VOLUME 30 • NUMBER 99 • 2017

Community Eye Health Journal

South Asia Edition

A preterm under going ROP follow up.
INDIA
PVRI, INDIA

Retinopathy of prematurity: it is time to take swift action

Subhadra Jalali
Deputy Director: Newborn Eye Health Alliance (NEHA) and Director, Quality: LV Prasad Eye Institute, Hyderabad, India.

Rajvardhan Azad
Chairman: National Task Force on ROP, Ministry of Health and Family welfare, Government of India and Chairman: Raj Retina and Eyecare Centre, Patna, India.

In the 21st century, South Asia faces an additional new challenge of childhood blindness from retinopathy of prematurity (ROP). The epidemic of ROP blindness is here and is rapidly spreading across all countries in South Asia.

Advances in science and technology, coupled with human compassion, focused goals and enhanced global collaboration, have greatly improved our ability to eliminate some of the most dangerous diseases around the world. Even without the power of the internet, fast transport and communication systems available today, health workers and governments worked together in successfully wiping away the scourge of small pox from the world in the early seventies. The more recent success like prevention of polio and maternal tetanus from large parts of the world encourage many health workers and policy makers to believe that "yes, we can!"

Blindness and vision loss in babies and infants is often not perceived by parents and public as being preventable. Although most health workers are aware of preventable conditions like ophthalmia neonatorum or treatable conditions like congenital cataract, the general public perception remains that babies are born blind, and very little can be done in terms of public health preventive measures. Blindness and eye diseases in young children are considered difficult to diagnose and treat and lack of public awareness of these eye diseases including the absence of formal curriculum in medical or nursing schools, are few of the key challenges in the region. In many places in South Asia, health workers including doctors are not

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About this issue

More neonatal services worldwide means that more babies are surviving, including those born preterm. Sadly, many of these babies will go blind from retinopathy of prematurity. But there is hope: ROP can be prevented and treated. In this issue, we offer up-to-date information and guidance for each member of the clinical team involved in the care of preterm babies, including neonatologists, nurses, and ophthalmologists, and emphasise the importance of involving parents in every aspect of their child's care. We hope that you will be inspired to share this knowledge within your team and with others in the neonatology unit and thereby help to save the sight of many young children.

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trained to conduct eye screening of newborns along with their systemic health evaluation. It is not uncommon to see children in schools for the blind who have never been screened or examined comprehensively by a trained eye specialist. The biggest assumption in many cases is that the numbers are too small to require the attention of policy makers, health media and blindness prevention programmes. A notable exception in preventing childhood blindness was the successful global Vitamin A prophylaxis programme in India. It was the first of it's kind in which the health workers were trained in identifying ocular signs and symptoms in children. Apart from this initiative, in the absence of any newborn eye screening programmes, largest number of children in South Asia are already facing needless blindness.

In the 21st century, South Asia faces an additional new challenge of childhood blindness from retinopathy of prematurity (ROP). The epidemic of ROP and ROP blindness is here and is rapidly spreading across all countries in South Asia.[1] What started in a few major cities of South Asia in the late 90's, has now rapidly spread across smaller towns and even rural areas.[2-5] This is a consequence of rapid scaling up of sick newborn and neonatal intensive care units (SNCU/NICU) to reduce the unacceptably high neonatal mortality rate in South Asia. The association between institutional survival of preterm babies and ROP blindness is well documented in the scientific literature, from the first case recorded in Boston (1942) to the epidemic in middle-income countries.[6]

In the South Asia region almost 5 million babies are born preterm every year, with an estimated 80,000 surviving neonatal care and at risk of ROP. All these babies need to be screened for retinal disease within thirty days of birth to identify those who develop sight-threatening ROP, followed by timely treatment. However, there is often lack of awareness about this emerging condition coupled with challenges of accessibility, affordability, lack of knowledge, inadequately skilled human resource and resource allocation. What is required of us is to establish and expand ROP programmes and build capacities at a very rapid rate - the babies cannot wait, as they become blind within the first few months of birth. Many individuals and child care/eye care teams have evolved different models of ROP care across South Asia that are geared up to meet this challenge.[5,7,8] Human resource training, improved quality of neonatal care, fundoscopy screening for the sight-threatening stages of ROP through regular visits by ophthalmologists or telemedicine, capacity building by providing lasers, data registries, curriculum upgrades, scientific publications and numerous medical education presentations are some of the initiatives taken up across the region. Awareness and advocacy have slowly convinced some governments to start considering ROP as a serious and preventable cause of blindness. While substantial work in some regions of South Asia is ongoing, with many success stories, a huge amount of work still needs to be done before this epidemic can be overcome. Combined and coordinated efforts in the South Asian region may help us achieve this goal faster.

IIPH

A preterm infant admitted to an SNCU in India.

This issue of the Community Eye Health Journal South Asia brings together the knowledge and experiences of ophthalmologists, neonatologists, paediatricians, care givers, nurses and health workers in an accessible style. Since the region has diverse cultures and terrains, different health systems and financing mechanisms, with huge gaps in human resources, local ROP leaders have modified the models of care to align with local needs for effective implementation. We hope that the experiences documented in this journal will provide an impetus to implement ROP programmes in all communities that have an SNCU/NICU so that no baby goes needlessly blind. Preterm babies can take heart that ROP service providers are all very enthusiastic and working towards their Right to Sight!

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Community Eye Health Journal South Asia Edition

VOLUME 30 • NUMBER 99 • 2017

Address for subscriptions
Community Eye Health Journal South Asia, Indian Institute of Public Health, Plot no.1, ANV Arcade, Amar Co-operative Society, Kavuri Hills, Madhapur, Hyderabad - 500033, India.
Tel +91-40-49006000
Email editor@cehjsouthasia.org

Correspondence articles
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Published by the International Centre for Eye Health, London School of Hygiene & Tropical Medicine.

ISSN 0953-6833

Development of retinopathy of prematurity

Seema Qayyum
Professor of Paediatric Ophthalmology: The Children's Hospital & Institute of Child Health, Lahore, Pakistan.

Retinopathy of prematurity (ROP) is an ocular disorder which affects infants born before 34 weeks of gestation and/or with birth weight of less than 2000 grams. If not detected on time and appropriately managed, it can lead to irreversible blindness.

How does ROP develop?

The retinal blood vessels first appear between 15-18 weeks of gestation. These vessels grow outwards from the central part of the retina and extend towards the retinal periphery. The nasal part of the retina is fully vascularised by 36 weeks of gestation followed by the temporal retina which is completely vascularised between 36-40 weeks of gestation age (Figure 1). Following a premature birth, the growth of retinal blood vessels is halted and does not reach the periphery of retina (Figure 2).

Figure 1 In a full term child, the retinal blood vessels are fully developed.

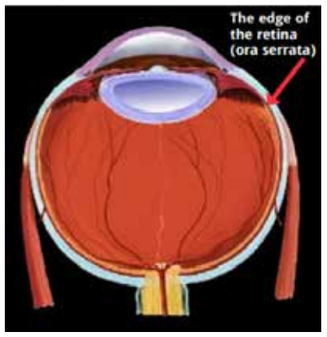
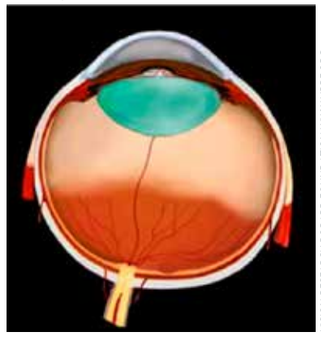


Figure 2 In a preterm infant, the retinal blood vessels are not fully developed.



The development of ROP can be divided into two phases - an initial phase of delayed growth of retinal vessels followed by a second phase of retinal vessel proliferation (Figure 3).

Phase I (Vaso-cessation): from birth to 30-32 weeks of gestation
At birth the lungs of an infant born preterm are immature placing him/her at a high risk of developing abnormally low level of oxygen in arterial blood.

To overcome this, the newborn infant is given supplemental oxygen in NICU. Prior to 32 weeks of gestation, the retina is very immature and the retinal metabolic demand is low. This excess oxygen creates retinal hyperoxia and oxygen toxicity, inhibiting the production of VEGF. This is followed by temporary stopping or stoppage of normal retinal growth, and constriction of new immature vessels. As a result, there is a reduction of blood supply to retinal tissue and shortage of oxygen needed for metabolism.

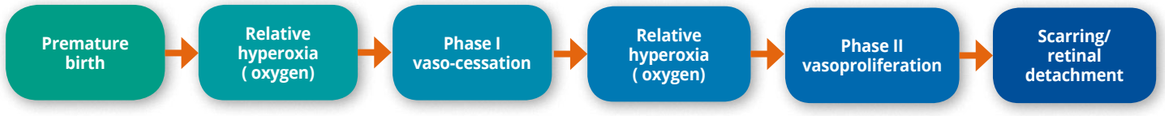
Phase II (vaso-proliferation): after 30-32 weeks of gestational age
With increasing age of the preterm infant the retina matures. There is an increase in metabolic demand and oxygen consumption by the retina, creating a relative decrease in oxygen level. This promotes increase in the level of vascular endothelial growth factor (VEGF), triggering the formation of new blood vessels along the inner retinal surface. A demarcation ridge develops along the retina that separates the central vascularised retina from the peripheral avascular retina (Figure 4).

Figure 4 ROP in the junction of vascularised and non-vascularised retina

Figure 5 Advanced ROP with partial retinal detachment

The growth of retinal blood vessels at this stage may restart normally or may progress to significant ROP as seen by an abnormal growth of retinal vessels into the vitreous and over the surface of the retina. These new vessels are weak and underdeveloped failing to fulfill the oxygen demand of retinal tissue resulting in continuous growth of abnormal vessels. There is leakage of fluid or blood from these weak blood vessels. If not treated on time this can result in scarring or traction of the retina leading to retinal detachment and blindness (Figure 5).

Figure 3 ROP can be divided into two phases



Classification of retinopathy of prematurity: from then till now

Komal Agarwal
Consultant: Srimati Kannuri Santhamma Centre for vitreoretinal diseases and Jasti V Ramanamma Childrens' Eye Care centre
Kallam Anji Reddy Campus, L V Prasad Eye Institute, Hyderabad, India.

Subhadra Jalali
Deputy Director: Newborn Eye Health Alliance (NEHA) and Director, Quality: LV Prasad Eye Institute, Hyderabad, India.

The complex and variably progressive nature of ROP warrants a robust description of the disease and its classification into various severities which helps the clinicians to properly document, prognosticate and treat the disease.

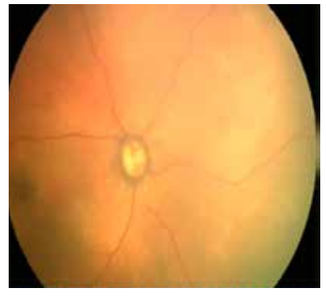
The first case of ROP was described in the 1940s, very soon after the first incubators were set up in childrens' hospitals.[1] At birth, most preterm babies would have an immature retina, defined as retinal vessels not reaching the ora serrate (end of the retinal tissue) and caliber of vessels is normal with vessels showing a dichotomous branching pattern (Figures 1a,1b). After birth in 2-3 weeks, ROP starts manifesting and can be seen on fundoscopy. ROP is a rapidly changing disease condition in the newborns. It can regress completely in some, regress with some sequelae in others while progress to severe retinal detachment and vision loss in a few babies. This complex and variably progressive nature of ROP warrants a robust description of the disease and its classification into various severities, which helps clinicians to properly document, prognosticate and treat the disease.

In 1979, an international committee involving 23 ophthalmologists from 11 countries was formulated and the "International Classification for Retinopathy of Prematurity" (ICROP) was devised.[2]

ICROP 1984 and a modification in 1987 takes into account three major aspects of the disease – its location, extent and severity.

Figure 1a Immature retina with dichotomous branching and

Figure 1b Posterior pole with normal vessel caliber in a premature baby



Location
The retina is divided into three zones centered on the optic disc (Figure 2). More posterior the disease, more severe and likely the progression is seen. Zone 1 is defined as the circle, the radius of which is twice the distance between the center of optic disc and center of macula. Zone 2 is defined as the area from the edge of the zone 1 peripherally to a point tangential to the nasal ora serrata. Zone 3 is the residual temporal crescent of retina anterior to zone 2.[2]

Extent
Extent of ROP is defined by the hours of the clock from 1-12 with each clock hour at 30 degrees.[2]

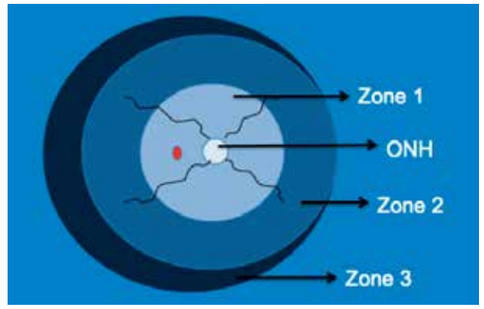
Severity
The disease is staged according to severity, in four stages. It was also realised that the disease can exist in more than one stage in the eye at a time. For staging, the worse stage was noted, however, for proper documentation, it was recommended that the extent of each stage should be defined in clock hours.[2]

Stage 1, demarcation line
A thin delicate line-like white structure separating the vascular and avascular retina is visible. There is abnormal branching and arcading leading to it. It is relatively flat and lies in the plane of the retina.
Stage 2, ridge
It is a line which has grown and has a volume of thickness and height. It extends above the plane of the retina. Small tufts of new vessels may be found
Stage 3, extraretinal fibrovascular proliferation
This stage is reached when the component of extraretinal fibrovascular proliferation which is continuous with the posterior border of the ridge appears. It grows into the vitreous perpendicular to the ridge.
Stage 4, retinal detachment
When the fibrovascular proliferation leads to a retinal detachment, it is classified as stage 4. It is often tractional and sometimes exudative.

Plus disease

Progressive vascular incompetence presenting as dilatation and tortuosity of vessels in four quadrants at posterior pole, iris vascular engorgement leading to pupillary rigidity and vitreous haze comprises the

Figure 2 Retina divided into 3 zones to describe the location of ROP



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active and progressive status of ROP and is termed as the plus disease.[2]

Prethreshold and threshold ROP
Threshold ROP was defined as a condition with 50% risk of retinal detachment if left untreated. This includes ROP of more than 5 contiguous or 8 cumulative clock hours of stage 3 plus ROP in zone 1 or zone 2. All eyes with threshold disease were recommended to be treated.

Prethreshold ROP was defined as any zone 1 ROP less than threshold, zone 2 stage 2 with plus, zone 2 stage 3 without plus or zone 2 stage 3 with plus but less than 5 contiguous or less than 8 cumulative clock hours of ROP. Initial recommendations advised followup of these eyes.

Three major problems were encountered while using the ICROP classification of 1984. The first one was the anatomical delineation of zone 1. Anatomical landmarks are ill-defined in premature eyes and hence the divisions of the zones were arbitrary. Secondly, it was also recognised that there was a need to further classify stage 3 due to its prognostic importance. Tractional detachments were classified as stage 4. However, the cicatricial (fibrous scar) forms of the ROP continuum were not classified in the ICROP classification. A revised ICROP classification was put forward in 2005[3] by a committee of 15 ophthalmologists. This new classification tried to cover the gaps of the previous one with the new insights provided by the upgraded imaging technologies for prematures.[4]

Three main highlights of the revised system were:
- Description of an aggressive form of ROP in babies with very low birth weight– aggressive posterior ROP (APROP).
- Recognition of a "pre-plus" form of the disease, intermediate to the normal vessels and plus disease as described earlier.
- Anatomical definition of zone 1.

The revised ICROP classification of 2005[3] retained descriptions under the three major aspects of the original classification: location, extent and severity.

Location
The zones were defined as in the earlier classification. For better understanding during practical use, it was recommended to use a 25 or 28D lens with the optic disc at the nasal edge. The image formed was described as zone 1.

Extent
Extent of the disease was described in clock hours as per the original classification.

Severity
The revised classification[3] divided ROP into five stages.

Stage 1, demarcation line
Same as ICROP 1984.

Stage 2, ridge
Same as ICROP 1984.

Stage 3, extraretinal fibrovascular proliferation
Same as ICROP 1984. In addition proliferation was further divided into mild, moderate and severe.

Figure 3a Stage 1, demarcation line

Figure 3b Stage 2, ridge

Figure 3c Stage 3, extraretinal proliferation

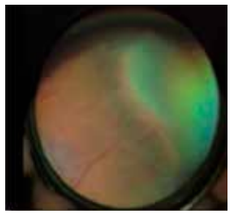
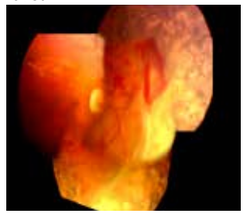


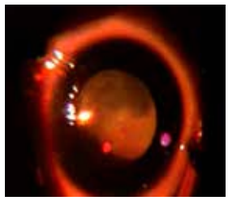
Figure 3d Stage 4A ROP, post laser partial retinal detachment, not involving fovea



Stage 4, partial retinal detachment
The 2015 revision classifies the tractional retinal detachments into extrafoveal (Stage 4A, Figure 3d) and foveal (Stage 4B, Figure 3e). They are usually circumferentially oriented and described according to the clock hours involved.

Figure 3e Stage 4B, partial retinal detachment involving fovea

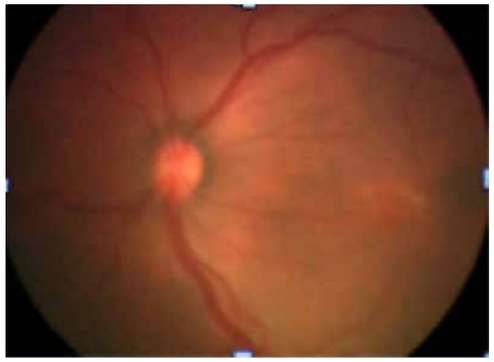
Figure 3f Stage 5, total retinal detachment



Stage 5, Total retinal detachment
They are funnel shaped and mostly tractional in nature (Figure 3f).

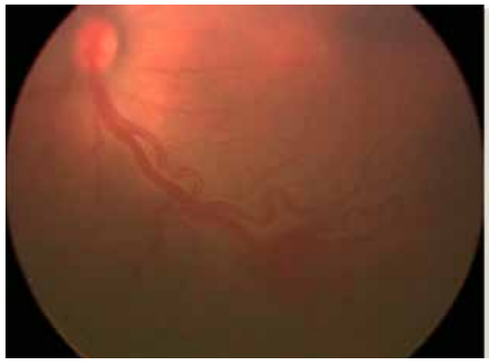
The concept of "pre-plus disease"
The revised ICROP classification recognised and defined the state of active ROP where the features were insufficient for the diagnosis of plus disease but the vascular changes were more marked than normal. This entity was called "pre-plus disease" (Figure 4). This signified the pre stage which could in further course of time develop into plus disease.

Figure 4 Pre-plus disease



Plus disease
Increased venous dilatation and arteriolar tortuosity of posterior vasculature, with increasing iris engorgement, pupillary rigidity and vitreous haze were defined under the more active ROP, "plus disease". A standard clinical photograph (Figure 5) was used to define the disease. At least two quadrant involvements of the signs were required to define the disease as plus disease. This was a change from the original four quadrants.

Figure 5 Plus disease showing dilatation and tortuosity of posterior pole vessels



Aggressive posterior ROP
A rapidly progressive, ill-defined form of ROP had been previously described as type II ROP or "Rush disease" or "Fulminate ROP". It was not specifically included in the original ICROP classification. The revised classification defines it as the "aggressive posterior ROP" (Figure 6a). It is characterised by severe dilatation and tortuosity of the vessels which is out of proportion to the peripheral retinopathy. The disease is limited to the posterior pole in zone 1 or posterior zone 2 and usually does not progress through the classic stages 1-3 of ROP.

Figure 6a APROP with avascular pockets and shunts

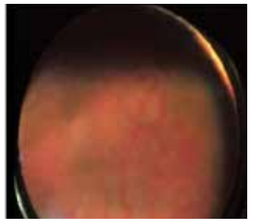
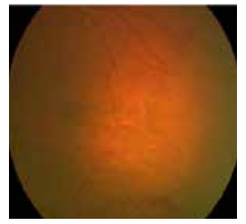


Figure 6b Hybrid ROP with shunting of vessels.



Shunting occurs between vessels intraretinally and flat neovascularisation is noted. It extends circumferentially and if left untreated, very rapidly progresses to Stage 5 within few days. This type of ROP can be easily missed.

Staged ROP versus APROP
It is very important to distinguish these two. Some important differences are in Table 1.

Current guidelines for treatment

In 2005, randomised trials of early stages of ROP showed better outcomes than treating at threshold ROP stage. Prethreshold ROP was divided into two types.[4]

Type 1 high risk prethreshold ROP
Defined as zone 1 plus with any stage, zone 1 stage 3 with no plus and zone 2 stage 2 or 3 plus. All eyes with type 1 prethreshold ROP are currently recommended for immediate treatment.

Type 2 low risk prethreshold ROP
Defined as zone 1 stage 1 or 2 without plus disease and zone 2 stage 3 without plus disease and follow-up is recommended for such eyes.

Cicatricial ROP
Untreated or partially treated eyes can present with cicatricial ROP with sequalae as disc and macular dragging, peripheral vitreoretinal-lenticular adhesions and subretinal pigmentation from reattached exudative detachments. These eyes have variable potential for vision and often benefit from low vision services.

Future directions

Several studies have compared the interobserver agreement of diagnosing various stages of ROP.[5-7] It has been noted well that while the agreement on diagnosing the treatment requiring stages of ROP is good, the earlier stages of ROP have discrepancies. This has led us to believe that other objective features need to be added in the classification to increase the interobserver agreement especially with telemedicine being increasingly used in the screening of ROP.

Klufas et al used fundus fluorescein angiography (FFA) in addition to color fundus photographs and noted that the agreement on the diagnosis improved significantly with the objective assessment of FFA.[8] Although FFA alone didn't show any significant advantage, defining characteristics on the newer imaging techniques in today's era would probably be beneficial and overcome the drawbacks of existing classification.

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Newer disease presentations have been described such as 'hybrid ROP'[9] that has components of both staged ROP and APROP (Figure 6b). Other gaps in ROP classification include absence of classifying regressing new vessels in ROP, regression of plus stages to post plus states, classifying the rare exudative or rhegmatogenous presentations, classifying progressive stage 5 ROP, identifying various severities of evolving APROP, and classifying the disease based on possible differences in the pathogenesis of staged ROP and APROP.

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Table 1 Staged ROP versus APROP

	Staged ROP	Aggressive Posterior ROP
Pattern of vessels	Dichotomously branching	Looping and shunting
Plus and preplus	Clearly made out	Very subtle and appears suddenly
Location of new vessels	Appear at junction of vascular and avascular retina, often temporally	Appear at any place, especially can start nasally as well
Type of new vessels	As individual twigs growing vertically into vitreous	Flat new vessels with each vessel ill defined and almost like a globule of vessels
Junction	Avascular and vascular junction are very well defined and often 'wavy' and continuous	No definitive junction as multiple pockets of avascular retinal tissue are enclosed within vascularised boundary. Pockets are discontinuous.
Location	In any zone	In zone I or posterior zone II
Progression timeline	Progresses to detachment over 3-6 weeks or more going through each stage for variable time periods	Progresses to detachment within few days and may not show each stage clearly
Progression pattern	Progresses through each stage with each stage lasting at least for 1-2 weeks	Early phases of APROP are not classified well as yet. Each phase may be lasting for only short time
Response to timely treatment	Excellent response in most cases	May respond poorly and treatment failures can occur
Detection of disease	Not difficult as findings are clear	Often missed as findings are unclear

Screening for ROP

Anand Vinekar
Programme Director: KIDROP, Professor & HoD: Department of Pediatric Retina Narayana Nethralaya Eye Institute, Bangalore, India.

A low-cost, portable camera developed in India, 3Nethra Neo has made transport, imaging and scaling-up of the KIDROP programme easier.

KIDROP PROGRAMME

Mothers being shown images of the retinae of their infants during a counseling session. INDIA

Screening is an essential first step in management of retinopathy of prematurity (ROP). This requires training, skill, patience and appropriate equipment. Identification of a child requiring treatment for ROP has a short window period, and a high-risk of poor outcome if the diagnosis is missed.

Although indirect ophthalmoscopic retinal examination is the standard for examining the retinae of infants, imaging based examination and screening is gaining popularity. This article focuses on the use of wide-field imaging as the primary method in ROP screening. This is especially relevant in countries that lack ROP specialists. 'Wide-field' in the context of ROP would be 120-degree field of view (or greater), as the disease affects the peripheral retina first. Photographic documentation is a powerful tool in recording medical findings. This also serves as strong medical and legal evidence.

Can wide-field imaging based ROP screening be used in countries with few ROP specialists?

India with a population of 1.3 billion people, has less than 1,000 trained retinal surgeons, of which less than 150 are currently practicing management of ROP programmes. With a majority of rural areas devoid of such experts, wide-field imaging performed within the neonatal intensive care unit (NICU) by trained and accredited non-physicians could help to bridge the gap.

Who can take images of infants?

Practically anyone with aptitude can be trained to take ROP-related images of infants. In the Karnataka Internet Assisted Diagnosis of Retinopathy of Prematurity (KIDROP) programme (www.kidrop.org) in India; doctors, ophthalmic imagers, optometrists, nurses and para-medics have been trained to capture retinal images as well as review, record and report them within minutes. They can help them act as the 'first triage' in the community, enabling 'on-the-go' diagnosis for mothers living in rural areas, even before the ROP specialist reviews these via a tele-medicine platform.[1-3]

What equipment may be useful in South Asia?

The most commonly used camera worldwide is the RetCam. The 'shuttle version' of this device is portable using a four-wheeler and can be moved between several NICUs. The camera is rugged and can withstand the rigors of a tropical climate and rural roads. In the KIDROP programme, 110 NICUs are covered by five cameras, each managed by a separate team. On average, 7000 kilometres of travel are undertaken to reach these centres wherein 1500-2000 imaging sessions are performed every month.[1,3] More recently, a low-cost, portable camera that was developed in India, 3Nethra Neo has made transport, imaging and scaling-up of the programme easier.

What kind of on-site imaging and documentation can be expected?

Once the device reaches the scheduled centre, it is wheeled into the NICU where the identified infants have their eyes dilated by the nurses. Images can be taken inside the incubator or in an adjoining 'step-down' room. A special infant wire speculum keeps the eye open. The camera comes into contact with the cornea with a coupling agent between the two surfaces. Images are captured in the video mode, to reduce movement. Artefacts and the required quadrants are saved as still images. A ROP card is filled out for the mother with the diagnosis and date for next follow-up. Images are used to educate the mother and the treating neonatologist. This reduces follow-up attrition. Findings are recorded and maintained in an onsite register and online. All images are backed up on to a secure online database and are read by the remote expert.[1,2]

How are images reported?

To aid reporting by non-physicians a 'decision-aiding algorithm' was developed with three-way triaging code of

- red (requiring treatment or urgent review by the MD),
- orange (disease or immature retina that can be followed) and
- green (mature retina in both eyes).

The algorithm is based on the International Classification of ROP (ICROP). The remote specialist views and reports these images on his or her smart phone. Over 97% sensitivity is possible while reporting on the smart phone. Owing to low internet speeds in some rural areas, the upload time for a single infant's

Continues overleaf ➤

images can range from two to over 15 minutes. The reporting time on an average after upload is four minutes. The time taken to report all 'severe cases' of any session that need urgent attention is less than 30 minutes.[3]

How are imagers trained and accredited?
A KIDROP STAT (Score for Training and Accreditation of Technicians) score has been developed to train and certify imagers. This comprises of three levels (I, II and III) and has a 20 point score, which tests the knowledge, skill, and practise patterns of the imager in their native setting. On an average, training a new imager can take between 30 and 90 working days. This period has been considerably shortened after the introduction of online training.

KIDROP PROGRAMME

Wide-field imaging being performed by a level III imager in a rural neonatal intensive care unit using the portable RetCam Shuttle. INDIA

What are other uses of imaging?
Wide-field imaging used for ROP screening has helped diagnose and manage other 'non-ROP' conditions in preterm infants. In a study of 1,450 preterm infants, 7.7% had a diagnosis other than ROP, which included conditions as severe as retinoblastoma. Imaging can also be easily performed for anterior and posterior

Findings in the other eye

Findings in one eye	Mature vessels	Regressing ROP	Immature retina	Stage 1 ROP, no plus in non-zone 1 location	Stage 2 with no plus in non zone 1 location
Mature vessels	Discharge	Follow up	Follow up	Follow up	Referral to ROP specialist/ needs treatment
Regressing ROP	Follow up	Follow up	Follow up	Follow up	Referral to ROP specialist/ needs treatment
Immature retina	Follow up	Follow up	Follow up	Follow up	Referral to ROP specialist/ needs treatment
Stage 1 ROP, no plus in non-zone 1 location	Follow up	Follow up	Follow up	Follow up	Referral to ROP specialist/ needs treatment
Stage 2 with no plus in non zone 1 location	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment
Plus or pre plus with any stage any zone	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment
Zone 1 disease (any stage)	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment
Aggressive posterior ROP	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment	Referral to ROP specialist/ needs treatment

KIDROP PROGRAMME

Rural Government owned neonatal intensive care unit which are overburdened with admissions and limited resources. INDIA

segment screening of full term, healthy infants to provide 'universal eye screening'. A study of 1,021 term infants imaged within three days of birth showed that 4.7% had an abnormality, 1% of whom required medical or surgical intervention. As more affordable cameras become available, the role of imaging is likely to expand under the national programme to provide universal eye screening at birth.

What is the impact of tele-screening?
An impact assessment of scaling up the image based tele-ROP programme in India showed that in the 10 high-risk ROP states, with a population of roughly 680 million, over 35,000 infants would be detected with ROP and over 1,200 need treatment annually. The financial saving in 'blind-person-years' (BPY) is estimated at USD 108 million.[4] Over 650 government owned special new born care units (SNCUs) are already functional in most of the district headquarters in India and many private NICUs also exist. Most of these centres are currently not providing in-house ROP screening. This gap must be met. The United Nations Development Programme (UNDP) report on the tele-imaging programme and the National Health and Medical Research Council (NHMRC, Australia) report based on the Center for Disease Control (CDC) guidelines[5] on the KIDROP programme both strongly suggest that wide-field imaging is likely to become the new gold standard in ROP screening, and similar models would allow rapid replicability and sustainability in countries like India and others with similar ROP demographics.

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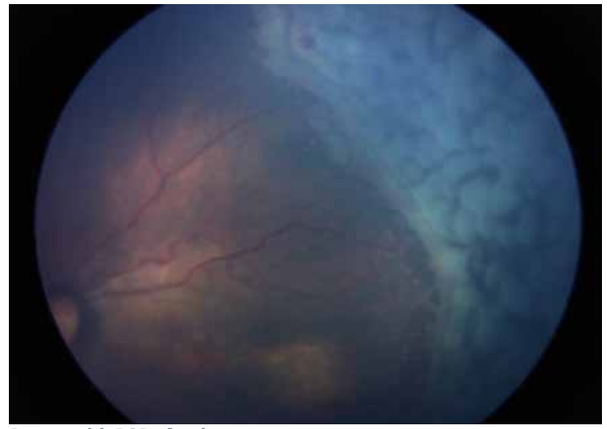
Treatment of retinopathy of prematurity (ROP)

Renu Puthenvilayil Rajan
Vitreo Retinal Surgeon: Aravind Eye Hospital, Madurai, Tamil Nadu, India

Tavisha Udupihille
Consultant Paediatric Ophthalmologist: Sirimavo Bandaranaike Specialised Children's Hospital, Peradeniya, Sri Lanka.

Although laser is the mainstay of ROP treatment, antibodies against vascular endothelial growth factor (VEGF) are being increasingly used. In either case long term follow-up is essential.



TAVISHA UDUPIHILLE

An eye with ROP after laser treatment.

The mainstay of treatment of ROP to date is laser therapy. There is also an increasing use of antibodies against vascular endothelial growth factor (VEGF) either as a primary treatment or as a procedure for selected cases due to failure of primary treatment using laser. It has also been used in situations where laser therapy cannot be instituted due to clinical instability of the baby.

Which babies require treatment?
Treatment indications are primarily governed by the findings of two clinical trials: Cryo-ROP trial[1] and Early treatment ROP (ETROP) trial.[2] The Cryo-ROP trial identified treatment indications are:
"Stage 3 ROP involving a threshold number of at least five contiguous or eight total clock hour sectors of zone 1 or 2, and 'plus' disease."[1]

Although this trial used cryotherapy as the treatment modality its findings have been applied to laser therapy as well. The subsequent ETROP study found benefit in laser treatment of some babies who did not meet the criteria in the Cryo-ROP trial. These indications have been identified in the ETROP study, defined as high risk prethreshold ROP.[2]

- Zone I, any stage ROP with plus disease
- Zone I, stage 3 ROP without plus disease
- Zone II, stage 2 or 3 with plus disease

Zone III, stage 3 with plus disease is not recognised as an indication for treatment in either study, although these babies are sometimes treated. In addition another indication for treatment called Aggressive Posterior ROP (APROP) is increasingly being recognised. This condition is characterised by dilated and tortuous vessels in the posterior pole, although clear definitions and treatment indications are lacking.

What treatment modalities are available?
Cryotherapy has mainly been superseded by laser therapy. Intra-vitreal injections of VEGF antibodies (bevacizumab and ranibizumab) are also used.

Detached retinas that have occurred due to failure of treatment or late presentation require vitreo-retinal surgery.

Laser treatment
Laser therapy is applied to the region of avascular retina that is anterior to the ridge or demarcation line. Both diode and green (argon or double frequency Neodymium: Yttrium Aluminium Garnet) can be used and delivered via a laser indirect ophthalmoscope. General anaesthesia is ideal for the procedure although sedation and/or topical anaesthesia is used extensively in the South Asian region. The baby has to be monitored during the procedure.

Anti VEGF therapy
Intra-vitreal injection of bevacizumab or ranibizumab is used in the management of very severe ROP, when laser treatment fails or when the baby is unstable for laser treatment. Bevacizumab eliminates the angiogenic threat of ROP (BEAT-ROP)[3] and other studies have shown the efficacy of this procedure in causing regression of ROP. However the long term risk to the retina and the baby as a whole have not been studied extensively.

Follow-up after treatment
Babies need to be followed-up after treatment to ensure that ROP is completely regressed and does not recur. Babies treated with anti-VEGF agents need a longer period of follow-up until the retina is completely vascularised. In addition long term follow-up with regard to the possibility of refractive errors and cortical visual impairment has to be instituted.

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Role of neonatal team including nurses in prevention of ROP

Srinivas Murki
Chief Neonatologist: Fernandez Hospital, Hyderabad, India.

Sandeep Kadam
Neonatologist: KEM Hospital, Pune, India.

Neonatal nurses are pillars of the neonatal intensive care units (NICU). Their knowledge and clinical skills are essential in providing best practices in quality care in preventing ROP in preterm babies.

FERNANDEZ HOSPITAL

A nurse optimising oxygen for a preterm infant by adjusting the FiO2 with a blender at Fernandez Hospital. INDIA

Retinopathy of Prematurity (ROP) is a preventable cause of blindness in children. As smaller and sicker neonates are surviving in the neonatal intensive care unit (NICU), the incidence and severity of ROP is also on the rise. We are now facing the third epidemic of ROP; the first being in 1950s with liberal oxygen use, the second one in the developed world where smaller and smaller babies survived and the third epidemic in India/developing world, where ROP is additionally seen in bigger babies, for lack of optimal care and oxygen administration.[1] It is time to identify the preventable causes of ROP and implement solutions that would result in reduction of incidence and severity of ROP. In this article we aim to identify the role of nurses and health staff in preventing ROP and in identifying at-risk babies in the NICU for effective screening of ROP.

Prevention of ROP

Prevention of ROP includes improved care in the NICU. Improved care results in reduced morbidities and reduced risk factors that put a neonate at-risk for developing ROP. Improved neonatal care is the domain of pediatricians, medical officers, resident doctors and neonatal nurses who are involved in the care of these babies. Any intervention to improve quality care of a newborn can contribute to reducing the incidence of ROP in developing countries.

Judicious oxygen therapy

Oxygen is a drug and it should be administered in a quantity that is appropriate to the need. Each neonatal care unit should have a written policy outlining appropriate use of oxygen therapy. Oxygen level in the blood should be continuously monitored using a pulsoximeter. A target of 90-95% SpO2 in all newborns on any respiratory support, including oxygen therapy, should be maintained.[2] One should avoid 100% oxygen in the labour room and use a blender to target SpO2. The most important tool at hand today is control of oxygen saturation. It is also important to avoid fluctuations in SpO2 especially at high levels.

Judicious use of blood transfusions

Transfusion of packed RBCs is another ROP risk factor. Adult haemoglobin has α2β2 chains which have low affinity for oxygen as compared to the haemoglobin of preterm babies, hence more tissue delivery of oxygen results in hyperoxia. Adult RBCs are rich in 2, 3 Diphosphoglyceric acid (DPG) and this binds with deoxyhemoglobin and stabilises the low oxygen carrier state making it difficult for oxygen to bind, resulting in more release of oxygen to the retinal tissue. Significantly low haemoglobin or platelets on the other hand can also worsen ROP. Hence written guidelines for transfusion in the NICU will help in restricting adult blood transfusions.

Prenatal steroids

Use of prenatal steroids is a well-known approach to prevent respiratory distress and intraventricular hemorrhage, two important risk factors of ROP. All women expected to deliver between 24 to 34 weeks of gestation should be given a course of either betamethasone or dexamethasone intramuscularly at-least 24 hours before the delivery of the baby.[3]

Nutrition

Postnatal weight gain predicts risk of retinopathy of prematurity. Poor weight gain in postnatal period increases the risk of severe ROP.[4,5] Insulin-like growth factor 1 (IGF-1) controls VEGF-mediated vascular growth, which is important for retinal vasculature. Hence both increased nutrition and adequate IGF-1 concentrations seem to be necessary for postnatal growth and reduction in risk of ROP.[6] Ensuring early administration of colostrum, exclusive and aggressive use of mothers own milk or donor milk, human milk fortification, kangaroo mother care, mothers involvement in baby care are some of the interventions in improving the nutritional status of preterm infant.

Infections

Neonatal infections, particularly fungal infections, are also risk factors for ROP. A systematic review and meta-analysis of eight studies found that systemic fungal infection in very low birth weight infants was significantly associated with ROP and severe ROP.[7] Neonatal bacteremia is associated with severe retinopathy of prematurity in extremely low gestational age neonates. The increased risk associated with infection might be partly due to systemic inflammation, which could act synergistically with hyperoxia. Chorioamnionitis is often associated with higher levels of circulating proinflammatory cytokines which could act with postnatal infections resulting in higher cytokines and later development of ROP. Some of the Do's and Don'ts in prevention of neonatal infections are described in Table 1.

To summarise, prevention of ROP by reducing risk factors that disrupt normal retinal vascularisation is likely to be more effective than late treatment of neovascularisation. This is not only with respect to vision, but also with other co-morbidities of a premature birth. Careful control of oxygen saturation, normalisation of serum IGF-1 concentrations, provision of adequate nutrition, curbing the negative effects of infection and inflammation, judicious use of oxygen in delivery room and the NICU, and a reduction in blood transfusion in the NICU could promote adequate postnatal growth and improve neural and vascular development of the retina. Nurses in the NICU are the backbone of all NICUs across the world. All the nurses should promote quality care and developmentally supportive care in the NICU.

Secondary prevention of ROP: early case detection and treatment

The unit should have protocols that cover all steps of screening and management of ROP.

- The simplest method to ensure that all eligible infants are examined at an appropriate time is to identify them when they are first admitted to the NICU. A nurse can help by entering details into a book or electronic database, noting the date of the first examination and subsequent examinations. This helps in ensuring no baby is missed for ROP screening.
- Deciding when examinations are complete and organising timely treatment and long-term follow-up also remains a challenge. Nurses can help in establishing clear communication between neonatologists, resident doctors and ophthalmologist in the NICUs and, importantly, with parents.
- ROP prevention is a team responsibility, and parents must be seen as equal partners in that team. Good communication is at the heart of the relationship between the baby's present medical caregivers and the parents, the future caregivers. Nursing staff inevitably spend the maximum time talking to parents. They are often the most trusted members of the team, so their input into written material and how it is presented is vital.
- Good awareness of communication problems, clear-cut organisational responsibilities and most importantly, working closely with parents as equal partners should prevent most of the difficulties in ROP screening.

Nurses role in prevention can be summarised in the following manner

Specialist knowledge in clinical management

Nurses should be aware of all the risk factors known to be associated with ROP. They should form the core team in implementing good practices such as target oxygen saturation, encouraging breastfeeding, hand hygiene and asepsis to reduce infections, and support for nutrition to achieve good weight gain. These would help in reducing ROP in the unit.

Clinical advocacy

Nurses are primary care givers in a neonatal ICU. They can also advocate for providing best practices in the NICU. Some of these include kangaroo care, thermal care, infection prevention and breastfeeding. Advocating for the adjustment of environmental factors (minimal handling, noise and light) and developmental care are core components of nursing. That will maximise the chances of healthier developmental outcomes in extremely preterm newborns, including vision, hearing and cognitive function.

Leadership and mentoring

For sustainable change, leadership from within the nursing profession for policies on educational opportunities and competency-based training programmes is needed. Experienced nurses can coach the young nurses to improve quality care in the NICU.

FERNANDEZ HOSPITAL

A nurse helping a new mother providing kangaroo mother care. INDIA

Counseling

Nurses are key personnel who counsel parents regarding breast milk and kangaroo care. They provide emotional support and motivate parents in developmental care, adherence to ROP screening and follow-up. Using innovative strategies such as ROP appointment and follow up cards for parents or using mobile applications can ensure timely management of ROP.

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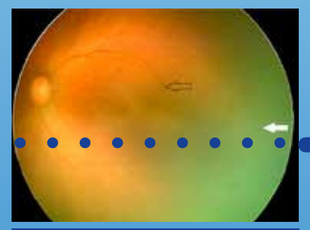
ROP in images: before and after screening

Sucheta Kulkarni
Medical Director and Head ROP services:
PBMA's H. V. Desai Eye Hospital, Pune, India

Tapas Padhi
Consultant: Retina Vitreous Services, Shri Mithu Tulsi Chanrai Campus, LVPEI, Bhubaneswar, India

No Retinopathy of Prematurity

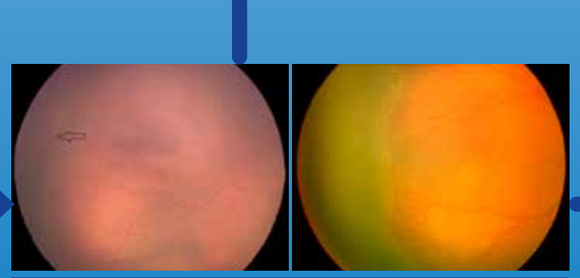


Immature blood vessels in the retina

No ROP. Blood vessels grow normally

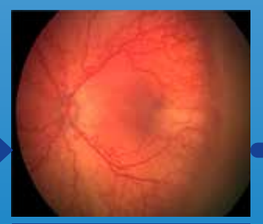
ROP gets better on its own and blood vessels grow normally

Post Laser ROP gets better. Sight is saved.



ROP starts to develop, stage 1 (left) & 2 (right)

ROP progresses to stage 3



Sight threatening ROP develops

Treatment by an experienced opthalmologist

Retinopathy of Prematurity

Blindness

Without treatment, ROP can progress to blindness

Table 1 Do's and Don'ts to prevent neonatal infections

Do's	Don'ts
Hand hygiene	Excessive use of antibiotics
Aggressive use of enteral feeds	Evasive ventilation
Restricted oxygen	Central lines
Bundles of care (eg. VAP, CLABSI)	
Optimal nurse : patient ratio	
Maternal participation	
Kangaroo care	
Good house keeping	

Conclusion

Neonatal nurses are pillars of the NICU. Their knowledge and clinical skills help in providing the best practices to prevent ROP in preterm babies. Nurses ensure that services for preterm and low birth weight (LBW) babies include timely eye screening and organisation of follow up services.

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Table 2 Ready reckoner for nurses in prevention and management of ROP

- Identify newborns at risk of ROP at admission to the NICU. Note the expected screening date and time on the case file.
- Encourage communication with the obstetrician for improving the coverage of antenatal steroid usage.
- Restrict oxygen use in the NICU. Monitor saturations in all babies on oxygen and set targets between 90 to 95%.
- Restrict usage and duration of antibiotics, intravenous fluids, parenteral nutrition and continuous positive airway pressure.
- Encourage mothers of preterm babies to use kangaroo mother care, continue with breastfeeding and aggressive enteral nutrition and developmentally supportive care.
- Co-ordinate with the neonatal and ophthalmology team in timely preparation of the newborn (pain relief and eye dilatation) for ROP screening.
- Monitor the newborn during the screening procedure.
- Play an active part in communication with the parents on screening outcomes and need for treatment when needed.
- At discharge brief the mother on the need for subsequent screening for ROP, hearing and neurodevelopment.
- Ensure follow up on schedule and become part of the extended family of every newborn.

The role of community health workers in prevention of blindness due to ROP

Sai Kiranmayee P
Consultant: Vitreo-Retinal Services, Pushpagiri Vitreo-Retinal Institute, Secunderabad, India.

Viswanath K
Chairman: Pushpagiri Vitreo-Retinal Institute, Secunderabad, India.

Muralidhar O
Director: Pushpagiri Vitreo-Retinal Institute, Secunderabad, India.

Community health workers can play an important role in health education and ante-natal care that will help reduce the number of preterm births. As members of their communities, they are best placed to advise and support parents and extended families in reducing the risk of ROP and visual loss.

PUSHPAGIRI VITREO-RETINAL INSTITUTE

ASHA workers visit a Special Newborn Care Unit (SNCU). INDIA

Preterm births are an important public health concern worldwide due to the resultant morbidities. Survival of premature babies has improved largely due to improved neonatal care services. However premature infants are at greater risk of cerebral palsy, developmental delays, hearing and vision related issues.

Retinopathy of prematurity (ROP) remains one of the leading causes of childhood blindness worldwide. Recent estimates show that worldwide 32,000 infants become blind or visually impaired due to ROP. Most of the ROP blind infants are born in countries in Asia.[1] Although the numbers seem insignificant, the number of blind years is huge, leading to an immense socio-economic burden to the family, society and country. Currently, ROP is a significant problem even in district and remote hospitals in rural India.[2] Community-based interventions help in reducing perinatal and neonatal morbidity and mortality.[3] The most promising short-term strategy for providing newborn care entails training and equipping community health workers.

Community health workers in India: role in ROP programmes

Community health workers are members of communities where they provide preventive, promotional and rehabilitation care to other members. The community health workers in India are

- Auxiliary nurse midwife (ANM)
- *Anganwadi* worker (AWW) and
- Accredited social health activist (ASHA worker).

They play a crucial role in the health care system especially in maternal and child health care and thus can help in prevention of blindness due to ROP.

Auxiliary nurse midwife

Commonly known as ANM, they are a village level female health worker who is the first contact person between community and health services. ANMs are regarded as the grassroots workers in health organisation pyramid.

Anganwadi Workers

Anganwadi centers are government run mother and child care center in villages in India. The anganwadi workers ensure antenatal and postnatal care for pregnant women, nursing mothers and immediate diagnosis and care for new born children. Monitoring regular health and medical check-ups for women and children is one of their key responsibilities.

Accredited social health activists

ASHA workers are local women trained to act as health educators and promoters in their communities. Their tasks include motivating women to give birth in hospitals, bringing children to immunisation clinics, encouraging family planning, treating basic illness and injury with first aid, keeping demographic records and improving sanitation.

Community health workers serve as a key communication pathway between the healthcare system and the rural population, especially in reducing preterm deliveries and in prevention of ROP in babies born too soon. Preterm deliveries can be reduced by working on modifiable risk factors such as maternal nutrition, pregnancy planning, birth spacing etc. ROP blindness can be reduced by expanding and improving screening and treatment services at medical colleges and district hospital sick newborn care units (SNCUs) and neonatal intensive care units (NICUs). The community health workers play a key role in preventing ROP blindness in three different stages:

- Reducing preterm deliveries
- Prevention of ROP in preterm babies
- Screening and treatment services for ROP

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Role of community health workers in prevention of ROP blindness

1. Reducing preterm deliveries

a. Child marriages and early pregnancy

Child marriage has lasting consequences on girls, from their health, education and social development perspectives which often last well beyond adolescence. It has been found that teenage mothers are three times more likely to deliver preterm babies and twice as likely to deliver low birth weight (LBW) babies compared to older mothers (21 Yrs to 34 Yrs).[4] Health workers, especially in rural areas can counsel newly weds and public about such age-old harmful practices.

b. Birth spacing

It is likely that when the space between births is short, there will be depleted nutrition in new mothers, as these women do not get enough time to recover before getting pregnant again. Therefore, after a birth, the interval before attempting a new pregnancy should be at least 24 months to reduce the risk of adverse maternal and infant outcomes.[5] Community health workers can explain that optimally spaced births reduce the infant and maternal morbidity and mortality. They can help in educating their communities about different family planning methods and encourage their use for optimal birth spacing.

c. Maternal nutrition

Maternal undernutrition is still a major problem in India. In populations with food insecurity and high rates of maternal undernutrition, balanced protein energy supplementation may improve foetal growth and reduce the risk of foetal and neonatal death.[6] Community health workers can monitor and advise on proper dietary intake of balanced energy and protein contents. As anaemia is more common in rural women, iron supplements may be provided to them. The health workers may provide periconceptual folic acid supplements which help in reducing neural tube defects, preterm births and low birth weight. As village health workers are trusted by friendly pregnant women, they can monitor and guide them about their diet and nutritional supplements from time to time.

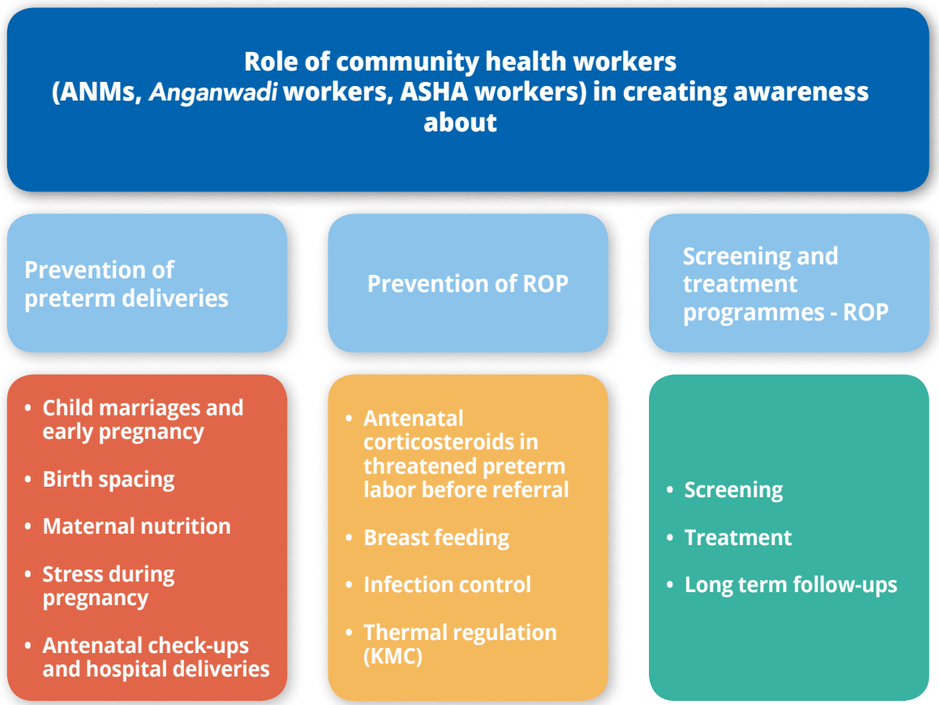
d. Stress during pregnancy

Prenatal maternal stress, depression and anxiety are found to be related to preterm labour.[7,8] A community health worker can explain to the spouse of the pregnant woman and their family members about the ill effects of domestic violence on the outcome of pregnancy.

e. Antenatal check-ups and hospital deliveries

ASHA workers can help in educating pregnant women about regular antenatal check-ups and the importance of periodic follow-up. This aids in monitoring for hypertension, diabetes, infections etc, which if properly managed may reduce preterm deliveries. The community health workers play a role in birth preparedness which consists of preparing the mother, family and community for delivery and potential complications. They should encourage and increase the percentage of hospital deliveries which are safe for the mother and child.

Figure 1 Role of community health workers



2. Prevention of ROP in a preterm infant

With a preterm birth, the focus shifts to prevention of ROP and other morbidities. A well- trained health worker anticipates and prepares to minimise the morbidities that may ensue. Risk factors like poor weight gain, infection etc if tackled properly can prevent ROP related childhood blindness.

a. Antenatal corticosteroids (ANC) in threatened preterm labour

A significant reduction in the risks of mortality, respiratory distress syndrome and intraventricular haemorrhage have been confirmed after administering antenatal steroids in babies delivered before before 34 weeks gestation.[9] ANMs who are skilled birth assistants should be guided on giving ANC to pregnant women in preterm labour. Guidelines include diagnosis of preterm labour, indications, contraindications and doses of ANC. Thus, the health workers help in prevention of ROP by giving prereferral dose of steroid and arrange for referral to an appropriate facility.

b. Breastfeeding

It has been found that exclusive breastfeeding for six months starting within an hour after birth may prevent ROP. Health workers can help in explaining to mothers the importance and advantages of exclusive breast feeding. There are several significant short term and long term benefits of breastfeeding preterm infants. Neurodevelopmental outcomes are also proven to improve with early and exclusive breastfeeding.[10] The health worker can also be trained to check for proper weight gain.

c. Infection control

As sepsis in preterm infants leads to increased risk of ROP, infection control procedures like personal hygiene can be clearly explained to mothers. Small yet significant measures such as bathing regularly and washing all clothes used for the baby can be easily explained to the mothers in the local language. Educating family members along with the mother on washing hands thoroughly before touching the baby and keeping surroundings clean help in keeping infections under control.

Sensitisation of ASHA workers. INDIA

PUSHPAGIRI VITREO-RETINAL INSTIT

d. Thermal care

Hypothermia is another concern in the management of pre-term infants. Kangaroo mother care (KMC) involves direct and continuous skin to skin contact between infant and mother. It helps in preventing hypothermia, improving weight gain and reducing incidence of infection. The procedure and benefits of KMC when explained clearly to the mothers, help in improving survival and decrease ROP. Along with KMC, the ASHA workers can also show proper swaddling of babies and keeping babies warm.

Continues overleaf ➤

3. Screening and treatment programmes for ROP

a. Screening for ROP

Community health workers should be made aware that all the babies born too soon (<34 weeks) and small (<2000grams) who have been admitted to SNCU/NICU should undergo first eye screening for ROP before 30 days of birth. They are best placed to motivate parents to take their preterm infant for ROP eye screening to a trained ophthalmologist nearest to them. Educating parents about the disease with the help of visual aids like flash cards or posters of the disease and how it leads to blindness helps in reaching out to illiterate population in a better way. Health workers can also encourage parents to take the baby for ROP screening before they are 30 days old.

b. Treatment

Community health workers can help parents understand that ROP is a disease with a narrow time period between detection and treatment and that treatment cannot be delayed. Counselling parents and their families about laser photocoagulation can also be done by a community health worker.

c. Long term follow-up

The most common challenge faced in management of ROP is lack of compliance and follow-up. Though the initial screening is done when the baby is in NICU, parents especially in rural areas do not come back for follow-up. As ROP is a disease which requires multiple visits the ASHA workers can help in tracking pre-term infants in their communities and motivating parents to go for follow up visits. Educating parents about long term effects a pre-term birth can have on the eyes is also important, to encourage them to attend for follow up. Simple language must be used in training the ASHA workers so they can effectively counsel parents.

Conclusion

Community health workers can play an important role in health education and ante-natal care that will reduce the number of premature babies born. They also have an important role in advising and supporting the mothers of preterm babies in order to reduce the risk of ROP and visual loss.

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ASHA workers observing ROP screening. INDIA

Innovations in technology and service delivery to improve Retinopathy of Prematurity care

Anand Vinekar
Programme Director: KIDROP, Professor & HoD: Department of Pediatric Retina Narayana Nethralaya Eye Institute, Bangalore, India.

Pramod Bhende
Director: Shri Bhagwan Mahavir Department of Vitreo Retinal Services, Sankara Nethralaya, Chennai, India.

A novel method of using mobile screening by non-physician imagers can address a key challenge of lack of ROP specialists in the South Asia region.

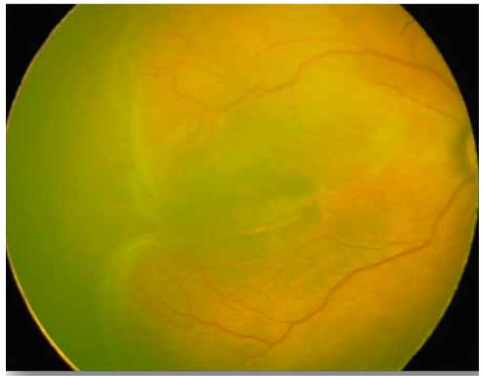
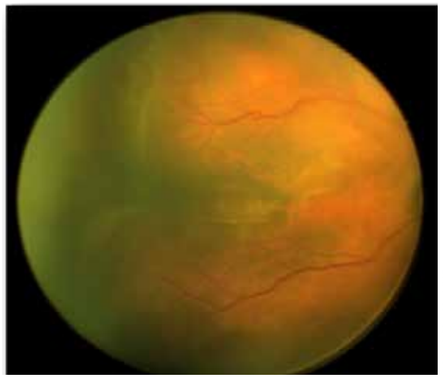


Figure 1A RetCamShuttle (Natus USA) image of Stage 3 ROP in the right eye. The image is rectangular due to the 1800 x 1600 sensor of the camera.



KIDROP PROGRAMME

Figure 1B Neo (Forus Health, India) camera of the same eye showing a 2040 x 2040 square image with an additional superior and inferior retinal arc.

Improved neonatal care, enhanced preterm survival and a proliferation of neonatal units in middle-income countries has resulted in a steep rise in the number of infants requiring screening for ROP. Unfortunately a gross lack of specialists has resulted in a large gap in the demand and supply equilibrium. A novel method of 'task shifting' using mobile screening units manned by non-physician imagers has tried to address this challenge (pp. 9–10). However, there is an unmet deficit that requires innovations in technology and service delivery that can enhance affordability, accessibility and availability of these services even in remote regions. This article focuses on some of these resources especially in the context of middle-income countries.

Affordable technology for ROP screening

The infant retinal camera of choice for ROP imaging has been the RetCam (Natus USA, formerly Clarity MSI, USA). The portable version of this camera, i.e. the "Shuttle", has been successfully used to provide ROP screening even in challenging rural conditions in India. A single unit can travel several thousand kilometres in a single week, screening in several units spread across a geographically defined zone. Despite a successful, impactful and scalable working model, the roadblock for larger replicability has been the cost of the camera which is over USD 125,000 in India.

Recently, an indigenously invented wide-field camera from India for ROP screening, the "3Nethra Neo" has become available for commercial use.[1] The camera provides a 120-degree field of view, is a contact camera with a single, monolithic, hand-held probe. The innovative liquid lens is integrated into the hand-piece and does not require to be removed after each session. The illumination source is a patented warm LED light which has been tested for safety. The image resolution is 2040 x 2040 (compared to 1800 x 1600 of the RetCam) and results in a square image which provides an extra arc of the superior and inferior retina which would be cropped out in the rectangular image of the RetCam (Figure 1A and 1B).

In a pilot study, the "Neo" was evaluated as a ROP screening tool by comparing it with images from the RetCam. Two masked observers reported the diagnosis and decision in over 128 infants, which gave good sensitivity (ability to identify cases) of 97-99%, and good specificity (ability to identify normal eyes) of 75-81%. The study has subsequently been expanded to include over 1,200 infants and the results are encouraging.

From the community aspect, the advantages of the Neo are: first, the cost. Currently, in the Indian market, the Neo is one-sixth the cost of the RetCam and with increased demand the price is likely to reduce further. Second, it is smaller and portable, (Figure 2) allowing easier transport (including a two-wheeler) in rural areas and between centres. Third, the Neo has an

Continues overleaf ➤

inbuilt software that allows automatic upload to online servers even in low bandwidth areas, allowing seamless integration into a tele-medicine platform.

With the ubiquitous nature of the smart phone even in rural areas, we are hopeful that in the near future, companies will develop wide-field imaging lens attachments that would allow us to use the mobile phone for ROP screening.

Online training and e-certification platforms

One of the limitations in scaling up a tele-ROP programme is the lack of a uniform accreditation for imagers. With increasing numbers of "imaging-for-ROP-screening" adopters, it becomes imperative to create trained and accredited imagers who comply with regulatory as well as clinical criteria. Online training modules is one possible solution. For example the 90 working day training of the KIDROP programme (Bangalore, India)[2] has now become available as an e-learning platform, "WISE-ROP" (Wide-field Imaging for Screening and Education for ROP). Imagers read and undergo self-assessment quizzes at the end of each module. Video sessions and viva voce to correct the technique and practical difficulties are scheduled with an assigned mentor. Graded levels of skill are sought and tested before a certificate is awarded to these new imagers. A report evaluating a tele-ROP programme based on the Center for Disease Control (CDC, Atlanta) guidelines has provided the desired credibility for adopting tele-medicine not only in developing countries, but also in developed nations like Australia.

KIDROP PROGRAMME

Figure 2 The RetCam Shuttle (left) and the Neo ROP camera (right) adjacent to each other showing their relative sizes.

Software innovations and artificial intelligence

Once retinal images are uploaded on to the server, in the current scenario, experts have to review most of them before either providing or confirming the diagnosis. Given the limited number of experts, this could become an important roadblock as an increasing number of centres switch to image-based screening. Innovations in automated software algorithms are becoming refined to bridge this gap. Disease severity detection, enhancing clinical features of 'poor quality' images (Figure 3) and image processing tools to enhance vascular details non-invasively (Figure 4) are now getting integrated into the imaging platform.[3] With artificial intelligence algorithms already showing promise in other ophthalmic diseases, codes to predict, prognosticate and influence follow-up and management in ROP are in the pipeline.

Figure 3 Image processing of a RetCam image using RetiView software that highlights the edge of the disease, the severity of the plus and the elevation of the traction in a case of aggressive posterior ROP (APROP).

KIDROP PROGRAMME

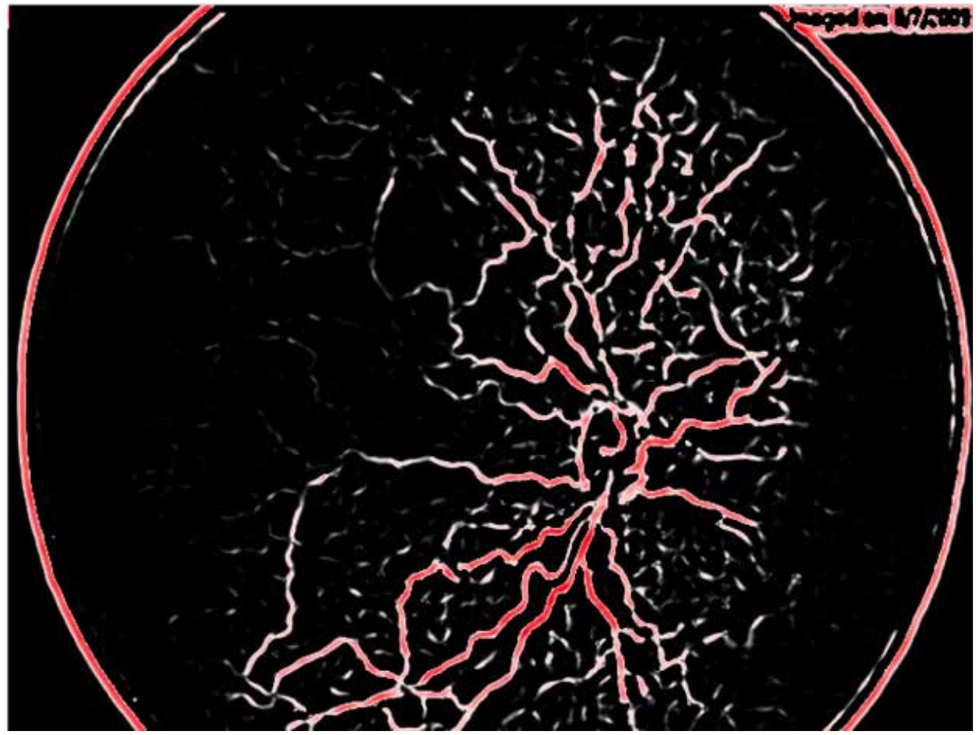
Novel service delivery methods

New models of health delivery participation between ROP skilled private institutes or individuals and the government under a 'public-private-partnership' or PPP scheme should be encouraged. This has the advantage of state funding combined with private expertise which can be integrated into the country's public health system. Government support has played a major role in promoting ROP tele-health in Mexico, New Zealand and Brazil.

Gilbert et al[4] suggested another paradigm shift in ROP screening which involves replacing the ophthalmologist-led model with a pediatrician/neonatologist-led model where there is a shortage of ophthalmologists. Neonatologists would monitor their trained nursing staff using a portable low-cost camera to image the babies and an ROP specialist would give an opinion remotely and visit the centre for treatment alone.

Integrating ROP screening with universal eye screening, using imaging is being practiced in parts of India and China. This model serves a larger population of infants and thus, reduces screening costs.

Figure 4 A non-invasive vascular map using the RetiView algorithm which helps the clinician detect smaller capillaries anterior to the clinically visible posterior border of vascularization on the fundus image.



KIDROP PROGRAMME

Creating stronger surveillance

ROP has gained medical and legal significance in recent years. After a landmark judgment in 2015 by the Supreme Court of India effectively making ROP screening mandatory, surveillance of ROP screeners and treatment providers has become even more important. The National Task force of ROP in India is now an apex body that regulates and promotes such activity. The Indian Retinopathy of Prematurity (iROP) Society,[5] which comprises of ROP skilled ophthalmologists have united to collaborate on best care practices that are ethical, evidence-based and address local needs.

Conclusion

Innovations in ROP management are constantly improving the accessibility, affordability and availability of care for these tiny and precious babies.

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Evolution of ROP screening at Aravind Eye Hospital, Coimbatore - Lessons learnt and the way ahead

Parag K. Shah
Consultant: Department of Pediatric Retina & Ocular Oncology, Aravind Eye Hospital & Post Graduate Institute of Ophthalmology, Coimbatore, India.

V. Narendran
Chief Medical Officer: Department of Pediatric Retina & Ocular Oncology, Aravind Eye Hospital & Post Graduate Institute of Ophthalmology, Coimbatore, India.

N. Kalpana
Senior Medical Officer: Department of Pediatric Retina & Ocular Oncology, Aravind Eye Hospital & Post Graduate Institute of Ophthalmology, Coimbatore, India.

Through Aravind ROP Tele-screening Project called Retinopathy of Prematurity Eradication Save Our Sight (ROPE-SOS), 8117 babies were screened and 127 babies were treated between 2015 and 2017.

ARAVIND EYE CARE SYSTEMS

Figure 1 ROP trainee practising indirect laser on RetiEye.

ROP in India

According to World Health Organization (WHO) report, there are 15 million preterm births (<37 weeks) per year in the world, and annually India has the largest number of premature babies (3,59,100).[1] With improving economies, the neonatal care facilities are also improving and consequently survival rate of premature babies has increased. With a birth rate of 23 per 1000 population and about 12% of infants being born prematurely in India, it is estimated that incidence of ROP is 20-30%.[2] India also has a highest risk of ROP blindness due to sub-optimal neonatal care and lack of screening facilities.[3] ROP is rapidly becoming a public health issue as the screening and treatment services are estimated to be 30% lower than the present need.[4]

ROP services at Aravind Eye Hospital, Coimbatore

ROP screening was started at Aravind Eye Hospital, Coimbatore in the year 2000 by the paediatric ophthalmology department. Initially screening started covering a single neonatal intensive care unit (NICU) once a week. Babies who needed laser treatment were treated with green laser (532 nm). From 2002 the retina department took over the ROP screening services and since then, on a weekly basis a retina specialist visited the NICU. From 2003 more NICUs were added and currently Aravind Hospital covers eight major NICUs in Coimbatore.

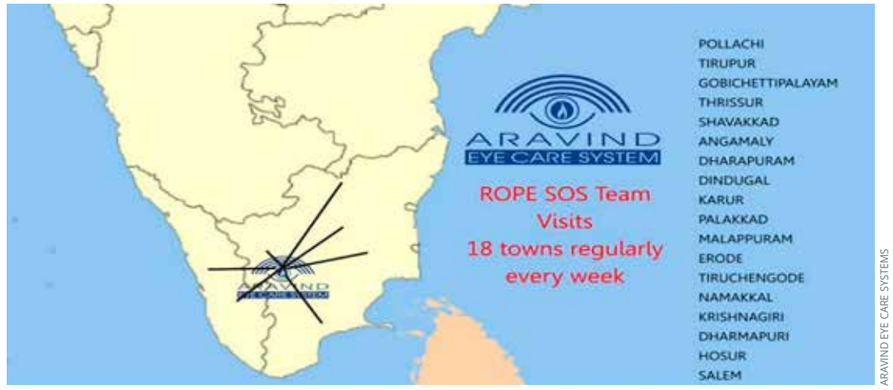
Aravind Coimbatore was the first institute in India to get the RetCam 120 digital fundus imaging camera in 2003 and infra-red diode (810 nm) laser was also added in the following year. Use of intra-vitreal injection of anti-vascular endothelial growth factor (VEGF) was introduced in 2006. As the number of ROP cases increased over a period of time, a separate Paediatric Retina Clinic was inaugurated. A month-long ROP training programme was initiated, wherein candidates are trained to examine infants using indirect ophalmoscopy and practice indirect laser on the RetiEye Model eye (Aurolab, Madurai, India) (Figure 1). So far 54 candidates from India and abroad have been trained under this programme, 41 from India, five from African countries and eight from a variety of other countries.

To serve the unreached in rural areas, Aravind ROP Tele-screening Project called Retinopathy of Prematurity Eradication Save Our Sight (ROPE-SOS) was launched in August 2015. The project aimed to screen 2000 babies per year in the sub-urban and rural areas. Technicians are trained to capture fundus images of pre-term babies with help of digital retinal camera (RetCam). The team comprises of one manager, two trained technicians, one mid-level ophthalmic assistant and a driver. The team covers 56 NICUs of 18 cities in 12 districts of Tamil Nadu and Kerala (Figure 2). The team visits scheduled district hospital NICU on specified days in a customised van with a RetCam shuttle. The technicians enter the details of the babies in RetCam and obtain fundus images. The digital images of the fundus are then transmitted to the base hospital through broadband internet.

The indigenously developed Aravind Diabetic Retinopathy Eye Screening (ADRES) software is used to transmit these images. The ADRES software was modified for ROP. At the base hospital, images are graded by a ROP expert (retinal specialist) and the report is sent back immediately to the NICU. The 4G network (which is now available in remote parts of India) is used to transfer these images. The family is explained about the baby's eye status and given a follow-up date. The whole process for screening and counselling parents takes about 12-15 minutes per baby. If a baby requires treatment and if the baby is stable systemically, the baby is transferred to Aravind Eye Hospital Coimbatore for management. If the baby is not stable for distant travel, the ROP expert visits the NICU within three days to provide treatment. With the help of tele-screening, various other eye conditions like cataract, corneal opacity and even retinoblastoma have been diagnosed and promptly managed by early referral.

Through this mode of screening from August 2015 to June 2017, 8117 babies were screened and 127 babies were treated. By including anterior segment photography 10 babies underwent cataract surgery which was diagnosed by tele-screening.

Figure 2 Cities covered in the states of Tamil Nadu and Kerala under the ROPE-SOS Tele-screening project.



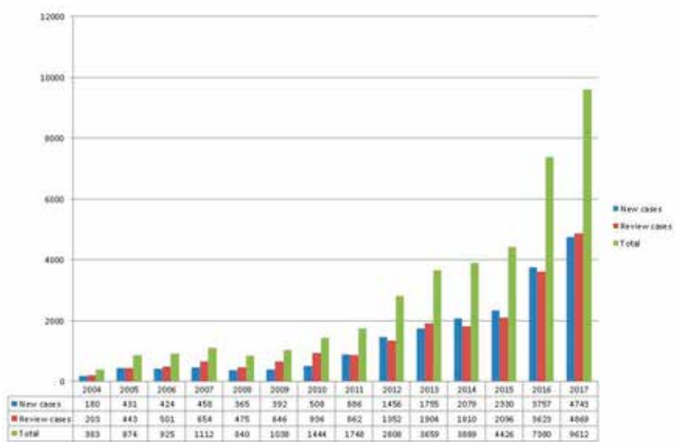
ARAVIND EYE CARE SYSTEMS

With this process about 127 babies were prevented from going blind due to ROP in the last two years. The total growth of ROP screening from 2003 to 2017 is shown in Figure 3. As part of the ROPE-SOS project, awareness of ROP and the importance of screening is spread by means of continued medical education (CME) programmes conducted in the districts screened. The CME programme spreads awareness of ROP, the impact of external factors like oxygen on disease, the ideal time for screening and indication for screening. The neonatal nurses and neonatologist are targeted in all CME programmes. So far CME programmes were held in 11 cities sensitising 711 NICU staff. Of these 233 were nurses and 31 were paediatricians and neonatologists. Patient information posters and brochures were displayed and distributed widely. With the success of ROPE SOS project, it is now being replicated at Aravind Eye Hospital, Tirunelveli. Vitrectomies for advanced ROP are done using the 25 or 27 gauge instruments. With lack of surgical training in ROP, a one year long term Surgical Paediatric Retina Fellowship was also launched in 2016.

Conclusion

The journey of starting ROP services at Aravind Eye Hospital, Coimbatore has been quite satisfactory and with the tools for screening and management in place, mentoring other upcoming institutes in India and abroad is on-going. Developing automated diagnosis of ROP using computer assisted deep learning is the next goal.[5]

Figure 3 Bar diagram showing a steady increase in ROP cases in Aravind Eye Hospital, Coimbatore over a period of 13 years (2004 – 2017).



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Retinopathy of prematurity in Bangladesh: an overview

Nazmun Nahar
Associate Professor: Ispahani Islamia Eye Institute and Hospital

Sarat Adolore Badmus
Fellow Paediatric Ophthalmology: Ispahani Islamia Eye Institute and Hospital

Sanjoy Kumer Das
Consultant: Ispahani Islamia Eye Institute and Hospital.

Mohammad Ibn Abdul Malek
Consultant: Ispahani Islamia Eye Institute and Hospital.

Mostafizur Rahman
Senior Consultant: Ispahani Islamia Eye Institute and Hospital.

Mohammad Abdul Mahid Khan
Senior Consultant: Ispahani Islamia Eye Institute and Hospital.

National ROP guidelines, database for monitoring, evidence-based policy making, and provision of infrastructure and equipment are critical to prevent a ROP epidemic in Bangladesh.

IIEI&H

IIEI&H ROP team with Retcam. BANGLADESH

Bangladesh is the eighth most populous country in the world and currently a lower middle income country.[1]The improvement in the country's economy has led to a visible improvement in its neonatal care. As more premature babies now survive, the incidence of retinopathy of prematurity (ROP) is also on the rise. This improvement in neonatal care, which is sometimes suboptimal because of limited facilities and manpower contributes to the current epidemic of ROP in Bangladesh.

Approximately 3.75 million infants are born in Bangladesh each year. About 25,000 of these weigh 1,500 grams or less (and hence at risk for ROP).[2] From our experience, even bigger babies may be at risk because of inadequate monitoring of oxygen and difficulty with management of perinatal complications.

IIEI&H

ROP screening at IIEIH. BANGLADESH

One of the earlier studies for ROP in Bangladesh included preterm infants of gestational age <33 weeks between December 1998–July 2003, and found an incidence of 5.5% (five babies) in 114 babies, all presenting at various stages.[3] Another study assessed the presence of ROP and potential risk factors other than supplementary oxygen in premature infants ≤34 wks and or ≤1500g, and detected ROP in 40% of cases (23 out of 58).[4] Before 2010, screening for ROP was almost non-existent. Between 2010 and 2012, basic services were available for screening and laser treatment in only two centres, namely the Ispahani Islamia Eye Institute and Hospital (IIEI&H), and National Institute of Ophthalmology (NIO) in Dhaka. Only 55 babies were examined during this period at IIEI&H, of which 30% required laser treatment. Seven babies at presentation had stage V ROP, with total retinal detachment, which carries an extremely poor visual prognosis. In 2013, ORBIS International in collaboration with IIEI&H organised a stakeholders' awareness and sensitisation programme for neonatologists and other personnel. This support from ORBIS included human resources development, infrastructure and equipment. The goal of the collaboration was to ensure that no premature baby would be left out of the screening net in the NICUs of Dhaka within the next five years.

Through this programme, three retina specialists were trained in ROP at the LV Prasad Eye Institute (LVPEI) in India. ORBIS also supported the training of a ROP programme manager and technicians. The ROP programme manager is responsible for communication between the NICUs and ROP team of IIEI&H. According to a protocol, the ROP team visits NICUs to screen and treat babies before discharge. This collaboration has led to an increase in the number of babies screened. It has also reduced the proportion of babies with blinding ROP at presentation.

Currently, there are 20 NICUs in Dhaka and only three are government owned. In a survey carried out by ORBIS in 2014 at 12 NICUs of Dhaka, 2962 preterm infants were managed over a six-month period in 2014. IIEI&H screens ROP babies who are referred to the hospital from the NICU centers, and additionally performs on-site screening at three NICUs. At IIEI&H, babies with gestational age of less than 35 weeks and/or birth weight (BW) of less than 2000g are screened. Babies outside these criteria adjudged to be at risk of ROP by the neonatologist are also screened.

Results

Between January 2013 and March 2017 staff in IIEIH screened over 2000 preterm infants. 40% of the babies had birth weight (BW) between 1500- 2000g and 38% had BW < 1500g (Figure 1).

About a third of these babies had different stages of ROP. Stages 1 and 2 constituted 45% of the ROP cases, stage 3 was 23%, stage 4 was 5% and stage 5 was 9%.

Figure 1 Total babies screened.

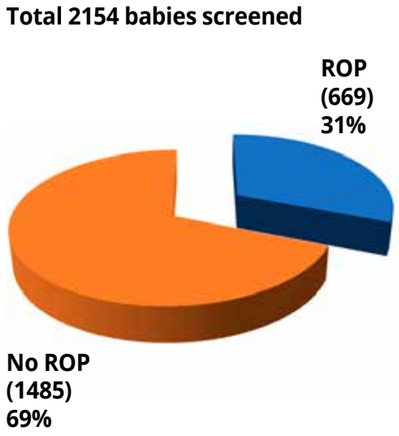
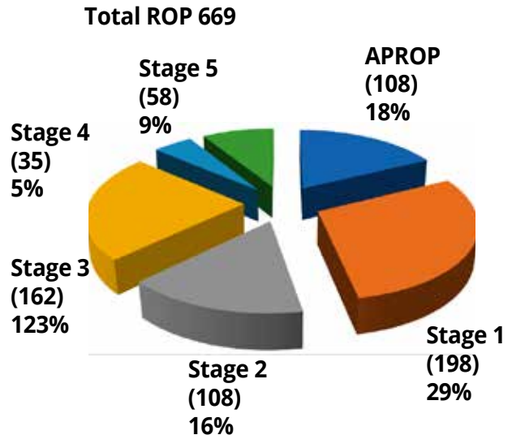


Figure 2 Distribution of ROP.



Aggressive posterior ROP occurred in 18% of all ROP cases seen at this center (Figure 2). During this period, 274 babies have been treated with laser, 69 with intraocular bevacizumab injection and 53 babies have had ROP surgery for stage 4 or 5 ROP.

The mean gestational age of babies with ROP was 31.09 ± 2.28 weeks (range: 26-36 weeks) and mean birth weight was 1354.13 ± 266.38g (range: 700 -1900g). Even though our screening protocol is for babies to be screened between 20 and 30 days after birth, the mean chronological age at screening is unfortunately still very far from ideal (mean 46.63 ± 25.37 days, range: 20-150 days).

Existing challenges

The current staff in Bangladesh includes three retinal surgeons who are proficient in ROP surgery, and 16 ophthalmologists who can diagnose and treat ROP. Four other ophthalmologists who can only screen for ROP are in districts outside Dhaka.

Five centers have equipment for laser treatment and two centers offer ROP surgical services. All these centers are located in Dhaka and are either private or NGO driven. The only RetCam in Bangladesh is in IIEI&H.

Lack of adequate trained human resources, infrastructure and equipment are major challenges. Level of awareness is still low, especially outside Dhaka. A greater level of participation from the government, better coordination between the existing centers and increased awareness of the condition, especially about the appropriate time of referral are the need of the hour.

Future strategies

ROP training is now incorporated into retina and paediatric ophthalmology long-term fellowship programmes at IIEI&H. Short term training in ROP management is also available for ophthalmologists. We hope to develop a national ROP screening guideline in conjunction with relevant stakeholders. A national database on ROP for monitoring and evidence-based policy which will be owned by the government for continuity is imperative. We look forward to government participation in the area of infrastructure and equipment provision. Current stakeholders (both private and non-government) should aid future government programmes in light of current achievements and failures in management of ROP. There should be adequate incentives for all levels of personnel involved to sustain morale and encourage specialists at the district level.

Conclusion

ROP is rapidly attaining public health significance in Bangladesh. There is a significant gap between the increasing need and the limited resources. The current efforts are mainly driven by the private and NGO sectors. More government involvement and commitment is required for a nationwide sustainable programme.

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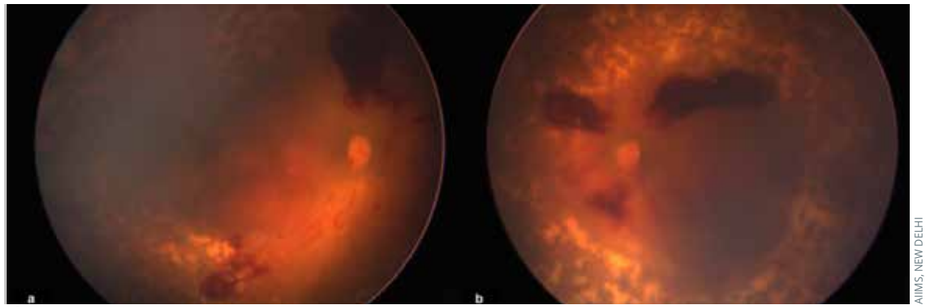
The restless retina in aggressive posterior retinopathy of prematurity: prevention is better than cure

Aggressive Posterior Retinopathy of Prematurity (APROP) is a severe variant of ROP that usually affects the smallest and sickest babies. Following the best neonatal care practices is a good way to prevent it.

Parijat Chandra
Additional Professor of Ophthalmology: Dr Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India.

Ruchir Tewari
Senior Resident (Ophthalmology): Dr Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India.

Shreyans Jain
Senior Resident (Ophthalmology): Dr Rajendra Prasad Centre for Ophthalmic Sciences, All India Institute of Medical Sciences, New Delhi, India.



AIIMS, NEW DELHI

Figure 1 Fundus images of the right (a) and left (b) eyes showing very small zone 1 ROP with poor vascularised macula, plus disease, sub-hyaloid hemorrhages and peripheral laser spots.

A 34 weeks-old male baby with history of bilateral laser photocoagulation for zone 1 aggressive posterior retinopathy of prematurity (APROP) and disease progression was treated with bilateral intravitreal injection of half adult dose Bevacizumab (0.625mg/ 0.025ml). After an initial favorable response, the disease recurred and gradually progressed to stage 4A ROP with tractional retinal detachment (TRD) in both eyes necessitating surgical intervention. This case study highlights the relentless course of severe APROP, a disease which can be effectively prevented by good NICU practices.

Introduction

Aggressive Posterior Retinopathy of Prematurity (APROP) is a severe variant of ROP that usually affects the smallest and sickest babies. It manifests as a relentless progressive retinopathy that occurs due to arrested vascularisation limited to very small areas of the retina (zone 1 or zone 2 posterior). This often leads to progressive retinal detachment despite treatment. APROP usually occurs due to poor neonatal care practices, notably exposure to unregulated oxygen for prolonged periods. Laser photocoagulation of the avascular retina has been the mainstay for ROP treatment, but recently anti-VEGF drugs have emerged as an alternative treatment in APROP, despite the safety concerns.

This case highlights the challenges associated with APROP, a disease which is difficult to control, and requires a multipronged treatment approach over a prolonged follow up period. The report stresses the need for better neonatal care which can prevent development of APROP and avoid the challenges for its treatment.

Case Report

A male baby was born at 29 weeks gestational age with birth weight of 1100g. The baby's twin did not survive. The baby suffered from neonatal sepsis and apnea that required a stay at neonatal intensive care unit (NICU) for 33 days. Supplemental oxygen was given to the baby for a duration of 20 days including three days of continuous positive pressure ventilation in the NICU. Blood transfusions were performed twice. As per records, timely screening was performed at 32-week post menstrual age (PMA). The ophthalmologist noted a poorly dilating pupil, a small zone of vascularisation and presence of dilated and tortuous vessels at the posterior pole suggestive of zone 1 APROP. Uneventful laser photocoagulation of anterior avascular retina was performed using 532nm green laser, but the disease worsened and the child was referred to us for management.

Figure 2 At PMA 41 weeks, good disease regression is observed in both eyes (a, b).

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At 34 weeks PMA, the pupils were still poorly dilating. Fundus examination revealed a very small zone 1 APROP, with media haze and markedly dilated and tortuous vessels indicating severe plus disease with patches of sub-hyaloid bleed in both eyes (Figure 1). Intravitreal Bevacizumab (0.625mg/ 0.025ml – half adult dose) injections were given in both eyes under aseptic conditions in the same sitting in the operation theater

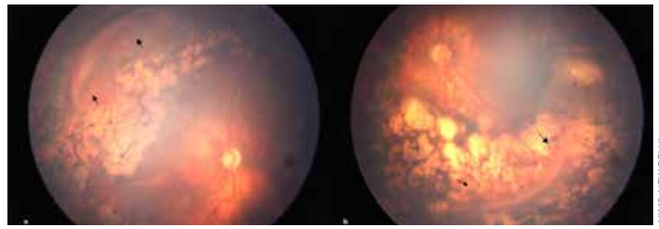

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Figure 3 At 50 wks PMA, developing recurrence of plus disease with progressive FVP and TRD (black arrows) in the laser treated regions in both eyes (a, b).

pupillary dilation, improved media clarity, significant reduction in plus disease and partial resolution of the sub-hyaloid bleed. 7 weeks after injection (PMA 41 weeks), good disease regression was observed in both eyes (Figure 2).

However, at 48-50 weeks PMA, both eyes started developing dilation and tortuosity of vessels (plus disease) with progressive fibrovascular proliferation (FVP) and tractional retinal detachment (TRD) suggestive of stage 4A ROP (Figure 3). At 54 weeks PMA, bilateral

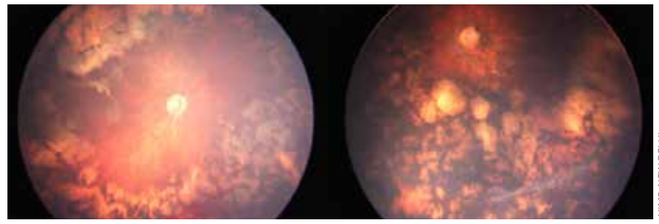

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Figure 4 One month after LSV in both eyes, resolution of plus disease and regression of FVP is noted in both eyes (a, b).

25G suture-less lens sparing vitrectomy (LSV) was performed. One month later, both eyes showed near complete disease regression (Figure 4). At the last follow up, the retina was attached with no evidence of retinal traction. The parents were counselled regarding a need for close and long term follow up for retinal status and detection of refractive errors.

Discussion

This case study demonstrates the aggressive disease in APROP, a severe ROP variant which required treatment with laser, anti-VEGF drugs and surgery in both eyes, a prolonged follow up with active treatment over a period of months in a sick preterm baby.

Emerging role of Anti-VEGF drugs in APROP

Laser treatment of avascular retina has been the gold standard for ROP treatment.[1] However, laser treatment scars the avascular retina with limited prospects of further retinal growth. In small zone 1 ROP/APROP, this can lead to constriction of visual fields and high incidence of severe myopia. Anti-VEGF drugs like Bevacizumab/Ranibizumab are now emerging as a good alternative treatment in zone 1 ROP. The BEAT ROP[2] study showed significantly better outcomes of Bevacizumab in cases of zone 1 ROP compared with laser, with decreased chances of recurrences and progression of normal retinal vascularisation, leading to future prospects of better visual fields.

Anti VEGF pharmacotherapy also has the added benefit of lesser incidence of high myopia,[3] but is often complicated by delayed recurrences requiring much longer follow up, and laser treatment may be needed. The ideal dose for preterm babies, choice of Anti-VEGF drug, the role of multiple injections, and long-term safety (due to systemic absorption and VEGF suppression) still remains unclear due to lack of relevant data.[4]

Anti-VEGF agents are especially useful in cases with severe plus disease with rigid non-dilating pupils, where laser treatment is not possible. It leads to rapid pupillary dilation in a few days, that allows laser treatment to be completed. Currently, many use them as adjunct before or after laser treatment as well.

Multimodal treatment for APROP

The diagnosis of zone 1 APROP needs a high index of suspicion because of a featureless vascular-avascular junction and avascular loops, which confuse the observer. Indeed, prompt aggressive treatment is warranted as the disease can progress rapidly. Multiple treatments are needed with laser or Anti-VEGF drugs, or a combination of both, but the outcome is unpredictable. Our case had delayed recurrence despite combined treatment, and quickly progressed to retinal detachment needing surgical treatment. However, timely surgical management in developing countries is still difficult due to lack of advanced vitreoretinal surgical setups; experienced paediatric retinal surgeons and; trained anaesthesia teams willing to provide general anaesthesia to such small babies. Such services are scarce and available in very few apex eye care facilities.

ROP Prevention is better than cure

It is well known that implementation of best neonatal practices and simple measures like strict regulation of oxygen delivery can prevent development of severe ROP.[5,6] In fact, absence of zone 1 APROP is considered an important marker of quality neonatal care. But poor NICU care across the country is leading to severe ROP developing in even larger babies.[7] This has led to repeated changes in screening guidelines to include these bigger babies as well. Lack of proper screening and treatment facilities, adds to increase in the number of cases with ROP blindness. Thus, it is recommended to follow the best neonatal care practices to prevent ROP and especially APROP.

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Counselling and co-opting parents to get best outcomes

Subhadra Jalali
Deputy Director: Newborn Eye Health Alliance (NEHA) and Director, Quality: LV Prasad Eye Institute, Hyderabad, India.

Divya Bala Krishnan
Consultant: Srimati Kannuri Santhamma Centre for Vitreoretinal Diseases and Jasti V Ramanamma Childrens Eye Care Centre, Kallam Anji Reddy Campus, L V Prasad Eye Institute, Hyderabad, India.

Timely, realistic and appropriate counseling of parents and making them a part of the team at each step is a critical way to get the best vision for the baby.

Retinopathy of prematurity is one of the leading causes of preventable blindness in preterm babies. The number of preterm deliveries is increasing. Although the survival of these preterm babies is on the rise due to better and more accessible neonatal care, the situation leads to a period of great stress to family members. This includes emotional, monetary, physical and logistical stress to those involved in giving care to the fragile baby (Figure 1).

In such a situation, the ophthalmology care team has to provide the best possible vision and least ocular morbidity. The main factors in preventing blindness due to ROP are timely screening and treatment, as this is a time-bound disease. The disease occurs in at-risk babies around three to four weeks after birth. A timely screening (between 20-30 days after birth) will help in detecting any sight threatening ROP. Very close follow up, sometimes every three to seven days is needed during this time which requires close coordination between all stakeholders.

Major factors that need to be tackled at various levels to prevent ROP blindness are discussed below:

Factors responsible for delayed screening of preterm babies for ROP are:
(Table 1)

Factors responsible for delay in treatment and non-compliance to follow up are:

- Non-availability of ophthalmologists trained in laser or surgical treatment.
- Delay in initiating treatment even after detecting treatable disease, due to financial and logistic constraints. Most often parents have to travel a long distance with babies to reach specialist doctor for treatment. The expenditure for two to three attendants who may have to accompany the baby becomes unaffordable. This is especially after having spent a major amount of money for NICU care.
- Ignorance among parents regarding the need for regular and long-term follow up and the threat to sight if the treatment is delayed.
- Unlike other diseases, the symptoms of vision loss due to ROP are manifested in the late stage of disease. Unless the parents are made aware of this, they are likely to delay the eye check-up.
- Sometimes parents do not consent to timely treatment as they are not sure of the benefits of treatment. The lack of trust in modern medicine with apprehension that some 'experiment' may be done on their baby are a few of the reasons.

IIPH, HYDERABAD

Figure 1 An anxious mother waiting for her baby's eye screening at Niloufer Hospital, Hyderabad, India.

Care factors responsible for worsening of ROP or severe ROP:
Most factors that lead to severe forms of ROP are related to low gestational age and the type of medical care. Parents can help in caring for their infants by

- washing hands regularly,
- breast feeding on time,
- giving kangaroo mother care,
- taking good nutritious food while breastfeeding,
- taking proper care of cough and cold episodes in the baby, and
- overall positive communication while interacting with the baby.

Some of these factors may not have robust evidence in terms of ROP management but are part of good practices and low-cost additions for integrated and improved neonatal care.

Why counsel parents?

Most of the babies, who need eye evaluation and treatment are either preterm or have significant co-morbidities. It is imperative that team members work in coordination to ensure safe and timely screening. Lack of coordination or lack of appreciation of each others' roles, or lack of faith in the management can lead to needless delays and doubts in the parents' mind.

In most cases, neither our medical training nor our mainstream ophthalmic or newborn care literature and training address this issue. Over more than a decade, we have personally tried to understand and devise ways to build the team. It has been a continuous learning and refining process and in this article we share our experiences.

Table 1 Myths and facts about ROP

Factor	Myth	Fact
Sickness	Sick babies should not be screened or treated as it can lead to death.	Sick babies can be screened and treated safely using short protocols and appropriate safety monitoring against pain, hypoglycemia, apnoea, bradycardia and hypothermia
Care status and ROP	Since the care provided is excellent or baby did not get any oxygen or was given only minimum oxygen, babies will not get ROP and hence no need to screen.	Blinding ROP can occur even in those preterm babies who have never received oxygen and even if they have got the best possible care. Large for gestational age babies can also be affected, because it is the prematurity itself that is the major risk factor. Hence screening is mandatory.
Taking baby home	After discharge the preterm babies should not be taken out of home and hence cannot go for ROP screening as they can catch infection or are too fragile to be moved out.	Babies can be taken for screening after discharge from the hospital by taking proper precautions such as wrapping baby well for warmth and infection control, feeding on time and keeping the baby close to the mother
Appearance of eyes	Since eyes look normal, eye check can be done later once baby gains weight.	Baby cannot express reduced or blurred vision. Serious eye problems remain hidden and are not visible in the eye till stage 5 of ROP when child has become irreversibly blind.
Public perception	Eye check is an unnecessary test that doctors do for money, or for research or just as an extra precaution.	ROP screening is mandatory for all at-risk preterm babies because of severe irreversible blindness in such babies that can only be prevented by timely screening and urgent treatment
Newborn care givers' perception	Vision development of newborns is part of neuro-developmental assessment and can be done once baby is relieved of all critical care issues.	To preserve the vision of newborns ROP care is integral to the critical management of newborns and cannot be postponed to the phase of neuro-developmental assessments.
Information to parents about ROP	Writing that 'ROP evaluation to be done' in the discharge summary and informing 'get eye check also done' is enough to ensure compliance by parents to timely ROP screening.	Detailed awareness creation by brochures, wall posters, videos on TV in waiting lounges and proper verbal explanation to each parent about need for timely ROP screening and asking for the ROP screening report at each follow-up visit can improve compliance.
Parents role	Parents are ignorant and are on one side of the management and should give the written or implied consent but are not part of the core team that provides the medical care. Medical care teams 'know everything' and are on the other side.	Best outcomes are achieved when parents are co-opted to be included in the core team of providing ROP management. Strong communication system and appreciation of each others' roles helps in overcoming many challenges.

Timely, realistic and appropriate counseling of parents and making them a part of the team (Figure 2) at each step is a critical way to get the best vision for the baby. If a screening facility is not available in the NICU, the parents should be motivated to take the babies to the nearest available eye hospital. The display of posters and videos of babies showing the sequelae of delayed treatment will help to create the awareness. Connecting parents of babies affected with ROP, ones who had timely treatment and ones who had delayed treatment will help to gain the trust of parents.

How to co-opt parents into the team and make the processes more robust?

The team
The team has to include an ophthalmologist, a paediatrician/neonatologist, a duty doctor (fellow/resident), nursing staff, parents and sometimes extended family like grandparents/uncles etc and the receptionist/administrator at the neonatology and ophthalmology clinics.

Roles
Each person in the team has to contribute to a safe, effective and efficient service for the baby. Communication, protocols and procedures must be well-defined and standardised so that everyone is on the same page.

The neonatologist is the first point of contact with the baby and family. He/she has to take complete ownership for the smooth transition of the baby through the process of ROP screening and follow-up until the baby is safely discharged from any risk of blindness. This has to be done while taking care of other critical day-to-day issues of a fragile baby. Parents should be counseled that all delivery and post-natal treatment related documents/discharge summary are essential during ROP management.

Delay in laser surgery even by a day can cause irreversible damage. It is critical to counsel parents about the urgency of the situation. Studies have shown that if doctor sits down and talks, the perception is more reassuring to the family, than if the doctor stands while talking, even if the same things are said!

Continues overleaf ➤

LVPEI

Figure 2 Mother, team of doctors and nurses partner to care for baby with ROP.

With the help of diagrams/photos/images the urgency of the situation and eye condition needs to be explained in simple terms in a language that is understood by parents. The small risk of apnoea/ bradycardia or even rarer need for possible ventilation, must be explained. The language used here is very critical. No negative words should be used. For example, words like "damage" or "failure" can be replaced by positive sounding statements such as "may not be as good as we want to achieve" or "we may not succeed in our attempt but can definitely try and do our best."

Making parents or extended families part of your team is the next crucial step. Stressing on collectively taking care of the baby helps.

Tips for speaking to parents

- The baby is fragile and you know this. The eye condition needs immediate treatment.
- What we need to do is to take care of your baby and the eyes as a team. We-you and I-are responsible for this baby.
- Please do not ask me to take all the responsibility and I won't ask you either
- Time is of essence: keep your documents ready, do not delay the surgery.
- All those who are handling the baby must wash their hands regularly
- Please feed the baby on time and continue to give kangaroo care
- Your baby will need surgery, and like all surgery there are risks. My team has a good safety record and you are in safe hands
- If you have any questions about the surgery, please don't hesitate to ask. You can always contact me by phone or email later too.
- The surgery is a difficult one. If it succeeds, I will celebrate with you. If it does not, I will be with you during that difficult time as well.

Body language and tone are critical in such conversations. Ensure everyone is sitting comfortably. Talk to the parents and hold the baby's hand while maintaining eye contact with the parents. The parents need to understand the gravity of the situation. They also need to be assured that care is at hand.

Give the family few minutes to digest the information. They are sure to come back to you with some questions. Take time to answer them. Our body language must depict that we have ample time to answer their queries. Generally they have one or two small queries only but our attitude should convey our empathy. If they have more questions, then direct them to a counselor who can explain in more detail. Sometimes writing down all their questions also helps. Sharing your email address or phone numbers can save time during a busy OPD. In most cases ROP screening and treatment sessions run smoothly and safely. Once ROP regresses and baby starts to see, it is time for the whole 'team' to relax and rejoice!

Counselling during adverse events

In a rare event of death or moving the baby to a ventilator, the ophthalmologist and the neonatologist should stand together with the parents to share their grief in those difficult moments. The surgeon along with other professionals must note down all information with proper time and chronology of events. He/ she must also be the one to speak to the parents so no confusing information or versions of events are communicated. The team of surgeons, neonatologist, anesthetists, and parents must work together with deep understanding of each other's critical roles. This is the key to success and overcoming challenges.

Steps for enhanced team work

- Place information posters in local languages about ROP in waiting areas of SNCUs/NICUs.
- Give information brochures/handouts in local languages to parents at the time of admission. This must include space to write dates of ROP screening.
- If the baby is not going to be discharged soon, ensure that screening is done within 20-30 days of birth. If the baby is getting discharged early then screening must be done before discharge. This is to ensure that parents are sensitised about need for next follow-up.
- Clearly mention the exact date, time, place and doctor's name to be contacted for ROP screening.
- At time of discharge re-emphasise the written information orally by a member of the NICU/SNCU hospital team. Underline important statements on the information sheet so that it is not missed by parents.
- If baby is not going to return for a follow-up, give clear written instructions to the next doctor about prompt and timely screening. Emphasise the date and the high risk of irreversible blindness if instructions are not followed.
- Customising measures to specifically address the logistical and monetary challenges especially of parents from rural communities can enhance follow-up and compliance.[2]
- Counselling and creating awareness helps to provide a tight net of vision loss prevention around the baby.

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The role of advocacy and communication in reducing ROP in India

Deeksha Katoch
Assistant Professor: Vitreo- retina services, PGIMER, Chandigarh, India

Mangat Dogra
Professor: Advanced Eye Centre, PGIMER, Chandigarh, India.

Visual loss from ROP will continue to increase unless improvement in neonatal care facilities includes services for the detection and treatment of ROP. This requires strong advocacy efforts, communication and collaboration among all the stakeholders.

PGIMER

Figure 1 Members at the launch of the iROP society. INDIA

Low birth weight (LBW) and prematurity are two major causes of neonatal and infant mortality rates in India. Nearly 7.5 million LBW and 3.5 million preterm infants are born in India every year, making it the country with highest number of preterm births in the world.[1] With the aim of lowering perinatal and neonatal mortality rates, there has been a drive to expand neonatal care facilities. This impetus has been furthered by the National Neonatology Forum (NNF), National Rural Health Mission (NRHM), United Nations International Children's Fund (UNICEF) and other agencies, resulting in the opening of a number of Neonatal Intensive Care Units (NICUs)/ Special Newborn Care Units (SNCUs). However, lack of infrastructure, human resources, knowledge and skills have led to imbalances in quality of services being offered. These, along with some other contributing factors (Table 1) have led to a rise in the rates of retinopathy of prematurity (ROP).[2,3]

ROP is a disorder of the developing preterm retina. It is an emerging cause of "potentially preventable" childhood blindness worldwide. India and other low and middle income countries are facing an epidemic of ROP blindness.[2]

India accounted for nearly 10% of the worldwide estimated visual impairment due to ROP, with nearly 5,000 children developing severe disease and 2,900 with visual impairment related to ROP in the year 2010.[3] Visual loss from ROP will continue to increase unless improvement in neonatal care facilities includes services for the detection and treatment of ROP. This requires strong advocacy efforts, communication and collaboration among all the stakeholders (i.e., neonatologists, nurses, ophthalmologists, parents, social workers and the government) in the following aspects:

- High quality neonatal care including availability of equipment and establishment of appropriate care protocols
- Mandatory ROP screening of babies at risk,
- Availability of trained ophthalmologists to screen and treat babies with ROP
- Information for parents to ensure follow up.

The following sections outline the issues in each of the above aspects requiring strong advocay efforts for ROP control and detection.

Neonatal Care

Neonatal care is divided into three levels:

- Level I includes referral of sick newborns from Primary Health Centres (PHCs) to Neonatal Stabilisation Units (NSUs). Care in the NSUs includes stabilisation of sick newborns and care of low-birthweight (LBW) babies not requiring intensive care.
- Level II includes functioning of Special Newborn Care Units (SNCUs) at the district hospital level. These units are equipped with radiant warmers, phototherapy units, oxygen concentrators, pulse oxymeters and intravenous infusion pumps, to handle sick newborns with birth asphyxia, jaundice, sepsis, and LBW other than those who need ventilatory support and surgical care.
- The level III units are the neonatal intensive care units.

Advocacy efforts should stress the availability and regular maintenance of essential equipments in the NICUs/ SNCUs. Mandatory periodic accreditation of neonatal care facilities by independent empowered organisations can also help to improve quality of care. Uniform protocols should be set up and widely disseminated to:

- monitor oxygen supplementation starting inside the delivery room while moving the baby within the NICU and throughout hospitalisation,
- setting up alarms for oxygen saturation targets,
- control of infection,
- prevention of hypothermia,
- improving nutrition and monitoring of weight gain.

For this, adequately trained and knowledgable staff who are aware of ROP and its risk factors (nurses, neonatologists and pediatricians) are required.

Continues overleaf ➤

Intensive efforts for expanding in-service training and innovative approaches to training are needed. Improvement in neonatal care has a direct impact on reduction in the incidence of ROP.

Vinekar et al. have shown that with interventions such as increasing awareness about risk factors of ROP, oxygen regulation protocols, use of pulse oxymetry, monitoring postnatal weight gain, nutritional best practices and management of sepsis it was possible to significantly reduce the overall incidence of ROP, incidences of treatment-requiring ROP as well as aggressive posterior ROP over four years in rural neonatal centres in Karnataka, India.[4]

Table 1 Factors contributing to ROP blindness in our country.

- **High rates of preterm birth**
- **Unequal and variable quality neonatal care**
- **Lack of awareness among paediatricians/neonatologists regarding risk factors for ROP, protocols to be followed for its prevention, timing and indications for ROP screening**
- **Lack of basic equipment such as oxygen blenders, oxygen monitors at SNCUs/NICUs**
- **Poor patient-bed, doctor-patient and nurse-bed ratios leading to overcrowding**
- **Lack of mandatory ROP screening programs in the NICUs/ SNCUs**
- **Non availability of trained ophthalmologists for ROP screening and treatment**
- **Lack of information among parents regarding prematurity and its complications**

Mandatory ROP Screening of babies at risk

Infants presenting with stage five ROP and irreversible blindness because they were "never screened" for ROP is still a matter of grave concern in India. In one report, 86.4% of infants who presented with stage five ROP to a large tertiary care institute had never been screened for ROP. Majority (74.2%) were brought by the parents (i.e self-referred) when they noticed that the child was not seeing.[5]

There is a lack of ROP screening programmes in the NICUS/SCNUs at many places. ROP screening programmes have remained confined to tertiary care institutions and select few hospitals in private sector without percolating down to the district level SNCUs. The National Neonatology Forum (NNF) developed evidence-based clinical practice guidelines for ROP screening and treatment in 2010,[6] It was recommended that all infants weighing ≤ 1,750g at birth and/or born at < 34 weeks gestation should be screened for ROP. Infants with birth weight of 1,750-2,000g or gestation of 34-36 weeks should also be screened if they have risk factors like ventilation, prolonged oxygen therapy, hemodynamic instability or adverse respiratory or cardiac disease profile.

Strong advocacy efforts recently helped incorporate ROP as one of the 30 pathological conditions to be screened for in a government run national programme. This programme [named as the Rashtriya Bal Swasthya Karyakram (RBSK)] is aimed at providing child health screening and early intervention services for children, including infants. Realising the difficulties in knowing the exact gestational age in many cases, a birth weight criterion of less than 2000g has been agreed upon to identify infants eligible for screening. The programme also entrusts the responsibility of screening up to six weeks of age with the facility providing neonatal care.

The following aspects of screening for ROP need to be focused upon:

- Enforcement of the national ROP screening guidelines at district level SNCUs
- Making ROP screening mandatory at all NICUs/ SNCUs
- The original SNCU toolkit, which guides the establishment of new SNCUs in India must specifically mention ROP screening as an essential requirement. The accreditation criteria for level II and III units should have ROP-screening facility as an essential requirement.
- Availability of equipment for ROP screening such as indirect ophthalmoscope, a 20 or 28 dioptre lens, infant eye speculums, infant scleral depressors in the district level hospitals and possibly retinal imaging systems such as the low cost wide field fundus cameras in the future.

Training human resources (neonatologists, nurses) who are the first point of contact for the following aspects of screening in the SNCUs/NICUs:

- Time of first screening: within the first 20 to 30 days of life.
- Whom to screen? Wall charts need to be displayed in all NICUs on whom to screen and nurses must be trained to dilate pupils, administer drops and assist in screening.
- Ensure that once an "at-risk" baby is identified, it is important that the baby gets enrolled into the screening programme and completes the required follow up examinations as per protocol.
- Follow up: under the Home-Based Newborn Care programme (HBNC), it has been proposed that accredited social health activist (ASHA), can provide a crucial community link for identification of at-risk infants as well as ensuring that such infants complete the required follow up.

Counseling parents on presence of risk factors and the expected date of next screening is essential.

- A simple information leaflet in local language can help in educating parents about ROP and its complications. At risk babies can be marked with color-coded wrist bands or colored stickers applied on their files/ cots for easy identification and as a reminder to the treat them.

The National Programme for Control of Blindness (NPCB) along with various non-government organisations (NGOs) such as the Queen Elizabeth Diamond Jubilee Trust, Public Health Foundation of India (PHFI) have been pivotal in advocacy and communication efforts with the Government of India in formulating national guidelines and policy regarding ROP. A 'National ROP Task Force' has been constituted under NPCB and the Ministry of Health. It brings together leading ROP experts, who advise on the direction of the programme and provide impetus to help bring about change in policy.

Availability of trained ophthalmologists

There is a huge lacuna as far as availability of trained ophthalmologists well-versed with indirect ophthalmoscopy and laser treatment. The Indian Retinopathy of Prematurity (IROP) Society[7] was formed in July 2016 to bring together ophthalmologists who are involved in ROP treatment from across India (Figure 1). The current membership of this society is a mere 113 specialists, of which less than 100 are comfortable with screening and treatment. This again highlights the huge gap in the availability of trained personnel to effectively treat ROP.

There are some states or regions in India with only one or two ROP trained ophthalmologists. Some ROP specialists perform only screening and refer the babies to other specialists (often in another state) for treatment. Most of the 600-odd special care units (SNCUs) in the government sector do not have access to trained ophthalmologists for ROP screening. Training comprehensive ophthalmologists in ROP screening is thus another area requiring strong advocacy efforts and innovative approaches. Medical colleges need to be equipped and strengthened to provide a mentoring role in every state. Collaboration with non-government organisations for capacity building in this area can further strengthen and widen the scope of services.

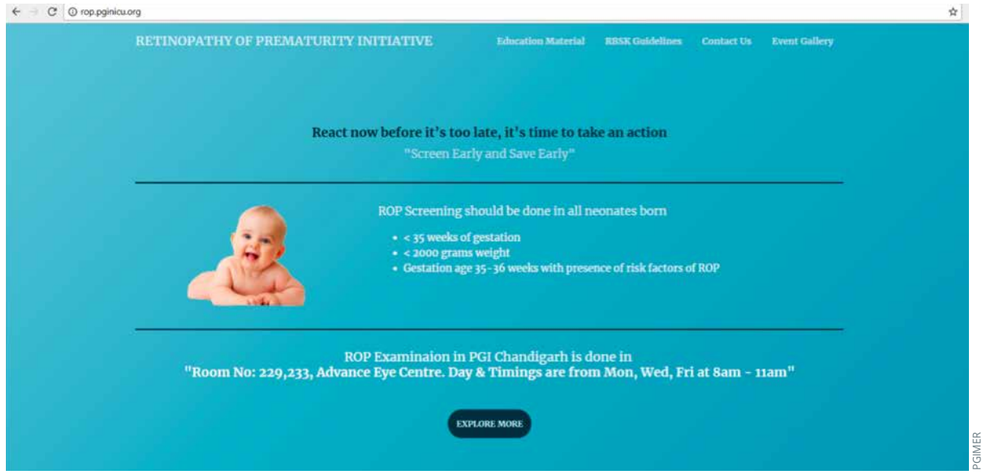
Future policy

Planning and prioritisation of policies should be based on data about local needs and the country's geopolitical scenario. A system for data collection and monitoring to track the number of new borns screened and treated for ROP from various SNCUs and NICUs in medical colleges across the country is needed.

Conclusion

The ROP epidemic can be controlled by concerted efforts of all the people involved in the management and care of preterm infants. There is a need for national policy, legislation and strong advocacy. Advocacy with the government would require strong evidence and a clear message to integrate ROP services with neonatal care. A strong committed leadership is the key for policy change.

Figure 2 PGIMER's NICU website with information on ROP.



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Test your knowledge and understanding

This page is designed to help you to test your own understanding of the concepts covered in this issue, and to reflect on what you have learnt.

CLARE GILBERT

Preterm baby being given unmonitored supplemental oxygen (via the blue tube). The baby is very pink and hyper-oxygenated. This increases the risk of ROP and must be avoided.

We hope that you will also discuss the questions with your colleagues and other members of the eye care team, perhaps in a journal club. To complete the activities online – and get instant feedback – please visit **www.cehjournal.org**

Tick ALL that are TRUE

Question 1
Which of the following factors can increase the risk of for ROP during the first 4 weeks of life?

- ☐ **a** Infection
- ☐ **b** Poor weight gain after birth
- ☐ **c** Oxygen saturations that are above 95%
- ☐ **d** Gestational age of 36 weeks or above
- ☐ **e** Low body temperature

Question 2
Screening for retinopathy of prematurity

- ☐ **a** The ophthalmologist should identify which babies should be screened
- ☐ **b** The first screening should take place as soon as the neonatologist says the baby is well enough
- ☐ **c** An ophthalmologist should visit the unit every two weeks to screen
- ☐ **d** Babies with plus disease should be screened again in a week
- ☐ **e** Screening is usually undertaken using an indirect ophthalmoscope

Question 3
Treatment of ROP

- ☐ **a** Laser treatment is painful
- ☐ **b** ROP in zone 3 has a worse prognosis than ROP in zone 1
- ☐ **c** The laser spots should be confluent
- ☐ **d** Stage 2 ROP in zone 2 with plus disease should be treated
- ☐ **e** After treatment, babies should be seen again in 4 weeks

Question 4
Follow-up of babies who developed ROP

- ☐ **a** Babies who have been treated for ROP have more complications than babies who had ROP that did not need treatment
- ☐ **b** Strabismus should be operated on as soon as it is detected
- ☐ **c** High myopia can occur within a few months of laser treatment
- ☐ **d** Occlusion therapy may be required to prevent or treat amblyopia
- ☐ **e** Children born preterm may be developmentally delayed

ANSWERS

1. a, b, c and e are true. Gestational age of less than 36 weeks is a risk factor.
2. a, c, and d are true. Zone 1 ROP has a worse prognosis, and babies should be seen within 1–2 weeks of laser to ensure that the disease is regressing.
3. e is true. The neonatologist should identify which babies need to be screened, and screening must be done before 30 days after birth. An ophthalmologist should visit the unit once a week, and all babies with plus disease require treatment.
4. a, c, d, e are true. In children with strabismus who were born preterm, the degree of misalignment can vary so the decision about when to operate is more difficult.

Picture quiz

CLARE GILBERT

Tick ALL that are TRUE

Question 1 What could be done to improve the care of this preterm baby?

- ☐ **a** Monitor blood oxygen saturation
- ☐ **b** Kangaroo care
- ☐ **c** Feed the baby with the mother's breast milk
- ☐ **d** Support the baby's limbs
- ☐ **e** Keep the baby cool

Question 2 How is ROP classified?

- ☐ **a** Aggressive posterior ROP
- ☐ **b** 5 zones
- ☐ **c** 5 stages
- ☐ **d** Posterior ROP
- ☐ **e** 3 zones

Question 3 Screening for ROP

- ☐ **a** Can be done at any time as long as the baby is stable
- ☐ **b** Can cause the baby stress
- ☐ **c** Is never needed after the baby is discharged from the neonatal unit
- ☐ **d** Should include babies at risk even if they are sick
- ☐ **e** Should be done by 30 days after birth

Question 4 Follow-up of children born preterm

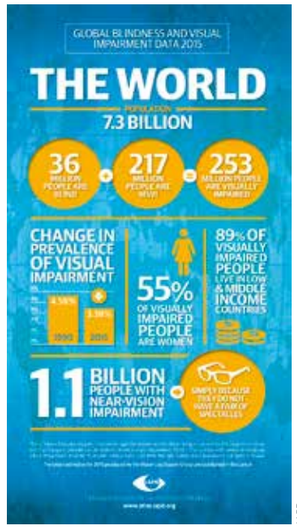
- ☐ **a** Refractive errors are uncommon after laser treatment for ROP
- ☐ **b** Babies less than 12 months of age should not be given spectacles
- ☐ **c** Some preterm babies are developmentally delayed
- ☐ **d** A normal eye examination means the child can see normally
- ☐ **e** Strabismus is easy to manage

ANSWERS

1. a, b, c and d are true. Premature babies need to be kept warm; a plastic bag can be used immediately after birth (see p. 54).
2. a, c and e are true.
3. b, d and e are true. Babies who are premature or low birthweight should ideally be screened by 30 days of life.
4. c is true. After laser treatment, a high degree of myopia can develop within a few months of treatment, while they are still infants (<12 months of age). Low degrees of myopia do not need to be treated immediately, but high myopia should be treated to prevent amblyopia. Strabismus can be difficult to manage because it can change over time.

IAPB Vision Atlas

The IAPB Vision Atlas was launched on World Sight Day 2017. It contains the latest data on prevalence and causes of blindness and visual impairment by region and country, as well as projections to 2020 and 2050. It also includes the success indicators (e.g., cataract surgical coverage, number of eye health personnel) needed to achieve the WHO Global Action Plan. To find out more, please visit: **http://atlas.iapb.org**. This infographic is available for free download from **http://tinyurl.com/IAPB-atlas**



IAPB

Affordable spectacles

VisionSpring is a US-based non-governmental organisation that provides affordable, high-quality, and durable spectacles to organisations and institutions that serve people who live on less than US $4 per day. They are seeking partners who would be interested in starting a community eye care outreach programme in their local area, and can also provide affordable spectacles to existing outreach activities. Read more on **www.visionspring.org**

Courses

MSc Public Health for Eye Care, London School of Hygiene & Tropical Medicine

Fully funded scholarships are available for Commonwealth country nationals. The course aims to provide eye health professionals with the public health knowledge and skills required to reduce blindness and visual disability. For more information visit **www.lshtm.ac.uk/study/masters/mscphec.html** or email **romulo.fabunan@lsthm.ac.uk**

Free online courses

ICEH Open Education for eye care programme offers a series of online courses in key topics in public health eye care. All the courses are free to access. Courses: Global Blindness, Eliminating Trachoma, Ophthalmic Epidemiology Basic Principles (1) and Application to Eye Disease (2). More free courses coming! Certification also available. For more information visit **http://iceh.lshtm.ac.uk/oer/**

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Next issue

The next issue of the *Community Eye Health Journal* is our **100th issue** and celebrates the first 30 years of our work.

Key community eye health messages

Babies born before 36 weeks (preterm) are at risk of retinopathy of prematurity (ROP)

GERTFRIK/123RF

- The more preterm they are, the greater the risk
- Poor neonatal care increases the risk, even in less premature babies

It is possible to prevent ROP from causing visual impairment and blindness. This requires:

NAPOCSKA/SHUTTERSTOCK

- High quality neonatal care. If there is not enough equipment to safely deliver and monitor oxygen, this must be strongly advocated for
- Screening: All babies at risk must be screened before 30 days after birth
- Treatment: Laser treatment should be given urgently, with confluent spots
- Follow-up: All children born preterm are at risk of visual impairment and must be followed up by an ophthalmologist and/or optometrist

Parents are important members of the eye care and neonatal team

PHFI

- Involve parents in the day-to-day care of the baby and encourage kangaroo care
- Keep parents informed of the need for screening and the results of screening, and the need for urgent treatment, if required
- Ensure parents understand the need for follow-up visits