

Utility analysis of disability caused by amblyopia and/or strabismus in a population-based, historic cohort

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Abstract

Background Amblyopia (prevalence 3.4%) is in principle treatable, but approximately one quarter of children do not reach reading acuity in the amblyopic eye. Adults with persistent amblyopia and/or strabismus experience a decrease in quality of life. This was now quantified by patient-perceived utility values.

Methods Subjects were born 1962–1972 and had been treated by occlusion therapy for amblyopia by one orthoptist 30–35 years ago. All children in Waterland with amblyopia and/or strabismus had been referred to this orthoptist. Utilities were derived by methods of time trade-off, TTO (lifetime traded against perfect vision) and standard gamble, SG (death risk accepted for perfect vision). Most troubling eye disorder (low acuity of the amblyopic eye, lacking stereopsis or strabismus) was chosen and ranked among nine chronic disorders according to the subject's perceived severity.

Results From 201 patients that could be contacted 35 years after occlusion therapy — out of 471 who had been

occluded — 135 were included: 17 could not be reached, 34 refused, and 15 had other reasons to not participate. Mean age was 40.86 years; 53% were male. Seventy percent were willing to trade lifetime according to the TTO method; its mean (log) utility was 0.963, i.e., a decrease in quality of life of 3.7%. Thirty-seven percent accepted death risk according to the SG method; its mean utility was 0.9996. TTO outcomes correlated with current near and distance visual acuity. Low acuity of the amblyopic eye, chosen as most troubling eye disorder, ranked slightly less severe than tooth decay.

Conclusion Amblyopia and/or strabismus patients had a slightly decreased utility. The decrease is small but still important in the cost-effectiveness of vision screening because these conditions occur very frequently.

Keywords Quality of life · Amblyopia · Utility values

Introduction

Amblyopia has a prevalence of approx. 3.4% [1], i.e., occurring very frequently. In a recent birth-cohort study it was found that one quarter (0.8%) is insufficiently screened and/or treated [1]. Cost-effectiveness analysis of vision screening [2, 3] requires, among others, that the impact of persistent amblyopia is transformed into an objectively measurable form, a utility value. It was, to this end, necessary to estimate the decrease in quality of life in unilateral amblyopia and/or strabismus patients, as quantified by the applied utility analysis, wherein the burden of disease, as perceived by patients, should be measured [4].

A recent birth-cohort study [5] could not detect a gross decrease in quality of life due to insufficiently treated amblyopia and/or strabismus at the level of education,

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employment and socioeconomic achievement. However, a disease-specific quality-of-life instrument might well detect such decrease at the level of visual day-to-day activities. We had, to this end, developed the Amblyopia & Strabismus Questionnaire (A&SQ). Clinical [6], content [7], and construct [8] validity of this novel questionnaire has been confirmed.

A utility is the value (ranging from 1.0 perfect vision to 0.0 death) a patient assigns to his present health state, including the disability caused by the current disease. A utility analysis of amblyopia and/or strabismus was now performed in a historic cohort of amblyopia and/or strabismus patients to quantify their decrease in quality of life. In utility analysis, it is imperative to measure decrease of quality of life in a representative sample of the population. This necessity was, for instance, demonstrated by our previous finding that quality of life perception in amblyopic persons who came to an outpatient clinic was much lower than in persons with similar disability in the general population [7].

The subjects from our historic cohort were an almost non-select sample of amblyopia and strabismus patients, because all children who were suspected of amblyopia had been referred between 1968 and 1974 to a single orthoptist and a single ophthalmologist who served the entire Waterland region.

In this study, utility was measured by the time trade-off (TTO) and the standard gamble (SG) methods that are commonly applied to derive direct patient preferences about health states [9]. Most troubling eye disorder (low visual acuity, lack of stereopsis, strabismus, glasses) was chosen and ranked among nine adult chronic diseases according to severity.

Methods and materials

Subjects were patients from the historic cohort. The historic cohort was taken from all patients who had consulted the orthoptist from the orthoptic outpatient clinic of the Waterland Hospital in Purmerend, the Netherlands between 1968 and 1974 ($N=1,250$). From these subjects, born between 1962 and 1972, 471 had been occluded, and 201 could be traced by telephone 30–35 years later. One hundred and seventy four of these had filled out the A&SQ [7, 8]. One hundred and thirty seven of them had been orthoptically re-examined by orthoptists [6, 10]. The historic cohort formed an almost non-select sample of all patients occluded at that time, because all children with insufficient visual acuity or strabismus from the entire region around Purmerend had been referred to a single practicing ophthalmologist and orthoptist at the time. The orthoptist had kept the original charts of the 1,250 patients. Local birth rates of the villages from the years in which most of the occluded were born (1965, 1966, 1967) in this region had been derived as

previously described [6]. These indicated that the historic cohort was representative for the children with amblyopia within the entire population in the region at that time. Of the children born in this region in 1965, 1966 and 1967, 4.8 % had received occlusion therapy [10].

Occlusion treatment and glasses had improved visual acuity of the amblyopic eye to more than 0.5 (0.3 logMAR) in one-third of patients. After occlusion therapy, visual acuity had remained the same from the end of occlusion therapy until adulthood in most patients, but children with combined-mechanism amblyopia or increasing anisohypermetropia had suffered a decrease of visual acuity of the amblyopic eye [10].

Subjects, after having given oral consent, were interviewed by one researcher (ESvdG) face-to-face, at the Waterland Hospital in Purmerend, and by phone. First, they were asked how long they expected to live.

Bisectional top-down titration search procedure was used to arrive at TTO and SG forced choices (See Appendix). They were set against a hypothetical medicine that could perfectly heal the eye condition (TTO) and a hypothetical operation that could perfectly heal the eye condition (SG).

Most troubling eye condition (low visual acuity of amblyopic eye, lack of depth perception, strabismus, wearing glasses or other eye complaint) was chosen.

In order to perceive their reference values, subjects were also presented with nine indicator conditions and the own eye trouble to rank on a scale from 1 (least severe) to 10 (worst) [11]. The indicator conditions were: *chronic bronchitis, chronic ear infection, complete loss of smell, complete loss of taste, eczema, migraine, partial deafness, partial memory loss, tooth decay* [12].

In an exploratory fashion, the measured utility values were compared by correlation-analysis with the previously derived results [7] in the five domains of the A&SQ: *fear of losing the better eye, distance estimation, visual disorientation, diplopia, and social contact and cosmetic problems*. This was done to discern which of the functional restrictions determined the impact of the current health state.

The measured utility values were also, in an exploratory fashion, compared by correlation-analysis with the previously examined clinical parameters [6] of the amblyopia and/or strabismus patients: distance visual acuity, near visual acuity, binocular vision, angle of strabismus, latent nystagmus, and refraction [13].

Results

Subjects

One hundred and thirty five subjects from the historic cohort who, in a previous study [7] had filled out the A&SQ ($N=174$) were interviewed, 106 in person, 29 by

phone. Thirty eight subjects could not be included in the study: 17 could not be reached, four were unable to be interviewed (illness, other impairments), 11 refused to participate, two did not meet the appointment. Male: $N=72$ (53%), female: $N=63$ (47%). Mean age of subjects was 40.86. Mean of expected life years of all subjects was 40.71 years.

Subjects chose as most troubling eye condition: low visual acuity of the amblyopic eye (52), lack of depth perception (31), strabismus (13), wearing glasses (14), none (eight). Other troubling eye conditions were: dry or itching eyes (three), fear of losing the better eye (four), diplopia (two), impaired accommodation (one), tired eyes (two), having to turn the head entirely to one side (two), deterioration of the eyes (one), no depth perception in sunlight (one).

Utility values

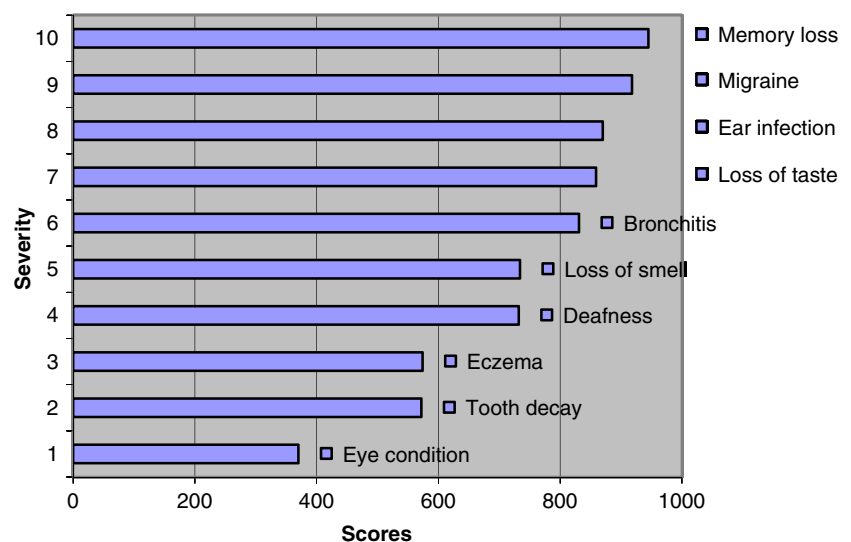
The top-down search procedure (forced-choices) for the TTO method resulted in 95 subjects (70%) who were willing to trade some of their remaining life years in return for perfect vision. From the 38 subjects with a visual acuity of the amblyopic eye that had improved to >0.50 (0.3 logMAR) by occlusion therapy and retained this acuity for 30–35 years, 17 were not willing to trade any lifetime. Mean of traded lifetime of all subjects, including those who were unwilling to trade lifetime, was 11 months. Differentiated to their most troubling eye condition, the mean traded lifetime was 14.6 months for low visual acuity, 8.3 months for lack of depth perception, and 7.2 months for strabismus.

Based on the calculation:

$$1 - (\text{traded lifetime} / \text{expected life years})$$

mean TTO utility value was: 0.977 ± 0.0379 . The TTO mean logarithmic utility value was 0.963.

Fig. 1 Ranking severity of the ten disorders. Scores are ranked scores from subjects. Ranking scale was from 1, least severe disorder, to 10 as the most severe disorder. "Eye condition" comprises low visual acuity of the amblyopic eye, lack of depth perception, strabismus, wearing glasses or other eye complaints



The top-down search procedure (forced-choices) for the SG method resulted in 49 subjects (37%) who accepted death risk, 86 subjects (63%) did not accept any death risk. Mean of accepted death risk of all subjects, including those who did not accept any death risk, was 1 in 20,000. Differentiated to their most troubling eye condition, the accepted death risk for low visual acuity was 1 in 10,000; for lack of depth perception, 1 in 20,000; and for strabismus, none.

Based on the calculation:

$$1 - \text{death risk taken}$$

mean SG utility value was 0.9994 ± 0.00307 .

Ranking chronic disorders

Ranking of the nine chronic disorders with own eye impairment according to subject's perceived severity showed that own eye impairment — mostly low visual acuity of the amblyopic eye — was experienced as the least severe disorder, less severe than eczema and tooth decay (Fig. 1).

Correlations utility values

It was determined, in an exploratory fashion, whether the measured utility values were associated with the previously derived results in the five quality of life domains of the A&SQ [7]. Pearson test of the TTO and SG utilities was done according to a matrix format with the data on the five A&SQ domains. It showed that only the domain *fear of losing the better eye* correlated significantly with the utility value assessed by the TTO. None of the A&SQ domains correlated with SG utility values (Table 1).

Table 1 Utility values (TTO and SG) correlated to the five A&SQ domains

Util. Val.	Five domains of the A&SQ									
	Fear loss better eye		Distance estim.		Visual disorient.		Diplopia		Contact & cosmetic	
	<i>r</i>	<i>P</i> *	<i>r</i>	<i>P</i> *	<i>r</i>	<i>P</i> *	<i>r</i>	<i>P</i> *	<i>r</i>	<i>P</i> *
TTO	.207	.027*	.161	.063	.162	.060	-.037	.671	-.086	.320
SG	.061	.521	-.029	.735	-.034	.698	-.049	.574	-.097	.264

r: Pearson correlation (two-tailed) of the utility values with the A&SQ domains

Level of significance (two-tailed): **P*=0.01–0.05

Abbreviations: estim.: estimation; disorient.: disorientation

It was also determined, in an exploratory fashion, whether the utility values correlated with the previously derived clinical parameters: visual acuity, binocular vision, angle of strabismus, refraction and latent nystagmus [6]. Pearson test of the TTO and SG utilities was done according to a matrix format with previously examined clinical parameters. It showed that the distance visual acuity and the near visual acuity of the amblyopic eye correlated significantly with the utility values assessed by the TTO (Table 2). The correlations were, however, weak. We had expected better correlations between measured TTO values and clinical parameters, because in the clinical validation study, the visual acuity of the amblyopic eye correlated significantly with quality of life as measured by four A&SQ domains [6].

None of the clinical parameters correlated significantly with SG utilities (Table 2)

Discussion

Utility in amblyopia and/or strabismus patients is lower than in healthy persons: 70% of all 135 subjects were willing to trade lifetime for perfect vision. The mean logarithmic TTO utility value of unilateral amblyopia and/or strabismus in adult patients was 0.963. This mean value included the subjects

(30%) unwilling to trade any lifetime. It is equal to an estimated decrease in quality of life due to amblyopia and/or strabismus of 3.7%. This small decrease is important in cost-effectiveness of prevention of amblyopia, as amblyopia and strabismus are very frequent conditions.

Thirty-seven percent of all 135 subjects accepted death risk to achieve perfect vision. The mean SG utility value of unilateral amblyopia and/or strabismus in adult patients was 0.9994, including the subjects unwilling to accept death risk.

Clearly, the decrease of utility value of amblyopia is not the same as that of acquired unilateral visual loss that has been reported to be 0.83 [4, 14].

The recruitment of the patients from a historic cohort of 471 occluded amblyopia and/or strabismus patients contributed to the unbiased character of the study outcomes. All children with insufficient visual acuity or strabismus from the Waterland area had been referred to the single ophthalmologist and orthoptist, and there had been little migration in this area between 1968 and 1974. Hence, almost all of these children within this region had been treated within this hospital and were eligible for this study [6].

We were interested to know whether the subjects who were willing to trade much lifetime or did accept death risk had low quality of life as found by the A&SQ. The TTO

Table 2 Past and current orthoptic parameters correlated to the utility values (TTO and SG)

Utility values	Examined orthoptic parameters									
	VA ambly. eye (start occl.)		VA ambly. eye (end occl.)		VA ambly. eye (current)		Reading VA ambly. eye		Anisometropia	
	<i>r</i>	<i>P</i> **	<i>r</i>	<i>P</i> **	<i>r</i>	<i>P</i> **	<i>r</i>	<i>P</i> **	<i>r</i>	<i>P</i> **
TTO	-.196	.038*	-.237	.010*	-.305	.001**	-.211	.023*	.211	.024*
SG	-.103	.277	-.005	.956	.011	.908	.009	.921	.093	.326

r: Pearson correlation (two-tailed) of the utility values with the orthoptic parameters

Levels of significance (two-tailed): **P*=0.01-0.05; ***P* <0.01

Abbreviations: ambly.: amblyopic; occl.: occlusion; VA: visual acuity

utility values correlated significantly only with the domain *fear of losing the better eye*, out of the five A&SQ domains (Table 1). Indeed, patients with insufficiently treated amblyopia spend on average the last 15 months of their lives with bilateral visual impairment when they lose the function of the better eye, in comparison to 8 months in healthy persons [15].

Similarly, visual acuity of the amblyopic eye was found to relate to quality of life in four ways. Low visual acuity of the amblyopic was perceived as the most troubling eye disorder. Subjects with low visual acuity were most willing to trade lifetime for perfect vision. They were also most willing to accept death risk in exchange for perfect vision. Finally, the utility, as measured by TTO, correlated with the distance and near visual acuity of the amblyopic eye.

This implies that good vision screening and good occlusion therapy are of major importance for quality of life in amblyopia and/or strabismus patients.

Conclusion

Amblyopia and/or strabismus patients — in an almost non-select sample — had a slightly decreased utility. The decrease is small but still important in cost-effectiveness of treatment and prevention of amblyopia, as amblyopia and strabismus occur very frequently.

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Appendix

TTO bisectional top-down titration search alternatives for trading lifetime were:

No time or 1 day > 1 week > 1 month > 3 months > 6 months
5 years > 2 years > 1 year > 6 months,

SG bisectional top-down titration search alternatives for accepted risk of dying were:

No or one person dying in 20,000 > 10,000 > 1,000
One person dying in 50 > 100 > 200 > 1,000

References

1. Groenewoud JH, Tjiam AM, Lantau VK, Hoogeveen WC, de Faber JTHN, Juttman RE, de Koning HJ, Simonsz HJ (2010) Rotterdam Amblyopia Screening Effectiveness Study: detection and causes of amblyopia in a large birth cohort. *Invest Ophthalmol Vis Sci* Jan 20 (Epub ahead of print)
2. Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen (2008) Früherkennungsuntersuchung von Sehstörungen bei Kindern bis zur Vollendung des 6. Lebensjahres. Abschlussbericht S05-02. Köln: IQWiG:147
3. Carlton J, Karnon J, Czoski-Murray C, Smith KJ, Marr J (2008) The clinical effectiveness and cost-effectiveness of screening programmes for amblyopia and strabismus in children up to age of 4-5 years: a systematic review and economic evaluation. *Health Technol Assess* 12(25):89
4. Nilsson J (2008) The burden of amblyopia and strabismus: justification of treatment and screening revisited. *Arch Ophthalmol* 126:143–144
5. Rahi JS, Cumberland PM, Peckham CS (2006) Does amblyopia affect educational, health, and social outcomes? Findings from 1958 British birth cohort. *BMJ* 332:820–825
6. van de Graaf ES, van der Sterre GW, van Kempen-du Saar SH, Simonsz B, Looman CWN, Simonsz HJ (2007) Amblyopia and Strabismus Questionnaire (A&SQ): clinical validation in a historic cohort. *Graefes Arch Clin Exp Ophthalmol* 245: 1589–1595
7. van de Graaf ES, van der Sterre GW, Polling JR, van Kempen H, Simonsz B, Simonsz HJ (2004) Amblyopia & Strabismus Questionnaire: design and initial validation. *Strabismus* 12:181–193
8. van de Graaf ES, Felius J, van Kempen-du Saar SH, Looman CWN, Passchier J, Kelderman H, Simonsz HJ (2009) Construct validation of the Amblyopia and Strabismus Questionnaire (A&SQ) by factor analysis. *Graefes Arch Clin Exp Ophthalmol* 247:1263–1268
9. Brown MM, Brown GC, Sharma S, Busbee B (2003) Quality of life associated with visual loss. *Ophthalmology* 110:1076–1081
10. Simonsz-Tóth B, Loudon SE, van Kempen-du SH, van de Graaf ES, Groenewoud JH, Simonsz HJ (2007) Visusevaluierung in einer historischen Kohorte van 137 okkludierten Patienten, 30-35 Jahre nach Ende der Okklusionsbehandlung. *Klin Monatsbl Augenheilkd* 224:40–46
11. Krabbe PFM, Essink-Bot M-L, Bonsel GJ (1997) The comparability and reliability of five health-state valuation methods. *Soc Sci Med* 45:1641–1652
12. Stouthard MEA et al. (1997) Disability weights for diseases in the Netherlands. Department of Public Health, Erasmus University Rotterdam. 22 ISBN: 90-72245-84-9
13. Brown MM, Brown GC, Sharma S, Smith AF, Landy J (2002) A utility analysis correlation with visual acuity: methodologies and vision in the better and poorer eyes. *Int Ophthalmol* 24:123–127
14. Beauchamp GR (2007) Chronic amblyopia and strabismus in children. *Arch Ophthalmol* 125:821–822
15. van Leeuwen R, Eijkemans MJC, Vingerling JR, Hofman A, de Jong PTVM, Simonsz HJ (2007) Risk of visual impairment in individuals with amblyopia: the Rotterdam study. *Br J Ophthalmol* 91:1450–1451