Comparison of Lea Symbols Chart and Sheridan Gardiner Chart in Assessing Vision Screening among Pre-School Children: A Malaysia Perspective

Rokiah Omar BOptom, PhD*,
Duratul Ain Hussin BOptom, MSc**, Victor Feizal Knight MBBS, MHP***

** Optometry & Visual Science Program, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Kuala Lumpur, Malaysia*
*** Department of Ophthalmology, Hospital Ampang, Kuala Lumpur, Malaysia*
**** Faculty of Medicine & Defence Health, National Defence University of Malaysia, Sungai Besi Camp, Malaysia*

Objective: *Compare the performance of Lea Symbols and Sheridan Gardiner charts against the standard test chart used to determine reduced VA during vision screening among pre-schoolers.*
Material and Method: *Seven hundred seventy five pre-school participated where 389 subjects were boys and 386 subjects were girls were tested using the Lea Symbols chart and the Sheridan Gardiner chart. The mean age of the pre-school children was 5.3 $\pm$ 0.7 years old.*
Results: *The Lea Symbols chart showed a higher sensitivity (97.5%) compared to the Sheridan Gardiner chart (57.1%). While the Sheridan Gardiner chart showed higher specificity (92.0%) compared to the Lea Symbols chart (45.0%).*
Conclusion: *The Lea Symbols chart offers a better pick-up rate of visual impairment during a vision-screening program especially cases of amblyopia among pre-school children compared to the Sheridan Gardiner chart in Malaysia.*

Keywords: *Pre-school children, Visual impairment, Amblyopia, Lea Symbols chart, Sheridan Gardiner chart*

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Choosing a sensitive and specific visual acuity (VA) chart to be used during vision screening is very important in order to identify reduced VA especially among pre-school children. However, most vision screening studies conducted used non-standardized test charts. World Health Organization[1] (WHO) in 2003 suggested that for VA screening, charts that use the principal of the logarithm of minimum angle of resolution, (LogMAR) should be used for VA screening test but many studies still continue to use VA charts that use the Snellen principle. Test charts that use the Snellen principle is easy to use with children. On the other hand, the LogMAR chart has been determined to be more accurate in VA measurement. Furthermore, it can determine the VA at varying distances without compromising the measurement consistency[2-5]. Examples of charts that use the logMAR principal are Lea Symbols chart, Bailey Lovie chart, and ETDRS chart. While charts that use the Snellen principle are Sheridan Gardiner chart, HOTV chart, Tumbling E card, and Cardiff Acuity card.

The Lea Symbols chart has been used more often in the United States, Canada, and Germany compared to other types of chart during vision screening in pre-school children[2,6,7]. In the United Kingdom, the Sheridan Gardiner is the preferred chart[8]. Each country has its own opinion on which VA chart to use based on the specificity and sensitivity of the chart. For example, Hered et al[2] reported that the Lea Symbols chart had a higher specificity compared to the HOTV chart among 3 year old children (92.0% vs. 85.0%, p = 0.05). On the other hand, Newman & East[8] found that the negative predictive value (NPV) for the Sheridan Gardiner chart was high at 99.6% (95% CI 98.7%-99.9%) when used to detect amblyopia among children. In Malaysia, both Lea Symbols and Sheridan Gardiner charts are used in the clinical setting and rarely for vision screening purposes. Therefore, little information is available on the performance of these two charts to determine reduced visual acuity among

Correspondence to:
Omar R. Optometry & Visual Science Program, Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Jalan Raja Muda Abdul Aziz, Kuala Lumpur 50300, Malaysia.
Phone: +603-9289-7495, Fax: +603-2691-0488
E-mail: r_omar@fskb.ukm.my

pre-school children in Malaysia. It is, therefore important to determine the performance of these two charts in the Malaysian context. The present study was conducted to identify the performance of Lea Symbols and Sheridan Gardiner charts compared to a standard test chart used to determine reduced visual acuity among pre-school children in Malaysia.

Material and Method

This was a cross sectional study and conducted between February and November 2007. The sample size calculation was based on the method of Krejcie & Morgan[9]. The pre-school children were randomly selected using a random table from 34 kindergartens in Malaysia. Nine hundred ninety pre-school children were selected for the present study. A consent letter was distributed to the parents two weeks before the present study started. This research project was approved by the Universiti Kebangsaan Malaysia (UKM) Human Subject Ethics Committee (Code project FF-107-2007) and followed the tenants Declaration of Helsinki[10].

Subject criteria

The subjects recruited for the present study were pre-school children aged 4 to 6 years old on January 1, 2007. They were known to be healthy during the vision screening session conducted. The children's health status was confirmed by their health records kept by the kindergarten teachers and from the reply slip received from their parents.

Vision testing

The vision test was conducted at the selected kindergartens during the school session in a room with good illumination (> 300 lux), measured by the illuminance meter model Topcon IM-5. All the children underwent VA testing. The VA tests were conducted using two charts *i.e.* Lea Symbols Chart and Sheridan Gardiner Chart. The Lea Symbols chart used in the present study (apple, square, house, and circle) was serial number 250100 and the size 17" x 21" (43 cm x 53.4 cm) with response and flash cards. The right eye was tested first followed with the left eye at three meters. The pass/fail score was conducted based on the Modified Clinical Method (MCT)[11]. The scores were recorded in logMAR based on the number of correctly identified optotype *i.e.* 0.2 logMAR for each optotype based on formula by Holladay[12]. Failed VA score for Lea Symbols chart was VA > 0.3 logMAR is equivalent to Snellen 6/12.

The Sheridan Gardiner chart used in the present study was 2204-P-1003 with orthoptic booklet consisting of optotype letters such as O, A, T, V, X, and H. The right eye was tested first followed by the left eye at six meters[13]. The VA value was recorded in Snellen notation and then converted to logMAR using the Snellen-logMAR conversion value[12]. The bigger the denominator, the worse the VA achieved by the children[14]. Failed VA score for the Sheridan Gardiner chart was VA < 6/12 based on the pass/fail criteria from the MCT[11].

Standard optometric examination

Pre-school children who failed the VA testing for both charts were referred to the Optometry Clinic for further standard optometric examination. This examination was conducted to determine if they were positive or negative for reduced VA as detected by the VA screening test. The standard optometric examination included distance VA with Lea Symbols chart, cycloplegic retinoscopy test, and subjective refraction. After completing the standard optometric examination, all the children were then classified as to whether they were true positive, (TP), false positive (FP), true negative (TN) and false negative (FN) based on the VA < 6/12 equivalent to VA > 0.3 LogMAR MCT by Peters[11]. Glasses were prescribed to the pre-school children who required correction. The VA measurement was repeated again after 4 weeks of wearing the glasses.

Data analysis

SPSS version 14.0 was used to analyze the data. Descriptive tests were used to analyze the VA data to determine the mean, standard deviation (SD), range, percentage, and confidence interval (CI) 95%. Comparison performance of the Lea Symbols chart and Sheridan Gardiner chart was determined using the validity test, Student's t-test, and Kappa Cohen Agreement analysis. Validity tests included the measurement of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV)[15,16].

$$\text{Sensitivity} = \frac{TP}{(TP+FN)}$$

$$\text{Specificity} = \frac{TN}{(FP+TN)}$$

$$\text{PPV} = \frac{TP}{(TP+FP)}$$

$$\text{NPV} = \frac{TN}{(FN+TN)}$$

Results

Of the 990 pre-school children selected for the present study, only 775 pre-school children received consent from their parents to participate in the screening program for VA testing. Almost equal numbers of pre-school boys (389 subjects) and girls (386 subjects) participated in the present study. A majority of the pre-school children participating in the screening VA program were from the 5-year-old age group (43.8%) followed by the 6-year-old age group (42.7%), and 4-year-old age group (13.5%). The mean age for the pre-school children was 5.3 ± 0.7 years old. Most of the pre-school children participating in the VA screening program were of Malay ethnicity (62.1%), followed by Chinese ethnicity (31.7%), Indian ethnicity (5.9%), and other ethnicities (0.3%).

Sixty pre-school children failed the screening program. The pre-school children were then referred to the optometry clinic and completed the standard optometric examination. The range of the VA of pre-school children who failed the Lea Symbols chart was between 0.3 to 0.8 logMAR (mean 0.44 logMAR). For the Sheridan Gardiner chart, the range of VA of pre-school children who failed was 0.30 to 0.80 logMAR (mean 0.25 logMAR). Student t-test showed that there was a significant difference between the two charts with regards the VA *i.e.* $t(52) = 4.91$, $p = 0.01$ in order to identify vision reduction or problems. Hence, there is a difference in the mean VA reading using the Lea Symbols chart compared to the Sheridan Gardiner chart to detect pre-school children with VA worse than 0.3 logMAR. Kappa Cohen analysis was conducted to determine the agreement between the two charts. It was found that there was a moderate agreement between the two charts ($p = 0.58$). This finding suggests that Sheridan Gardiner chart has a moderate diagnostic agreement with the Lea Symbols chart in order to detect pre-school children in Malaysia with VA > 0.3 logMAR.

Validity test of the charts performance

The VA performance of pre-school children for Lea Symbols chart against the standard test chart was summarized in the 2 x 2 Table (Table 1) below. After the standard test was conducted, 39 pre-school children were confirmed to be TP and 11 pre-school children were confirmed to be FP. However only one pre-school child passed the VA test with Lea Symbols chart during screening but failed the standard test (FN).

The VA performance of pre-school children with the Sheridan Gardiner chart against the standard chart test was summarized in the 2 x 2 Table (Table 2) below. After the standard test was conducted, 20 pre-school children failed the VA test with the Sheridan Gardiner chart during the screening VA program and only two pre-school children passed the standard test. It was also found that the Sheridan Gardiner chart failed to detect 15 pre-school children with VA > 0.3) logMAR during vision screening program.

Based on the 2 x 2 Tables for both charts, the calculation of the validity for the Lea Symbols chart and Sheridan Gardiner chart was determined and summarized in Table 3. It was found that there was a difference in the specificity for both charts in detecting VA worse than 0.3 logMAR. The sensitivity of the Lea Symbols chart was 40.4% more compared to the Sheridan Gardiner chart.

Table 1. 2 x 2 Table for performance of the pre-school children in VA test using Lea Symbols chart compared to standard test chart

		Standard test chart		
		Fail	Pass	Total
Lea Symbols chart	Fail	39	11	50
	Pass	1	9	10
	Total	40	20	60

Table 2. 2 x 2 Table for performance of pre-school children in VA test using Sheridan Gardiner chart compared to standard test chart

		Standard test chart		
		Fail	Pass	Total
Sheridan Gardiner chart	Fail	20	2	22
	Pass	15	23	38
	Total	35	25	60

Table 3. Performance of the sensitivity and specificity of VA test using Lea Symbols chart and Sheridan Gardiner chart among pre-school children

Validity value	Lea Symbols chart	Sheridan Gardiner chart
Sensitivity	97.5%	57.1%
Specificity	45.0%	92.0%

Discussion

From the descriptive analysis, it was found that the mean VA for the Lea Symbols chart was larger compared to the Sheridan Gardiner chart *i.e.* 0.41 logMAR and 0.25 logMAR respectively. There were also statistically significant differences between these two charts (p = 0.01) suggesting that most children had difficulty identifying the Symbols during VA test when using the Lea Symbols chart compared to Sheridan Gardiner chart. The significant differences found in the measurement of VA using the Lea Symbols chart and Sheridan Gardiner chart (0.16 log unit) in the present study was not only because of the crowding effect but also due to grading scales and the technique of scoring the VA. Lea Symbols chart had consistent scales increments that provide a finer range of 0.10 log unit differences compared to Sheridan Gardiner, which uses a 0.20 log unit scale for every change in the unit. Furthermore, the Lea Symbols chart can be used at any distance and the results can be converted and calculated with a simple calculation. Hence, the Lea Symbols chart is not restricted to 6-meter test distance, which is required with the Sheridan Gardiner chart. It can also be done in a smaller room with a 3-meter length. This will assist and facilitate the examiner in getting the children's attention and co-operation during the VA testing part during vision screening. On the other hand, the 6-meter testing distance for VA assessment needs to be adhered to for the Sheridan Gardiner chart for the assessment to be valid. This will make the VA testing possible only in rooms of sufficient length or in the school corridor and this is not suitable because of the noise and student traffic, lighting, which may be variable or insufficient, as well as other disturbances that may occur. Furthermore if the VA test using the Sheridan Gardiner chart is conducted at a distance of 3 meters, the accuracy and scoring standard will be reduced[3].

In the present study, the Lea Symbols chart showed a higher sensitivity (97.5%) compared to the sensitivity of the Sheridan Gardiner (57.1%). Hence, the Lea Symbols chart was able to identify twice as many pre-school children with VA worse than 0.3 logMAR compared to the Sheridan Gardiner chart. In other words, if the Sheridan Gardiner chart was used as the criteria to determine reduced VA in the present study, the Sheridan Gardiner chart failed to identify about 42.9% of pre-school children with reduced VA compared to 2.5% if the Lea Symbols chart is used. Furthermore, 42.9% of the pre-school children with visual impairment were able to achieve a VA of 6/6 with the Sheridan Gardiner chart *i.e.* outside the 95.0% sensitivity limit of the Lea Symbols chart. Similar findings were noted by Simmers et al[17] where the researchers concluded that the Sheridan Gardiner chart was less sensitive in identifying children with amblyopia compared to the Glasgow Acuity chart, which was a logMAR chart similar to the Lea Symbols chart[17]. Study by Dobson et al[19] also reported that the Lea Symbols chart produced visual acuity scores that were about 0.5 line better than visual acuity scores obtained with ETDRS chart, which was similar to Sheridan Gardiner chart.

Even though in the present study the authors found that the Sheridan Gardiner chart was higher in terms of specificity (92%) compared to the Lea Symbols chart (45.0%), it does not necessarily mean that it is important in assessing the strength of a vision-screening program. This is because the strength of a screening model depends on the value of the sensitivity and NPV compared to value of the specificity. Furthermore, the value of the specificity for the Sheridan Gardiner chart in the present study was higher because only two pre-school children failed the VA test with Sheridan Gardiner, which is false positive during the standard test compared to the number of pre-school children false positive with VA test using Lea Symbols chart. However, the Sheridan Gardiner charts are still preferred as a vision-screening tool in certain countries such as the United Kingdom[8]. Newman & East[8] found that the NPV for the Sheridan Gardiner chart in identifying amblyopia was high *i.e.* 99.9% with a lower threshold VA of 6/9 as the fail criteria for vision screening.

In Malaysia, the optometric practices in the public sector seldom use logMAR charts when conducting vision screening among children[18]. The scenario is different when compared to developed countries such as the United States of America and Holland where LogMAR charts are used especially the Lea Symbols chart for vision screening especially to identity amblyopia[2,3,5]. Furthermore, this chart has diagnostic criteria, practical, easy to use, foldable, and cheap compared to other charts that being used during vision-screening program. Hence, the Lea Symbols chart is more suitable compared to Sheridan Gardiner chart from the perspective of comparison of VA and performance values of the chart to identify reduce vision among pre-school children in Malaysia. Therefore, the usage of Lea Symbols chart is encouraged especially in vision screening programs for pre-school children.

Due to constraints of time and personnel conducting the vision screening, some specific tests such as VA with +1.00 Ds was not conducted in the present study. Hence, in the future a study should be done to include the VA with +1.00 Ds to identify latent hyperopia cases. The authors also would like to suggest that similar studies be conducted among other Allied Health personnel such as nurses and medical assistants (MA) who may conduct vision screening at pre-school. The results of the vision screening can be analyzed and determine the effectiveness of such a program so that improvement can be suggested for the vision-screening program for pre-school children in the future.

Conclusion

In conclusion, Lea Symbols chart offers a better pick-up rate for visual impairment especially in cases of amblyopia among pre-school children in Malaysia compared to the Sheridan Gardiner chart. The Lea Symbols chart has a high sensitivity value compared to the Sheridan Gardiner chart. It is thereby recommended that the Lea Symbols chart should be used in vision screening programs for pre-schoolers in Malaysia.

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Potential conflicts of interest

None.

References

1. World Health Organization. Consultation on development of standards for characterization of vision loss and visual functioning. Geneva: WHO; 2003.
2. Hered RW, Murphy S, Clancy M. Comparison of the HOTV and Lea Symbols charts for preschool vision screening. J Pediatr Ophthalmol Strabismus 1997; 34: 24-8.
3. Becker R, Hubsch S, Graf MH, Kaufmann H. Examination of young children with Lea symbols. Br J Ophthalmol 2002; 86: 513-6.
4. Jones D, Westall C, Averbeck K, Abdolell M. Visual acuity assessment: a comparison of two tests for measuring children's vision. Ophthalmic Physiol Opt 2003; 23: 541-6.
5. Kvarnstrom G, Jakobsson P. Is vision screening in 3-year-old children feasible? Comparison between the Lea Symbol chart and the HVOT (LM) chart. Acta Ophthalmol Scand 2005; 83: 76-80.
6. Barry JC, Konig HH. Test characteristics of orthoptic screening examination in 3 year old kindergarten children. Br J Ophthalmol 2003; 87: 909-16.
7. Chui L, Fraser T, Hoar K, LaRoche GR. Negative predictive value of a vision screening program aimed at children aged 3 to 4 years old. J AAPOS 2004; 8: 566-70.
8. Newman DK, East MM. Preschool vision screening: negative predictive value for amblyopia. Br J Ophthalmol 1999; 83: 676-9.
9. Krejcie RV, Morgan DW. Determining sample size for research activities. Educ Psychol Meas 1970; 30: 607-10.
10. Declaration of Helsinki. Ethical principles for medical research involving human subjects Helsinki [Internet]. 1964 [cited 2011 Jun 22]. Available from: http://www.wma.net/en/30publications/10policies/b3/index.html.pdf?print-media-type&footer-right=[page]/[toPage
11. Peters HB. The Orinda Study. Am J Optom Physiol Opt 1984; 61: 361-3.
12. Holladay JT. Visual acuity measurements. J Cataract Refract Surg 2004; 30: 287-90.
13. Carlson NB, Kurtz D, Heath DA, Hines C. Clinical procedures for ocular examination. Norwalk, CT: Appleton & Lange; 1990.
14. Grosvenor TP. Primary care optometry. Boston: Butterworth-Heinemann; 1989.
15. Krishnamurthy GB, Kasovia-Schmitt P, Ostroff DJ. Statistics: an interactive text for the health and life sciences. Boston: Jones and Bartlett Publishers; 1994.
16. Armitage P, Berry G, Matthews JNS. Statistical methods in medical research. 4th ed. Oxford: Blackwell Science; 2002.
17. Simmers AJ, Gray LS, Spowart K. Screening for amblyopia: a comparison of paediatric letter tests. Br J Ophthalmol 1997; 81: 465-9.
18. Standard operating procedure: care for patients with refractive errors. Kuala Lumpur: Optometry Services, Ministry of Health, Malaysia; 2007.

19. Dobson V, Clifford-Donaldson CE, Miller JM, Garvey KA, Harvey EM. A comparison of Lea Symbol vs ETDRS letter distance visual acuity in a population of young children with a high prevalence of astigmatism. J AAPOS 2009; 13: 253-7.

เปรียบเทียบการใช้แผนภูมิสัญลักษณ์ Lea และแผนภูมิ Sheridan Gardiner ในการตรวจคัดกรองสายตาของเด็กก่อนวัยเรียน: มุมมองจากประเทศมาเลเซีย

Rokiah Omar, Duratul Ain Hussin, Victor Feizal Knight

วัตถุประสงค์: *การศึกษานี้มีวัตถุประสงค์เพื่อเปรียบเทียบประสิทธิภาพของการใช้แผนภูมิสัญลักษณ์ Lea และแผนภูมิ Sheridan Gardiner ในการตรวจคัดกรองสายตาของเด็กก่อนวัยเรียน*

วัสดุและวิธีการ: *เด็กก่อนวัยเรียนที่เข้าร่วมในการศึกษาจำนวน 775 คน เป็นเด็กชาย 389 คน และเด็กหญิง 386 คน อายุเฉลี่ย 5.3 $\pm$ 0.7 ปี การตรวจสายตาใช้แผนภูมิสัญลักษณ์ Lea และแผนภูมิ Sheridan Gardiner*

ผลการศึกษา: *แผนภูมิสัญลักษณ์ Lea พบว่ามีความไวสูง (97.5%) เมื่อเทียบกับแผนภูมิ Sheridan Gardiner (57.1%) ในขณะที่แผนภูมิ Sheridan Gardiner มีความจำเพาะสูง (92.0%) เมื่อเทียบกับแผนภูมิสัญลักษณ์ Lea (45.0%)*

สรุป: *แผนภูมิสัญลักษณ์ Lea ให้อัตราการคัดเลือกความด้อยของสายตา โดยเฉพาะในรายตามัว (amblyopia) ของเด็กก่อนวัยเรียน ในประเทศมาเลเซีย ดีกว่าการใช้แผนภูมิ Sheridan Gardiner*