

Results of a Pediatric Vision Screening Program in Western South Dakota.

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Abstract

Background: South Dakota is one of eight states that do not require any vision screening for children. This study describes the results of the first children's vision screening program in the state.

Methods: Children ages 6 months to 12 years were screened using the SPOT photoscreener by lay volunteers as part of the Northern Plains Eye Foundation's Western South Dakota Children's Vision Screening Initiative (CVSI). Referral criteria were based on the recommendations of the manufacturer. Data was stratified by age group, sex, and percentage of children referred for hyperopia, myopia, astigmatism, anisocoria, anisometropia, and ocular misalignment. The cost benefit of amblyopia treatment in South Dakota was also calculated.

Results: Screenings were completed on 4,784 children from August 2012 to May 2014 with 62 excluded due to age. Mean age of the 4,722 (2,373 females) subjects was 6 years 7 months. Overall, the SPOT device referred 563 (11.9 percent) children. There was no significant difference in referral rate based on sex ($p=0.598$). Children aged 73-144 months had the highest referral rate (12.2 percent) and children aged 12-30 months had the lowest referral rate (7.9 percent). The suspected reasons for referral based upon the screenings were as follows: 371 (7.9 percent) astigmatism, 24 (0.5 percent) ocular misalignment, 101 (2.1 percent) anisometropia, 135 (2.9 percent) myopia, 36 (0.8 percent) hyperopia, and 16 (0.3 percent) anisocoria.

Conclusions: The SPOT photoscreener yielded an acceptable referral rate of 11.9 percent. This study represents an effective model for pediatric vision screening in South Dakota.

Introduction

Pediatric vision screenings and eye exams detect risk factors which inhibit proper vision development. Failure to detect vision problems in children can lead to permanent vision loss from amblyopia.¹ In the U.S., there are currently eight states which do not mandate some type of pediatric vision screening, despite recommendations by the American Academy of Pediatrics that all newborns and children be screened.² States requiring screenings have varying requirements with some requiring a complete eye exam by an eye care professional and others simply requiring a visual acuity screening. South Dakota is one of the eight states that do not require any vision screening, and it is currently impossible to determine how many children in the state have received some sort of vision testing.

National data indicate the prevalence of amblyopia in the U.S. to be 2-5 percent, with two of the leading risk factors being refractive error and strabismus.^{3,4} Early detection and treatment of amblyopia risk factors, preferably less than 7 years old, has been shown to reduce the risk of amblyopia.⁵ Studies have shown untreated amblyopia to negatively affect academic performance and cause decreased self-esteem.⁶ The traditional screening methods to detect amblyopia require subjective responses from the patient that can be difficult to accurately obtain from a pediatric population when screened by lay personnel. However, automated refractors and photoscreeners can be used to produce objective responses to refractive error and ocular alignment requiring less patient cooperation and less training of vision screening staff. The purpose of this

paper is to report data collected by the SPOT photoscreener (PediaVision Holdings LLC Lake Mary, FL) in a pediatric population in western South Dakota.

Methods

Study Design and Population

Institutional Review Board approval was obtained from The University of South Dakota Sanford School of Medicine, and the study conforms to the requirements of the United States Health Insurance Portability and Accountability Act of 1996. Children ages 6 months to 12 years were screened using the SPOT photoscreener by non-medical volunteers as part of the Northern Plains Eye Foundation's Western South Dakota Children's Vision Screening Initiative (CVSI), a program designed to provide free vision screenings to children in South Dakota. Volunteers from five western South Dakota Lions Clubs participated in training sessions offered by Northern Plains Eye Foundation on vision screening and device operation. Screenings were conducted by the project coordinator and Lions Club volunteers at structured locations such as schools and community centers from 2012-2014. Prior to the screening the project coordinator provided children with consent forms. Only children with completed parental consent forms were screened. Comprehensive screening results were documented and mailed to parents of children screened. The results indicated either no follow-up was required, or a complete eye exam was recommended, as well as why the child was being referred to an eye care professional. In the case of children who were referred for a complete eye exam, additional information was provided regarding the meaning of conditions identified on the screening result, eye care professionals in the region, and agencies that may provide financial assistance to families in need. When the child received an eye exam, the study was designed for Northern Plains Eye Foundation to receive an evaluation form back from the eye care professional.

Device and Eye Examination

The SPOT photoscreener is a wireless portable infrared device that measures and records binocular refractive error, pupil size, interpupillary distance, and ocular alignment in partially dark adapted mid-dilated pupils. The screening is done without pupil dilation or cycloplegia. The screening device is held approximately 1 meter from the child. It then produces a noise to attract the child's attention, and will not record data until the image is properly focused. Using the eyes' optical reflex an image can be obtained in a matter of seconds with multiple readings in three separate meridians. The device uses

programmable criteria which refers a patient if the measurements suggest significant refractive error, anisometropia, anisocoria, or if the pupillary light reflexes indicate strabismus. A pass or fail result is displayed on the screen and can be sent wirelessly to a printer or data storage device. PediaVision reports the accuracy of the device to be ± 0.25 - 0.50 D for spherical error and ± 0.50 - 1.00 D for cylindrical refractive error. Several studies have determined the sensitivity to be approximately 80 percent and the specificity to be 74-85 percent.⁷ Referral criteria (Table 1) were based on the guidelines initially determined from the manufacturer and differed slightly from those published by the Vision Screening Committee of the AAPOS in February 2013⁸ (Table 2).

Data Analysis

Data was stratified by age group, sex, and percentage of children referred for hyperopia, myopia, astigmatism, anisocoria, anisometropia, and ocular misalignment. Sex was compared using a chi-squared test. Cost benefit analysis for the state of South Dakota was completed using the method described by Membrano et al.¹⁹

Results

A total of 4,784 children were screened using the SPOT photoscreener. The mean age was 79 months with 62 children (1.3 percent) excluded due to being out of the age range determined using the categories derived from the Vision Screening Committee of the AAPOS. The final study group totaled 4,722 children consisting of 2,373 females and 2,349 males broken into four age groups (178 ages 12-30 months, 322 ages 31-48 months, 1,327 ages 49-72 months and 2,895 ages 73-144 months).

Overall 563 (11.9%) of the children failed the screening and were referred for a complete eye exam. There was no significant difference in referral rate based on sex ($p=0.598$). Children aged 73-144 months had the highest referral rate (12.2 percent) and children aged 12-30 months had the lowest referral rate (7.9 percent). The reasons for referral based upon the screenings (Figure 1) were as follows: 371 (7.9 percent) astigmatism, 24 (0.5 percent) ocular misalignment, 101 (2.1 percent) anisometropia, 135 (2.9 percent) myopia, 36 (0.8 percent) hyperopia, and 16 (0.3 percent) anisocoria. The referral rate for astigmatism was highest for children aged 49-72 months (9.3 percent) and lowest for children aged 12-30 months (5.1 percent), while the referral rate for myopia was highest in children aged 73-144 months (3.8) and lowest for children aged 12-30 months (0 percent).

The cost benefit of amblyopia was found to be highly

favorable. The South Dakota birth rate was 12,092 in 2012.¹⁷ Assuming an annual incidence of 2 percent, and that every child is screened and treated, the annual expenditure for amblyopia in South Dakota is \$1,041,413.¹⁹ One study estimated an individual with untreated amblyopia will diminish a 30-year income by \$281,520, this cost extrapolated to the South Dakota workforce represents a yearly loss of \$23 million in earning power.¹⁹

Discussion

Our study reported a referral rate of 11.9 percent for the SPOT photoscreener. As this is the first published study examining vision screening in South Dakota, there is no existing data for this population with which to compare referral rates. Our rate is lower than a similar study from Riverside County, California using the SPOT photoscreener which reported a referral rate of 30.6 percent⁹, but higher than published rates of the MTI and Plusoptix photoscreener.^{10,11} Two large volunteer driven community screening programs using the MTI photoscreener in Tennessee and Iowa reported referral rates of 6.7 percent and 4.4 percent respectively.^{10,12} Both of these studies had a significantly higher rate of screenings deemed to be unreadable, which could partially explain the difference in referral rate. Additionally, the Iowa study reported a mean age of 40.8 months as opposed to 79 months in our study. In both studies referral rate increased dramatically as age increased.¹² Thus, the large proportion of children over 6 years of age in our study (61 percent) could be driving the higher referral rate. The manufacturer's referral criteria (Table 1) were more sensitive than that recommended by the 2013 Vision Screening Committee's guidelines (Table 2) for all categories. As our data collection began before these guidelines were published, we chose to continue

with the original criteria which also contributed to a referral rate that was higher than other studies using the updated guidelines.⁷

Photoscreeners do not detect amblyopia directly, but detect problems (amblyopia risk factors) that lead to amblyopia. While our referral rate is higher than the estimated 2-5 percent of preschool age children with amblyopia, it is much more in line with the estimated 15-20 percent prevalence of amblyopia risk factors.¹³⁻¹⁶ According to South Dakota census information from 2012, there are approximately 60,000 children under the age of 5 in the state. The referral rate from this report applied to South Dakota as a whole indicates that there is greater than 7,000 children with amblyopia risk factors. Without treatment, between 1,200 and 3,000 of these children are at risk of permanent vision loss from amblyopia.¹⁷

Amblyopia detection can only be performed by evaluation of visual acuity. Reliability of visual acuity results from a pediatric population can be inconsistent due to short attention spans, cooperation, symbol recognition, or testing by lay personnel. Although children as young as three can be screened with visual acuity testing, recent studies have shown it to have poor sensitivity and specificity.⁷ In preverbal children it is more efficient to detect amblyopia risk factors using photoscreeners during vision screenings.¹⁸

The benefits of early diagnosis are widely documented. Not only is the response to amblyopia treatment quicker in younger children, but treatment has also shown to decrease in effectiveness with increasing age leading to worse visual outcomes.^{6,18-21} In January 2011, the United States Preventative Task Force (USPTF) recommended screening children ages 3-5 years for amblyopia risk factors and cited insufficient evidence for screening children younger than 3 years. They also concluded that there was limited data demonstrating improved functional outcomes due to amblyopia screening. In response to these recommendations Longmuir et al.¹² published data that concluded accuracy and reliability can be extended to children as young as one. This conclusion is an important consideration when developing a statewide program and suggests vision screening should be started at one year of age.

Detection and early institution of treatment of amblyopia has been shown to be cost effective and can contribute substantially to the earning power of the affected individual.^{19,22} The cost of detecting and treating amblyopia is relatively low with a ratio of cost to quality-adjusted life years for amblyopia screening estimated to be \$2,281, much lower than the estimated \$54,000 for

Table 1. Manufacturer referral criteria for the SPOT photoscreener (software version 1.0.3)

Age Range, months	Anisometropia, Diopters	Astigmatism, Diopters	Myopia, Diopters	Hyperopia, Diopters
12-36	1	2	2	3
37-72	1	1.75	1.25	2.5
73-240	1	1.5	0.75	2.5

Table 2. 2013 AAPOS Vision Screening Committee referral criteria

Age Range, months	Anisometropia, Diopters	Astigmatism, Diopters	Myopia, Diopters	Hyperopia, Diopters
12-30	>2.50	>2.00	-3.50	>4.50
31-48	>2.00	>2.00	-3.00	>4.00
>48	>1.50	>1.50	-1.50	>3.50



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Table 3. Screening results in western South Dakota with the Spot photoscreener

Reason for referral	Total, % (n=4,722)	12-30 months % (n=178)	31-48 months % (n=322)	49-72 months % (n=1,327)	73-144 months % (n=2,895)
Astigmatism	7.9 (371)	5.1 (9)	8.1 (26)	9.3 (123)	7.4 (213)
Misalignment	0.5 (24)	1.1 (2)	0.3 (1)	0.5 (7)	0.5 (14)
Anisometropia	2.1 (101)	1.1 (2)	0.6 (2)	2.6 (35)	2.1 (62)
Myopia	2.9 (135)	0.0 (0)	0.9 (3)	1.0 (13)	3.8 (109)
Hyperopia	0.8 (36)	1.1 (2)	0.3 (1)	1.0 (13)	0.7 (20)
Anisocoria	0.3 (16)	0.0 (0)	0.9 (3)	0.4 (5)	0.3 (8)
Total Referred	11.9 (563)	7.9 (14)	10.6 (34)	12.1 (161)	12.2 (354)

hypertension.¹⁹ Well-designed screening programs can have referral rates of less than 10% while maintaining high sensitivity and specificity for detecting amblyopia risk factors and low per child cost.²¹

Major limitations of this study include the lack of demographic data and lack of follow-up data from the eye care professional. The racial/ethnic makeup of the Black Hills of South Dakota is distinct and could be affecting the referral rate. However, several studies have indicated that the prevalence of amblyopia and strabismus was similar among various race/ethnic groups making it unlikely that the results are skewed due to racial or ethnic factors.²³ Low income and factors linked with low socioeconomic status have been reported to be associated with amblyopia.²⁴ Our data contained no information regarding economic status which could also skew the results.

Lack of follow up after a failed screening is a common problem encountered with community vision screenings programs. A number of studies have identified barriers to obtaining eye care after failed screenings such as logistical and scheduling difficulty, cost, and lack of parental time and understanding about the results.²⁵ Addressing these barriers as well as improved communication with eye care professionals is vital to the success of any screening program. Future studies will examine follow-up data from the eye care professional to identify these barriers in South Dakota as well as validate the diagnosis from the eye screening. This is the first project addressing pediatric vision screening in South Dakota, and represents an effective model for statewide implementation.

REFERENCES

1. Eye examination and vision screening in infants, children, and young adults. American Academy of Pediatrics Committee on Practice and Ambulatory Medicine, Section on Ophthalmology. *Pediatrics*. Jul 1996;98(1):153-157.
2. American Academy of Pediatrics Section on Ophthalmology and Committee on Practice and Ambulatory Medicine; American Academy of Ophthalmology; American Association for Pediatric Ophthalmology and Strabismus; American Association of Certified Orthoptists. Instrument-based pediatric vision screening policy statement. *Pediatrics*. 2012; 130: 983-986
3. Simons K. Preschool vision screening: Rationale, methodology and outcome. *Survey of Ophthalmology*. Jul-Aug 1996;41(1):3-30.
4. Attebo K, Mitchell P, Cumming R, Smith W, Jolly N, Sparkes R. Prevalence and causes of amblyopia in an adult population. *Ophthalmology*. Jan 1998;105(1):154-159.
5. Colburn JD, Morrison DG, Estes RL, Li C, Lu P, Donahue SP. Longitudinal follow-up of hypermetropic children identified during preschool vision screening. *Journal of AAPOS*. Jun 2010;14(3):211-215.
6. Kirk VG, Clausen MM, Armitage MD, Arnold RW. Preverbal photoscreening for amblyogenic factors and outcomes in amblyopia treatment: Early objective screening and visual acuities. *Archives of Ophthalmology*. Apr 2008;126(4):489-492.
7. Silbert DI, Matta NS. Performance of the Spot vision screener for the detection of amblyopia risk factors in children. *Journal of AAPOS*. Apr 2014;18(2):169-172.
8. Donahue SP, Arthur B, Neely DE, et al. Guidelines for automated preschool vision screening: A 10-year, evidence-based update. *Journal of AAPOS*. Feb 2013;17(1):4-8.
9. Ransbarger KM, Dunbar JA, Choi SE, Khazaeni LM. Results of a community vision-screening program using the Spot photoscreener. *Journal of AAPOS*. 10// 2013;17(5):516-520.
10. Donahue SP, Johnson TM, Leonard-Martin TC. Screening for amblyogenic factors using a volunteer lay network and the MTI photoscreener. Initial results from 15,000 preschool children in a statewide effort. *Ophthalmology*. Sep 2000;107(9):1637-1644; discussion 1645-1636.

Please note: Due to limited space, we are unable to list all references. You may contact South Dakota Medicine at 605.336.1965 for a complete listing.

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