kerber KJ, Amouzou A, Fournier S, Grove J, *et al.* Count every newborn; a measurement improvement roadmap for coverage data. *BMC Pregnancy Childbirth.* 2015;15:S8.
  54. NNF Clinical Practice Guideline. Retinopathy of Prematurity. [Internet]. [cited 2016 Mar 2]. Available from: <http://v2020resource.org/content/files/NNF.html>. Accessed March 02, 2016.
  55. Chawla D, Agarwal R, Deorari A, Paul VK, Chandra P, Azad RV. Retinopathy of prematurity. *Indian J Pediatr.* 2010;79:501-9.
  56. Kalyan G, Vatsa M. Neonatal nursing: an unmet challenge in India. *Indian J Pediatr.* 2014;81:1205-11.
-