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Assessment of a Tele-education System to Enhance Retinopathy of Prematurity Training by International Ophthalmologists-in-Training in Mexico

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Purpose: To evaluate a tele-education system developed to improve diagnostic competency in retinopathy of prematurity (ROP) by ophthalmologists-in-training in Mexico.

Design: Prospective, randomized cohort study.

Participants: Fifty-eight ophthalmology residents and fellows from a training program in Mexico consented to participate. Twenty-nine of 58 trainees (50%) were randomized to the educational intervention (pretest, ROP tutorial, ROP educational chapters, and posttest), and 29 of 58 trainees (50%) were randomized to a control group (pretest and posttest only).

Methods: A secure web-based educational system was created using clinical cases (20 pretest, 20 posttest, and 25 training chapter–based) developed from a repository of over 2500 unique image sets of ROP. For each image set used, a reference standard ROP diagnosis was established by combining the clinical diagnosis by indirect ophthalmoscope examination and image-based diagnosis by multiple experts. Trainees were presented with image-based clinical cases of ROP during a pretest, posttest, and training chapters.

Main Outcome Measures: The accuracy of ROP diagnosis (e.g., plus disease, zone, stage, category) was determined using sensitivity and specificity calculations from the pretest and posttest results of the educational intervention group versus control group. The unweighted kappa statistic was used to analyze the intragrader agreement for ROP diagnosis by the ophthalmologists-in-training during the pretest and posttest for both groups.

Results: Trainees completing the tele-education system had statistically significant improvements ($P < 0.01$) in the accuracy of ROP diagnosis for plus disease, zone, stage, category, and aggressive posterior ROP (AP-ROP). Compared with the control group, trainees who completed the ROP tele-education system performed better on the posttest for accurately diagnosing plus disease (67% vs. 48%; $P = 0.04$) and the presence of ROP (96% vs. 91%; $P < 0.01$). The specificity for diagnosing AP-ROP (94% vs. 78%; $P < 0.01$), type 2 ROP or worse (92% vs. 84%; $P = 0.04$), and ROP requiring treatment (89% vs. 79%; $P < 0.01$) was better for the trainees completing the tele-education system compared with the control group. Intragrader agreement improved for identification of plus disease, zone, stage, and category of ROP after completion of the educational intervention.

Conclusions: A tele-education system for ROP education was effective in improving the diagnostic accuracy of ROP by ophthalmologists-in-training in Mexico. This system has the potential to increase competency in ROP diagnosis and management for ophthalmologists-in-training from middle-income nations. *Ophthalmology 2017;■:1–9 © 2017 by the American Academy of Ophthalmology*

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Retinopathy of prematurity (ROP) is a vasoproliferative disease of the developing retina that is largely treatable with an appropriate and timely diagnosis.[1–4] Although major advances in the management of ROP have occurred as a result of the classification criteria outlined by the Cryotherapy for ROP[5] and Early Treatment for ROP[6] studies, ROP remains a leading cause of childhood blindness throughout the world.

An increase in the incidence of ROP, termed the "third epidemic," has uniquely occurred in middle-income countries.[1,2,7] Middle-income countries like Mexico are in the unique conundrum of having sufficiently advanced medical facilities to support premature babies; however, they may lack the necessary resources to manage ROP appropriately.[2] Specifically, previous reports have documented an inadequate number of ophthalmologists experienced in ROP diagnosis and management.[1,2,7] The root cause of these shortages are partly based on workforce limitations and variable education on ROP diagnosis and

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management. Indeed, the previous literature has noted that there is a lack of standardization for ROP education within both high- and middle-income countries that has resulted in significant differences in the accuracy of ROP diagnosis among ophthalmologists-in-training.[8–11]

Web-based learning offers the unique opportunity to provide high-quality education to medical trainees in developing countries, particularly those with a critical shortage of medical faculty.[12] The Global Education Network for ROP is a multi-institutional collaboration interested in developing innovative ways to educate and increase the workforce for ROP. In conjunction with the Imaging and Informatics in ROP Consortium, the Global Education Network for ROP has previously demonstrated the efficacy of web-based education for ROP among trainees in the United States and Canada,[13] but there is limited work on web-based learning for ROP in developing and middle-income countries.

The purpose of this study is to evaluate whether a tele-education system can improve the diagnostic competency of ophthalmologists-in-training in a middle-income country.

Methods

The Weill Cornell Medical College Human Studies Committee approved this as a prospective study for the analysis of retinal images and approved the educational material used in this study. Administration of the tele-education system was also reviewed by the Weill Cornell Medical College Human Studies Committee and was granted an exemption because it was considered research in an established or commonly accepted educational setting involving normal educational practices such as research on the effectiveness of instructional techniques, curricula, and instructional strategies.

Image Acquisition

Images in the tele-education system were obtained utilizing a repository of over 2500 unique sets of ROP images. A total of 36 infants were used for the 65 clinical cases (20 pretest, 20 posttest, and 25 training chapter–based) in the system. Both eyes of each infant underwent funduscopic imaging, for a total of 72 eyes. All cases selected for the pretest, posttest, and training chapters were reviewed by the study authors (R.V.P.C., M.F.C.) to ensure that a spectrum of disease was represented. The relevant clinical characteristics of the cases are summarized in Table S1 (available at www.aaojournal.org).

Study Subjects

Ophthalmologists-in-training at the resident or fellow level were recruited by the co-authors (K.E.J., R.V.P.C., M.M.C.), from a single ophthalmology training program in Mexico. Trainees who participated in the tele-education system were provided access to a website where they could access the system. At initial recruitment, trainees were randomized to either the group who were to complete the tele-education system (referred to as the intervention group) or a control group who only took a pretest and posttest (Fig S1, available at www.aaojournal.org). The intervention group completed the pretest, training chapters, and posttest in sequential order. The control group completed the pretest and posttest and was not given access to any of the educational material available to the intervention group until completion of the study. The trainees in the intervention group were scheduled on a weekly schedule such that they completed 1 to 2 sections of the tele-education system per week, for a total of 8 sections.

Study Design

The specific study design of the pretest, ROP educational materials, and posttest used in the tele-education system has previously been described.[13] Briefly, the tele-education system was created based on clinical cases applied in 3 different scenarios: pretest, chapters, and posttest. A clinical case was defined as providing a clinical diagnosis in both eyes of 1 patient. For each clinical case, demographic information including gestational age, birth weight, and postmenstrual age at time of imaging was provided to the trainee. A set of 5 retinal images (superior, inferior, posterior, nasal, temporal) was included for each eye and additional images were included if deemed to be clinically significant. Retinal images for both eyes were provided simultaneously; however, a clinical diagnosis of plus disease (no, pre-plus, plus), zone (I, II, III), ROP (yes, no), stage (1–5), category (none, mild, type 2 ROP, ROP requiring treatment), and aggressive posterior ROP (AP-ROP) (yes, no) was required for each individual eye. Participants were asked to provide a clinical follow-up time based on the diagnosis of both eyes for the patient.

After completion of the tele-education system, trainees were directed to complete a web-based survey regarding the effectiveness of the tele-education system. Items in existing psychometric instruments were adapted to measure trainees' attitudes,[14] and there were a total of 6 survey items, consisting of 2 items that assessed the trainees' perception of their understanding of the diagnosis of ROP, 3 items that assessed the trainees' attitudes toward preferred learning environment, and 1 item that assessed the trainees' opinion of ease of use of the ROP tele-education system. Survey responses were recorded using a 5-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree), and the average score for each question was calculated.

Data Analysis

All data were analyzed using statistical software (Stata/SE 12.0; StataCorp LP, College Station, TX). Statistical significance was considered to be represented by a 2-sided P value < 0.05. The diagnostic accuracy for ROP by the trainees was evaluated using sensitivity and specificity compared with the consensus reference standard diagnosis.[15] Briefly, the reference standard diagnosis combined the clinical diagnosis as determined from indirect ophthalmoscopy by an ROP examiner with the image-based diagnosis from multiple experienced readers. For sensitivity and specificity calculations, the cutoff values that were investigated included stage 1 disease or worse, stage 2 disease or worse, stage 3 disease or worse, zone I or II disease, zone I disease, pre-plus or worse, plus disease, mild or worse disease, type 2 ROP or worse disease, disease requiring treatment, and the presence of AP-ROP.

Pretest and posttest sensitivities and specificities were compared within and between the intervention group and control group using the paired t test. Based on the 4 cases that were repeated in both the pretest and posttest, intragrader reliability was evaluated using the kappa statistic for chance-adjusted agreement in diagnosis. Specifically, pretest and posttest unweighted kappas for both the intervention and control groups were calculated for the diagnosis of plus disease, zone, stage, category, AP-ROP, and the presence of ROP of any severity. A well-known scale was used for interpretation of results: 0 to 0.20, slight agreement; 0.21 to 0.40, fair agreement; 0.41 to 0.60, moderate agreement; 0.61 to 0.80, substantial agreement; and 0.81 to 1.00, almost perfect agreement.[8]