Impact of Bilateral Visual Impairment on Health-Related Quality of Life: the Blue Mountains Eye Study

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Purpose. To assess the impact of visual impairment on health-related quality of life (HRQOL) in an older population and compare it with the impact of major medical conditions.

Methods. Participants of the second cross-sectional Blue Mountains Eye Study (BMES; $n = 3509$; mean age, 66.7 years; 57% female) were asked to complete the self-administered 36-item Short-Form health survey (SF-36), a comprehensive interview, and an eye examination. Visual impairment was defined as visual acuity less than 20/40 (better eye).

Results. Of 3154 (89.9%) participants with complete data, 172 (5.5%) had visual impairment due to refractive errors (correctable visual impairment) and 66 (2.1%) due to eye conditions (noncorrectable visual impairment; 49 mild, 9 moderate, 8 severe). After adjustment for demographic and medical confounders, there was a trend toward lower SF-36 scores in participants with noncorrectable impairment than in those with correctable impairment (physical component score [PCS] $P_{\text{trend}} = 0.01$ and mental component score [MCS] $P_{\text{trend}} = 0.02$). Increasingly severe noncorrectable visual impairment was associated with significantly poorer SF-36 scores in all but two dimensions. The impact of noncorrectable visual impairment was comparable to that from major medical conditions (e.g., stroke) and had a greater impact on mental than physical domains (mean MCS = 46.2, PCS = 41). No significant differences in HRQOL were demonstrated between visual impairment cases caused by age-related maculopathy and cataract, after adjusting for severity of visual impairment.

Conclusions. Noncorrectable visual impairment was associated with reduced functional status and well-being, with a magnitude comparable to major medical conditions. These data have implications for disability weights such as those developed by the Global Burden of Disease study. (*Invest Ophthalmol Vis Sci.* 2004;45:71–76) DOI:10.1167/iovs.03-0661

The age-related increase in the prevalence of visual impairment[1–3] and its impact on nursing home placement,[4] falls[5] and hip fractures,[6] increased use of community support services,[7] and mortality[8,9] has been well documented. The shift toward broader health perspectives and the emphasis on the patient's preferences have resulted in the use of health outcome measures that encompass physical, emotional, and social impacts of a condition.[10] Both generic[11–13] and vision-related[14–16] health questionnaires are increasingly used as primary and secondary outcome measures in clinical trials and to aid the organization, financing, and delivery of health care services.

The generic, multidimensional 36-item Short-Form health survey (SF-36)[13] has been used across a range of populations, treatment groups, and diseases, including ophthalmic conditions, such as visual impairment or blurred vision,[17,18] aged-related macular degeneration,[19,20] cataract,[21] glaucoma,[22,23] diabetic retinopathy,[20] uveitis,[24] and corneal transplantation.[25] Although recent reports have shown that generic health outcome measures such as the SF-36 are not as sensitive to changes in vision-related function as vision-related questionnaires,[17,21,23,24] the use of the SF-36 enabled comparison of the impact of visual impairment on health-related quality of life (HRQOL) with the impact from a range of other medical conditions.

It is clear that visual impairment detrimentally affects HRQOL, resulting in lower self-rated health,[26] decreased physical,[19,27] and emotional functioning,[17,28] and lower socialization.[7,17] However, many issues are yet to be clarified: Is there any impact on HRQOL from visual impairment due to undercorrected refractive error and if so, how does it compare with the impact of visual impairment due to eye conditions? Are there differences in the impact of visual impairment on HRQOL between the two major causes: cataract and age-related maculopathy (ARM)? How does the impact of visual impairment compare with impacts from other major medical conditions?

Using data from the Blue Mountains Eye Study, this report explores these questions in relation to bilateral visual impairment. It supplements our recent report of the impacts from unilateral visual impairment on HRQOL.[18]

Materials and Methods

Study Population

The Blue Mountains Eye Study (BMES) is a population-based study of visual impairment, common eye diseases, and other health conditions in an older community-living population.[3] Study procedures were approved by the University of Sydney Ethics Committee and were in accordance with the tenets of the Declaration of Helsinki. Informed consent was obtained from all participants.

In 1991, BMES baseline survey (BMES I) identified 4433 eligible noninstitutionalized permanent residents in a door-to-door private census from a defined area in the Blue Mountains region, west of Sydney, Australia. Of this target population, 3654 (82.4%) participated in detailed examinations from 1992 to 1994. From 1997 to 1999, all surviving participants ($n = 3111$) were invited to the 5-year follow-up examinations. These were attended by 2335 (75.1%) persons (BMES IIA). In 1999, another door-to-door census conducted in the same area identified 1378 newly eligible residents who had moved into the study

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area or study age group, of which 1174 (85.2%) were examined from 1999 to 2000 (BMES IIB). The second cross-sectional BMES thus comprised 3509 participants from BMES IIA and IIB.

Instrument Used

The SF-36 contains 36 items measuring eight dimensions of health and well-being: "physical functioning," "role limitations due to physical problems," "bodily pain," "general health perceptions," "vitality," "social functioning," "role limitations due to emotional problems," and "mental health."[13] The Australian adapted version[29] was used in this study. Each dimension was scored from 0 (worst possible health state) to 100 (best possible health state) by coding, summating, and transforming its relevant item scores according to the SF-36 manual.[30] Physical and mental component scores (PCS and MCS, respectively) were summary measures calculated using factor analysis and Australian normalized scores (mean = 50, SD = 10).[31,32]

Data Collection

Participants attended a comprehensive medical interview and eye examination by trained technicians. Self-reported history of angina, heart attack, stroke, arthritis, diabetes, and asthma were collected. The self-reported history of cancer was collected but not included due to the high proportion of nonmelanotic skin cancer.

Monocular distance logarithm of the minimum angle of resolution (logMAR) visual acuity was measured using forced-choice procedures according to the Early Treatment Diabetic Retinopathy Study (ETDRS) methods with habitual correction and with best correction after subjective refraction.[3] Lens and stereo retinal photographs were taken and graded by trained graders and adjudicated by an ophthalmologist.

Before their examination, all participants of the second cross-sectional BMES were sent a detailed questionnaire that included the SF-36. Participants were asked to bring the questionnaire booklets to the examination or to return it by reply-paid mail. The SF-36 was not administered in BMES I.

Definitions

Bilateral visual impairment was defined as visual acuity of less than 20/40 in the better eye. Correctable visual impairment was defined as visual impairment at presentation but improved to no impairment after subjective refraction. Noncorrectable visual impairment was defined as impairment at both presentation and after subjective refraction. The latter was stratified into mild visual impairment defined as visual acuity less than 20/40, but 20/80 or more; moderate as less than 20/80 but 20/200 or more, and severe as less than 20/200.

Cataract was diagnosed during the slit lamp examination and documented with lens photography (SL-7e camera; Topcon Optical Co., Tokyo, Japan, and retroillumination CT-R cataract camera; Neitz Instrument Co., Tokyo, Japan). Age-related maculopathy (ARM) was diagnosed and confirmed by grading of stereoretinal photographs. Details of the cataract[33] and ARM[34] photography and grading used in the Blue Mountains Eye Study have been reported. The causes that contributed to visual loss were determined by the examining ophthalmologist (PM) during the final stage of dilated eye examination. Only in this portion of analysis, comparing HRQOL associated with the two major causes of visual impairment, were participants with cataract surgery excluded.

Statistical Analysis

Persons who did not attempt the SF-36 questionnaire or who had incomplete visual acuity data were excluded from analysis, which was performed on computer (SAS 8.2 for Windows; SAS Institute Inc., Cary, NC). Comparison of sociodemographic and medical characteristics and the determination of the trend (P_{trend}) among participants without visual impairment compared with those with correctable and noncorrectable impairment were performed with χ^2 analysis. The same analysis was used to calculate the trend (P_{trend}) associated with increasing severity of noncorrectable visual impairment.

Possible confounding sociodemographic and medical variables were analyzed dichotomously (yes versus no). A stepwise regression model was used to determine the subset of these variables that significantly affected either the physical or mental component scores. Only significant variables were included in multiple linear regression analysis to calculate multivariate-adjusted mean scores by analysis of covariance. Age–sex adjustment was used when the numbers of participants were too few to allow multivariate adjustment.

The two principal causes of visual impairment in our study were cataract and ARM. Only these two conditions were compared because of the low number of subjects with other conditions. Analyses were conducted in two ways. First, mean physical and mental component scores of participants with cataract and ARM were compared, stratifying by the severity of visual impairment. Second, multiple linear regression models using physical and mental component scores as outcome variables were used to assess the independent effects of each eye condition.

To compare the SF-36 profiles between participants with certain medical conditions, disease-specific SF-36 scores were age and sex standardized to the BMES population, using the direct method.

Results

Prevalence of Visual Impairment

Participants had a mean age of 66.7 years (range, 49–98 years) and 57% were female. Complete data sets that included SF-36 questionnaires were available for 3154 (89.9%) participants. Of these, the prevalence of presenting bilateral visual impairment was 7.5% ($n = 237$) but decreased to 2.1% ($n = 66$; 49 mild, 9 moderate, and 8 severe) after subjective refraction. Because of the relatively low numbers, cases with moderate and severe visual impairment were pooled for the analysis.

Correctable and Noncorrectable Visual Impairment

Participants with either correctable or noncorrectable visual impairment were more likely to be older and to receive a government social security pension, but were less likely to be married, to have higher qualifications, to own a home or be currently employed than participants without impairment (Table 1). They were also more likely to report a history of angina and stroke, but there were no significant differences in the prevalence of other medical conditions.

After adjustment for demographic and medical confounders, there was a trend toward lower SF-36 scores in participants with noncorrectable impairment than in those with correctable impairment (Table 2) in five dimensions ($P_{trend} \leq 0.05$) and in both physical and mental component scores (PCS $P_{trend} = 0.01$, MCS $P_{trend} = 0.02$).

After multivariate adjustment, participants with any noncorrectable visual impairment had significantly poorer SF-36 scores in five dimensions and in the mental component score (Table 3). Increasingly severe noncorrectable visual impairment was associated with deteriorating SF-36 profiles (the latter was only age–sex adjusted because of low sample numbers). Mental domains were more greatly affected than physical domains, as reflected by the trend in the summary component scores (PCS $P_{trend} = 0.25$, MCS $P_{trend} = 0.001$). When compared with participants without visual impairment (excluding participants with correctable visual impairment), participants with mild visual impairment had significantly lower scores in the physical-functioning, vitality, and mental health dimensions ($P = 0.02$, 0.001, and 0.01 respectively), and participants with moderate to severe visual impairment had lower scores in role limitation due to physical problems, vitality, social functioning, and mental health and in the mental component score ($P = 0.02$, 0.002, 0.001, 0.005, and 0.001, re-

TABLE 1. Sociodemographic and Self-Reported Medical Characteristics among Participants with No Visual Impairment, Correctable or Noncorrectable Visual Impairment

	None (n = 2916)	Correctable (n = 172)	Noncorrectable (n = 66)
Mean age (y)	65.9	74.4*	79.2*
Women (%)	57.0	61.6	69.7*
Married (%)	63.9	49.4*	36.4*
Qualifications after high school (%)	65.1	50.0*	50.9*
Receives government pension (%)	57.3	73.8*	87.9*
Owns home (%)	91.0	86.1*	80.3*
Currently employed (%)	24.4	8.1*	6.1*
Hospital admission previous 12 months (%)	23.2	25.6	34.9*
Angina (%)	9.7	15.7*	21.2*
Stroke (%)	4.0	9.9*	10.6*
Diabetes (%)	7.2	8.1	7.6
Arthritis (%)	40.0	47.1	51.5
Asthma (%)	11.9	10.5	16.7
Thyroid disease (%)	9.1	9.9	9.1
Current smoker (%)	9.9	9.3	9.2

* Significantly different from no visual impairment ($P \leq 0.05$).

spectively). Similar results were also obtained when participants with correctable visual impairment were included in the reference group.

Major Causes of Visual Impairment

Participants with ARM were significantly older (mean age, 76.6 years) and more likely to have more severe levels of visual impairment (8.7% had mild and 4.0% had moderate to severe visual impairment) than participants with cataracts (mean age, 73.3 years; 4.5% had mild and 1.3% had moderate to severe visual impairment). Multiple linear regression models simultaneously adjusting for age, sex, visual impairment, any cataract, and any ARM showed physical component scores were significantly affected by age and sex ($P < 0.0001$), and mental component scores by age and visual impairment ($P = 0.0005$ and 0.012, respectively). Participants with cataract and ARM did not have significantly different physical and mental component scores when compared with participants without these two conditions, after adjustment for visual impairment (Table 4), except among participants without visual impairment. In this group, participants with either or both these eye conditions had significantly poorer physical component scores than those without either condition.

Comparison of Impacts on HRQOL with Other Major Medical Conditions

Table 5 tabulates both the physical and mental component scores and disability weights[35] in descending order of magnitude. The impact of visual impairment (shown in bold) on mental domains was much greater than that of other medical conditions, whereas its physical impact was milder, as reflected by the respective component scores (PCS = 41.0, MCS = 46.2). Stroke, which had similar disability weights as low vision, had a greater impact on physical domains and a milder impact on mental domains than visual impairment (PCS = 39.3 and MCS = 51.5).

DISCUSSION

In this older population, both correctable and noncorrectable visual impairment detrimentally affected HRQOL, although the impact from noncorrectable impairment was greater and increased with higher levels of impairment. This impact appeared to be directly related to the severity of visual impairment but not to the underlying eye condition. The impact of visual impairment was comparable with that of major medical conditions and affected mental more than physical domains.

These findings have important implications. First, the burden from visual impairment will increase as its prevalence increases (expected to double in the next 30 years[36,37]), due to the aging population. Second, the impact from correctable visual impairment reinforces the benefits of eye care services for older people.[38] Although the impact of correctable visual impairment is not as great as that of noncorrectable visual impairment, its higher prevalence, accounting for one third to two thirds[39] of all visual impairment, substantially increases its overall burden. Possible contributors to the high prevalence of correctable visual impairment in the older population include disabling systemic disorders that mask the cause of difficulties, inability to afford costs of treatment, and perceptions that visual loss is to be expected in later life and cannot be ameliorated.[38,40]

The decrease in function and well-being associated with visual impairment is integrated into a person's HRQOL and is not easily isolated from other medical conditions. Lower sociodemographic status, medical conditions, and disabilities could confound the relationship between visual impairment and HRQOL. We have adjusted for the potential confounders measured in our study but have excluded factors that were not measured.

The arbitrary cutoff used to define the severity of visual impairment that predicted significant disability may be insufficient to reflect the gradual deteriorating trend in HRQOL with increasing severity of visual impairment. Our data show that moderate to severe visual impairment had the greatest impact on HRQOL. This is consistent with our previous findings that participants with this level of impairment had significantly reduced ability to maintain mobility and independence[4] and had a significantly greater need for community and family support.[7]

Brown et al.[20] compared utility values of diabetic retinopathy and ARM and found that the impact on HRQOL was related to the degree of the impairment and not the underlying condition causing the impairment.[19,20] Our findings are in keeping with these studies. There was a significant difference in the physical component score among participants without visual impairment between those with cataract and/or ARM and those without either condition, probably because this latter group consisted mainly of participants without any eye condition. Participants with visual impairment but who do not have

Table 2. Multivariate Adjusted Mean Scores (Standard Error) for the Eight Dimensions and Physical and Mental Component Scores among Participants with No Visual Impairment, Correctable or Noncorrectable Visual Impairment

Visual Impairment	Physical Functioning	Role Limitation Due to Physical Problems	Bodily Pain	General Health	Vitality	Social Functioning	Role Limitation Due to Emotional Problems	Mental Health	Physical Component Score	Mental Component Score
None (n = 2916)	72.3 (0.4)	67.0 (0.7)	70.6 (0.5)	68.1 (0.4)	62.0 (0.4)	84.1 (0.4)	81.0 (0.7)	78.8 (0.3)	45.0 (0.2)	52.0 (0.2)
Correctable (n = 172)	68.2 (1.8)*	61.1 (3.1)	68.2 (1.9)	66.9 (1.6)	61.7 (1.7)	79.3 (1.9)*	75.8 (2.8)	77.5 (1.3)	42.7 (0.8)*	51.3 (0.8)
Noncorrectable (n = 66)	66.2 (3.0)*	61.9 (5.4)	66.4 (3.2)	61.1 (2.8)*	50.7 (2.8)*†	76.9 (3.2)*	77.3 (4.8)	71.8 (2.3)*†	43.0 (1.4)	48.0 (1.5)*†
P_{trend}	**0.02**	0.13	0.23	**0.04**	**0.0004**	**0.01**	0.17	**0.01**	**0.01**	**0.02**

Data are adjusted for age and the dichotomous variables sex, home ownership, current employment, marital status, higher qualifications after high school, receives government pension, hospital admission during the past 12 months, current smoker; reported diagnosis of angina, stroke, diabetes, arthritis, asthma, or thyroid disease; and cognitive impairment (Mini Mental State Examination [MMSE] <24). P_{trend} in bold indicates statistically significant trend.

* Significantly different from no visual impairment ($P \leq 0.05$).

† Significantly different from correctable visual impairment ($P \leq 0.05$).

Table 3. Mean Scores (standard error) for the Eight Dimensions and Physical and Mental Components among Participants with Noncorrectable Visual Impairment

Noncorrectable Visual Impairment*	Physical Functioning	Role Limitation Due to Physical Problems	Bodily Pain	General Health	Vitality	Social Functioning	Role Limitation Due to Emotional Problems	Mental Health	Physical Component Score	Mental Component Score
None (n = 2916)	72.9 (0.4)	67.8 (0.7)	70.8 (0.5)	68.2 (0.4)	62.3 (0.4)	84.2 (0.4)	81.2 (0.6)	78.5 (0.3)	45.3 (0.2)	51.9 (0.2)
Mild (n = 49)	64.9 (3.5)	69.1 (6.2)	66.0 (3.7)	61.8 (3.3)	51.6 (3.2)†	79.9 (3.5)	75.8 (5.3)	72.1 (2.6)†	43.7 (1.7)	48.9 (1.6)
Moderate-severe (n = 17)	64.5 (5.9)	42.7 (10.3)†‡	63.8 (6.2)	58.6 (5.2)	45.9 (5.2)†	65.5 (5.8)†‡	67.9 (8.6)	66.9 (4.1)†	41.3 (2.8)	42.9 (2.6)†‡
§Any (n = 66)	66.2 (3.0)†	62.1 (5.4)	66.3 (3.2)	61.1 (2.8)†	50.5 (2.8)†	76.4 (3.1)†	76.8 (4.8)	71.7 (2.3)†	42.9 (1.4)	47.8 (1.4)†
P_{trend}	**0.03**	**0.05**	0.24	**0.03**	**<0.0001**	**0.003**	0.19	**0.001**	0.25	**0.001**
‖P_{trend}	0.06	0.06	0.31	**0.04**	**<0.0001**	**0.01**	0.31	**0.002**	0.35	**0.001**

* Age- and sex-adjusted model.

† Significantly different from no visual impairment ($P \leq 0.05$).

‡ Significantly different from mild visual impairment ($P \leq 0.05$).

§ Multivariate-adjusted model (adjusted for age and dichotomous variables sex, home ownership, current employment, marital status, higher qualifications after high school, receives government pension, hospital admission during the past 12 months, and current smoker; reported diagnosis of angina, stroke, diabetes, arthritis, asthma, or thyroid disease; and cognitive impairment).

‖ Trend where no bilateral visual impairment includes persons with correctable visual impairment. Bold type indicates statistically significant trend.

TABLE 4. Comparison of Physical and Mental Component Scores for Participants with Cataract, ARM, Both or Neither Eye Condition in the Better Eye, by Level of Visual Impairment

	Physical Component Score				Mental Component Score			
Visual Impairment	No Cataract or ARM	Cataract	ARM	Cataract and ARM	No Cataract or ARM	Cataract	ARM	Cataract and ARM
None	46.6 (n = 1937)	43.4* (n = 520)	42.9* (n = 94)	40.2* (n = 65)	51.8 (n = 1937)	52.3 (n = 520)	52.5 (n = 94)	53.0 (n = 65)
Mild	35.4 (n = 7)	44.4 (n = 16)	38.8 (n = 2)	36.3 (n = 12)	48.2 (n = 7)	54.8 (n = 16)	50.9 (n = 2)	47.9 (n = 12)
Moderate to severe	54.3 (n = 2)	28.0 (n = 3)	25.3 (n = 3)	41.6 (n = 5)	48.3 (n = 2)	36.0 (n = 3)	43.3 (n = 3)	49.9 (n = 5)

* Significantly different from no cataract or ARM ($P \leq 0.05$).

either cataract or AMD commonly have another eye condition that causes the impairment.

Some studies have reported that generic health outcome measures such as the SF-36 may not be as sensitive to ocular conditions as vision-related health outcome measures.[17,21,23,41] However, its acceptable validity and reliability and its ability to allow comparison across a wide range of medical conditions made this instrument appropriate for the purposes of this report.

Our data documented that the impact on HRQOL of visual impairment was comparable with that of major medical conditions and affected mental more than physical domains. Our results are comparable to those of Fryback et al.,[42] who compared cataract, glaucoma, and ARM with other medical conditions, using four general health measures including the SF-36. This highlights the importance of the disability weight of visual impairment, which has been overlooked until now.

Disability weights are an essential parameter for the calculation of the disability-adjusted life year (DALY), a health-economic tool increasingly used for the assessment of the burden of disease and priority setting for health research.[43] It is needed for weighting the years lived with a specific disease by the severity of the disability associated with it, hence combining information on the impact of premature death with that of disability and other nonfatal health outcomes.[35] These weights were developed by the World Health Organization (WHO) Global Burden of Disease (GBD) study,[35] using an internationally representative group of health experts and person tradeoff (PTO) methods. Some of these weights were extended in a Dutch study.[44] However, there remains considerable concern about the accuracy of disability weights assigned to various disease categories and the development of most of these weights.[45,46]

In this study, we attempted to compare the impact of poor vision on HRQOL, with these two commonly used health outcome measures. Although their values are not directly comparable because of their different origins, the ranking of these items should be similar. We used the GBD weights instead of those by the Dutch study, as the latter stratified each condition by severity and we had an insufficient number in our population for direct comparison. The GBD weights are stratified by age (0–4, 5–14, 15–44, 45–59, and 60+ years) and treatment status (treated or untreated). We used the disability weights of the treated group aged 60+ years, as this was most comparable to our population. As shown in Table 5, the mental impact of visual impairment in an older population is much greater than that of other medical conditions, although its physical impact is milder. Stroke, which had similar disability weights to low vision, had a greater physical impact and a milder mental impact than visual impairment in our study. Assuming equal weighting of physical and mental components, the impact of visual impairment and other conditions could be comparable to the GBD disability weight, despite the differences in their respective developments.

In conclusion, the increasing prevalence of age-related visual impairment and its associated reduction in well-being, functional status, and independence, will greatly increase the resultant burden of disease. This suggests a greater need for eye care services in older populations, particularly in relation to visual impairment due to undercorrected refractive errors. The impact of visual impairment, which is directly related to its severity but not its underlying condition, stresses the importance of low-vision services. Visual impairment has an impact comparable to that of major medical conditions. These data have implications for disability weights, such as those developed by the Global Burden of Disease study.

TABLE 5. Comparison of Age- and Sex-Standardized Physical and Mental Component Scores for Visual Impairment and Certain Medical Conditions, with the WHO Disability Weights

Physical Component Score		Mental Component Score		Disability Weights*	
Arthritis	41.0	Arthritis	51.7	Diabetes	0.033–0.129†
Asthma	41.0	Stroke	51.5	Asthma	0.059
Bilateral visual impairment	**41.0**	Heart attack	51.4	Angina	0.095
Diabetes	40.7	Asthma	50.8	Arthritis	0.108–0.174‡
Stroke	39.3	Diabetes	50.6	**Low vision**	**0.245§**
Angina	37.6	Angina	49.9	Stroke	0.258‖
Heart attack	37.3	**Bilateral visual impairment**	**46.2**	Heart attack	0.395

Bold type highlights the comparison of the visual impairment variable.

* World Health Organisation disability weights for treated group aged 60+ years.[46]

† Diabetes cases, 0.033; with neuropathy, 0.064; with diabetic foot, 0.129; with retinopathy resulting in blindness, 0.488.

‡ Osteoarthrits (knee or hip), 0.108; rheumatoid arthritis, 0.174.

§ Low vision (corrected visual acuity in the better eye of <20/60 but ≥10/200), blindness from cataract, 0.488; blindness from glaucoma, 0.600; blindness from trachoma, 0.488.

‖ First ever stroke.

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