A survey on self-assessed well-being in a cohort of chronic locked-in syndrome patients: happy majority, miserable minority

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ABSTRACT

Objectives: Locked-in syndrome (LIS) consists of anarthria and quadriplegia while consciousness is preserved. Classically, vertical eye movements or blinking allow coded communication. Given appropriate medical care, patients can survive for decades. We studied the self-reported quality of life in chronic LIS patients.

Design: 168 LIS members of the French Association for LIS were invited to answer a questionnaire on the Anamnestic Comparative Self-Assessment (ACSA) scale, whose +5 and −5 anchors were their memories of the best period in their life before LIS and their worst period ever, respectively.

Results: 91 patients (54%) responded and 26 were excluded because of missing data on quality of life. 47 patients professed happiness (median ACSA +3) and 18 unhappiness (median ACSA −4). Variables associated with unhappiness included anxiety and dissatisfaction with mobility in the community, recreational activities and recovery of speech production. A longer time in LIS was correlated with happiness. 58% declared they did not wish to be resuscitated in case of cardiac arrest and 7% expressed a wish for euthanasia.

Conclusions: Our data stress the need for extra palliative efforts directed at mobility and recreational activities in LIS and the importance of anxiolytic therapy. Recently affected LIS patients who wish to die should be assured that there is a high chance they will regain a happy meaningful life. End-of-life decisions, including euthanasia, should not be avoided, but a moratorium to allow a steady state to be reached should be proposed.

INTRODUCTION

Locked-in syndrome (LIS) is defined by quadriplegia (or quadriaparesis) and aphasis (or severe hypophonia) with a primary mode of communication by eye movements or blinking. Most often LIS is caused by an acute (vascular) anterior pontine brainstem lesion. The syndrome can be subdivided on the basis of motor disability: ‘classic’ LIS is characterised by quadriplegia and aphasis with coded communication by vertical eye movement or blinking; ‘incomplete’ LIS patients have remnants of voluntary motion other than vertical eye movement; and ‘total’ LIS is defined by complete immobility,
Self-assessed well-being in locked-in syndrome

Article summary

Article focus

Strengths and limitations of this study

- This study is the largest survey of chronic locked-in syndrome patients ever performed and assesses the patients’ own self-assessed quality of life, general well-being and end-of-life wishes. The clinical and ethical implications are evident and important for the medical community at large.
- We also identify variables associated with unhappiness that can be improved and permit evidence-based policy changes in the management of these challenging and vulnerable patients.
- Our study had a low response rate and may be subject to selection bias, and the results might therefore not be representative of chronic LIS patients in general since all participants were members of a patient association (ie, Association of Locked-in Syndrome, ALIS), indicating a stable condition and possibly a degree of social integration. Nonetheless, as discussed in the article, quality of life research has many methodological pitfalls, especially in this low-incidence pathology with limited and difficult communication.

METHODS

Participants and procedures

In collaboration with the French association for LIS (ALIS; http://alis-assoc.fr/), a non-profit association created in 1997 to help LIS patients and their families, 168 patients who were members of LIS were invited (in January 2008) by letter to fill in a structured questionnaire, aided by the patient’s proxy. The questionnaire included items about socio-demographic (age, gender, educational level, place and condition of living, religiosity, net monthly household income), clinical (etiology and duration of LIS, level of speech production and motor recovery) and QoL and SWB variables. We used the French postal version of the Reintegration to Normal Living Index (RNLI),9–12 which evaluates the degree to which a patient has been able to return to a normal life. The RNLI is an 11-item scale that covers areas such as participation in recreational and social activities and movement within the community, and how comfortable the individual is in his or her role in the family and with other relationships. Given the specific constraint of eye-coded communication in the surveyed LIS patients, instead of the visual analogue scale11 a 4-point Likert scale was used as described elsewhere,13 where a value of 1 was assigned to ‘no’, 2 to ‘rather no’, 3 to ‘rather yes’ and 4 to ‘yes’. The scores were normalised to 100, with a score of 100 indicating that the participants were fully satisfied, scores of 60–99 indicating mild to moderate restrictions in self-perceived community reintegration, and scores less than 60 indicating severe restrictions in self-perceived community reintegration, as previously reported.14 Overall SWB was rated by means of the Anamnestic Comparative Self-Assessment (ACSA)15 scale, whose biographical +5 and −5 scale anchors were the patients’ memories of the best period in their life before LIS and their worst period ever (figure 1). Participants were also asked about the presence of depressive symptoms (yes, no), pain and anxiety (none, moderate, extreme) and end-of-life issues: suicidal thoughts (never, occasionally, often), resuscitation in case of cardiac arrest (yes, no) and euthanasia (ensigned, never envisaged). Completion of the anonymous questionnaire was voluntary and taken as consent for participation in the survey. The study was approved by the ethics committee of the Faculty of Medicine of the University of Liège.

Statistical analysis

Data were analysed using Stata 10.0 (Stata, 2007, Stata Statistical Software, TX, USA). The normality distribution of continuous variables was assessed using Shapiro-Wilk tests. For the descriptive analyses, we used subject counts and percentages for categories, calculating mean±SD or median with IQR for continuous variables.

Figure 1 Anamnestic Comparative Self-Assessment scale. LIS, locked-in syndrome.
variables. Only questions with a response rate above 70% were deemed representative of the population and considered for further analyses. ACSA ratings were divided into happy (ratings 0 to 5) and unhappy (ratings –1 to –5). Univariate associations between the dependent variable happy/unhappy and the RNLI and end-of-life questions co-variables were assessed using the Student t test, Wilcoxon or $\chi^2$ tests as appropriate. Multivariable backward stepwise logistic regression was used to assess the associations between happiness status and the significant covariates selected by the univariate analysis. Analyses were performed using casewise deletion. Differences were considered as significant at $p<0.05$.

RESULTS
A total of 168 LIS patients were invited to fill in the structured questionnaire. Seventy-seven patients did not reply (46%). Among the 91 LIS patients who replied, 26 responses (29%) had missing RNLI and/or ACSA data and were excluded: five subjects gave ACSA ratings but failed to answer RNLI questions and 21 failed to report ACSA ratings. The included sample hence consisted of 65 patients (figure 2). LIS patients who failed to report QoL and/or SWB (n=26) were less educated ($p=0.009$) and had more physical pain ($p=0.009$) compared to LIS patients included in the QoL and SWB study sample (n=65). Other socio-demographic, physical and functional variables including age, duration in LIS, living at home or with a partner, income, recovery of speech production or limb mobility were not different between QoL/SWB non-respondents and respondents (table 1).

The socio-demographic characteristics of the 65 LIS patients included in our sample are shown in table 2. All had chronic LIS (>1 year after the insult; median 8 years, range 1–28 years) following a brainstem vascular accident. The majority lived at home (64%), had a spouse or partner (64%) and were religious (70%). About half (55%) had recovered some speech and 70% had recovered some limb mobility.

Overall SWB, as measured by the ACSA scale, permitted the two subpopulations to be disentangled: 72% of LIS patients declared happiness (ACSA rating ≥0, median +3) and 28% unhappiness (ACSA rating <0, median –4) (figure 3). As assessed by the RNLI, 51% of the sampled LIS patients reported severe restrictions and 49% reported mild to moderate restrictions in self-perceived overall community reintegration. Most (82%) were comfortable with personal relationships, but only 21% were engaged most of the day in activities which they considered important. Only a minority were dissatisfied with their participation in recreational (12%) or social (40%) activities.

The happy and unhappy groups did not differ regarding socio-demographic, physical and functional variables including religion, living at home or with a partner, income, education, physical care and feeling comfortable in the company of others (table 2). Depression, suicidal ideas, consideration or wish for euthanasia and the wish not to be resuscitated in case of cardiac arrest were significantly more frequent in the unhappy group. Variables associated with unhappiness were dissatisfaction with mobility in the community, with recreational activities and with the capacity to deal with life events. Shorter time in LIS, anxiety and non-recovery of speech production were also associated with unhappiness. Only half of the respondents stating happiness wished to be resuscitated in case of cardiac arrest and this rate was as low as 14% among the unhappy respondents ($p=0.011$) (table 2). Multivariate logistic regression showed that the variables associated with happiness were time spent in LIS ($p=0.007$), absence of anxiety ($p=0.032$) and recovery of speech production ($p=0.013$) (table 3).

DISCUSSION
It is important to stress that our study may be subject to selection bias given that only 91 of 168 invited patients participated in the study (54%). The patients who did not return the questionnaire may be those with the lowest QoL. Therefore, our results might not be representative of chronic LIS patients in general. All participants were members of a patient association (ie, the French Association of LIS), indicating a stable condition and possibly a degree of social integration.16 Given the dependence of LIS participants on the help of a caregiver for communication of the survey answers, a dependency relationship, social desirability or ‘self-presentation’18 19 may also have biased some responses, despite a written recommendation not to allow helpers influence responses. Patients with a lower educational level and more pain were under-represented among those answering the QoL questions. This might also have resulted in overestimation of QoL rates in our LIS patients as low educational level6 20 and presence of pain are inversely associated with satisfaction with QoL.21–23

In sum, some methodological constraints may have biased the SWB ratings of our patients and most biases were likely to result in overestimations of SWB.

A recurrent problem in QoL research19 is the possible relativity bias or response shift, by which, for example, patients with severe chronic conditions tend to assess their QoL relative to peers or given the circumstances. This problem tends to invalidate comparisons of SWB

Figure 2 Participation. LIS, locked-in syndrome; QoL, quality of life; SWB, subjective well-being.
between groups. Such relativity biases may result in rather similar responses across objectively very dissimilar disease groups, and even between healthy and diseased people, including those with spinal cord injury. We have therefore chosen to employ the ACSA scale, a self-anchored scale whose upper limit here was the memory of the best period in the patient’s life experience before their LIS state. A strength of the ACSA methodology is that by virtue of its biographical references, it affords a practical compromise between the hedonic and the eudaimonic philosophies of QoL, allowing the respondent to choose between the two perspectives, or to take both into account. This internal standard of the ACSA reduces the likelihood of peer relativity or ‘under-the-circumstances’ responses. However, the retrospective anchoring of the ACSA scale also has a drawback. Paraplegic patients may recall their past as happier than do controls, a phenomenon called the ‘nostalgia effect’. If this applies in LIS, it would have tended to depress the ratings of current SWB with the ACSA. This said, some authors have played down relativity biases, arguing that ‘given the circumstances’ responses of disabled people must be taken at face value and that there is no such thing as a disability paradox.

Given these limitations, our results show that most chronic LIS patients self-report severe restrictions in community reintegration, in line with previous studies in paraplegia following spinal cord injury. Nevertheless, the majority of our sample profess ‘good’ SWB. This is in line with the notion that patients with severe disabilities may report a good QoL despite being socially isolated or having major difficulties in activities of daily living. That some LIS patients self-report happiness may suggest that they have succeeded in adapting to their condition of extreme physical disability. According to Cummins’ theory of SWB, their homeostatic resources may have overcome even the formidable challenge of LIS. Our results hence underscore the strength of homeostatic processes of adaptation to chronic (often definitive) extreme disability.

The ‘happy’ subgroup of LIS survivors may indeed be those capable of high flexibility and plasticity who have...
| All patients (N = 65) | Unhappy (ACSA < 0) (N = 18) | Happy (ACSA ≥ 0) (N = 47) | p Value |
|-----------------------|-----------------------------|-----------------------------|---------|
| **Mean age ± SD (years)** | 49 ± 11 | 50 ± 10 | 49 ± 12 | 0.571 |
| **Male gender** | 43/63 (68%) | 12/18 (67%) | 31/45 (69%) | 0.864 |
| **Mean duration in LIS*, median (IQR)** | 8 (5–10) | 7 (3–8) | 9 (5–13) | 0.005 |
| **Educational level: university or college (vs high school or lower)** | 25/56 (45%) | 5/16 (31%) | 20/40 (50%) | 0.197 |
| **Net monthly income: €2500 (vs < €2500)** | 20/53 (38%) | 4/13 (30%) | 16/40 (40%) | 0.547 |
| **Place of living: home (vs institution)** | 38/59 (64%) | 9/17 (53%) | 29/42 (69%) | 0.247 |
| **Living with spouse or partner** | 36/56 (64%) | 9/16 (56%) | 27/40 (67%) | 0.431 |
| **Religious (vs non-religious)** | 40/57 (70%) | 13/16 (81%) | 27/41 (66%) | 0.240 |
| **Recovery of speech production** |  |  |  |  |
| None | 26/58 (45%) | 10/16 (63%) | 16/42 (38%) | 0.049 |
| Words | 11/58 (19%) | 4/16 (25%) | 7/42 (17%) | 0.049 |
| Sentences | 21/58 (36%) | 2/16 (12%) | 19/42 (45%) | 0.049 |
| **Recovery of some limb mobility** | 39/56 (70%) | 10/17 (59%) | 29/39 (74%) | 0.252 |
| **I move around my living quarters as I feel necessary** |  |  |  |  |
| Yes | 23/60 (38%) | 6/17 (35%) | 17/43 (40%) | 0.453 |
| Rather yes | 13/60 (22%) | 2/17 (12%) | 11/43 (26%) | 0.453 |
| Rather no | 10/60 (17%) | 3/17 (18%) | 7/43 (16%) | 0.453 |
| No | 14/60 (23%) | 6/17 (35%) | 8/43 (18%) | 0.453 |
| **I move around my community as I feel necessary** |  |  |  |  |
| Yes | 6/59 (10%) | 0/18 (0%) | 6/41 (15%) | 0.042 |
| Rather yes | 16/59 (27%) | 4/18 (22%) | 12/41 (29%) | 0.042 |
| Rather no | 14/59 (24%) | 3/18 (17%) | 11/41 (27%) | 0.042 |
| No | 23/59 (39%) | 11/18 (61%) | 12/41 (29%) | 0.042 |
| **I am able to take trips out of town as I feel necessary** |  |  |  |  |
| Yes | 17/57 (30%) | 3/17 (18%) | 14/40 (35%) | 0.298 |
| Rather yes | 13/57 (23%) | 3/17 (18%) | 10/40 (25%) | 0.298 |
| Rather no | 7/57 (12%) | 2/17 (11%) | 5/40 (13%) | 0.298 |
| No | 20/57 (35%) | 9/17 (53%) | 11/40 (27%) | 0.298 |
| **I am comfortable with how my self-care needs (dressing, feeding, toileting, bathing) are met** |  |  |  |  |
| Yes | 36/59 (61%) | 10/18 (56%) | 26/41 (64%) | 0.292 |
| Rather yes | 16/59 (27%) | 4/18 (22%) | 12/41 (29%) | 0.292 |
| Rather no | 3/59 (5%) | 1/18 (6%) | 2/41 (5%) | 0.292 |
| No | 4/59 (7%) | 3/18 (16%) | 1/41 (2%) | 0.292 |
| **I spend most of my days occupied in work activity that is necessary or important to me** |  |  |  |  |
| Yes | 8/60 (13%) | 1/18 (5%) | 7/42 (17%) | 0.390 |
| Rather yes | 5/60 (8%) | 2/18 (12%) | 3/42 (7%) | 0.390 |
| Rather no | 7/60 (12%) | 1/18 (5%) | 6/42 (14%) | 0.390 |
| No | 40/60 (67%) | 14/18 (78%) | 26/42 (62%) | 0.390 |
| **I am able to participate in recreational activities (hobbies, crafts, sports, reading, television, games, computers, etc) as I want to** |  |  |  |  |
| Yes | 35/61 (57%) | 8/18 (44%) | 27/43 (63%) | 0.028 |
| Rather yes | 18/61 (31%) | 4/18 (22%) | 14/43 (33%) | 0.028 |
| Rather no | 2/61 (3%) | 1/18 (6%) | 1/43 (2%) | 0.028 |
| No | 6/61 (9%) | 5/18 (28%) | 1/43 (2%) | 0.028 |
| **I participate in social activities with family, friends and/or business acquaintances as is necessary or desirable to me** |  |  |  |  |
| Yes | 22/60 (37%) | 5/18 (28%) | 17/42 (40%) | 0.113 |
| Rather yes | 14/60 (23%) | 4/18 (22%) | 10/42 (24%) | 0.113 |
| Rather no | 9/60 (15%) | 1/18 (6%) | 8/42 (19%) | 0.113 |
| No | 15/60 (25%) | 8/18 (44%) | 7/42 (17%) | 0.113 |
| **I assume a role in my family which meets my needs and those of my family members** |  |  |  |  |
| Yes | 25/59 (42%) | 8/18 (44%) | 17/41 (41%) | 0.396 |
| Rather yes | 21/59 (36%) | 4/18 (22%) | 17/41 (41%) | 0.396 |
| Rather no | 5/59 (8%) | 2/18 (12%) | 3/41 (8%) | 0.396 |
| No | 8/59 (14%) | 4/18 (22%) | 4/41 (10%) | 0.396 |

Continued
fully succeeded in recalibrating, reprioritising and reorienting their needs and values, whereas the low raters cope poorly because they cannot shed the needs and values from their previous life. Because such an adaptation process is lengthy, this hypothesis is consistent with the observed positive association of SWB with duration of time in LIS, corroborating previous studies on QoL in spinal cord injury patients.\textsuperscript{31, 34} However, the direction of causality might be otherwise if unhappiness and its correlates, by whatever mechanisms, reduce survival. Unhappy patients may be more susceptible to complications, these may be treated less vigorously and more end-of-life decisions may be made. The association between a long time in LIS and happiness would then be an effect of selection by attrition.

The second finding is that some LIS patients self-report a state of unhappiness. Depression, suicidal ideas and a wish not to be resuscitated were associated with unhappiness, but are most probably co-variables of unhappiness rather than causal factors. The identified predictors of SWB in LIS differed somewhat from those previously reported in traumatic brain or spinal cord injury.\textsuperscript{35, 36} Living conditions appear less determining for SWB than in spinal cord injury, possibly because in LIS expectations are lower. In our LIS patients, partner relationships were also not correlated with SWB, unlike in traumatic spinal cord or brain injury\textsuperscript{37, 38} or in patients with multiple sclerosis.\textsuperscript{39} Importantly, a shorter time spent in LIS, anxiety and no recovery of speech production were found to be possible predictors of unhappiness. Yet, the studied variables and objective characteristics explained only 38\% of the variance of overall SWB. Maybe this was because some potentially important variables such as

| Table 2 | Continued |
|---------|------------|
| In general I am comfortable with my personal relationships | |
| Yes | 32/61 (52\%) | 9/18 (50\%) | 23/43 (53\%) | 0.884 |
| Rather yes | 18/61 (30\%) | 5/18 (28\%) | 13/43 (30\%) |
| Rather no | 4/61 (7\%) | 1/18 (5\%) | 3/43 (7\%) |
| No | 7/61 (11\%) | 3/18 (17\%) | 4/43 (10\%) |
| In general I am comfortable with myself when I am in the company of others | |
| Yes | 27/60 (45\%) | 7/18 (39\%) | 20/42 (48\%) | 0.293 |
| Rather yes | 19/60 (31\%) | 4/18 (22\%) | 15/42 (36\%) |
| Rather no | 7/60 (12\%) | 3/18 (17\%) | 4/42 (9\%) |
| No | 7/60 (12\%) | 4/18 (22\%) | 3/42 (7\%) |
| I feel that I can deal with life events as they happen* | |
| Yes | 20/60 (33\%) | 6/18 (33\%) | 14/42 (33\%) | 0.022 |
| Rather yes | 18/60 (30\%) | 3/18 (17\%) | 15/42 (36\%) |
| Rather no | 12/60 (20\%) | 2/18 (11\%) | 10/42 (24\%) |
| No | 10/60 (17\%) | 7/18 (39\%) | 3/42 (7\%) |
| Depression, anxiety and pain | |
| Depression* | Yes | 8/60 (13\%) | 5/18 (28\%) | 3/42 (7\%) | 0.040 |
| No | 52/60 (87\%) | 13/18 (72\%) | 39/42 (93\%) |
| Anxiety* | No | 20/61 (33\%) | 5/18 (28\%) | 15/43 (35\%) | 0.015 |
| Moderate | 33/61 (54\%) | 7/18 (39\%) | 26/43 (60\%) |
| Extreme | 8/61 (13\%) | 6/18 (33\%) | 2/43 (5\%) |
| Pain | No | 32/59 (54\%) | 10/18 (56\%) | 22/41 (54\%) | 0.071 |
| Moderate | 25/59 (43\%) | 6/18 (33\%) | 19/41 (46\%) |
| Extreme | 2/59 (3\%) | 2/18 (11\%) | 0/41 (0\%) |
| End-of-life issues | |
| Resuscitation in case of cardiac arrest* | Yes | 23/55 (42\%) | 2/14 (14\%) | 21/41 (51\%) | 0.011 |
| No | 32/55 (58\%) | 12/14 (86\%) | 20/41 (49\%) |
| Euthanasia* | Envisaged | 31/59 (53\%) | 12/16 (75\%) | 19/43 (44\%) | 0.032 |
| Never envisaged | 28/59 (47\%) | 4/16 (25\%) | 24/43 (56\%) |
| Suicidal thoughts* | Never | 40/59 (68\%) | 9/17 (54\%) | 31/42 (74\%) | 0.040 |
| Occasionally | 14/59 (24\%) | 4/17 (23\%) | 10/42 (24\%) |
| Often | 5/59 (8\%) | 4/17 (23\%) | 1/42 (2\%) |

*Significant variables identified by the univariate analyses comparing unhappy versus happy with related p values.

ACSA, Anamnestic Comparative Self-Assessment Scale; LIS, locked-in syndrome.
personality traits could not be explored in our study. Other variables associated with unhappiness that can potentially be remediated, included dissatisfaction with mobility in the community and with recreational activities, in line with previous studies on QoL in spinal cord injury, multiple sclerosis, cerebral palsy and stroke.40 41

For clinical practice, our data show that, whatever the physical devastation and mental distress of LIS patients during the acute stage of the condition, optimal life-sustaining care and revalidation can have major long-term benefit. Maybe, since low satisfaction with mobility and recreational activities were here associated with poor SWB, extra palliative efforts directed at these problems could be helpful. Also more vigorous treatment of anxiety may be valuable. Finally, our results also bear on existential and ethical issues.42 Because they are cognitively intact, LIS patients are competent to make decisions on whether to continue life in LIS or to ask for withholding or withdrawal of treatment or for physician-assisted death.44 That half of the respondents professing happiness do not wish to be resuscitated in case of cardiac arrest complicates the interpretation of their statement of happiness. As for current wish for euthanasia, expressed by only four of the 59 subjects (7%) responding to this question, it must be taken into account that, unlike in Belgium, the Netherlands, Luxemburg, Oregon, Washington and Montana, euthanasia and physician-assisted suicide are not legally permitted in France, where the study was carried out.

What do our data suggest regarding the practice of euthanasia or physician-assisted suicide? The principal clinical conditions for requests for physician-assisted death to be legally valid are ‘unbearable’ suffering and irreversibility of the situation. Whereas the first condition may apply in some LIS patients, irreversibility cannot be ascertained until, after rehabilitation, their SWB has reached a steady state, which may take as long as a year.3 This is particularly true in view of expected medical progress such as by, for example, brain—computer interfaces (ie, modes of communication in which commands or messages are emitted directly by the brain without needing motor or verbal mediation).45 46 We suggest that patients recently struck by LIS should be informed that, given proper care, they have a considerable chance of regaining a happy life. In our view, shortening-of-life requests by LIS patients are valid only when the patients have been given a chance to attain a steady state of SWB. Anderson et al reported suicidal thoughts in four out of seven LIS patients with long-term survival, but all patients nevertheless wanted life-sustaining treatment.47 Acute or subacute LIS patients’ requests for early death should be received with sympathy, but our data suggest that a moratorium should be proposed.48 49

Taking into account the possible methodological challenges and limitations of QoL research, especially when dealing with LIS patients, our data show that a non-negligible group of chronic LIS survivors self-report a meaningful life and their demands for euthanasia are surprisingly infrequent. It is important to stress the discussed possible biases in our study. The observed results may hence not be representative of chronic LIS patients in general. It should also be noted that given the dependence of LIS participants on the help of a caregiver for communication of their answers, social desirability might have confounded patients’ responses. Nevertheless, in our view, these results are important as healthy individuals and medical professionals might assume that the comfort of a LIS patient is so limited that it is not worth living.8 Such discrepancies in valuation of disability states between the healthy and those affected raise questions about the validity of utility measures based on valuation of disease states by panels of healthy people using, for example, standard gamble or time trade-off.50 Underestimation of patients’ self-reported QoL by caregivers and family has previously

| Table 3 | Significant associations between happiness status and variables identified by the univariate analyses (marked by an asterisk in table 2) |
|----------|---------------------------------------------------------------|
| Odds ratio | SE | Z score | p>|z| | 95% CI |
| Duration in LIS* | 1.5 | 0.2 | 2.71 | 0.007 | 1.1 to 2.0 |
| Speech production | 20.47 | 24.87 | 2.48 | 0.013 | 1.89 to 221.45 |
| Anxiety | 0.19 | 0.15 | -2.14 | 0.032 | 0.04 to 0.87 |

*Odds ratio per year in LIS. LIS, locked-in syndrome.
also been reported for amyotrophic lateral sclerosis patients. More research is needed to investigate the factors influencing the success or failure of adaptation to LIS. Also, longitudinal studies of LIS patients should throw light on the reversibility of high or low SWB and on when happiness is a consequence or a causal factor of long survival in LIS.

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**STROBE Statement—Checklist of items that should be included in reports of cohort studies**

| Item No | Title and abstract | Recommendation |
|---------|-------------------|----------------|
| 1       | (a) Indicate the study’s design with a commonly used term in the title or the abstract -ok |
|         | (b) Provide in the abstract an informative and balanced summary of what was done and what was found -ok |

| Introduction |
|--------------|
| 2            | Explain the scientific background and rationale for the investigation being reported -ok |

| Objectives |
|------------|
| 3          | State specific objectives, including any prespecified hypotheses -ok |

| Methods |
|---------|
| 4        | Present key elements of study design early in the paper -ok |
| 5        | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection -ok |

| Participants |
|--------------|
| 6           | (a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up -ok |
|             | (b) For matched studies, give matching criteria and number of exposed and unexposed -ok |

| Variables |
|-----------|
| 7         | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable -ok |

| Data sources/ measurement |
|---------------------------|
| 8*           | For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group -ok |

| Bias | Study size | Quantitative variables |
|------|------------|------------------------|
| 9    | 10         | 11                     |
|      |            | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why -ok |

| Statistical methods |
|---------------------|
| 12                  | (a) Describe all statistical methods, including those used to control for confounding -ok |
|                     | (b) Describe any methods used to examine subgroups and interactions -ok |
|                     | (c) Explain how missing data were addressed -ok |
|                     | (d) If applicable, explain how loss to follow-up was addressed -ok |
|                     | (e) Describe any sensitivity analyses -ok |

| Results |
|---------|
| 13*     | (a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed -ok |
|         | (b) Give reasons for non-participation at each stage -ok |
|         | (c) Consider use of a flow diagram -ok |

| Descriptive data |
|------------------|
| 14*              | (a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders -ok |
|                  | (b) Indicate number of participants with missing data for each variable of interest -ok |
|                  | (c) Summarise follow-up time (eg, average and total amount) -ok |

| Outcome data |
|--------------|
| 15*          | Report numbers of outcome events or summary measures over time -ok |

| Main results |
|--------------|
| 16           | (a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included -ok |
(b) Report category boundaries when continuous variables were categorized-**ok**

(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period

| Other analyses | 17 | Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses-**ok** |

**Discussion**

| Key results | 18 | Summarise key results with reference to study objectives-**ok** |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias-**ok** |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence-**ok** |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results-**ok** |

**Other information**

| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based-**ok** |

*Give information separately for exposed and unexposed groups.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.