Published in final edited form as:

Ophthalmic Physiol Opt. 2018 March ; 38(2): 193–202. doi:10.1111/opo.12440.

Clinical outcomes of low vision rehabilitation delivered by a mobile clinic

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Abstract

Purpose: This prospective cohort study examined clinical outcomes of low vision rehabilitation (LVR) delivered by a mobile clinic.

Methods: Participants were recruited from those scheduled for mobile clinic LVR and met the United States definition of legal blindness. Participants completed the Massof Activity Inventory (AI) before LVR, 3 months post-LVR, and 1 year post-LVR. Change scores and measures of clinical effect (i.e. Cohen's effect size and minimum clinically important difference, MCID) were calculated for each time point and compared. Additional participant characteristics (age, acuity, contrast sensitivity, cause of visual impairment, training recommendations, and prior LVR experience) were also explored with respect to outcome measures.

Results: Of the 66 participants enrolled in this study, 47% had no prior LVR experience. Significant differences were noted between baseline and 3-month person measures, and between baseline and 1-year person measures. There was no significant difference between 3-month and 1-year person measures, nor was there a significant difference in change score between these two time points. At 1 year post-LVR, overall visual ability effect size was 0.74. A clinically meaningful outcome was achieved in 56% of participants at 3 months and 71% at 1 year for overall visual ability. There was no significant difference in the proportion of participants achieving MCID at 3 months vs 1 year. Of participants who completed the 1-year post-LVR AI, 59% reported a subjective worsening of vision during the study period. This subgroup also tended to have smaller 1-year change scores.

Conclusions: Mobile clinic LVR is effective at expanding access to care and produces clinically meaningful outcomes comparable to those seen in other outpatient LVR delivery models.

Keywords

epidemiology; low vision

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Disclosures

The corresponding author, Professor Nicole Ross serves as a consultant for Genentech and has served on Advisory Boards for Genentech Inc. Professor Ross has received honoraria and travel support from Genentech as part of her participation on the advisory board.

Introduction

Visual impairment is a highly prevalent problem, affecting approximately three million Americans and increasing in incidence as the population ages.¹ With this expanding population, effective and accessible low vision rehabilitation (LVR) provision becomes a pressing concern. Randomised clinical trials conducted in Veterans Affairs (VA) hospital-based programmes have evaluated effectiveness of intensive rehabilitation service delivery models.^{2–4} Private outpatient LVR has also been shown to produce clinically meaningful outcomes in the United States.^{5,6} Additionally, a primary care-based low vision service has been shown to improve outcomes and expand access to LVR in Wales.⁷ However, no prior study has evaluated the effectiveness of mobile clinic LVR.

Outcome studies have relied on various visual function questionnaires to evaluate a clinical intervention's impact on quality of life. These questionnaires ask patient to self-report the difficulty performing a number of visually mediated tasks or goals. Utilising Rasch Analysis, a measurement of a person's visual ability is obtained by comparing self-reported difficulty for each item with the inherent level of difficulty of that item (i.e. item measure). The Massof Activity Inventory (AI) is one such validated questionnaire which has been implemented, measured, and calibrated with nearly 3000 low vision patients.^{8,9} The AI makes use of a hierarchical activity breakdown structure, with 460 tasks serving one of 50 larger goals.⁹

When completing the AI, a person first rates the importance of a visually mediated goal. He/she then rates his/her difficulty ('Slightly Difficult', 'Moderately Difficult', 'Very Difficult', 'Impossible to do without Help from Another Person', 'Not Applicable'), accomplishing each task that is related to that goal if the goal was rated as important. Due to this adaptive format coupled with Rasch Analysis, a visual ability variable is approximated in such a way that it is impacted only by goals and tasks rated as important and difficult at baseline. Additionally, the AI's many items span a broad range of item measures, limiting the likelihood that floor and ceiling effects will impact outcomes. This allows accurate and precise measurement, making the AI a powerful tool to measure LVR outcomes.

This prospective cohort study uses the AI to examine outcomes from LVR provided by a mobile clinic, which travelled to areas with an identified scarcity of low vision providers. Outcomes are explored in comparison to previous work completed in other delivery models. Additional factors such as participant characteristics and training recommendations are also examined in relation to outcome measures.

Methods

Participants

Participants were recruited between May 2015 and October 2016. All patients scheduled for mobile clinic LVR were contacted by telephone prior to their examination to determine eligibility and interest in study participation. Patients who elected to enrol as participants were required to be legally blind according to 2014 United States Social Security standards¹⁰ (i.e. better seeing eye worse than 0.70 LogMAR (20/100 or 6/30 Snellen

Equivalent) and/or visual field subtending less than 20 degrees in the largest diameter) at time of enrolment. Participants were at least 14 years of age and able to complete the AI in English by telephone on three separate occasions as dictated by study protocol. Use of a telephone questionnaire excluded those with inadequate English fluency and/or telephone access to comply with data collection procedures. Participants with a medical or self-reported history of cognitive impairment were also excluded (Figure 1). The study protocol was approved by the New England College of Optometry Institutional Review Board and followed the tenets of the Declaration of Helsinki. All participants provided both oral and written informed consent.

Clinical examination and study setting

Mobile clinic examinations were delivered to provide usual LVR. The mobile clinic consists of two, 10 foot fully-equipped optometric examination lanes with trial lenses for trial frame refraction, visual acuity charts (e.g. Feinbloom and Early Treatment Diabetic Retinopathy Study), Mars Contrast Sensitivity charts, MNREAD near charts, slit lamp microscope, retinoscope, binocular indirect ophthalmoscope, diagnostic lenses, optical coherence tomography imaging, and an assortment of visual assistive equipment (Table 1). Examinations were conducted by final-year optometry doctoral interns under the direct supervision and in concert with licensed LVR optometrists. The LVR examination included visual acuity, contrast sensitivity, confrontation visual field assessment, Amsler grid central field assessment, retinoscopy, trial frame refraction, visual assistive equipment (VAE) assessment, and ocular health evaluation.

During VAE assessment, equivalent dioptric power required for reading 1.0M print was determined using the inverse of the critical print size as assessed by MNREAD continuous text chart,¹¹ while participants wore their best reading correction. Distance magnification starting points were determined based on distant goal text size and visual acuity while wearing optimal distance correction.¹² A broad range of VAE were available for evaluation (Table 1). Evaluated VAE were then titrated to meet the individual's needs and preferences. If improvement was demonstrated (e.g. increased reading fluency, smaller threshold, subjective improvement, attainment of goal), VAE was recommended. Recommended VAE were provided at no charge to the patient through a grant administered by the state commission for the blind. VAE were dispensed on site or ordered and delivered at a later date, most often within 3 months.

While the literature has demonstrated that electronic devices are preferred for leisure reading,¹³ optical magnifiers were preferentially provided in this study due to the grant structure and coverage regulations in place. As such, for this study population electronic magnification was recommended whenever optical magnification strategies proved insufficient to meet participant goals (i.e. due to severely reduced contrast sensitivity or functionally significant scotoma and visual field loss).

Recommendations and referrals for orientation and mobility training, device use training, technology assessment, activity of daily living (ADL) skills training, follow up LVR, or follow up ocular health examination were provided when indicated. Training recommendations were made based on clinical examination and subjective report of

difficulty elicited by directly questioning participants. Orientation and mobility training was recommended for participants who reported concerns regarding safe navigation of their environment, had a significant history of falls, or reported a fear of falling. Those who reported difficulty achieving daily living tasks were referred for ADL training. Participants who identified adaptive computer access (i.e. screen magnification and/ or reader) as a rehabilitation goal were referred for technology assessment. Those who were not able to demonstrate efficient use of recommended VAE by the end of their mobile clinic examination were referred for further device use training by a local rehabilitation therapist. Follow up LVR or ocular health examinations were recommended for any participant whose functional or ocular health needs were not entirely met by mobile clinic LVR (e.g. need for follow up care prior to next mobile clinic visit or outside the scope of care available on the mobile clinic). Training recommendations were facilitated through the local state rehabilitation agency (the regional offices of the Massachusetts Commission for the Blind) and follow up care was coordinated by the mobile clinic LVR optometrist. The number of rehabilitation therapy and/or training visits was determined independently by local rehabilitation therapists based on a participant's needs.

Data collection

Participants completed the AI prior to receiving mobile clinic LVR, 3 months (± 14 days) after LVR, and 1 year (± 60 days) after LVR. One research assistant administered all phone questionnaires pertaining to this study. Participants who did not complete LVR were contacted in an attempt to obtain follow up data, but were unable to be reached by telephone. Thus, outcomes could not be assessed from these participants.

Demographic and clinical examination data were recorded during LVR. Demographic variables included age, incoming self-reported systemic and ocular diagnoses, and self-reported prior LVR examination experience. Clinical examination data included best corrected visual acuity measured by electronic LogMAR chart or, if necessary (i.e. visual acuity worse than 1.60 LogMAR [20/800 or 6/240 Snellen Equivalent]) a Feinbloom number chart.¹⁴ Also included were: Mars Contrast Sensitivity (if visual acuity was 1.48 LogMAR [20/600 or 6/182 Snellen Equivalent] or better),¹⁵ VAE recommendations, training recommendations, and follow up recommendations.

Outcome measures

Similar to previous studies,⁶ the primary outcome measure was change in overall visual ability, estimated from participants' difficulty ratings of AI goals at baseline, at 3 months, and at 1 year after the initial LVR evaluation. Secondary outcome measures were estimated from difficulty ratings of specific subsets of AI tasks, which included reading; mobility; visual information; visual motor functioning; instrumental activities of daily living function (IADL); inside the home functional ability; and outside the home functional ability. Item measures and response thresholds for each difficulty rating category were calibrated from the responses of over 3000 low vision patients, as described by Massof *et al.*^{8,9}

Effect size of AI change scores, and percentage of participants achieving a minimum clinically important difference (MCID) post-LVR were also explored and compared to other LVR models of care.

Sample size

A Cohen's effect size of 0.42 was the smallest determined in the Low Vision Rehabilitation Outcomes Study (LVROS).⁶ Results of the power analysis to detect a Cohen's d of 0.42 with alpha set at $p < 0.05$ and power of 0.80 indicated a sample of $N = 49$. A mobile clinic delivery model may create unique challenges to participant retention, so estimating a 20% drop-out rate, our target sample size was increased to $N = 63$.

Data analysis

Data collected by AI were filtered so that items rated as not difficult at baseline were scored as missing throughout all analyses.¹⁶ Filtered AI data underwent Rasch Analysis (www.winsteps.com) to estimate person measures for overall visual ability as well as for seven functional domains: reading, visual information, visual motor, mobility, IADL, inside the home activities, and outside the home activities.

A three (time: baseline, 3 months, 1 year) by eight (AI domains: overall visual ability, seven AI sub-score domains) within subject analysis of variance was conducted to explore significant improvements in person measures at each of these time points using SPSS Statistics (www.ibm.com). This was then followed with a principle component and a principle axis factoring analyses of baseline AI person measures.

Change scores (e.g. differences between baseline and 3-month post-LVR person measures, and baseline and 1-year post-LVR person measures) were computed. Student t -tests were conducted to explore statistically significant differences at the 95% confidence level.

Cohen's effect sizes (d coefficients) and MCID were then calculated using Excel (www.office.microsoft.com) to measure clinical effect in each domain as well as overall goals. Cohen's effect size was calculated as mean change score across participants divided by change score standard deviation. MCID was calculated for each participant by dividing change score by 1.96 (derived from the 95% confidence interval) times the standard error. Proportion of participants who achieved MCID (i.e. calculation greater than 1) was reported. As such, MCID is informative in terms of the proportion experiencing a clinically meaningful outcome, while d coefficients provide information regarding overall clinical effect magnitude. Participants who completed all follow up questionnaires (3 months and 1 year) were included in the analyses, as no trends or biases were observed in those who withdrew from the study. To determine significant changes in proportions between 3 months and 1 year a McNemar test was conducted.

To explore possible predictors between AI person measures and clinical examination measures (i.e. binocular logMAR visual acuity, binocular log contrast sensitivity, and age) a series of correlations were conducted. A follow up one-way analysis of variance (ANOVA) with Bonferroni technique to control for inflated type I error was performed, allowing

further investigation of AI change score predictors. This was followed by a multi-linear regression. All statistical analysis was performed with SPSS (www.ibm.com).

To assess the relationships of additional referrals (e.g. orientation and mobility training, rehabilitation therapy, technology assessment, follow up clinical LVR evaluation) on 1-year change scores, a series of bi-serial correlations were conducted between each type of referral with 1-year change scores for each AI domain result.

Results

Participants

Among participants ($n = 66$), the most common ocular diagnosis was age-related macular degeneration, although visual conditions which primarily affect peripheral vision (e.g. glaucoma, retinitis pigmentosa) were also present at high levels (Figure 2). Many participants had multiple ocular diagnoses ($n = 44$), and the mean number of systemic comorbidities was 2.45 (self-report). Psychosocial problems (e.g. anxiety, depression), heart disease, and neurological disorders were highly prevalent.

Mean baseline visual acuity was moderately reduced¹⁷ at 0.93 logMAR (S.D. = 0.45, 20/170 or 6/50 Snellen equivalent). Average log contrast sensitivity was severely reduced¹⁷ at 0.87 log CS (S.D. = 0.40) (Table 2). Of participants enrolled in the study, 60 had severe visual impairment – 49 based on acuity (i.e. VA 1.00 logMAR (20/200 or 6/60 Snellen equivalent) or worse) and 11 based exclusively on visual field (i.e. incoming visual field findings subtending less than 20 degrees in largest field diameter in the better seeing eye). Only six participants had mild to moderate visual impairment.

Most participants were female (64%), and ages ranged from 17 to 92 years, with a mean of 72.5 years and a median of 65.6 years (Table 2). Forty-seven percent had never previously had an LVR examination. Mean baseline overall goal visual ability was -0.33 logits, which is well within the range targeted by the AI.⁹ As such, the AI is unlikely to yield results limited by floor or ceiling effects in this sample.

Outcome measures

Figure 3 illustrates the person measures for overall goals and for each of the seven AI domains at baseline, 3 months and 1 year. At 3 months, person measures were significantly larger than at baseline after Bonferroni correction ($p < 0.0001$), with a positive mean change score in each domain (Table 3). Outcomes seen at 3 months were retained 1-year post-LVR; no significant differences were noted between 3-month and 1-year person measures for each AI domain; the finding was non-significant.

A principle axis factoring analysis was performed on baseline person measures of goals, reading, mobility, visual information and visual motor. IADL, inside the home, and outside the home were not included as these domains contain many of the same tasks already included in the other domains. In this sample, the first principle component accounted for 72% of the variance. Given that previous reports by Massof *et al.* support that visual ability is a composite variable with at least two dimensions, a two-dimensional factor analysis using

principle axis factoring was performed on the five sets of person measures with varimax rotation. Figure 4 shows the factor plot, which illustrates that while reading loads most heavily on one factor, mobility loads on the other.

Cohen's effect size for overall visual ability was 1.12 at 3 months and 0.74 at 1 year. Across domains, 1-year effect sizes ranged from 0.43 in visual information to 0.71 in inside the home activities (Table 3). A majority of participants achieved clinically meaningful outcomes in overall visual ability and in all domains (change in person measure >1.96 standard errors of baseline person measure estimate). Seventy-one percent of participants achieved MCID in overall visual ability at 1 year. This was most frequently achieved inside the home (65%) and least frequently achieved in visual information (49%) (Figure 5). There was no statistically significant difference in the percentage of participants who achieved MCID at 3 months vs 1 year across the seven AI domains.

Predictors of LVR outcome

A series of correlations were conducted between age, binocular logMAR visual acuity, binocular log contrast sensitivity and baseline person measures for overall goals and each AI domain. LogMAR visual acuity was negatively correlated with baseline overall goals (-0.37 , $p < 0.001$). Log contrast sensitivity was positively correlated with baseline overall goals (0.43 , $p < 0.001$). Effects of age were negatively correlated with baseline person measures, but were not significant.

A series of multiple regressions were conducted where age, binocular logMAR visual acuity, binocular log contrast sensitivity, subjective report of worsening vision during the study period, and previous exposure to LVR prior to the study period were regressed on each AI domain change score at 1 year. Of participants who completed 1-year follow up ($n = 51$), 30 self-reported a significant worsening of vision over the past year. Those who reported worsening vision during the study period were advised to follow up with the mobile clinic or their local eye-care provider. Part correlations are shown in Table 4. Subjective report of worsening vision emerged as a significant predictor when controlled by the other variables for the AI domains of visual information, IADL and outside the home activities.

A series of one-way ANOVAs were conducted with peripheral vision loss, central vision loss or combined visual loss as a fixed factor with the 1 year change score for each of the eight AI domains as the dependent variable. Results failed to achieve statistical significance on each of these analyses.

Referral patterns

Of the 66 participants, 22 were referred for orientation and mobility training while 16 were referred for rehabilitation therapy (i.e. ADL and/or device use training) (Table 5). A series of bi-serial correlations were conducted between each type of referral with 1-year change scores for each AI domain, and results failed to reveal any significant relationships.

One-year follow up on the mobile clinic with the optometrist was routinely recommended unless otherwise indicated. A follow up mobile clinic examination within the 1 year study period was recommended for 26 participants, of which 14 participants complied. Of the

participants who had multiple visits on the mobile clinic, eight participants had two visits, five participants had three visits and one participant had four visits within the study period. Due to small cell size further analysis was not possible.

Discussion

Mobile clinic LVR produced moderate to large clinical outcomes at 3 months ($d = 1.12$) and 1 year ($d = 0.74$). There was a clinically significant effect in a majority of participants (56% and 71% respectively). These findings are, overall, similar to what has previously been reported in other delivery models (Figure 6). The mobile clinic outcomes are most similar to those seen in LVROS⁶ and the Low Vision Depression Prevention Trial (VITAL),^{18,19} and are larger than some other outpatient LVR delivery models.^{2,20}

A Welsh primary care based low vision service measured a change score of 0.79 logits using the seven-item NEI-VFQ.⁷ While this is larger than the change score observed in this study, the apparent discrepancy may be explained by differences in both the analysis technique (Cohen's effect size and MCID not reported) and the survey questionnaire employed (the NEI-VFQ has been shown in other publications to be less robust⁹).

Participant demographics from the mobile clinic are different from those seen in VA hospital outcome studies in terms of age, gender distribution, and underlying aetiology of visual impairment. Additionally, many VA hospital-based studies have been able to measure outcomes via randomised clinical trial, which is less likely than cohort studies to inflate results due to placebo and Hawthorne effects. These differences may qualify comparison between the mobile clinic and VA hospital LVR outcomes. Two VA hospital-based studies included in this analysis made use of a waiting list control.^{2,3}

Outcomes seen in the VA Blind Rehabilitation Centre are substantially larger than those from the mobile clinic.² The Low Vision Intervention Trial (LOVIT) studies measured outcomes 4 months post-LVR and only enrolled participants who had macular disease.^{3,4} Outcomes from the mobile clinic are smaller than those reported in LOVIT I,³ and similar to those from LOVIT II.⁴ Participants in LOVIT I were more severely impaired (VA 0.7 to 1.4 logMAR, Snellen equivalent 20/100 or 6/30 to 20/500 or 6/150) than those enrolled in LOVIT II⁴ (VA 0.4 to 1.0 LogMAR, Snellen equivalent 20/50 or 6/15 to 20/200 or 6/60). With a mean acuity of 0.93 LogMAR (20/170 or 6/50 Snellen equivalent) observed in the mobile clinic participants, degree of visual impairment is intermediate to the two LOVIT studies.

Mobile clinic LVR change scores at 3 months were retained 1 year post-LVR. Additionally, 59% of participants reported a subjective worsening of vision at 1 year, which was shown to significantly affect outcomes in the domains of visual information, IADL, and outside the home. Device abandonment and clinical follow up schedules should be explored in consideration of these findings. Follow up LVR may be particularly important in patients whose ocular disease is progressive and likely to cause further decrease in visual function. The impact of follow up schedule has not yet been thoroughly explored, although a growing

body of literature begins to show enhanced outcomes with additional non-optometric vision rehabilitation services.^{4,21}

The high prevalence of glaucoma and retinitis pigmentosa in this sample led to analysis of LVR outcomes with respect to cause of visual impairment (i.e. central vision loss, peripheral vision loss, or a combination). However, type of visual loss was not found to be a significant predictor of outcomes. This analysis has some limitations. Participants were assigned to groups based on aetiology of visual impairment and presenting better eye visual acuity. Consequently, there is potential for error due to misclassification. Additionally, as Goldmann or automated visual field assessment is not possible on the mobile clinic, these data are not directly available for all participants. Participants were encouraged to continue care with their local eye care provider for these measures and as medically indicated. As such, the extent of visual field loss cannot be correlated with subjective outcome measures. This warrants further analysis and investigation.

In addition to the clinical outcomes produced, the mobile clinic was also successful at expanding access to LVR. The large proportion of participants who had no LVR experience prior to mobile clinic examination (47%) suggests that these patients would otherwise be unable to access LVR.

Strengths of this study include the use of the AI and Rasch Analysis, as well as an adequate sample size and excellent participant retention 3 months post-LVR. Limitations include lower retention 1 year post-LVR. In addition, participants enrolled in this study had severe visual impairment, and as such, results in a sample with mild to moderate visual impairment may differ. Finally, randomisation to a control group could not ethically be used in this study's design.

This work shows that mobile clinic LVR can produce outcomes comparable to those seen in other delivery models. Further research will explore device abandonment in patients receiving mobile clinic LVR.

Acknowledgements

We would like to acknowledge Gary Chu OD MPH, Anthony J Guarino PhD and Robert Massof PhD for their contributions to this work. We also extend our thanks to the anonymous reviewers for their insightful suggestions to this manuscript. This research was supported by the National Institutes of Health (NIH T35EY007149); Beta Sigma Kappa Student Research Grant 2017; Minnie Flaura Turner 2017 Fund for Impaired Vision Research; and the Massachusetts Commission for the Blind Mobile Clinic Support Grant.

References

1. Massof RW. A model of the prevalence and incidence of low vision and blindness among adults in the U.S. *Optom Vis Sci* 2002; 79: 31–38. [PubMed: 11828896]
2. Stelmack JA, Szlyk JP, Stelmack TR et al. Measuring outcomes of vision rehabilitation with the Veterans Affairs Low Vision Visual Functioning Questionnaire. *Invest Ophthalmol Vis Sci* 2006; 47: 3253–3261. [PubMed: 16877389]
3. Stelmack JA, Tang X & Reda D. Outcomes of the veterans affairs low vision intervention trial (LOVIT). *Arch Ophthalmol* 2008; 126: 608–617. [PubMed: 18474769]
4. Stelmack JA, Tang X, Wei Y et al. Outcomes of the veterans affairs low vision intervention trial II (LOVIT II): a randomized clinical trial. *JAMA Ophthalmol* 2017; 135: 96–104.

5. Goldstein JE, Chun MW, Fletcher DC, Deremeik JT & Massof RW. Visual ability of patients seeking outpatient low vision services in the United States. *JAMA Ophthalmol* 2014; 132: 1169–1177. [PubMed: 25073745]
6. Goldstein JE, Jackson ML, Fox SM, Deremeik JT & Massof RW. Clinically meaningful rehabilitation outcomes of low vision patients served by outpatient clinical centers. *JAMA Ophthalmol* 2015; 133: E1–E8.
7. Ryan B, White S, Wild J, Court H & Margrain TH. The newly established primary care based Welsh Low Vision Service is effective and has improved access to low vision services in Wales. *Ophthalmic Physiol Opt* 2010; 30: 358–364. [PubMed: 20492541]
8. Massof RW. Understanding rasch and item response theory models: applications to the estimation and validation of interval latent trait measures from responses to rating scale questionnaires. *Ophthalmic Epidemiol* 2011; 18: 1–19. [PubMed: 21275592]
9. Massof RW, Ahmadian L, Grover LL et al. The activity inventory: an adaptive visual function questionnaire. *Optom Vis Sci* 2007; 84: 763–774. [PubMed: 17700339]
10. Social Security Blue Book Section 2.00 Special Senses and Speech – Adult. 2016 Online version updated 01/2017; <https://www.ssa.gov/disability/professionals/bluebook/>
11. Subramanian A & Pardhan S. Repeatability of reading ability indices in subjects with impaired vision. *Invest Ophthalmol Vis Sci* 2009; 50: 3643–3647. [PubMed: 19339738]
12. Dickinson C Low Vision: Principles and Practice. Butterworth: Oxford, 1998; 73–151.
13. Taylor JJ, Bambrick R, Brand A et al. Effectiveness of portable electronic and optical magnifiers for near vision activities in low vision: a randomised crossover trial. *Ophthalmic Physiol Opt* 2017; 37: 370–384. [PubMed: 28497480]
14. Feinbloom W Introduction to the principles and practice of subnormal vision correction. *Clin Exp Optom* 1935; 18: 589–596.
15. Arditi A Improving the design of the letter contrast sensitivity test. *Invest Ophthalmol Vis Sci* 2005; 46: 2225–2229. [PubMed: 15914645]
16. Goldstein JE & Massof RW; Low Vision Research Network Study. The impact of item filtering on patient-reported low vision rehabilitation outcomes. *Invest Ophthalmol Vis Sci* 2012; 53: 4419.
17. Goldstein JE, Massof RW, Deremeik JT et al. Baseline traits of low vision patients served by private outpatient clinical centers in the United States. *Arch Ophthalmol* 2012; 130: 1028–1037. [PubMed: 22893074]
18. Rovner BW, Casten RJ, Hegel MT et al. Low vision depression prevention trial in age-related macular degeneration: a randomized clinical trial. *Ophthalmology* 2014; 121: 2204–2211. [PubMed: 25016366]
19. Deemer AD, Massof RW, Rovner BW, Casten RJ & Piersol CV. Functional outcomes of the low vision depression prevention trial in age-related macular degeneration. *Invest Ophthalmol Vis Sci* 2017; 58: 1514–1520. [PubMed: 28273318]
20. Lamoureux EL, Pallant JF, Pesudovs K, Rees G, Hassell JB & Keeffe JE. The effectiveness of low-vision rehabilitation on participation in daily living and quality of life. *Invest Ophthalmol Vis Sci* 2007; 48: 1476–1482. [PubMed: 17389474]
21. Acton JH, Molik B, Court H & Margrain TH. Effect of a home visit-based low vision rehabilitation intervention on visual function outcomes: an exploratory randomized controlled trial. *Invest Ophthalmol Vis Sci* 2016; 57: 6662–6667 [PubMed: 27930779]

Figure 1.
Enrolment flow chart.

Figure 2.

Primary cause of visual impairment. Other conditions included: congenital cataract ($n = 2$), retinopathy of prematurity ($n = 2$), neurological visual field loss ($n = 2$), chronic uveitis ($n = 2$), other unspecified congenital vision loss ($n = 2$), and cytomegalovirus retinitis ($n = 1$).

Figure 3.

Person measures at baseline, 3-month and 1-year time points. A three (time: baseline, 3 months, 1 year) by eight (overall goals and seven AI domains) within subject analysis of variance demonstrated significant improvements in person measures at each time point. Significant differences were identified between baseline and 3-month person measures (logits) for all AI domains ($p < 0.0001$). No significant differences were found between 3-month and 1-year person measures.

Figure 4. Factor analysis plot of five sets of person measures. These findings support previous reports, reading loads most heavily onto one factor and mobility loads most heavily on the other.

Figure 5.

Minimum clinically important difference (MCID) at 3 months and 1 year. Percentages of participants who achieved the MCID based on Activity Inventory (AI) outcomes at 3 months (red bars) and 1 year (blue bars) are shown for overall visual ability (goals) as well as each AI domain (i.e. reading, visual information, visual motor, mobility, instrumental activities of daily living [IADL], inside the home, and outside the home). MCID was less frequently achieved at 3 months than at 1 year for all domains. In overall visual ability (goals), MCID was achieved in 56% of participants at 3 months and 71% of participants at 1 year.

Figure 6.

Cohen's effect size comparison across prior studies. Cohen's effect sizes measured in previous studies using visual function questionnaire data after Rasch analysis are shown above. Reported effect sizes range from 2.51 seen in LOVIT to 0.25 measured in Lamoureux 2006. The mobile clinic outcomes from this study were 1.12 at 3 months and 0.74 at 1 year.

Table 1.**Devices available for participants**

Hand magnifiers	10 to 50 D, LED illumination available in white or yellow light
Pocket magnifiers	6D to 38D
Stand magnifiers	LED illuminated with white or yellow light 3 to 15×, Dome magnifier, Eschenbach Makrolux (2.2×, 3.6×), Eschenbach Scribolux magnifier
Prism half eyes	+4D/6 base out to +14D/16 base out
Microscope fit set	2× (8 D) to 89 (32 D)
Loupes	All available Eschenbach loupes, Donegan optivisor in all available dioptric powers
Telemicroscope	2.2× Max Detail spectacle or clip
Electronic magnification	Portable (Ruby, Smartlux, Pebble, Optelec) and desktop models (Topaz and Magnilink Zip)
Optical character recognition	AbiSee OCR, KNFB reader application on iPad
Filters	Fitover filters in all available NoIR and Eschenbach tints
Telescopes	2.2× Max TV (spectacles and clip), monocular telescopes (2 × 20, 3.15 × 25, 4 × 12, 6 × 16, 8 × 21; Keplerian and Galilean designs), bioptic telescope fitting sets (complete designs for vision telescope fitting set, Ocutech Sight Scope fitting set, Ocutech VES telescope fitting set, Ocutech instamount 2.2× telescope)
Field expansion	Ocutech image minifier (0.5×), Peli peripheral prisms
Other	Mattingly smart reading light clip, Verilux floor and stand daylight lamps, clip-boards and writing stands, Zoomtext software trial, Fresnel prism, Bangert occlusion foils, conventional spectacle frames with optical services coordinated offsite

Table 2.

Baseline subject characteristics

Characteristic or measure	Mean (S.D.)
Visual acuity (better eye, LogMAR)	0.93 (0.45)
Binocular MARS contrast sensitivity (log CS)	0.87 (0.40)
Age (years)	72.5 (21.0)
Gender	64% female, 36% male
Percent experiencing first LVR examination	47%

LVR, low vision rehabilitation.

Table 3.

Activity Inventory change scores at each time point; overall goals in bold

	Mean change score	Standard deviation	Cohen's <i>d</i> coefficient	95% confidence interval
Goals, 3 months	0.51	0.45	1.12	1.00–1.25
Reading, 3 months	0.76	0.99	0.76	0.49–1.04
Visual information, 3 months	0.26	0.45	0.59	0.46–0.71
Visual motor, 3 months	0.56	0.60	0.93	0.77–1.10
Mobility, 3 months	0.44	0.80	0.55	0.33–0.77
IADL, 3 months	0.52	0.54	0.97	0.82–1.12
Inside home, 3 months	0.63	0.79	0.80	0.58–1.02
Outside home, 3 months	0.39	0.57	0.69	0.54–0.85
Goals, 1 year	0.53	0.71	0.74	0.54–0.93
Reading, 1 year	0.56	1.13	0.50	0.19–0.81
Visual information, 1 year	0.29	0.66	0.43	0.25–0.62
Visual motor, 1 year	0.58	0.97	0.60	0.34–0.87
Mobility, 1 year	0.31	0.79	0.39	0.17–0.61
IADL, 1 year	0.47	0.82	0.58	0.35–0.80
Inside home, 1 year	0.59	0.83	0.71	0.49–0.94
Outside home, 1 year	0.27	0.81	0.33	0.11–0.56

Table 4.

Part correlations for 1 year change score for each domain and age, binocular visual acuity (VA in logMAR), binocular log contrast sensitivity, subjective reported worsening vision, and previous exposure to low vision rehabilitation (LVR)

	<i>R</i> ²	Age	LogMAR VA	LogCS	Subjective worsening of vision	Previous exposure to LVR
All goals	0.14	-0.05	-0.16	-0.02	-0.29 *	-0.12
Reading	0.12	-0.12	-0.02	0.03	-0.22	-0.20
Visual information	0.22 *	-0.02	-0.16	-0.05	-0.40 *	-0.15
Visual motor	0.04	0.05	0.06	0.07	-0.16	0.02
IADL	0.15	-0.08	-0.06	0.02	-0.30 *	-0.19
Inside the home	0.90	-0.05	0.03	0.08	-0.18	-0.21
Outside the home	0.17	-0.09	-0.19	-0.03	-0.32 *	-0.09

* $p < 0.05$.

Table 5.

Referrals provided to participants

Referral type	Count
Orientation and mobility training	28
Rehabilitation therapy	16
Technology assessment	23
Follow up examination	26

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