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Comprehensive prevention strategies for retinopathy of prematurity: a literature review

Review

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Abstract: Retinopathy of prematurity (ROP) is a kind of disease that can be seen in premature infants. It may cause a series of short- and long-term complications such as poor vision in premature infants, causing irreversible damage to them. Therefore, if we can prevent this disease, we can solve the above problems. This study summarized some factors that influence ROP, such as low gestational age, low birth weight, irrational oxygen use, anemia, blood transfusion, and thrombocytopenia; and also summarized a series of interventions that can prevent or delay the progression of ROP, such as reducing blood transfusion, the application of antenatal corticosteroids, and delaying clip umbilical cord, which can provide some reference for better clinical practice of preventing ROP.

Keywords: *preterm infants • retinopathy of prematurity • review • prevention • prevention strategies*

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1. Introduction

Retinopathy of prematurity (ROP) is a retinal angioproliferative disease, which can cause poor vision in premature infants.[1] For ROP, early prevention, screening, or delay of disease progression is crucial. In relevant researches, risk factors that are strongly associated with the occurrence and progression of ROP include gestational age (GA), birth weight (BW), and irrational use of oxygen.[2,3] Researchers attach more importance to the management of oxygen, since a lower SpO_2 target helps reduce the risk of ROP.[4] Although they are inclined to reduce oxygen management goals, reducing them blindly can increase the risk of death, suggesting we should seek a more rational intervention plan. This study reviewed some related factors of ROP and proposed the corresponding intervention plan, to provide some reference for clinical practice and research.

2. Data sources and searches

We searched several databases including PubMed, EMbase, Web of Science, CENTRAL, China National Knowledge Infrastructure (CNKI), VIP, and Wan Fang

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by using combinations of MeSH and entry terms "Retinopathy of Prematurity," "Prematurity Retinopathies," "Prematurity Retinopathy," "Retrolental Fibroplasia," "Fibroplasia, Retrolental," "Fibroplasias, Retrolental," "Retrolental Fibroplasias," "Infant, Premature," "Infants, Premature," "Premature Infant," "Preterm Infants," "Infant, Preterm," "Infants, Preterm," "Preterm Infant," "Premature Infants," "Neonatal Prematurity," "Prematurity, Neonatal" from inception to 1 February 2022. The references of eligible studies were manually searched for any other possible literature. The reports with poor research design, poor literature quality, and obvious design errors were eliminated.

3. Summary of ROP

3.1. Pathogenesis

The fetal retina is in a state of physiological hypoxia in utero, which can promote the increased level of vascular endothelial growth factor (VEGF), and then promote the formation of retinal blood vessels.[5–7] Normal retinal vascular development occurs through 2 stages: first, from 14 weeks of embryonic development to 21 weeks of angiogenesis and then from 22 weeks to complete retinal vascularization after term.[8] However, preterm babies are exposed to relatively hyperoxygen levels after birth, which inhibits the production of growth factors such as VEGF and erythropoietin (EPO). Lack of growth factors can delay the growth of retinal blood vessels and cause hypoxia of retinal blood vessels, which can induce a large number of hyperplasia of VEGF and EPO. Retinal neovascularization is out of control, resulting in ROP.[9] If left untreated, it can lead to retinal detachment and blindness.[10]

3.2. Common complications of ROP

Common complications of ROP include macular folds and myopia, which can lead to persistent vision loss in childhood.[5,11] In addition, there are long-term complications, such as glaucoma, amblyopia, cataract, strabismus, and retinal detachment,[11] among which retinal detachment is the most common complication of ROP.[12,13] Therefore, we should pay more attention to prevent ROP.

4. Risk factors associated with the onset of ROP

4.1. GA and BW

A multicenter study of 4000 newborns with BW of ≤1251 g found that the risk of ROP decreased by 27% for a 100 g increase in BW and 19% for a 1 week increase in GA.[2] It suggests that we should take good care of high-risk pregnant women during pregnancy, prolong the GA as far as possible, and promote the growth and development of the fetus.

4.2. Oxygen

Excessive oxygen concentration will increase the risk of ROP.[3] Studies have shown that when percutaneous PO_2 of ≥80 mmHg, the risk of ROP doubles every 12 h.[7] The long duration of oxygen therapy is also an important risk factor for severe ROP,[14] so reasonable oxygen management is very important.

4.3. Anemia

The study[15] showed that anemia in the first week after birth is an important risk factor for severe ROP in newborns born at <28 weeks of GA, which suggested that we need to pay attention to the early management of anemia in preterm infants, which may reduce the risk of ROP development.

4.4. Early transfusion of red blood cells

The study[16] showed that for newborns with GA of ≤32 weeks or BW of ≤1500 g, early transfusion of packed red blood cells (pRBCs) within 10 d after birth will increase the risk of severe ROP by about 4 times. This suggests that early erythrocyte transfusion should be minimized to reduce the risk of severe ROP. Studies[17–20] have shown that we may overestimate the severity of hypovolemia in critical neonates, and that pRBC transfusion has no significant advantage over other perfusion strategies. In addition, we can use phlebotomy to limit blood loss and hypovolemia, as well as crystalloid solution expansion and early use of dopamine to control hypotension, thus reducing neonatal transfusion.[16]

4.5. Low platelet count

Platelets also play an important role in retinal angiogenesis. Platelets contain important stimulators and inhibitors of angiogenesis, for example, VEGF, insulin-like growth factor-1, and platelet-derived growth factor.[21] Low platelet count may lead to delayed normal retinal vascularization.[22] The study[23] has shown that low platelet count in the first week after birth is a risk factor for the development of ROP. In addition, thrombocytopenia is also significantly correlated with acute ROP, such as aggressive posterior retinopathy of prematurity (AP-ROP). In a patient with AP-ROP accompanied by severe thrombocytopenia, after platelet transfusion therapy,

symptoms spontaneously subsided 3 d later without laser treatment,[24] indicating that early thrombocytopenia treatment can prevent or relieve ROP, suggesting that we should focus on a more comprehensive clinical approach.

5. Prevention and nursing measures

The study[25] has shown that in high-income countries, severe ROP is commonly seen in premature infants with GA of <32 weeks or BW of <1500 g at birth, with GA of <30 weeks or BW of <1250 g being the most common. However, in middle-income countries, severe ROP usually occurs in premature infants with GA of ≥32 weeks or BW of ≥1500 g, which suggested that severe ROP occurs in more mature infants in low/moderate developmental countries compared with highly developed countries, and this difference is usually caused by the gap in financial expenditure for medical system support. Many factors will affect the development and outcome of preterm infants with ROP. Therefore, in the management of ROP, we should pay attention to various factors and implement more comprehensive prevention and intervention programs (Table 1).

5.1. Application of prenatal corticosteroids

The study[26] showed that antenatal corticosteroids are economical and can reduce the morbidity and mortality of premature infants. Prenatal application of corticosteroids can reduce the incidence of ROP in preterm infants at <35 weeks of pregnancy.[27] WHO recommends the prenatal use of corticosteroids for pregnancies <35 weeks (usually 24–34 weeks) if preterm delivery is imminent (usually within 7 d, even within 24 h before delivery) without maternal infection and adequate obstetric care for mother and her baby is available.[28]

5.2. Delayed umbilical cord clamping

A meta-analysis[29] showed that for newborns with GA of <37 weeks, delayed umbilical cord clamping 30–60 s or longer after birth can reduce in-hospital mortality, which can increase the peak hematocrit of premature infants by increasing placental transfusion, thus reducing the proportion of blood transfusion. Although not directly associated with the prevention of ROP, delayed clamping of the umbilical cord is beneficial for the prevention of anemia and reduction of early blood transfusion, which may indirectly have a positive impact on the prevention of ROP. It is also safe for the mother and her baby. Evidence showed that delayed clamping of the umbilical cord has no negative effect on postpartum bleeding. In addition, delayed cord clamping was well tolerated and had no negative effect on Apgar scores in preterm neonates.[30]

5.3. Neonatal temperature management

The study[31] showed that among premature infants with GA of <33 weeks, the comprehensive morbidity, including severe ROP, was lowest when the body temperature

Intervention measures	The specific content of measures
Reduce early transfusion	Early transfusion should be minimized, and perfusion strategies such as dopamine and crystalloid solution expansion should be adopted at an early stage
Platelet transfusion therapy	For premature infants with low platelet counts, platelet transfusion therapy can be considered
Antenatal corticosteroids use	Prenatal corticosteroids may be used at <35 weeks of pregnancy when adequate obstetric care is available
Delayed clamping of the cord	Delayed clamping of the umbilical cord for 30–60 s or even longer after birth indirectly reduces the incidence of retinopathy of prematurity and is also safe for both mother and her baby
Temperature management	Control the body temperature between 36.5°C and 37.2°C, wrap the newborn with plastic wrap, skin-to-skin care, use the heated mattress, appropriately raise the temperature of the delivery room, dry immediately after birth, and put on a hat to warm the baby's head
Infection management	Strict hand hygiene (hand disinfection before and after contact with newborns), reasonable and standard use of antibiotics and appointed nurses can be responsible for infection management
Breastfeeding	Continue breastfeeding as long as possible, it is beneficial for babies' growth and can decrease the risk of retinopathy of prematurity for preterm infants
Oxygen management	According to different gestational ages, the SpO_2 target can be adjusted appropriately within the rational range, and the stability of SpO_2 should be maintained
Pain management	To reduce unnecessary pain, and use some intervention methods such as swaddling, oral sucrose or glucose, non-nutritive sucking, kangaroo mother care, sensorial saturation, and music therapy for pain relief
Supportive care	Maintain the newborn stable and comfortable, such as kangaroo mother care, maintain the comfortable posture for preterm infants, to give the baby sense of safety

Note: ROP, retinopathy of prematurity.

Table 1. The summary table of comprehensive interventions to prevent ROP.

was between 36.5°C and 37.2°C after initial admission into the NICU. There are 2 methods for maintaining the body temperature. One method is to establish a barrier to prevent heat loss, such as plastic wraps used in newborns (such as closed polyethylene transparent wraps[32]) and this method can improve the core temperature of newborns initially in the NICU or 2 h after birth. Another method is providing external heat sources, such as skin-to-skin care (SSC) or "kangaroo mother care" (KMC), and the application of a transwarmer mattress. For preterm newborns with 1200 g ≤ BW ≤ 2199 g, SSC can significantly reduce the risk of hypothermia, and the application of a thermal mattress can also significantly maintain the body temperature of newborns with BW of ≤1500 g.[33] These measures can reduce the risk of hypothermia in newborns, while the risk of hyperthermia should be considered, especially when multiple heat preservation measures are used together. Other thermal insulation measures also include increasing the temperature of the delivery room. One RCT[34] in China showed that when the environmental temperature was 24–26°C, the average admission temperature of neonatal NICU increased by 0.5°C and the hypothermia rate decreased by 31.9% compared with the environmental temperature of 20–23°C. Researchers suggest that all delivery rooms should be equipped with independent temperature control equipment to adjust the temperature of the delivery room at any time.[35] In addition, newborns should be dried immediately after birth (special attention should be paid to keeping the head warm), wear a hat on the head, remove the wet blanket on the body, and wrap it with a preheated blanket to reduce heat dissipation and temporarily eliminate air circulation.[36]

5.4. Infection management

Studies[22,37,38] have shown that sepsis is directly related to the increased risk of ROP and can increase neonatal mortality, while proper hand hygiene (such as washing hands before and after touching infants) and reasonable management of antibiotic use are still important measures for hospital infection prevention.[39] If possible, a nurse should be appointed to take charge of infection management.

5.5. Advocating breastfeeding

The study[40] showed that postnatal growth faltering is associated with an increased risk of ROP. Therefore, evidence supports early and sustained breastfeeding, and breast milk of preterm infants' mothers is characterized by high protein content. A meta-analysis[41] showed that breastfeeding was a protective factor for ROP. Breastfeeding has a limited direct effect on reducing the risk of ROP. However, it facilitates nutrient absorption and promotes growth and development of preterm infants, which reduces the risk of ROP. However, in addition to breastfeeding, some additional nutrients, such as amino acids, lipids, and minerals, are also needed.[40] Therefore, in clinical work, nursing staff should emphasize to mothers of preterm newborns to continue breastfeeding as long as possible; it is beneficial for babies' growth and can decrease the risk of ROP.

5.6. Oxygen management

Oxygen monitoring targets include PaO_2 and SpO_2. The ideal goal is to maintain PaO_2 between 50 mmHg and 80 mmHg. In clinical settings, SpO_2 is more commonly used to monitor oxygen supply in premature infants in real time due to its convenience, non-invasive, and continuous advantages. In recent years, there have also been studies on standardized oxygen use in China, including indications of oxygen supply, methods of oxygen supply, and matters needing attention.[42] As mentioned above, high oxygen concentration and long duration of oxygen therapy are the risk factors for the occurrence of ROP. Therefore, in clinical practice, low SpO_2 targets are preferred to reduce ROP. However, on the other hand, research data showed that too low an oxygen supply will increase the risk of death in premature infants, and the SpO_2 target is recommended to be controlled between 90% and 94%,[43] which indicates that too much or too little oxygen may pose a threat to premature infants. Therefore, we need to find the most appropriate SpO_2 target. Target recommendations for oxygen saturation have been updated in recent years. 2012 Guidelines for oxygen therapy of the American Academy of Pediatrics indicate that SpO_2 should be maintained between 85% and 95% in preterm infants.[44] However, WHO recommends that for premature infants born <32 weeks of gestation, the target of SpO_2 should be set at 88%–95%,[45] which may be based on the increased risk of hypoxic death in newborns of younger GA. In addition, European guidelines were revised in 2016, suggesting that SpO_2 targets should be set at 90%–94%.[46] In addition, some researchers suggested setting the upper limit of alarm value at 95% and the lower limit at 88%.[47] Therefore, for SpO_2 management, we can set the target within the scope of reasonable values, such as for smaller GA at birth (such as <32 weeks), the goal of lower limit can be set higher, and for bigger GA babies, the goal of lower limit can be set lower, in pursuit of balance

between reducing mortality and incidence of ROP. In practical clinical application, reasonable management of SpO_2 should be explored and clinical practice norms should be formed to promote better management of oxygen therapy for premature infants and reduce the occurrence of ROP. In 2015, guidelines issued by the International Liaison Committee on Resuscitation recommended the early use of 21%–30% oxygen concentration for premature infants <35 weeks of gestation.[48] In addition, studies have shown that when SpO_2 fluctuates greatly, the risk of ROP increases,[49] which suggests that we should try to maintain the stability of blood oxygen saturation in premature infants.

5.7. Pain management

Necessary painful measures. If pain is expected, swaddling or oral sucrose or glucose can be used for pain relief.[47] Other analgesic interventions are available, such as non-nutritional sucking (NNS), KMC, sensorial saturation (SS), music therapy, and other interventions.[50] Effective pain control helps to stabilize SpO_2 and thus reduces the risk of ROP.

5.8. Supportive care

Supportive care refers to the care methods designed to ensure the newborn is comfortable and stable, including KMC, which ensures the newborn's posture and limbs are well supported,[47] and clinical workers should instruct the parents of the newborn to assist in care, which maintains the newborn's health.

For all the measures listed above to decrease the risk of ROP or to prevent and manage ROP, health care personnel must provide complete care for the newborn.

6. Conclusions

ROP is a serious disease affecting the quality of life of premature infants. ROP can bring a variety of short-term and long-term complications, such as persistent vision loss in childhood and retinal detachment. Therefore, early screening and active prevention are more important than treatment. A series of intervention measures were evaluated in this study; those mentioned above have been shown to reduce the occurrence of ROP, slow disease progression, or reduce the severity of ROP.. However, the good implementation of all these requires the close cooperation of medical staff and even the parents of newborns, who strive to ensure that all high-risk premature infants and confirmed cases get good prevention or treatment. The influencing factors involved in this study may not be detailed, and it is hoped that more high-quality clinical studies will be carried out in the future. In conclusion, this study provides some enlightenment for the scientific and comprehensive management of clinical premature infants to improve the management of ROP and can explore its application effect in future practical studies.

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Ethical approval

Ethical issues are not involved in this paper.

Conflicts of interest

All contributing authors declare no conflicts of interest.

References

1. Good WV, Hardy RJ, Dobson V, 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.
2. Schaffer DB, Palmer EA, Plotsky DF, et al. Prognostic factors in the natural course of retinopathy of prematurity. The Cryotherapy for Retinopathy of Prematurity Cooperative Group. *Ophthalmology*. 1993;100:230–237.
3. Pastro J, Toso BRGO. Influence of oxygen in the development of retinopathy of prematurity. *Rev Bras Enferm*. 2019;72:592–599.
4. Tin W, Milligan DW, Pennefather P, Hey E. Pulse oximetry, severe retinopathy, and outcome at one year in babies of less than 28 weeks gestation. *Arch Dis Child Fetal Neonatal Ed*. 2001;84:F106–F110.
5. Broxterman EC, Hug DA. Retinopathy of prematurity: a review of current screening guidelines and treatment options. *Mo Med*. 2016;113:187–190.
6. Dogra MR, Katoch D, Dogra M. An update on retinopathy of prematurity (ROP). *Indian J Pediatr*. 2017;84:930–936.
7. Flynn JT, Bancalari E, Snyder ES, et al. A cohort study of transcutaneous oxygen tension and the incidence and severity of retinopathy of prematurity. *N Engl J Med*. 1992;326:1050–1054.
8. Flynn JT, Chan-Ling T. Retinopathy of prematurity: two distinct mechanisms that underlie zone 1 and zone 2 disease. *Am J Ophthalmol*. 2006;142:46–59.

9. Aiello LP, Pierce EA, Foley ED, et al. Suppression of retinal neovascularization in vivo by inhibition of vascular endothelial growth factor (VEGF) using soluble VEGF-receptor chimeric proteins. *Proc Natl Acad Sci USA*. 1995;92:10457–10461.
10. Giannantonio C, Papacci P, Cota F, et al. Analysis of risk factors for progression to treatment-requiring ROP in a single neonatal intensive care unit: is the exposure time relevant? *J Matern Fetal Neonatal Med*. 2012;25:471–477.
11. Essex RW, Carden SM, Elder JE. Two-year results of laser treatment for retinopathy of prematurity at a single neonatal intensive care unit. *Clin Exp Ophthalmol*. 2005;33:390–394.
12. Hardy RJ, Good WV, Dobson V, et al. Multicenter trial of early treatment for retinopathy of prematurity: study design. *Control Clin Trials*. 2004;25:311–325.
13. 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(suppl 1):35–49.
14. Zhu Z, Hua X, Yu Y, Zhu P, Hong K, Ke Y. Effect of red blood cell transfusion on the development of retinopathy of prematurity: a systematic review and meta-analysis. *PLoS One*. 2020;15:e0234266.
15. Lundgren P, Hellgren G, Pivodic A, Sävman K, Smith LEH, Hellström A. Erythropoietin serum levels, versus anaemia as risk factors for severe retinopathy of prematurity. *Pediatr Res*. 2019;86:276–282.
16. Lust C, Vesoulis Z, Jackups R Jr, Liao S, Rao R, Mathur AM. Early red cell transfusion is associated with development of severe retinopathy of prematurity. *J Perinatol*. 2019;39:393–400.
17. Jeschke MG, Chinkes DL, Finnerty CC, Przkora R, Pereira CT, Herndon DN Blood transfusions are associated with increased risk for development of sepsis in severely burned pediatric patients. *Crit Care Med*. 2007;35:579–583.
18. Lacroix J, Hébert PC, Hutchison JS, et al. Transfusion strategies for patients in pediatric intensive care units. *N Engl J Med*. 2007;356:1609–1619.
19. Wyckoff MH, Aziz K, Escobedo MB, et al. Part 13: neonatal resuscitation: 2015 American Heart Association Guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care (reprint). *Pediatrics*. 2015;136(suppl 2):S196–S218.
20. Wyckoff MH, Perlman JM, Laptook AR. Use of volume expansion during delivery room resuscitation in near-term and term infants. *Pediatrics*. 2005;115:950–955.
21. Italiano JE Jr, Richardson JL, Patel-Hett S, et al. Angiogenesis is regulated by a novel mechanism: pro- and antiangiogenic proteins are organized into separate platelet alpha granules and differentially released. *Blood*. 2008;111:1227–1233.
22. Lundgren P, Lundberg L, Hellgren G, et al. Aggressive posterior retinopathy of prematurity is associated with multiple infectious episodes and thrombocytopenia. *Neonatology*. 2017;111:79–85.
23. Keşkek NŞ, Gülcan H, Yılmaz G, Akkoyun İ. Impact of platelet count in retinopathy of prematurity. *Turk J Ophthalmol*. 2020;50:351–355.
24. Vinekar A, Hegde K, Gilbert C, et al. Do platelets have a role in the pathogenesis of aggressive posterior retinopathy of prematurity? *Retina*. 2010;30(4 suppl):S20–S23.
25. Gilbert C, Fielder A, Gordillo L, et al. Characteristics of infants with severe retinopathy of prematurity in countries with low, moderate, and high levels of development: implications for screening programs. *Pediatrics*. 2005;115:e518–e525.
26. Roberts D, Brown J, Medley N, Dalziel SR. Antenatal corticosteroids for accelerating fetal lung maturation for women at risk of preterm birth. *Cochrane Database Syst Rev*. 2017;3:CD004454.
27. Travers CP, Clark RH, Spitzer AR, Das A, Garite TJ, Carlo WA. Exposure to any antenatal corticosteroids and outcomes in preterm infants by gestational age: prospective cohort study. *BMJ*. 2017;356:j1039.
28. WHO. *WHO Recommendations on Interventions to Improve Preterm Birth Outcomes*. Geneva: World Health Organization; 2015.
29. Fogarty M, Osborn DA, Askie L, et al. Delayed vs early umbilical cord clamping for preterm infants: a systematic review and meta-analysis. *Am J Obstet Gynecol*. 2018;218:1–18.
30. Hård AL, Smith LE, Hellström A. Nutrition, insulin-like growth factor-1 and retinopathy of prematurity. *Semin Fetal Neonatal Med*. 2013;18:136–142.
31. Lyu Y, Shah PS, Ye XY, et al. Association between admission temperature and mortality and major morbidity in preterm infants born at fewer than 33 weeks' gestation. *JAMA Pediatr*. 2015;169:e150277.
32. Ibrahim CP, Yoxall CW. Use of plastic bags to prevent hypothermia at birth in preterm infants — Do they work at lower gestations? *Acta Paediatr*. 2009;98:256–260.
33. McCall EM, Alderdice FA, Halliday HL, Jenkins JG, Vohra S. Interventions to prevent hypothermia at birth in preterm and/or low birth weight infants. *Cochrane Database Syst Rev*. 2018;2:CD004210.
34. Jia YS, Lin ZL, Lv H, et al. Effect of delivery room temperature on the admission temperature of premature infants: a randomized controlled trial. *J Perinatol*. 2013;33:264–267.

35. Bhatt DR, White R, Martin G, et al. Transitional hypothermia in preterm newborns. *J Perinatol*. 2007;27(suppl 2):S45–S47.
36. Moore ER, Bergman N, Anderson GC, Medley N. Early skin-to-skin contact for mothers and their healthy newborn infants. *Cochrane Database Syst Rev*. 2016;11:CD003519.
37. Klinger G, Levy I, Sirota L, et al. Outcome of early-onset sepsis in a national cohort of very low birth weight infants. *Pediatrics*. 2010;125:e736–e740.
38. Lee J, Dammann O. Perinatal infection, inflammation, and retinopathy of prematurity. *Semin Fetal Neonatal Med*. 2012;17:26–29.
39. Bowen JR, Callander I, Richards R, Lindrea KB; Sepsis Prevention in NICUs Group. Decreasing infection in neonatal intensive care units through quality improvement. *Arch Dis Child Fetal Neonatal Ed*. 2017;102:F51–F57.
40. Harding JE, Cormack BE, Alexander T, Alsweiler JM, Bloomfield FH. Advances in nutrition of the newborn infant. *Lancet*. 2017;389:1660–1668.
41. Bharwani SK, Green BF, Pezzullo JC, Bharwani SS, Bharwani SS, Dhanireddy R. Systematic review and meta-analysis of human milk intake and retinopathy of prematurity: a significant update. *J Perinatol.* 2016;36:913–920.
42. Li QP, Zhang GM. Guidelines for the treatment of oxygen of retinopathy of prematurity (revised edition). *J Deve Med*. 2016;4:196–198 (in Chinese).
43. Darlow BA, Husain S. Primary prevention of ROP and the oxygen saturation targeting trials. *Semin Perinatol*. 2019;43:333–340.
44. Owen LS, Manley BJ, Davis PG, Doyle LW. The evolution of modern respiratory care for preterm infants. *Lancet*. 2017;389:1649–1659.
45. WHO. Sources and delivery of oxygen. *Oxygen Therapy for Children: A Manual for Health Workers*. Chapter 4.2.1 (NLM classification: WS), 29:29–30. https://www.who.int/publications/i/item/9789241549554. Accessed January 18, 2022.
46. Sweet DG, Carnielli V, Greisen G, et al. European Consensus Guidelines on the management of respiratory distress syndrome — 2019 update. *Neonatology*. 2019;115:432–450.
47. Deorari A, Darlow BA. Preventing sight-threatening ROP: a neonatologist's perspective. *Community Eye Health*. 2017;30:50–52.
48. Wyllie J, Perlman JM, Kattwinkel J, et al. Part 7: Neonatal resuscitation: 2015 international consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Resuscitation*. 2015;95:e169–e201.
49. Hartnett ME, Penn JS. Mechanisms and management of retinopathy of prematurity. *N Engl J Med*. 2012;367:2515–2526.
50. Zeng Z, Duan YX, Song GM. Non-pharmaceutical intervention and pain management situation for neonatal analgesia. *Front Nurs*. 2020;4:1–7.