Telemedicine Screening for Retinopathy of Prematurity

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Abstract

A telemedicine system for identifying eyes with potentially serious retinopathy of prematurity has a high likelihood of success and can provide a reasonable alternative to examination by ophthalmologists as long as there is available ophthalmologic expertise if treatment is needed. Such an alternative may be particularly important in countries with rapidly developing neonatal care systems or widely dispersed populations.

Keywords

Telemedicine, prematurity, retinopathy of prematurity, pediatric ophthalmology

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Worldwide retinopathy of prematurity (ROP) is a treatable disorder that is a leading cause of blindness in children.[1] ROP can usually be effectively treated if detected in the severe acute disease phase, but detection currently requires a series of resource-intensive examination by ophthalmologists with expertise in ROP. Less than 10 % of premature infants at risk (in the US defined as <1,500 g birth weight or gestational age 30 weeks or less or, if birth weight between 1,500 and 2,000 g, at the discretion of the neonatologist) require treatment. However, with around 15 million premature infants born each year worldwide, this disease poses an increasing threat, in particular in countries with developing neonatal health care systems. The greatest numbers of premature infants at risk for ROP-related blindness is reported to be in east and southeast Asia, south Asia, central Asia and eastern Europe with an estimated 30,000 developing visual impairment or blindness worldwide each year.[1]

Use of digital images to evaluate eyes of at-risk infants became feasible in the late 1990s with a series of studies that compared the findings on clinical examinations with evaluation of digital retinal images.[3] A recent report from Fierson et al.[4] documents a series of eight level 1 studies that used digital retinal images to detect moderate to severe ROP in eyes of at-risk infants. In these studies, with sample sizes ranging from 43 to 1,257 patients, various definitions of moderate to severe ROP were detected by image evaluation with sensitivities ranging from 57 % to 100 % and lower limits of 95 % confidence intervals (CIs) of sensitivity ranging from 16 to 87 %. Differences in methods for defining ROP and image evaluation used in these studies do not permit direct comparison of the results.

The largest and most recent of the studies was the telemedicine approaches for evaluating acute-phase ROP—e-ROP study.[5,6] This large, multicenter observational study was conducted in 13 clinical centers in North America and enrolled 1,284 infants with birth weights <1,251 g. The e-ROP study was designed to detect in digital retinal images those eyes with "referral-warranted" ROP (RW-ROP), defined as any stage of ROP in zone I, any stage 3 or worse ROP, or the presence of plus disease.[7] Disease of this severity was considered in need of an evaluation for a diagnostic examination by an ophthalmologist to determine whether treatment is indicated.

In the e-ROP study, infants with birth weights of <1,251 g, born in 2011–2013, underwent both diagnostic ROP examinations by e-ROP-certified ophthalmologists and imaging sessions undertaken by trained nonphysicians using a wide-field camera in the neonatal intensive care nursery. The image sets, consisting of five retinal images—posterior, superior, inferior, nasal, and temporal—and an external eye image, were uploaded and each image set was assigned to two trained nonphysician readers at Penn for grading the presence of the retinal morphology findings of RW-ROP. An ophthalmologist director of the Reading Center adjudicated any disagreements between trained readers.

Among the enrolled infants, 19.4 % developed RW-ROP in one or both eyes on diagnostic examination. In the primary outcome report,[6] all images from the 244 infants who developed RW-ROP and a random sample of 691 infants who never developed RW-ROP were graded. The result of each diagnostic examination was compared with the result of the image set grading from the same session. The sensitivity for detecting the presence of RW-ROP in either eye of an infant, as would be performed in a clinical setting, was 90.0 % (95 % CI 85.4–93.5 %) with a specificity of 87 % (95 % CI 84.0–89.5 %) and a negative predictive value of 97.3 %. When only the last session before treatment was considered, sensitivity increased to 98.2 % (95 % CI 94.4–99.4 %) for detecting those 162 infants who underwent treatment with a specificity of 80.2 % and a negative predictive value of 99.6 %. Only three infants who were treated by the clinical center ophthalmologist were not found to have RW-ROP in retinal images of either eye.

In summary, the e-ROP study results provide strong support for the validity of a telemedicine system to detect the presence of potentially serious ROP. The study successfully trained nonphysician imagers at the clinical centers to obtain images for remote grading and nonphysicians readers to grade those images reliably. It provides further evidence that telemedicine in ROP is a promising approach to providing excellent ROP screening in the US and other countries with well-developed neonatal intensive care unit (NICU) systems.

Since there is a limited supply of ophthalmologists available for ROP examinations, such an approach will allow physicians to examine only those most at-risk infants. One advantage of such a system is the ability to assess remotely the need for transferring an infant to another center where treatment can be given. In addition, the imaging session in a NICU need not be constrained by the ophthalmologist's schedule, but can be conducted at an optimal time for the infant.

In other regions of the world with developing NICU systems and a limited number of ophthalmologists available, providing a telemedicine system can increase the likelihood of detecting potentially serious ROP. This may be particularly important in countries with widely dispersed populations and a limited number of ophthalmologists.

Still there are a number of matters that need to be addressed as we consider telemedicine in ROP. We must deal with licensing and liability concerns for telemedicine and establish reliable and consistent grading of the images. Timely reporting of these time-sensitive gradings to the physicians caring for the at-risk infant must be expedited. The cost-effectiveness of such a technology is yet to be established. In addition, the best schedule and optimal frequency for imaging of an individual infant needs to be developed and tailoring such a schedule will likely include various risk factors such as birth weight, gestational age, postmenstrual age, and weight gain. Further, thus far level 1 telemedicine ROP studies have only dealt with the period during which the infant is in the NICU and not addressed when a child can be safely discharged from care. ■

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