A need for standardization in visual acuity measurement

Medida da acuidade visual e necessidade de padronização

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ABSTRACT

Standardization of terminologies and methods is increasingly important in all fields including ophthalmology, especially currently when research and new technology are rapidly driving improvements in medicine. This review highlights the range of notations used by vision care professionals around the world for vision measurement, and the challenges resulting from this practice. The global community is urged to move toward a uniform standard.

Keywords: Visual acuity; Vision screening; Vision tests; logMAR; ETDRS

RESUMO

Nos tempos atuais, quando a pesquisa e a tecnologia estão avançando rapidamente, as melhorias na medicina, a padronização de terminologias e métodos está se tornando cada vez mais importante em todos os campos, incluindo a oftalmologia. Os profissionais de cuidados da visão em todo o mundo usam várias notações para a medição da visão. Nesta revisão, os autores destacam os desafios enfrentados por essa abordagem. A comunidade global precisa adotar um padrão uniforme.

Descritores: *Acuidade visual; Triagem visual; Teste de visão; logMAR; ETDRS*

INTRODUCTION

Visual acuity (VA) is presented in different units and using several notational systems(1-4). From a global vision care perspective, acceptance of a standard unit of vision testing and vision notation would help ease data consolidation between different countries and facilitate easier communication between policy makers, healthcare or socioeconomic benefits administrators, governments, healthcare training providers, and researchers. It would also establish a benchmark to evaluate all stakeholders on an equal footing.

Visual acuity measurement

Variations in charts

Worldwide, Snellen charts are the most popular charts for vision measurement, with many variations using a range of optotypes. For testing vision in children, the Landolt C chart, the Tumbling E chart, Lea Symbols, Lea grating, or other tests may be employed(2,5,6). Based on the judgment of trained professionals, these charts may also be used for vision testing in adults with impaired mental abilities or low literacy(2,7,8). Jaeger charts are used to test near VA(9). The choice of chart varies depending on patient requirement, practitioner preference, testing method, resource availability, and staff expertise.

Variations in notations

Visual acuity in Snellen charts is often represented as a fraction in which the numerator is distance from the chart and the denominator is size of the smallest line that can be read. Feet (ft.) and meters (m) are the most commonly used distance units for notation of VA. However, in clinical settings, a variety of notations are used throughout the world. For instance, the decimal system is used in Algeria, Bulgaria, Belgium, Denmark, Japan, and several other countries(4,8). Decimals as x/10 fractions are used in several parts of Europe(3,10) and some parts of Africa and Latin America. Five-score is used in China *(personal communication)*. Vision standards recommended by the Federal Aviation Administration include Military Standard MIL-STD-401E and National Aerospace Standards (NAS) developed by the Aerospace Industries Association (AIA). AIA-NAS-410 uses Jaeger units for vision notation. The International organization for Standardization (ISO) accepts Jaeger and N points of VA to qualify nondestructive inspection and testing (NDI/NDT) personnel using ISO-9712(9). When the Jaeger chart is used for vision testing, readings may vary depending on testing distance. A J1 measurement based on the revised Jaeger standard testing distance of 14 inches would be equivalent to 20/20 under the Snellen acuity standard. If the NDI/NDT vision standard of a 17.5-inch testing distance is followed, J1 would be equivalent to 20/15 and J2 would be 20/20(9). Grating tests may be used for patients with severely constricted visual fields or scotomas with notation units of cycles per degree(2).

ETDRS for research

In Snellen charts, every line has variable letter sizes and a variable number of letters are present in each line. Good vision lines have up to eight letters and some poor vision lines may have only two letters. They contain an irregular progression of letter sizes between lines, and non-uniform spacing between letters and rows. In clinical settings, variable testing distance, illumination, test chart design, font types, optotype size, optotype spacing, patient variables, and methods of scoring all contribute small margins of error to test-retest variabilities in vision testing(2,5,11). Building up on research data and theories from as early as 1868, Bailey and Lovie first designed the logMAR chart in 1976. They addressed several known drawbacks of the Snellen chart. Their new design incorporated five optotypes in each row and a uniform logarithmic letter size progression increasing in 0.1 logMAR steps where logMAR is an acronym for $\log_{10}$ of

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minimum angle of resolution (MAR). Spacing between letters and rows was equalized to letter height in the smaller of the two rows[5]. In 1982, the US National Eye Institute developed the Early Treatment Diabetic Retinopathy Study (ETDRS) chart and a protocol for vision testing. British standard letters (rectangular) in the Bailey Lovie chart were replaced with Sloan Letters (square). A testing distance of 4 m was used instead of the earlier 6 m. Readings for these charts could be noted in logMAR, Visual acuity score, Letter score, MAR, and others, adding further to the range of notations.

The use of the ETDRS method, which had a superior chart design and a defined method for testing vision resulted in considerable improvement of VA scores, especially in the low vision range with two-line improvement in patients with ≤20/200 vision, approximately five lines in those with 20/400 vision, and also in patients with exudative age-related macular degeneration, when compared to the Snellen chart[12]. The accuracy of results provided by the ETDRS method helped its establishment as a Gold standard in vision testing for research purposes. E-ETDRS or Electronic ETDRS testing is also now employed in clinical trials and has been proven to reduce test-retest time and technician bias[5,13]. Despite these advances, some researchers still express concern that there might be variation in scores with use of standard ETDRS or E-ETDRS charts in patients with visual disorders such as macular degeneration or amblyopia[13]. It should be noted that the standards of illuminance used in ETDRS protocols, measured in candela per square meter (cd/m^2) units, are also variable across countries. The ETDRS protocol approved by the US FDA defines a standard illumination of 85 cd/m^2, use of a wide chart on a lightbox, and mandates a testing distance of 4 m. The accepted standard in Germany is 300 cd/m^2 and 120 cd/m^2 has been adopted in the United Kingdom[11,14]. Nevertheless, even with these caveats, the appeal of the ETDRS method for vision testing in research and academic settings is undisputed.

logMAR for routine use

Though the ETDRS method seems ideal for vision testing in research settings, it does not automatically hold appeal among practicing ophthalmologists. Latin (Roman) alphabets on the ETDRS chart were modified to Sloan letters for use in Europe[14]. Thus, region-specific optotypes in vision charts were desirable for workers in the field. Many found the ETDRS protocol hard to adopt because of the need for special equipment, complex scoring, staff re-training, and the extended time needed to complete the evaluation. Some practitioners were of the opinion that the standard testing distance of 4 m is cumbersome when examining patients with low vision. However, there was general acceptance of the advantages of the ETDRS protocol and several practitioners explored methods to make it more clinic-friendly. Reduced logMAR E (RLME)[15], Compact reduced logMAR[16] Simplified logMAR[17], Reduced logMAR[18] and other charts were tested and found acceptable. These charts are all recognized as logMAR charts and differ in the use of optotypes, number of optotypes in a row, or number of lines in a chart. The use of logMAR charts with standard methods is expected to cause some test-retest variability based on the use of optotypes, number of lines, illumination, and other factors, but is a considerable improvement over using the Snellen chart. This method can reduce testing time and is much less cumbersome to use than the standard ETDRS research protocol. Though using the compact logMAR chart takes a slightly longer time than using the Snellen chart (5-40 sec *vs* 3-35 sec), the time taken was almost half that taken for using the ETDRS chart (9-80 sec)[16]. The difference in sensitivity and specificity of simplified logMAR compared to the standard is marginal (95 % *vs* 98%). The cost of a simplified logMAR chart printed on A4 size paper and pasted on a cardboard is less than $1, compared to the standard logMAR chart printed on acrylic material costing approximately $121. Training school teachers in the use of simplified logMAR charts was accomplished in half a day and the only logistics required for screening were a pen, a measuring tape, and the chart itself[17]. Thus, from a practical standpoint, using logMAR charts with standard methods would be an excellent compromise.

The challenge in the public healthcare arena

Current healthcare delivery is increasingly being driven by software platforms specializing in information exchange, data collection, and meta-analysis. Using software for analytics can have considerable influence in public healthcare decision-making and assessment of the effectiveness of policies by providing insights into trends including geographic locations, population genetics, economics, and many other parameters.

HelpMeSee, via its extensive network of partner surgeons and hospitals, provides cataract care in ten countries and is rapidly expanding. The initiative faced several challenges in developing an automated software platform for visual outcome reporting following cataract surgery. The system required user interfaces of hospitals to be adaptable, enabling entry of pre-surgery and post-surgery VA data in notations as used by vision care providers around the globe. On the HelpMeSee interface, the software required accuracy in sorting of data in various notations with identical numerical values but different clinical translations. For example, a numerical value of 1.9 in logMAR would mean near total visual impairment, but 1.9 in grating cycles per degree (cpd) units would mean severe visual impairment. An outcome monitoring report was required in a US format for HelpMeSee evaluation, but feedback to the surgeons on the field needed to be in a format familiar to them. These requirements were essential in order to facilitate continuous improvement in patient care.

To provide a framework for the development of this software, the authors conducted a survey of a wide variety of available VA conversion charts. No attempt was made to study the various strategies used to check visual acuities. A comprehensive table of conversions (Table 1*) was created to avoid errors in translation of information and provide correct logic to build data sorting algorithms. At a 20 ft. measuring distance, VA noted as 20/20 would be represented as 6/6 at 6 m in metric notation. At this level, the decimal notation equivalent would be 1 and logMAR would be 0 (Table 1: *highlighted in yellow*). In the absence of simplification, as seen in the conversion table, aggregated information from various charts makes the chart too big for routine printing or viewing on digital devices and very complex to understand. Therefore, it is not a surprise that most equivalency charts used in hospitals are highly simplified and tailored to meet individual requirements. This work revealed that absolute conversion of one unit to another is not always possible regardless of how the VA measurement was obtained[3,19,12]. Some levels of measurement might be skipped and values might show slight variations in published vision conversion charts e.g., either 20/60 or 20/63 may be used in 20ft notation to measure vision and depending on the chart used as reference, this could be translated to 6/18, 6/18.9, 6/19, or 6/20 in 6 m notation (Table 1: *highlighted in pink*). N12 notation used for notation at 40 cm is not the same as N12 notation used for notation at 100 cm (Table 1: *highlighted in green*). Gaps in the table show areas where no comparable values were found. Multiple values for the same unit were occasionally noted. In addition, some conversion values were skipped to maintain a linear progression in the table in cases of higher values in one column being translated to lower values in another using different reference sources. Another strong reason to recommend standardization for VA measurement and notation is the possibility of errors in defining blindness categories. WHO ICD-10 revision-2 recommends that VA worse than 6/18 (m), or 20/70 (ft.) is categorized as moderate visual impairment. Depending on the chart used for information translation (Table 1: *highlighted in orange*), a practitioner unfamiliar with the use of a specific system and using any available chart condensed for practical purposes, runs a risk of making mistakes in classification. For automated data systems, these variations need to be accounted for.

The presented conversion chart will be useful to people actively working in public healthcare, especially in the international arena. It is expected to help understand information recorded using different systems of measurements, while drawing attention to discrepancies that require attention and translating values for practical application in software development, training of healthcare professionals, or development of region-specific healthcare policies.

Practical solution

For organizations serving underprivileged areas, procuring special equipment might not be possible or financially viable. Availability of trained staff may also be a challenge resulting in long patient queues requiring optimum use of staff time. logMAR charts provide a practical solution in such scenarios. They borrow essential design elements of ETDRS charts and provide near-precise VA measurement while also overcoming issues identified in the Snellen methodology. Simplified formats allow evaluation in shorter timeframes than the ETDRS protocol. The authors believe that the logMAR chart when used with standard methodology provides a good balance of simplicity, acceptable level of accuracy, and reproducibility for routine clinical practice. Standardization of vision care professional training on a global level would also contribute hugely to harmonization.

HelpMeSee is working to adopt logMAR charts in the field and logMAR notation for reporting. HelpMeSee encourages standardization of VA notation to improve global collaboration and vision research. In the meantime, the equivalency chart will be used as a reference guide to ensure the best possible consistency in data analysis, outcome monitoring, and training programs for field staff.

**Owing to the large size of the table, viewing on digital screens with a resolution of at least 1920 × 1200 pixels and 24-in widescreen format, or a landscape print on A3 paper (11.7 × 16.5 in) is recommended.*

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Table 1 (Part A): Visual acuity conversion chart X-axis: equivalent values are presented in the rows, Y-axis visual acuity notation types are presented in coloums

	Other	20ft	10ft	5ft	2ft	6 m	5 m	4 m	3 m	1 m	Decimal	5 score	Decimal as x /10 fraction	logMAR ETDRS	Letter count	Read 1M at cm	Visual acuity score (VAS)	Visual acuity rating (VAR)	Visual angle/ Mar notation/minarc	VE% notation	spatial frequency cyc/ degree grating cpd	Line number	% central visual efficieny for distance vision	% central visual efficieny for near vision	0.40 mts	Reduced Snellen at 40 cm	Jaeger approximate 40 cm	Revised Jaeger standard	American point type	M notation/M-unit	N points *	x-height mm	40 cm UK	100 cm UK	Snellen at inches 14	Centimeters 35
Near total blind	NPL/NLP	NPL/LP																																		
	PL/LP	PL/LP																																		
	CF1/HM	CF1/HM																																		
		20/6060									0.0033			2.48																						
		20/5020									0.0040			2.40																						
	CF2/HM	20/4000									0.0050			2.30																						
		20/3170									0.0063			2.20																						
	CF3/HM (20/2666)	20/2500									0.0080			2.10																						
	CF4	20/2000	10/1000			6/630 6/600	5/500	4/400	3/320	1/100	0.0100	3.0		2.00	0		0	0	100		0.30	20	0		0.40/40	20/2000				40.0	320	58.2			14/ 1400	35/ 3500
												3.1		1.98			1																			
														1.96			2																			
														1.94			3																			
														1.92			4																			
	CF5	20/1600	10/800			6/500 6/480	5/400	4/320	3/250	1/80	0.0125 0.0130			1.90	5		5	5	80		0.35 0.38				0.40/32	20/1600				32.0	250	46.5			14/ 1100	
		20/1400									0.0140																									
	CF6 (20/1333)											3.2		1.88			6																			
														1.86			7																			
														1.84			8																			
														1.82			9																			
	CF7 (20/1143)	20/1250	10/630			6/400 6/380	5/320	4/250	3/200	1/63	0.0160			1.80	10		10	10	63						0.40/25	20/1250				25.0	200	36.4			14/ 880	
		20/1200				6/360													60	0.48%	0.5 0.65															
														1.78			11																			
														1.76			12																			
														1.74			13																			
														1.72			14																			
	CF8	20/1000	10/500			6/320 6/300	5/250	4/200	3/160	1/50	0.0200	3.3		1.70	15	2	15	15	50						0.40/20	20/1000				20.0	160	29.1			14/ 700	
														1.68			16																			
														1.66			17																			
														1.64			18																			
														1.62			19																			
Profound visual impairment	CF10	20/800	10/400			6/250 6/240 6/192	5/200	4/160	3/125	1/40	0.0250 0.0300	3.4		1.60	20	2.5	20	20	40		0.75 0.95	16	5		0.40/16	20/800				16.0	125	23.3			14/ 560	35/ 1400
		20/640										3.5		1.50																						
														1.58			21																			
														1.56			22																			
														1.54			23																			
														1.52			24																			
		20/630	10/320			6/200 6/190 6/180	5/160	4/125	3/100 3/95	1/32	0.0320		2/60	1.50	25	3.2	25	25	32	0.40%					0.40/12.5	20/630				12.5	100	18.2			14/ 440	
		20/600												1.50					30		1.00															
														1.48			26																			
														1.46			27																			
														1.44			28																			
														1.42			29																			
		20/500	10/250			6/160 6/152 6/150	5/125	4/100	3/80 3/75	1/25	0.0400	3.6		1.40	30	4	30	30	25	1.40%	1.20				0.40/10	20/500				10.0	80	14.5			14/ 350	
														1.38			31																			
														1.36			32																			
														1.34			33																			
														1.32			34																			

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Table 1 (Part B): Visual acuity conversion chart X-axis: equivalent values are presented in the rows, Y-axis visual acuity notation types are presented in coloums

Other	20ft	10ft	5ft	2ft	6 m	5 m	4 m	3 m	1 m	Decimal	5 score	Decimal as x /10 fraction	logMAR ETDRS	Letter count	Read 1M at cm	Visual acuity score (VAS)	Visual acuity rating (VAR)	Visual Angle/ Mar notation/minarc	VE% notation	spatial frequency Cyc/degree grating cpd	Line number	% central visual efficiency for distance vision	% central visual efficiency for near vision	0.40 mts	Reduced Snellen at 40 cm	Jaeger approximate 40 cm	Revised Jaeger standard	American point type	M notation/M-unit	N points *	x-height mm	40 cm UK	100 cm UK	Snellen at inches 14	Centimeters 35
Severe visual impairment	20/400	10/200	20/1600	20/4000	6/126 6/120	5/100	4/80	3/63	1/20	0.050	3.7	3/60	1.30	35	5.0	35	35	20.00	3.3%	1.50	13	10		0.40/8	20/400				8.0	63	11.60	~N48		14/280	35/700
											3.8																								
													1.28 1.26 1.24 1.22			36 37 38 39																			
	20/320	10/160			6/100 6/96 6/95 6/90	5/80	4/63	3/50 3/47	1/16	0.060 0.063			1.20	40	6.3	40	40	16.00	6.8%	1.88 1.90	12	15		0.40/6.3	20/320				6.4 6.3	50	9.16			14/224 14/220	35/560
	20/300									0.070			1.18 1.16 1.14 1.12			41 42 43 44		15.00		2.00		16							6.0			~N36		14/210	35/525
	20/250	10/125			6/80 6/76 6/75	5/63	4/50	3/40 3/37	1/12.5	0.080	3.9		1.10	45	8.0	45	45	12.50	12.8%	2.40	11	17	0	0.40/5	20/250				5.0	40	7.27			14/175	35/437.5
													1.08 1.06 1.04 1.02			46 47 48 49																			
	20/200	10/100	20/800	20/2000	6/63 6/60	5/50	4/40	3/32 3/30	1/10	0.100	4.0	1/10	1.00	50	10.0	50	50	10.00	20.0%	3.00	10	20	2	0.40/4	20/200	J15-J18	14	23	4.0	32	5.82	N24	N48	14/140	35/350
													0.98 0.96 0.94 0.92			51 52 53 54																			
	20/160	10/80			6/50 6/48 6/45	5/40	4/32	3/25 3/24	1/8	0.125 0.130	4.1		0.90	55	12.5	55	55	8.00	28.6%	3.75 3.80	9	30	5	0.40/3.2	20/160	J10-J15	13	21	3.2	25	4.65			14/112 14/110	35/280
	20/150									0.130								7.50		4.00		32	6		20/150				3.0			~N18		14/105	35/262.5
													0.88 0.86 0.84 0.82			56 57 58 59																			
Moderate visual impairment	20/125	10/63			6/40 6/38 6/37.5 6/34.2	5/ 32 5/30	4/25	3/20 3/19	1/6.3	0.160	4.2		0.80	60	16.0	60	60	6.30 6.25 5.70	38.8%	4.80	8	40	10	0.40/2.5	20/125	J9-J12	12	14	2.5	20	3.64		~N36	14/88 14/87.5	35/218.8
	20/120 20/114									0.180			0.76					5.10		5.26		44	12				11	13	2.3					14/79.8	35/199.5
													0.78 0.76 0.74 0.72			61 62 63 64																			
	20/100	10/50	20/400	20/1000	6/32 6/30	5/25	4/20	3/16 3/15	1/5	0.200	4.3	2/10	0.70	65	20.0	65	65	5.01	48.9%	6.00	7	50	15	0.40/2.0	20/100	J8-J12	10	12	2.0	16	2.91	N14		14/70	35/175
													0.68 0.66 0.64 0.62			66 67 68 69																			
	20/80	10/40	20/320	20/800	6/25 6/24	5/20	4/16	3/12.5 3/12	1/4	0.250	4.4		0.60	70	25.0	70	70	4.00	58.5%	7.50	6	60	20	0.40/1.60	20/80	J5-J9	9	11	1.6	12.5	2.33	N12	N24	14/56	35/140
	20/70		20/280	20/700	6/21 6/20					0.290		3/10						3.50		8.57		63	32						1.4					14/49	35/122.5
													0.58 0.56 0.54			71 72 73																			
													0.52			74																			

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Table 1 (Part C): Visual acuity conversion chart X-axis: equivalent values are presented in the rows, Y-axis visual acuity notation types are presented in coloums

	Other	20ft	10ft	5ft	2ft	6 m	5 m	4 m	3 m	1 m	Decimal	5 score	Decimal as x/10 fraction	logMAR ETDRS	Letter count	Read 1M at cm	Visual acuity score (VAS)	Visual acuity rating (VAR)	Visual angle/ Mar notation/minarc	VE% notation	spatial frequency Cyc/degree grating cpd	Line number	%Central visual efficieny for distance vision	% central visual efficieny for near vision	0.40 mts	Reduced Snellen at 40 cm	Jaeger approximate 40 cm	Revised Jaeger standard	American point type	M notation/M-unit	N points *	x-height mm	40 cm UK	100cmUK	snellen at inches 14	centimeters 35
Near normal vision		20/63	10/32			6/20 6/19 6/18.9 6/18	5/16	4/13 4/12.5	3/10 3/9	1/3.2	0.32	4.5	3/10	0.50	75	32	75	75	3.2/3.15	67.5%	9.5/9.52	5	65	40	0.40/1.25	20/63	J4-J7	8	10	1.30 1.25	10.0	1.82			14/44.1 14/44	35/110.3
		20/63		20/240	20/600	6/18	5/15				0.32 0.33		3/10	0.48			76		3.00		10		67	42				7	9	1.20			N10	N18	14/42	35/105
														0.46 0.44 0.42			77 78 79																			
		20/60 20/50	10/25	20/200	20/500	6/16 6/15	5/12.5	4/10	3/8 3/7	1/2.5	0.40	4.6	4/10	0.40	80	40	80	80	2.50	76.5%	12	4	75	50	0.40/1.0	20/50	J3-J6	6	8	1 0.9	8.0	1.45	~N8		14/35	35/87.5
														0.38 0.36 0.34 0.32			81 82 83 84																			
		20/40	10/20	20/160	20/400	6/12.5 6/12	5/10	4/8	3/6.3 3/6	1/2	0.50	4.7	5/10	0.30	85	50	85	85	2.00	83.6%	15	3	85	90	0.40/0.8	20/40	J1-J5	5	7	0.8	6.3	1.16	N6	N14	14/28	35/70
														0.28 0.26 0.24 0.22			86 87 88 89																			
		20/32	10/16			6/10 6/9.6 6/9.5	5/8	4/6.3	3/5	1/1.6	0.63	4.8	6/10	0.20	0.29	63	90	90	1.60	89.8%	18.75 19	2	90	94	0.40/0.63	20/32	J1-J3	4	6	0.64 0.63	5.0	0.92			14/22.4 14/22	35/56
		20/30	10/15			6/9	5/7.5 5/6.6				0.67 0.70		7/10	0.18							20		91	95				3	5	0.60			N5	N12	14/21	35/52.5
						6/8.5							7/10																							
														0.18 0.16 0.14 0.12			91 92 93 94																			
		20/25	10/12.5			6/7.5 6/6.6 8	5/6.3	4/5	3/4	1/1.25	0.80	4.9	8/10	0.10	95	80	95	95	1.25	95.6%	24	1	95	100	0.40/0.5	20/25	J1-J2	2	4	0.50	4.0	0.73		N10	14/17.5	35/43.8
													9/10																							
														0.08 0.06 0.04 0.02			96 97 98 99																			
Normal vision		20/20	10/10			6/6.3 6/6	5/5	4/4	3/3.2 3/3	1/1	1.00	5.0	10/10	0	100	100	100	100	1.00	100.0%	30	0	100	100	0.40/0.4	20/20	J1	1	3	0.40	3.2	0.58	N4.5	N8	14/14	35/35
														-0.02 -0.04 -0.06 -0.08			101 102 103 104	101 102 103 104																		
		20/17 20/16 20/15	10/8			6/5 6/4.8 6/4.5	5/4	4/3.2 4/3	3/2.5 3/2.4	1/8	1.20 1.25 1.33	5.1	12/10	-0.10	105	125	105	105	0.80	103.6%	37.5 38	-1	100	100	0.40/0.32	20/16				0.32	2.5	0.47			14/11.2 14/11	35/28
														-0.12 -0.14 -0.16 -0.18			106 107 108 109																			
		20/13 20/12.5 20/12	10/6.3			6/4 6/3.8 6/3.75	5/3.5 5/3.2	4/2.5	3/2 3/1.9	1/63	1.50 1.60 1.63	5.2	15/10	-0.20	110	160	110	110	0.63	106.8%	48	-2	100	100	0.40/0.25	20/12.5				0.25	2.0	0.36			14/8.8	35/21.9
														-0.22 -0.24 -0.26 -0.28			111 112 113 114																			
		20/10				6/3	5/3 5/2.5	4/2	3/1.5	1/0.5	2.00	5.3	20/10	-0.30			115	115	0.50	109.4%	60	-3	100	100	0.40/0.20	20/10				0.20	1.6	0.29			14/7	35/17.5
		20/8				6/2.4	5/2.0	4/1.6	3/1.2		2.50																									
References (key only)	21, 24	1, 2, 3, 7, 9, 10, 11, 13, 14, 16, 21, 24	9, 10	3	3	1, 2, 7, 9, 10, 11,13, 14, 16, 23	2, 3, 9, 10, 11	7, 9, 10	10	9, 10, 11	1, 2, 7, 9, 10, 11, 13, 14, 16, 21	personal communication	1, 11, 23	13	11	11	10, 13	7	7, 14	7	7, 14	14	14	14	7	7	7	14	14	7, 14	7	7	2	2	7, 14	14
	20, 22	1, 2, 3, 4, 7, 10, 11, 12, 20, 21, , 22, 23	7, 11	21	21	1, 2, 3, 4, 7, 10, 11, 12, 23, 24	4, 7, 10, 11, 21	2, 7, 11,	7	7, 10, 11	1, 2, 3, 4, 7, 10, 11, 12, 20, 23	personal communication	3, 10, 24	23	10	10	7, 23	2	1, 2	2	1, 2	1	1	1	2	2	2	1	1	1, 2	2	2	4	4	1, 2	1

Modification of visual acuity conversion chart. Holladay JT. Visual acuity measurement. J. Cataract Refract Surg 2004;30 (2):287-290.