### 114 Amblyopia: Detection and Prevalence

**Purpose:** To raise cost-efficiency of screening, EU-guidelines should be developed, but how to decide on the best screening program? Among EU member states these vary from visual acuity at age 4 to refraction at age 1. Youth health care doctors screen in the Netherlands, pediatricians in Germany, nurses in Sweden and general practitioners elsewhere. The number of exams ranges from 1 to 7 while half the countries have no population-based screening yet. We previously developed a microsimulation model (ARVO 2010 #4356) to evaluate the effectiveness of screening programs. We now build a EU consortium to employ the model for optimization of screening cost-efficiency in Europe.

**Methods:** In its basic form, the model (figure) uses input data from screening studies, estimated prevalence functions for strabismic, combined-mechanism and refractive amblyopia, sensitivity and specificity of screens determined by several other factors, and estimates of the effect of therapy, to calculate the effect of a screen. To build the consortium among the 36 EU (full, associate and candidate) member states, pediatric ophthalmologists and orthoptists are invited, together with (the consortium also studies ear and speech screening) ENT-surgeons, audiologists and representatives of the screening professionals, into country committees for gathering input data.

**Results:** The microsimulation model has performed well in predicting the outcome of disinvestment of preverbal eye screening (ARVO 2014, F Sloot et al). However, the model had been validated primarily with the data of the RAMSES observational birth cohort study (IOVS 2010;51:3476-84), and needed additional work to accommodate most of the variation found within European screening regarding age, interval, test, personnel, infrastructure etcetera. In the study consortium, 26 EU countries are represented by pediatric ophthalmologists. Orthoptists are invited into the country committees by a mandate of the Orthoptistes de la Communauté Européenne (O.C.E.).

**Conclusions:** To have widely different guidelines for screening in many EU member states and to revise these guidelines in all of these countries every 5 years seems inefficient. The microsimulation model allows us to compare these diverse screening programs and to reach dynamic EU screening guidelines, that are sensitive to local circumstances.

---

### 430 Startup of EU consortium for cost-efficiency optimization of population-based screening and development of EU screening guidelines

**Authors:** Huibert J. Simonsz, Frea Sloot. Ophthalmology, Erasmus Medical Center, Rotterdam, Netherlands.

**Purpose:** To investigate the normative distribution of uncorrected visual acuity (UCVA) and interocular difference (IOD) in a population of Chinese preschoolers without clinically significant ocular abnormalities or refractive errors and to discuss the implications for referral of preschoolers.

**Methods:** Preschoolers aged 3 to 6 years old were recruited from kindergartens in Shenzhen City, China. UCVA and IOD were estimated using Early Treatment Diabetic Retinopathy Study (ETDRS) Tumbling E charts, followed by ocular biometry measurement, cycloplegic autorefraction, as well as detailed ocular examinations. The normative population was defined as children without clinically significant refractive error or ocular abnormalities, whose spherical equivalent (SE) is > -0.50 to < 2.00 diopters (D), < 0.75 D astigmatism and < 2.00 D anisometropia.

**Results:** Among the 1255 children enrolled, UCVA was successfully collected in 1128 (89.9%) children. Among the 483 children who were classified as the normative population, the single side 95th percentile fell into the UCVA 20/50 category at age 3, 20/40 at age 4, 20/32 at age 5 and age 6. Using these UCVA cutoffs as the criteria would lead to the referral for further examination of 9.4% of children at age 3, 26.2% at age 4, 27.8% at age 5 and 18.6% at age 6 in the general population (N=1128). However, using IOD greater than 1 line as a criterion would generate referral in 3.6% at age 3, 3.7% at age 4, 4.1% at age 5 and 4.3% at age 6 in the general population.

**Conclusions:** Visual acuity is still developing in preschoolers. Using age-specific 95th percentile as cutoffs for referral may lead to false positives and unnecessary referrals. IOD greater than 1 line may provide a more stable and conservative criterion for referral.

**Commercial Relationships:** Xinxing Guo, None; Xiaohu Ding, None; Ian G. Morgan, None; Mingguang He, None.
Program Number: 432 Poster Board Number: D0051
Presentation Time: 8:30 AM–10:15 AM
Quality of eye screening examinations at Child Health Centers in the Netherlands assessed by semi-structured observations

Aya Sami1, 2, Hatice Karaman2, Frea Sroit, Trijntje Sjoerdsma3, Janine Benjamin4, Huibert J. Simonsz4, 1Ophthalmology, Erasmus MC, Rotterdam, Netherlands; 2Orthoptics, University of Applied Sciences, Utrecht, Netherlands; 3Municipal Health Service, Amsterdam, Netherlands; 4Public Health Service Icare, Meppel, Netherlands.

Purpose: Around 1980 preverbal screening was added to preschool screening at the Child Health Centers (CHC’s) that screen 97% of all Dutch children. Eye screening is performed 7 times from 1 month to age 5. The RAMSES birth-cohort study showed that preverbal eye screening contributed little to the detection of refractive amblyopia and that half of strabismic amblyopia cases were discovered outside of screening. Quality of screening exams was now assessed by semi-structured observations.

Methods: Fifteen CHC’s with 25 employed youth health care physicians were invited. Of the entire physical examination, only the eye exam was observed in a semi-structured fashion. The observation comprised demographics, parents language skill and detailed assessment of screening physicians’ performance of fundus reflex, pupillary reflex, Hirschberg test, cover test, eye motility, visual-acuity measurement, room and chart illumination, type of chart and testing distance.

Results: Of 334 eligible children, 1 was excluded because age was unknown. Two physicians who had examined 2 children each were excluded. Hence 329 children screened by 23 physicians or nurses were analysed; 239 were 0-24 months and 90 were 36-50 months of age. Fundus reflex was performed in 89%, pupillary reflex in 29% cover test in 65%, alternating cover test in 62%, binocular motility in 67% and monocular motility in 37% of children. At age 6-24 months, incomplete covering of the eye and/or too quick switching from the covered to the uncovered eye was noted in 37% of cover and 50% of alternating cover tests. In assessment of binocular motility at 6-24 months, 7% was tested fully in all directions of gaze. In testing visual-acuity with Amsterdam Picture Chart or Landolt C at age 36-50 months, only in 9% of 90 examinations errors were noted: Distance to the chart was incorrect, the last possible line was not reached or the threshold for the last read line was incorrect. Referral to ophthalmologist or orthoptist (N=30) was based in 80% on measurement of visual acuity.

Conclusions: In their current form, some preverbal screening examinations could be improved or abolished. Fundus reflex in preverbal children and visual acuity measurement in preschool children were assessed correctly in almost all cases.

Commercial Relationships: Aya Sami, None; Hatice Karaman, None; Frea Sroit, None; Trijntje Sjoerdsma, None; Janine Benjamins, None; Huibert J. Simonsz, None

Program Number: 433 Poster Board Number: D0052
Presentation Time: 8:30 AM–10:15 AM
Prevalence of visual alterations in Italian children using Binocular refractometer and vision analyzer

Lucia V. Scorolli1, 2, Sergio Zaccaria Scalinci1, 2, Paolo G. Limoli4, Enzo M. Vingolò2, 4, Daniela Domanico, 1Ophthalmology department, S.Lucia Hospital, bologna, Italy; 2DIMEC, University of bologna, bologna, Italy; 3Ophthalmology, S Orsola Malpighi Hospital Bologna, Bologna, Italy; 4Centro Studi Ipovisione Milano, CSIM, Milano, Italy; 5Ophthalmology, University of Rome La Sapienza, Rome, Italy; 1Ophthalmology, Ospedale di Latina Terracina, latina, Italy.

Purpose: To report refractive and visual defect in pre-school population of 3 typical italian cities (Milan,Bologne,Latina-Rome) with a new device (Automatic retinoscopy 2Win ) for fast screening

Methods: Observational study of 8573 children from 1 to 3 years using automatic retinoscopy 2Win developed on 1 year. Centers of screening: S. Lucia Hospital in Bologna, Centro Studi Ipovisione Milano,Eye Clinic La Sapienza -S. Maria Garetti Latina-Rome. 10 ophthalmologists, 12 orthoptists.

Results: 8573 children; in 1471 cases (17,2%) we found out a visual anomaly of any kind that was not previously noticed. A visual defect already known was present in 1948 ch.(22,8%). The defects is not related in any way with sex belonging to: 17,3% male,17% female. Refractive defects were present in 1414 out of 8573 ch.(16,5%)and in 2520 out of 17146 eyes examined (14, 7%) .

855(10%) ch. were wearing glasses and 378ch. had glasses with a wrong correction (44,2% of wearing glasses, 4,4% of total cases). Ocular motility was altered in 817 out of 8573 ch.(9,5%) with higher prevalence of exophoria (422 cases, 5,2%) In 1324 cases out of 1471 (90%) ophthalmological control confirmed the suspect of visual defect.

False positive were 1147(10%)

Conclusions: Visual abnormalities previously not shown were 17,2%, particularly high if we consider high social and economical level in the cities analyzed.Parents suspected anomalies in 20% of cases. The Automatic retinoscopy 2Win verification in visual function of the patient allows early analysis of the refractive defect, ideal for babies, children and uncooporative patients. The tool is not limited to the analysis of the refractive defect, but it is very useful as a tool for early diagnosis of phorias, instability of fixation, incorrect position of the face (tilting). These data confirm that ophthalmological control is needed in very young population even if ocular situation seems normal. Parents observations is not enough. 15% of children sent to ophthalmologists did not continue on with necessary controls.

Commercial Relationships: Lucia V. Scorolli, None; Sergio Zaccaria Scalinci, None; Paolo G. Limoli, None; Enzo M. Vingolò, None; Daniela Domanico, None

Program Number: 434 Poster Board Number: D0053
Presentation Time: 8:30 AM–10:15 AM
Attention attracting fixation targets

Boris I. Grammatikov, Kristina Irsc, David L. Guyton.

Ophthalmology, Johns Hopkins Wilmer Eye Inst, Baltimore, MD.

Purpose: Many devices for eye diagnostics require the patient to fixate steadily on a small point in space for a certain period of time during which the eyes do not move and data from one or more substructures of one or both eyes are acquired and analyzed. A typical example would be ophthalmic diagnostic devices for obtaining information from the retina. Some devices already have an optical subsystem that introduces a fixation target in the visual field of the test subject. For this purpose, a constant or blinking light is coupled into the subject’s field of view. The blinking light can be a low power laser or an LED. For young pediatric, less cooperative patients, unfortunately, a monotonously blinking target is not sufficient to attract attention steadily. This makes it impossible to acquire data over time periods longer than a second.

Methods: This method uses a combination of sound and modulated low power laser light to attract attention and to serve as a fixation target (Fig. 1). A computer controls the scanning optics and the data acquisition, and simultaneously plays attractive and engaging sounds to the test subjects. The sound signal also modulates the target laser, which is introduced into the eye’s visual field by means of a beamsplitter. The eye fixates on the target laser over a longer period.
of time, during which the retina does not move and can be efficiently scanned. The speaker is positioned in a way that the subject perceives it as coinciding with the target. The target laser is “pulsating” synchronously with the sound. This strongly enhances the attention attraction ability and locks fixation on the target.

**Results:** The method was tested mainly on children age 7-8, as a subsystem of a pediatric vision screener which employs retinal birefringence scanning for detecting strabismus and amblyopia. With appropriate choice of songs or sounds, it performed decisively better than a monotonously blinking target. Statistical results will be reported soon.

**Conclusions:** The method is particularly effective with young children, but can be used with older children or adults as well. A typical application would be as supplemental subsystems of ophthalmic diagnostic devices for obtaining information from the retina, such as scanning laser ophthalmoscopes, OCT, retinal tomographs, scanning laser polarimeters, retinal birefringence scanners, fundus cameras, and others. Other areas of application would be perimeters, behavioral or psychological, etc.

**Fig. 1**

**Commercial Relationships:** Boris I. Gramatikov, Patent Application Nr. 13773307 (P); Kristina Irsch, Patent Application Nr. 13773307 (P); David L. Guyton, Patent Application Nr. 13773307 (P)

**Support:** The Hartwell Foundation

**Program Number:** 435 **Poster Board Number:** D0054

**Presentation Time:** 8:30 AM–10:15 AM

**Photoscreening for Refractive Error and Strabismus With a Smartphone App**

Joannah M. Vaughan1, Talitha Dale2, Alex Choy3. 1Ophthalmology, Casey Eye Institute, OHSU, Portland, OR; 2Elks Children, Casey Eye Institute, OHSU, Portland, OR; 3Gobiquity Mobile Health, Inc., Aliso Viejo, CA.

**Purpose:** To detect risk factors for amblyopia using a smartphone app.

**Methods:** The GoCheck Kids photoscreening app (Gobiquity Mobile Health, Inc., Aliso Viejo, CA) was used with an iPhone 5. The app takes standardized flash photographs at a target working distance of 28 inches in 2 modes (portrait and landscape). Refraction was measured using crescent width, pupil diameter, and corneal diameter from the 2 photographs, according to the eccentric photorefraction principle. Strabismus was measured by the position of the corneal reflex relative to the pupil and cornea. Children between the ages of 3 and 5 years referred for eye examination at the Elks Preschool Vision Screening Program were examined on 1 day. Photoscreening was performed in a dimly lit room prior to cycloplegic eye drops. Clinical examination, including cover test and cycloplegic retinoscopic refraction, were then performed. AAPOS referral criteria for refractive error and strabismus were used.

**Results:** There were 23 subjects examined. Four subjects (17%) were excluded from analysis due to poor photographic quality; 3 were gazing off axis and 1 had small pupils. Of the remaining 19 subjects, 7 were referred by clinical examination; 5 for astigmatism, 1 for myopia, and 1 for exotropia. The gocheckkids photoscreening app correctly referred 6/7 of these subjects (86% sensitivity). One subject with astigmatism was missed. Of the 6 subjects referred by both clinical and gocheckkids criteria, the diagnosis agreed in 5 of the 6, but in one case the clinical examination identified astigmatism while gocheckkids identified exotropia. There were no false positive referrals by gocheckkids (100% specificity).

**Conclusions:** Smartphone photoscreening could be an effective method of detecting risk factors for amblyopia. Diagnostic accuracy appeared adequate but better quality control is needed through training and automation. Automated quality analysis software is needed for real-time feedback to the operators, particularly with regard to patient fixation and pupil size.
Purpose: To evaluate two pediatric vision screening devices in a clinical setting for children ages 12-30 months compared to cycloplegic refraction.

Methods: After informed consent, children ages 12-30 months underwent screening with the Spot and plusoptiX vision screeners prior to comprehensive examination by a pediatric ophthalmologist masked to the results. Data including refraction, pass/refer, testability (whether the device obtained a refraction), strabismus, and any ocular pathology, were entered into a Redcap database for statistical analysis. All differences in refractions were calculated as Crx minus device refraction for the right eye.

Results: Currently 9 children ages 12-17 months (testability Spot 100%, plusoptiX 44.4%), 13 ages 18-23 months (Spot 64.7%, plusoptiX 23.5%), and 33 age 24-30 months (Spot 82.9%, plusoptiX 48.6%) were included in analysis with a goal of 30 per group. Compared to cycloplegic retinoscopy, the Spot underestimates sphere by 0.89D +/-1.48 (p<0.001) and overestimates cylinder by 0.49D +/-0.89 (p<0.001). The plusoptiX underestimates sphere by 0.53D +/-0.91 (p<0.009) and overestimates cylinder by 0.40 +/-0.56 (p<0.002).

Conclusions: Traditional optotype screening is rarely attainable in this population. A validated and reliable vision screen is useful for the detection of amblyogenic risk factors as defined for children ages 12-30 months that would indicate the need for cycloplegic refraction by a pediatric ophthalmologist. Most children present to the general pediatrician at least twice during this age range for recommended vaccinations. Detection of amblyogenic risk factors is highly dependent on a screeners performance as an autorefractor. Preliminary results suggest that the Spot and the plusoptiX are efficacious autorefractors for young children. The Spot is more effective at obtaining a reading, however is less accurate than the plusoptiX when refraction is obtained. Sensitivity and specificity can also be calculated for both devices using the recently recommended referral criteria for children ages 12-30 months: astigmatism >2.0 D, hyperopia >4.5 D, and anisometropia >2.5 D, however in a pediatric ophthalmology clinic, prevalence of disease is expected to be higher than that of the general population and should be considered with interpreting sensitivity and specificity.

Commercial Relationships: Jennifer D. Davidson, None; Mae Millicent Peterseim, None; Edward W. Cheeseman, None; Rupal Trivedi, None; Carrie Papa, None; Courtney L. Kraus, None

Program Number: 438 Poster Board Number: D0057
Presentation Time: 8:30 AM–10:15 AM
High Specificity and Accuracy of the Pediatric Vision Scanner in a Pediatric Primary Care Setting
Reed Jost, David Stager, Jr, Lori Dao, Scott Katz, Russ McDonald, Eileen Birch. Retina Foundation of the Southwest, Dallas, TX; Pediatric Ophthalmology & Adult Strabismus, Plano, TX; Plano Pediatrics, PA, Plano, TX; Ophthalmology, University of Texas Southwestern Medical Center, Dallas, TX.

Purpose: The Pediatric Vision Scanner (PVS) directly detects strabismus and amblyopia by analyzing binocular scans for the presence or absence of birefringence that, due to the organization of the radially arranged Henle fibers, is characteristic of steady, bifoveal fixation. In an initial study of patients tested in a pediatric ophthalmology office setting, the PVS had 98% sensitivity and 87% specificity for detection of strabismus and amblyopia. (Jost et al., AAPOS 2013) Here we report an intermediate evaluation of PVS sensitivity, specificity, and accuracy for a preliminary cohort of children screened in a pediatric primary care setting.

Methods: 60 children (2-6y) were enrolled. In addition to screening with the PVS, children were screened with the SureSight™ Autorefractor. Each test yielded a recommendation of “pass” or “refer.” All children received a gold-standard comprehensive ophthalmic exam by a pediatric ophthalmologist who was masked to the screening results.

Results: At the gold-standard exam, 4 children were identified as having strabismus and/or amblyopia; 56 had normal exams. Three children were uncooperative for testing with the PVS and 7 could not be tested with SureSight™. Both the PVS and SureSight™ referred all 4 children with strabismus and/or amblyopia. Overall accuracy of the PVS was 90%. The PVS passed 47 of 53 children with no strabismus or amblyopia (89% specificity; 95%CI: 78-99%). In comparison, overall accuracy of the SureSight™ was 74%. The SureSight™ referred 14 of 49 children with no strabismus or amblyopia; i.e., the SureSight™ had significantly more false positives than the PVS (z=2.19; p=0.029; 71% specificity; 95%CI: 55-88%).

Conclusions: In this ongoing study of the PVS in a pediatric primary care setting, results were comparable to the 87% specificity reported previously for a large cohort (n=250) tested in an ophthalmology practice with high prevalence of strabismus and amblyopia. In a pediatric primary care setting, the PVS had higher specificity and accuracy than the SureSight™, resulting in fewer over-reerrals of children with no strabismus or amblyopia. Preschool vision screening

©2014, Copyright by the Association for Research in Vision and Ophthalmology, Inc., all rights reserved. Go to iovs.org to access the version of record. For permission to reproduce any abstract, contact the ARVO Office at pubs@arvo.org.
may be more efficient with a device that directly detects strabismus and/or amblyopia.

Commercial Relationships: Reed Jost, None; David Stager, Jr, None; Lori Tao, None; Scott Katz, None; Russ McDonald, None; Eileen Birch, None.

Support: Thrasher Research Fund Grant 9491, National Eye Institute Grant EY022313

Program Number: 439 Poster Board Number: D0058
Presentation Time: 8:30 AM–10:15 AM

Comparison of visual acuity across pediatric tests
Nicola Anstiss, Samantha Watkins, Melissa Thomson, Benjamin Thompson, Robert J. Jacobs, Andrew Collins. Optometry and Vision Science, University of Auckland, Auckland, New Zealand.

Purpose: The measurement of visual acuity (VA) is central to the management of many ocular diseases and is particularly critical in the diagnosis and treatment of amblyopia. Young children are unable to perform VA measurement on adult charts and, as they progress in age, their VA will be measured with picture optotypes followed by letter matching and letter naming tasks. Therefore it is important to know how measurements obtained on pediatric tests relate to one another. This study provides data on the comparability of 4 pediatric VA tests.

Methods: Four pediatric VA charts (crowded linear Kay Pictures, crowded linear Lea Symbols, crowded linear Keeler logMAR and multiple line HOTV) were used to obtain VAs for 25 adult participants and 17 children (4-9 years of age) under best corrected and defocused (+1.00 DS blur) conditions. Measurements were also made using the gold standard Early Treatment of Diabetic Retinopathy Study (ETDRS) chart for comparison. To investigate the legibility of individual Kay pictures optotypes, a separate group of 25 adults had their threshold recognition acuities measured using individual uncrowded Kay pictures and uncrowded Landolt C targets.

Results: In both adults and children, Kay Pictures produced significantly better VA outcomes than all other charts by 1.5-3 lines (p < 0.001), Lea symbols, HOTV and crowded Keeler logMAR charts produced comparable measurements. In children, ETDRS acuity was significantly worse than acuity measurements from all pediatric charts (p < 0.001). In adults, threshold VA for the uncrowded Kay Pictures ranged from 0.40 to -0.59 logMAR, compared with -0.20 logMAR for the Landolt C targets (a 2-4 line equivalent difference). Repeated measures ANOVA revealed significant differences between the legibility of each of the Kay Pictures with the duck being the most easily recognised of all pictures.

Conclusions: Visual acuity measured with the Kay pictures is significantly better than other VA tests. The different legibility between Kay pictures is because it is possible to perceive the shape, angle, tilt and curvature of the optotypes. These features allow the pictures to be recognized at distances greater than predicted from the human resolution limit and the size of details contained within the pictures. This suggests that the use of the Kay Pictures chart should be avoided for children who are likely to progress other recognition charts.

Commercial Relationships: Nicola Anstiss, None; Samantha Watkins, None; Melissa Thomson, None; Benjamin Thompson, None; Robert J. Jacobs, None; Andrew Collins, None.

Support: University of Auckland Faculty Research and Development Fund 3704420; Paul Dunlop Memorial Scholarship

Program Number: 440 Poster Board Number: D0059
Presentation Time: 8:30 AM–10:15 AM

Stimulus Characteristics Affect the Assessment of Pupil Defects in Amblyopia

Purpose: There is no clear consensus as to the frequency or clinical significance of pupillary response defects for amblyopia (Portnoy et al, 1983, Firth, 1990, Miki et al, 2008). New technology that is sensitive to subtle changes in pupil behavior may shed light on the true incidence of this defect in amblyopes. Pupillary responses have striate and extra-striate cortical influences (Kardon et al, 1993, 1998, Barbour et al, 1998, 2004), and by designing stimuli that highlight these contributions, one might better be able to identify pupil defects in amblyopes when they exist.

Methods: Steady state and dynamic pupil response measures using various stimulus conditions known to isolate cortical and pre-cortical contributions to pupil responses were acquired with a binocular infrared pupillometer (Konan-USA) on 15 amblyopic subjects (anisometropic and small angle strabismic) and 11 normally sighted age matched controls. One full field white flash stimulus (330 cd/m2) and three small annuli of varying contrast levels (0.3, 0.6, and 1.8 x above background) were presented alternatively for a stimulus duration of 100 msec and an inter-stimulus duration of 2000 msec. Each sequence was repeated until 9 valid pairs of data from each eye were obtained with each stimulus. Subjects were dark adapted for five minutes before each set of stimuli.

Results: All stimulus conditions tested found a greater degree of variability between the right and left eye’s afferent pupil responses in amblyopes compared to controls (p<0.01). However, on average when compared to normal subjects, afferent responses of the ambyopic eye were not significantly smaller than that of the fellow eye for the full field flash. For low contrast annular stimuli, the mid-contrast (0.6) stimulus exhibited the most statistically significant pupil response difference between the amblyopic and fellow eyes of amblyopes (p<0.04).

Conclusions: Small low contrast targets select for cortical contributions to the pupil response, and may be more useful for detecting mild pupil defects present in amblyopic patients. Proper documentation of the nature of pupil responses in amblyopes and further characterization of the potential mechanism involved in this deficit may elucidate cortical neural mechanisms responsible for amblyopia. Pupil analysis could prove useful if it is found to have a diagnostic or prognostic value for differentiating which amblyopes will respond best to treatment.

Commercial Relationships: Cristina Llerena Law, None; Matt Siu, None; Patricia A. Modica, None; Benjamin T. Backus, None.

Support: K23 EY 022669-01