Int Ophthalmol (2019) 39:563–569
https://doi.org/10.1007/s10792-018-0847-9

ORIGINAL PAPER

A rating scale is a proper method to evaluate changes in quality of life due to dry eye symptoms

Wenwen Xue · Xian Xu · Haidong Zou

Received: 9 September 2017 / Accepted: 1 February 2018 / Published online: 7 February 2018

Abstract

Purpose To determine which utility value assessment method is more suitable to evaluate changes in the quality of life due to dry eye symptoms.

Methods Dry eye outpatients with a presenting visual acuity of 20/25 or better in the worse-seeing eye were recruited. Presenting distance visual acuity, tear film break-up time, Schirmer I test and fluorescein were assessed. The severity of dry eye symptoms was assessed using the Ocular Surface Disease Index (OSDI), and utility values were measured using the time trade-off (TTO), standard gamble (SG1 and SG2) and rating scale (RS) methods. Different utility values were compared with each other. The most appropriate utility value method to evaluate quality-of-life changes solely due to dry eye symptoms is determined by calculating the correlation between the OSDI score and different utility values.

Results A total of 104 patients were enrolled. The three sections of OSDI in the order of high to low scores were as follows: "environmental trigger," "eye discomfort" and "visual function." The utility scores measured with TTO, SG1, SG2 and RS were 0.95 ± 0.11, 0.96 ± 0.10, 0.99 ± 0.07 and 0.89 ± 0.10, respectively. The utility scores evaluated by the TTO, SG1, SG2 and RS methods were significantly different from each other ($p < 0.05$). Only the utility scores measured with RS were significantly correlated with the composite OSDI score, "environmental trigger" and "eye discomfort" section scores ($p < 0.05$).

Conclusions RS is more sensitive than TTO and SG for the evaluation of altered quality of life due to dry eye symptoms.

Keywords Quality of life · Dry eye · Utility value

Wenwen Xue and Xian Xu have contributed equally to this study.

W. Xue · X. Xu · H. Zou (✉)
Department of Ophthalmology, Shanghai General Hospital, Shanghai Jiao Tong University School of Medicine, No. 100 Haining Road, Hongkou District, Shanghai 200080, China
e-mail: zouhaidong@263.net

W. Xue · X. Xu · H. Zou
Shanghai Key Laboratory of Fundus Disease, Shanghai Engineering Center for Visual Science and Photomedicine, Shanghai, China

W. Xue · X. Xu · H. Zou
Department of Preventative Ophthalmology, Shanghai Eye Diseases Prevention and Treatment Center, No. 380, Kangding Road, Jingan District, Shanghai 200040, China

Introduction

Dry eye disease is one of the most frequently encountered ocular morbidities. In the USA and UK, the prevalence of dry eye was reported to be

9.6–14.5% [1, 2]. In our previous study, we reported a dry eye prevalence of 30.05% in people above 20 years old in Shanghai [3]. Dry eye diseases are primarily considered symptomatic; most dry eye patients experience chronic ocular discomfort, such as ocular dryness, foreign body sensation, burning or stinging, and complain about vision-related quality-of-life (QOL) disturbances, with or without central visual acuity impairment [1, 4]. Because the commonly used objective visual impairment parameters, such as distance or near visual acuity, cannot reflect the severity of dry eye symptoms, several patient-reported outcome questionnaires were developed specifically for dry eye symptoms [5–7]. Among them, the 12-item Ocular Surface Disease Index (OSDI) introduced by Allergan, Inc [5] may be the most frequently used questionnaire, and it has been proven to address ocular symptoms consistent with dry eye disease and their impact on vision-related functions with high reliability and validity [8]. Until now, the OSDI has been used in a variety of studies to assess the severity of dry eye symptoms associated with certain conditions [9–11] and to investigate the efficacy of dry eye treatments [12, 13]. However, the OSDI may not be the best index for evaluating QOL in dry eye patients. Its limitations, which also exist in other item-based questionnaires, are inevitable: It cannot provide a complete measure of how patients value QOL changes due to various health states or outcomes.

The utility value was originated in medical economics [14] and has been appreciated by several researchers as one of the most all-encompassing QOL instruments; it can be easily used to compare QOL between different ophthalmic conditions [15, 16]. It can also be easily used in cost-effectiveness analyses in health care. Based on different building concepts, there are three methods commonly used to assess utility value: time trade-off (TTO), standard gamble (SG) and rating scale (RS). Until now, utility values have been proven to effectively reflect the change in QOL due to dry eye. For example, recent utility studies showed that moderate to severe dry eye can cause a decrease in the QOL comparable to that in dialysis, severe angina and disabling hip fractures [17, 19]. However, similar to item-based questionnaires, the utility values from patients with ocular disease were also strongly associated with central visual acuity, and there was a correlation between utility values and the level of visual acuity impairment in patients with ocular disease [18, 20]. None of published studies in dry eye patients clearly excluded utility value changes due to central visual acuity impairment, and therefore, it is still unknown how dry eye symptoms impair the QOL in patients with dry eye diseases without visual acuity impairment [21–24].

Our major concern in the present study is whether the utility value can be used to reflect QOL changes solely due to dry eye symptoms in patients without visual acuity impairment, and which one of TTO, SG and RS is the proper assessment method. To answer these questions, we enrolled a specific group of mild-dry eye patients with good central visual acuity (presenting visual acuity of 20/25 or better in the worse-seeing eye) and evaluated the dry eye symptoms with OSDI and QOL with utility values. The differences between the utility value scores obtained using different methods were compared. Assuming that the results of OSDI accurately reflect the severity of dry eye symptoms in these patients, the most appropriate utility value method to evaluate QOL changes solely due to dry eye symptoms is determined by calculating the correlation between the OSDI score and utility values.

Materials and methods

A cross-sectional hospital-based study was performed. Patients were recruited from the Department of Ophthalmology, Shanghai General Hospital, Shanghai Jiao Tong University between August 2012 and July 2014. A definitive diagnosis of dry eye disease was established only if all the following three criteria were present: (1) the presence of dry eye symptoms, including a frequent or sustained occurrence of subjective symptoms such as ocular dryness, foreign body sensation, burning or stinging, asthenopia (ocular fatigue), uncomfortableness, vision fluctuations; (2) the presence of either a quantitative or qualitative disturbance of the tear film (tear film break-up time $\leq$ 5 s or SchirmerItest $\leq$ 5 mm); and (3) the presence of conjunctivocorneal epithelial damage (fluorescein staining score $\geq$ 3 points) [10]. The inclusion criteria were: (1) the patient is confirmed to have dry eye disease; (2) can understand and cooperate in this study, i.e., complete the OSDI or utility value assessment with investigators' assistance and is willing to receive

an ophthalmic examination and provide informed consent; (3) has a presenting visual acuity of 20/25 or better in the worse-seeing eye; (4) is with the absence of other eye diseases such as keratopathy, glaucoma, dacrycystitis, uveitis, ocular trauma, retinal detachment; (5) does not have uncontrolled systemic diseases such as diabetes, hypertension, coronary heart disease; (6) does not have diseases that may influence intelligence, such as intellectual disturbance or Alzheimer's disease, and can communicate well with investigators. This study was approved by the Ethics Committee of Shanghai General Hospital, Shanghai Jiao Tong University, in accordance with the tenets of the Declaration of Helsinki. Written informed consent was obtained from each participant.

Basic information from the enrolled patients, including name, gender, age, education level, was collected. After completing a subjective questionnaire including the OSDI and utility value, the clinical data regarding visual acuity, tear film break-up time (BUT), fluorescein (FI) [25] and the Schirmer I test (a Schirmer test without anesthesia, S It) were assessed. All questionnaires and examinations were performed in the morning. Two well-trained investigators (X. X. and H. Z.) with experience in ophthalmic examination and QOL investigation conducted the eye examination and helped the patients complete the OSDI and utility value questionnaires with a face-to-face interview, since this approach weakened the influence of the patient's education level on utility value understanding.

In this study, we used presenting visual acuity because it better reflects the patients' daily status [26]. A Snellen chart was used to examine the patients' bilateral presenting distance visual acuity.

The OSDI was graded on a scale from 0 to 4, where 0 indicates none of the time; 1, some of the time; 2, half of the time; 3, most of the time; 4, all of the time. The total OSDI score was then calculated on the basis of the following formula: OSDI score = [(sum of scores of all questions answered) × 100]/[(total number of questions answered × 4)]. Higher scores indicated more ocular signs. Subscale scores were similarly computed but only with questions from each subscale [8].

The following methods were used to evaluate TTO, SG and RS utility scores [27, 28]. The validity of these measures in the Chinese population has been proven by previous studies [29, 30]. TTO requires the patients to estimate their own expected remaining life and then choose X years they wish to live with their present visual status or with perfect visual status at the cost of a reduction of t years from their expected life span, $U_{\mathrm{TTO}} = 1 - t/X$. SG is based on the highest risk Y (%) for the maximum treatment failure (death or blindness) the patient is willing to accept, $U_{\mathrm{SG}} = 1 - Y$. SG is divided into two types according to the outcome of treatment failure: SG1 and SG2. The outcome of treatment failure in SG1 is blindness and in SG2 is death. RS uses a graduated ruler (0–100 points) to take the measurement. Patients mark the position (P) that can best represent their present visual status; $U_{\mathrm{RS}} = 1 - P\%$.

The Snellen visual acuity results were transformed into LogMAR visual acuity for statistical analysis. Pairwise comparisons between any two of the utility scores measured with TTO, SG1, SG2 and RS were conducted with the Wilcoxon nonparametric test in order to assess whether a significant difference between the four utility values was present. The Spearman correlation test was used to determine the correlations between the four utility scores and the patients' gender, age, education level, BUT, S It, FI, OSDI and visual acuity. SPSS17.0 software (Chicago, IL) was used for statistical analysis. $p < 0.05$ indicates a statistically significant difference.

Results

A total of 104 patients were enrolled in this study. Basic information is listed in Table 1. Among the enrolled subjects, 99% had received a middle school or higher education. The mean age was 42 years, and 96 patients were aged 60 years or below. The patients were all symptomatic and reported one or more dry-eye symptoms often or all of the time. All of them were confirmed as dry eye patients. Fifty-six (53.8%) had a low tear film break-up time (BUT $\leq$ 5 s), 46 (44.2%) had a low Schirmer I test result ($\leq$ 5 mm), and 39 (37.5%) had corneal epithelial damage (FI total staining score of $\geq$ 3 points).

Three sections of OSDI in the order of high to low scores were as follows: "environmental trigger," "eye discomfort" and "visual function" (Table 1). In the 4-item section for visual function, 31 patients graded 0 in each of the items, 52 patients graded 1 in one of the items and graded 0 in all other items, and 21 patients

Table 1 Basic social information, tear film, ocular surface-related examination results and OSDI scores from 104 patients

Category	
Gender, *N* (%)	
Male	49 (47.1%)
Female	55 (52.9%)
Age (year)	
Mean (SD)	42.47 (12.56)
Age range	21–65
Education year, *N* (%)	
< 12, primary school or less	1 (1.0%)
12–14, junior middle school	7 (6.7%)
14–17, senior middle school	28 (26.9%)
> 17, university or higher	68 (65.4%)
Eye symptoms[a], *N* (%)	
1	10 (9.6%)
2	21 (20.2%)
3	36 (34.6%)
4	23 (22.1%)
5	14 (13.5%)
Systemic disease (under control)[b], *N* (%)	
0	64 (61.5%)
1	22 (21.2%)
2	16 (15.4%)
3	2 (1.9%)
Presenting distance visual acuity of the better-seeing eye	
Snellen visual acuity range	20/25–20/20
LogMAR visual acuity range	0–0.10
Tear film and ocular surface examination	
BUT median (P25–P75) (s)	4.82 (3.72–7.14)
SIt median (P25–P75) (mm)	7 (5–11.88)
FI median (P25–P75)	2 (0–3)
OSDI score, median (P25–P75)	
Composite OSDI score	18.75 (8.33–22.92)
Eye discomfort	25 (10–30)
Visual function	6.25 (0–12.5)
Environmental trigger	25 (8.33–33.33)

[a]Subject eye symptoms include: ocular dryness, foreign body sensation, burning or stinging, asthenopia (ocular fatigue) and other uncomfortableness

[b]Systemic diseases such as diabetes, hypertension and coronary heart disease

graded 1 in two of the items and graded 0 in the other items. The mean score of the "visual function" section is as low as 6.25 because of the good central visual acuity of the patients.

The utility scores measured with TTO, SG1, SG2 and RS were 0.95 ± 0.11, 0.96 ± 0.10, 0.99 ± 0.07 and 0.89 ± 0.10, respectively. The results of the pairwise comparison revealed that p values from comparisons of the 6 pairs were all less than 0.05 (Table 2), suggesting that there were statistically significant differences between the utility evaluated by the four methods.

As shown in Table 3, among the utility scores measured with the four methods, only the utility scores measured with RS significantly correlated with the composite OSDI score, "environmental trigger" and "eye discomfort" section scores ($p < 0.05$). Significant correlations were also found between the utility scores measured with RS and BUT ($p < 0.05$), as well as the utility scores measured with TTO and education level ($p < 0.01$), but no correlation was detected between gender, age, S It, FI, visual acuity and any of the utility scores (all $p > 0.05$).

Discussion

The Federal Food and Drug Administration has increased their emphasis on properly developing and using patient-reported outcomes, such as QOL measures, in clinical drug trials to determine treatment efficacy [31]. Based on our English-language MEDLINE literature search, this is the first study to assess which of the four methods (TTO, SG1, SG2 and RS) is best for evaluating QOL changes due to dry eye symptoms. The present study may help ophthalmologic doctors to choose QOL measurement methods in patients with dry eye symptoms and facilitate future investigations on QOL in dry eye patients.

Many researchers have assessed the consistency of utility values by different multi-dimensional utility indicators and have found that different methods usually lead to different results [32–34]. Zhu et al. [35] evaluated utility values associated with diabetic retinopathy and found that difference between TTO utility value and RS utility value was significant when Snellen BCVA was worse than 20/400 in the better-seeing eye. Here, we used the TTO, SG1, SG2 and RS methods to evaluate the QOL of patients who visited the clinic with dry eye symptoms. Since the median OSDI score was calculated as 18.75, the dry eye symptoms were considered more than mild in these patients. It is reported that mean utilities were 0.72 for

Table 2 Results of the pairwise comparison of utility scores measured with TTO, SG1, SG2 and RS Wilcoxon nonparametric test

Statistical indicator	Pairwise comparison					
	TTO-SG_1	TTO-SG_2	SG_1-SG_2	RS-SG_1	RS-SG_2	TTO-RS
Z	− 2.117	− 3.562	− 3.007	− 4.978	− 6.862	− 4.465
p	0.034	0.000	0.003	0.000	0.000	0.000

Table 3 Correlation coefficients between utility values measured with TTO, SG and RS and patients' basic social information, objective clinical examination, OSDI score and visual acuity

Correlation factor	Correlation coefficient			
	TTO	SG1	SG2	RS
Basic social information				
Gender	0.323	0.177	0.113	0.117
Age	0.081	0.012	0.014	0.015
Education level	− 0.264**	− 0.170	− 0.049	− 0.069
Tear film and ocular surface examination				
BUT	0.001	0.024	− 0.030	0.226*
S It	− 0.109	− 0.104	0.001	0.142
FI	0.128	0.138	0.088	0.058
OSDI				
Composite score	− 0.053	− 0.042	0.054	− 0.237*
Eye discomfort section score	− 0.016	− 0.031	0.041	− 0.238*
Visual function section score	− 0.022	0.086	0.055	− 0.041
Environmental trigger section score	− 0.047	− 0.060	0.042	− 0.217*
LogMAR visual acuity in the better eye	− 0.059	− 0.011	− 0.078	− 0.001

*$p < 0.05$; **$p < 0.01$

self-reported mild-to-moderate dry eye patients [36]. Meanwhile, our research showed that the utility value measured with RS was only 0.89, indicating that the utility value can be used to reflect impaired QOL solely due to dry eye symptoms.

However, the utility values obtained with TTO and SG were all greater than or equal to 0.95. We speculate that the differences between different values are caused by the different building principles of the four different methods. There is a gambler's concept in TTO and SG, i.e., the prerequisite for patients to obtain a higher QOL is to sacrifice something, such as life and visual acuity. To some extent, it also reflects the patients' fear of blindness or death. TTO takes the reduction of expected life span as said sacrifice, while SG takes the risk of immediate blindness (SG1) or immediate death (SG2) in exchange for perfect visual status. RS is simply an assessment of present eye status that reflects an individual's satisfaction. In this study, the patients had a visual acuity better than 20/25 and mild-to-moderate dry eye conditions (OSDI score < 35 points), indicating that the influence of visual acuity on the patients' life might be slight. It was found to be unacceptable to take the risk of immediate blindness or even immediate death in exchange for better visual status when the patients' visual quality could meet daily needs. Different from TTO and SG, RS, also known as a visual analog scale or feeling thermometer, only assigns a value that reflects the patients' feeling of the current condition. It does not involve risk or probabilities and has no roots in expected utility theory. Therefore, it is reasonable to assume that RS is more sensitive than TTO and SG to evaluate QOL changes due to dry eye symptoms. According to further correlation analyses, the significant correlation between RS-derived utility scores and OSDI scores, especially with the "environmental trigger" and "eye discomfort section" scores, provides substantial evidence to support the abovementioned assumption.

However, some inherent weaknesses of the present study should be noted. First, we did not check the functional visual acuity for the patients, which might be lower than presenting visual acuity [37]; second, although the high validity of TTO measures was confirmed in Chinese patients with a good visual acuity in our previous study [29], the validity of RS measures in these specific patients has not been proven before. This may undermine the conclusions of this study. Future studies with more dry eye patients will help to establish validity.

Acknowledgements This study was funded by Chinese National Nature Science Foundation (Project Numbers 81371069, 81670898), the Chronic Diseases Prevention and Treatment Project of Shanghai Shen Kang Hospital Development Centre (Grant Nos. SHDC12015315, SHDC2015644), the Shanghai High-level Oversea Training Team Program on Eye Public Health (Project No. GWTD2015S08) and the Shanghai Outstanding Academic Leader Program (Project No. 16XD1402300).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The institutional review board of the Shanghai General Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China, approved the study.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Paulsen AJ, Cruickshanks KJ, Fischer ME et al (2014) Dry eye in the beaver dam offspring study: prevalence, risk factors, and health-related quality of life. Am J Ophthalmol 157:799–806
2. Vehof J, Kozareva D, Hysi PG et al (2014) Prevalence and risk factors of dry eye disease in a British female cohort. Br J Ophthalmol 98:1712–1717
3. Tian YJ, Liu Y, Zou HD et al (2009) Epidemiologic study of dry eye in populations equal or over 20 years old in Jiangning District of Shanghai. Zhonghua Yan Ke Za Zhi 45:486–491
4. Goto E, Yagi Y, Matsumoto Y et al (2002) Impaired functional visual acuity of dry eye patients. Am J Ophthalmol 133:181–186
5. Walt JG, Rowe MM, Stern KL (1997) Evaluating the functional impact of dry eye: the ocular surface disease index [abstract]. Drug Inf J 31:1436
6. Amparo F, Schaumberg DA, Dana R (2015) Comparison of two questionnaires for dry eye symptom assessment: the ocular surface disease index and the symptom assessment in dry eye. Ophthalmology 122:1498–1503
7. Grubbs JR Jr, Tolleson-Rinehart S, Huynh K et al (2014) A review of quality of life measures in dry eye questionnaires. Cornea 33:215–218
8. Schiffman RM, Christianson MD, Jacobsen G et al (2000) Reliability and validity of the ocular surface disease index. Arch Ophthalmol 118:615–621
9. Gürdal C, Saraç O, Genç I et al (2011) Ocular surface and dry eye in Graves' disease. Curr Eye Res 36:8–13
10. Rossi GC, Tinelli C, Pasinetti GM et al (2009) Dry eye syndrome-related quality of life in glaucoma patients. Eur J Ophthalmol 19:572–579
11. Adatia FA, Michaeli-Cohen A, Naor J et al (2004) Correlation between corneal sensitivity, subjective dry eye symptoms and corneal staining in Sjogren's syndrome. Can J Ophthalmol 39:767–771
12. Monaco G, Cacioppo V, Consonni D et al (2011) Effects of osmoprotection on symptoms, ocular surface damage, and tear film modifications caused by glaucoma therapy. Eur J Ophthalmol 21:243–250
13. Luchs JI, Nelinson DS, Macy JI (2010) Efficacy of hydroxypropyl cellulose ophthalmic inserts (LACRISERT) in subsets of patients with dry eye syndrome: findings from a patient registry. Cornea 29:1417–1427
14. Cartwright WS (1999) Methods for the economic evaluation of health care programmes. In: Drummond MF, O'Brien B, Stoddart GL, Torrance GW (eds) 2nd edn. Oxford University Press, Oxford (1997) J Ment Health Policy Econ 2:43
15. Stein JD (2004) Disparities between ophthalmologists and their patients in estimating quality of life. Curr Opin Ophthalmol 15:238–243
16. Brown GC, Brown MM, Sharma S et al (2002) A cost-utility analysis of interventions for severe proliferative vitreoretinopathy. Am J Ophthalmol 133:365–372
17. Schiffman RM, Walt JG, Jacobsen G et al (2003) Utility assessment among patients with dry eye disease. Ophthalmology 110:1412–1419
18. Brown MM, Brown GC, Sharma S et al (2001) A utility analysis correlation with visual acuity: methodologies and vision in the better and poorer eyes. Int Ophthalmol 24:123–127
19. Buchholz P, Steeds CS, Stern LS et al (2006) Utility assessment to measure the impact of dry eye disease. Ocul Surf 4:155–161
20. Sharma S, Brown GC, Brown MM et al (2000) Converting visual acuity to utilities. Can J Ophthalmol 35:267–272

21. Miljanovic B, Dana R, Sullivan DA et al (2007) Impact of dry eye syndrome on vision-related quality of life. Am J Ophthalmol 143:409–415
22. Friedman NJ (2010) Impact of dry eye disease and treatment on quality of life. Curr Opin Ophthalmol 21:310–316
23. Pouyeh B, Viteri E, Feuer W et al (2012) Impact of ocular surface symptoms on quality of life in a United States veterans affairs population. Am J Ophthalmol 153(1061–66):e3
24. Rajagopalan K, Abetz L, Mertzanis P et al (2005) Comparing the discriminative validity of two generic and one disease-specific health-related quality of life measures in a sample of patients with dry eye. Value Health 8:168–174
25. Macri A, Rolando M, Pflugfelder S (2000) A standardized visual scale for evaluation of tear fluorescein clearance. Ophthalmology 107:1338–1343
26. Resnikoff S, Pascolini D, Mariotti SP et al (2008) Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bull World Health Organ 86:63–70
27. Brown MM, Brown GC, Sharma S et al (1999) Evidence-based medicine, utilities, and quality of life. Curr Opin Ophthalmol 10:221–226
28. Torrance GW (1986) Measurement of health state utilities for economic appraisal. J Health Econ 5:1–30
29. Zou H, Liu H, Xu X et al (2013) The impact of persistent visually disabling vitreous floaters on health status utility values. Qual Life Res 22:1507–1514
30. Zhang S, Liang Y, Chen Y et al (2015) Utility analysis of vision-related quality of life in patients with glaucoma and different perceptions from ophthalmologists. J Glaucoma 24:508–514
31. Bottomley A, Jones D, Claassens L (2009) Patient-reported outcomes: assessment and current perspectives of the guidelines of the Food and Drug Administration and the reflection paper of the European Medicines Agency. Eur J Cancer 45:347–353
32. Brazier J, Roberts J, Tsuchiya A et al (2004) A comparison of the EQ-5D and SF-6D across seven patient groups. Health Econ 13:873–884
33. Marra CA, Woolcott JC, Kopec JA et al (2005) A comparison of generic, indirect utility measures (the HUI2, HUI3, SF-6D, and the EQ-5D) and disease-specific instruments (the RAQoL and the HAQ) in rheumatoid arthritis. Soc Sci Med 60:1571–1582
34. Stavem K, Froland SS, Hellum KB (2005) Comparison of preference-based utilities of the 15D, EQ-5D and SF-6D in patients with HIV/AIDS. Qual Life Res 14:971–980
35. Zhu X, Sun Q, Zou H, Xu X, Zhang X (2015) Disparities between ophthalmologists and patients in estimating quality of life associated with diabetic retinopathy. PLoS ONE 10(12):e0143678. https://doi.org/10.1371/journal.pone.0143678
36. Buchholz P, Steeds CS, Stern LS et al (2006) Utility assessment to measure the impact of dry eye disease. Ocul Surf 4:155–161
37. Goto E, Yagi Y, Matsumoto Y, Tsubota K (2002) Impaired functional visual acuity of dry eye patients. Am J Ophthalmol 133:181–186