Is Health-Related Quality of Life Improving After Stroke?
A Comparison of Health Utilities Indices Among Canadians With Stroke Between 1996 and 2005

Jodi D. Edwards, MA; Mieke Koehoorn, PhD; Lara A. Boyd, PT, PhD; Adrian R. Levy, PhD

Background and Purpose—Recent innovations in diagnosis, management, and rehabilitation have resulted in measurable improvements in clinical and functional outcomes after acute stroke. However, whether gains in health-related quality of life after stroke have also occurred is not well characterized. Using 2 Canadian population surveys, the purpose of this study was to identify changes in health-related quality of life in individuals with stroke from 1996 to 2005.

Methods—Data from the public use files of the National Population Health Survey, Cycle 2 (1996), and the Canadian Community Health Survey, Cycle 3.1. (2005), were used. A total of 847 individuals with stroke were included. Self-reported information on health status based on the Health Utilities Index Mark 3 was used to generate single-attribute and overall health-related quality of life scores. Analysis of covariance and multiple logistic regression were used to determine the relationship between survey year and poststroke impairment adjusting for demographic variables and clinical comorbidities.

Results—A statistically significant and clinically important reduction in mean overall Health Utilities Index Mark 3 scores was observed for respondents with stroke from 1996 to 2005. In addition, 2 of the 8 single-attribute Health Utilities Index Mark 3 domains showed a significant change between survey years. Significantly more individuals with stroke reported dexterity and cognitive impairment in 2005 compared with respondents in 1996, indicating reduced health-related quality of life for these domains.

Conclusion—Despite improvements in medical management, quality of life is not improving after stroke in the Canadian population. These findings are useful to generate hypotheses about the impact of advances in management on quality of life after stroke and identify specific domains that may benefit from future study in stroke populations. (Stroke. 2010; 41:996-1000.)

Key Words: Canadian population surveys ▪ cognition ▪ dexterity ▪ health-related quality of life ▪ HUI3 ▪ stroke

Stroke remains the leading cause of adult disability in the United States1 and Canada.2 Although stroke mortality rates in North America have shown substantial declines,3,4 approximately 4 million Americans1 and 300 000 Canadians2 currently live with the effects of stroke. Health-related quality of life (HRQOL) refers to an individual’s perspective regarding the effect of disease-specific impairment on quality of life.5 Stroke significantly reduces HRQOL6 and the domains most consistently attributed to lower HRQOL after stroke include physical7,8 and cognitive impairments,4 disability,9 and depression.10,11

Recent advances in diagnosis, management, and rehabilitation have had a significant impact on clinical and functional outcomes after stroke. Diffusion-weighted diagnostic imaging can detect ischemic changes within hours of symptom onset,12 and diffusion-weighted imaging lesion volume has also been shown to independently predict clinical outcome.13 Medical interventions, including the increased use of tissue plasminogen activator within 3 hours of stroke onset, have resulted in significant improvements in clinical outcome at 90 days14 and 1 year15 poststroke. Progress in stroke rehabilitation, including early intervention,16 increasing doses of physical practice,17 and intensive training protocols,18,19 has significantly improved functional outcomes. Although these advances have had clear clinical and functional benefits for individuals poststroke, whether HRQOL has also improved has not been well characterized.

The purpose of this study was to identify changes in HRQOL from 1996 to 2005 in individuals with stroke in the Canadian population. Specifically, we examined differences in overall and single-attribute scores of the Health Utilities Index Mark 3 (HUI3)20 between 2 Canadian population surveys. We hypothesized that respondents would show improvements in HRQOL concordant to advances in stroke.
diagnosis and management, based on self-reported health status for the 8 domains included in HUI3 as well as for overall HUI3 utility scores in 2005 compared with data from the 1996 survey. Based on previous studies,6–10 we anticipated this improvement would be specific to the domains of physical, cognitive, and emotional impairment.

Methods

Survey Data
This study used data from the public use files of the National Population Health Survey (NPHS) Cycle 221 and the Canadian Community Health Survey (CCHS) Cycle 3.1.22 These cross-sectional surveys are conducted by Statistics Canada and contain information on self-reported health status and determinants of health in samples of community-dwelling respondents. Importantly, both surveys used the HUI3 to measure self-reported HRQOL. To obtain a representative sample of Canadian households, these surveys incorporated a multistage stratified cluster sampling design.23 Each respondent was assigned a weight to represent his or her contribution to the total population and weights were used to derive estimates for all characteristics surveyed.24 Previous reports provide detailed descriptions of these surveys.25

Analytic Samples
Analyses were restricted to respondents aged ≥25 years from each survey who responded “yes” to the question “Do you suffer from the effects of a stroke?”21,22 The CCHS sample was further restricted to the subset of respondents with stroke that provided answers to questions from the HUI3. A total of 847 respondents were identified: 674 individuals from the NPHS and 173 individuals from the CCHS.

Study Variables
The outcome was HRQOL, as measured by the HUI3, a standardized health status classification system for the measurement of HRQOL in individuals, general populations, and clinical cohorts.20,26 A previous population-based study has demonstrated the validity and reliability of the HUI3 in Canadian stroke populations.27 HUI3 scores are derived from self-reported information on health status and consist of an overall score, in which 0.0 = dead and 1.0 = perfect health, and scores on 8 single-attribute domains: vision, hearing, speech, mobility, dexterity, cognition, emotion, and pain20 (see Supplemental Table I; available at http://stroke.ahajournals.org). Differences of ≥0.03 in the overall score are considered clinically meaningful.26,27 In these surveys, scores for HUI3 domains were categorized to represent individuals ranging from “no impairment” to “severe impairment.”21,22 However, for these analyses, HUI3 domains were dichotomized: a score of 1 represented “no impairment” and a score of 2 represented “some degree of impairment.” The predictor was survey year, 1996 (NPHS) versus 2005 (CCHS), used to determine if the time period between these surveys was associated with changes in overall or domain-specific HUI3 score after stroke.

Categorical covariates were age, sex, marital status, socioeconomic status (SES), and clinical comorbidities, including arthritis, diabetes, heart disease, and depression.26 Age was classified into 3 groups (25 to 49 years, 50 to 79 years, and ≥80 years). Due to the proportion of missing respondents for household income (20.3% in the NPHS and 16.5% in the CCHS), level of education was used as a proxy for SES. Dichotomous clinical covariates indicated the presence or absence of comorbid diseases. Depression status, based on the Short Form score of the survey depression scale,28 was included as a continuous covariate, with scores ranging from 0 to 8, with 8 representing the most severe depression.

Statistical Analyses
Statistical analyses compared respondents with stroke sampled from the 2 surveys to determine whether overall HUI3 and the proportion of respondents with domain-specific impairment changed over time after adjusting for variables likely to explain change over time.

Descriptive statistics were generated to characterize the survey samples; χ² tests or t tests were used depending on if the variable was counted or measured. For HUI3 variables, descriptive statistics for the general population (survey respondents without stroke) were also generated; however, all comparisons were restricted to respondents with stroke.

Analysis of covariance (ANCOVA) was used to determine the change in mean overall HUI3 score from 1996 to 2005 adjusting for all demographic and clinical variables. To identify if the proportion of respondents reporting impairment in single-attribute HUI3 domains changed with time, separate multiple logistic regression models were generated for each domain. In all final adjusted models, the outcome was probability of reporting “some degree of impairment”; the main variable was time (survey year); and relevant potential confounding variables, including age, sex, marital status, SES, and comorbidity, were included as covariates. Odds ratios (ORs) greater than 1.00 (95% CIs that do not span 1.00) indicated a significant increase in the proportion of respondents with impairment in 2005 compared with 1996, whereas those <1.00 indicated a significant decline. Reported ORs do not denote the risk of impairment, in particular for domains in which impairment was more prevalent (eg, vision).

Frequency weights, provided by Statistics Canada, were used to adjust for differences in probabilities during sampling selection for both the NPHS and the CCHS.24 In all regression analyses, standardized probability weights were used to estimate standard errors (SEs) and coefficients of variation to account for unequal sample variances.24 To assess the potential for overlap in sampling populations between surveys, we conducted sensitivity analyses, excluding respondents from the highest age category, for each final adjusted model. All analyses were completed using SAS (Version 9.1; SAS Institute, Inc, Cary, NC).

Results
Descriptive data for χ² analyses revealed that there were similar proportions of men and women with stroke in both surveys; however, significant sex differences in HUI3 scores were apparent in this data (see Supplemental Figure I for further gender analyses, available at http://stroke.ahajournals.org). The proportion of respondents with clinical comorbidities did not differ between surveys (P >0.05). However, there were significant differences between surveys for several characteristics; respondents in the 2005 survey (CCHS) were significantly older, more were married/living common-law or single, and more had completed postsecondary education (Table 1).

ANOVA results demonstrated that there was a significant reduction in mean overall HUI3 score from 1996 to 2005 after adjusting for covariates (Table 2). The magnitude of this difference (0.14) was substantial and indicates that a clinically important26,27 decline in overall HRQOL has occurred over time in Canadians with stroke. Results of the adjusted multiple logistic regression analyses showed significant ORs for 3 of the 8 HUI3 domains in 2005 compared with 1996 (Table 2). Specifically, a smaller proportion of respondents with stroke reported visual impairment in 2005 compared with 1996, suggesting that HRQOL after stroke has improved over time for this domain. However, results also indicated that survey year was predictive of impairment in other domains; a higher proportion of respondents reported dexterity and cognitive impairment in 2005 compared with 1996. These results suggest that HRQOL related to dexterity and cognitive burden poststroke also declined during this time period. No significant differences were observed for the domains of speech, hearing, mobility, emotion, or pain.
Sensitivity analyses revealed that results for all models, with the exception of vision, remained unchanged when respondents from the highest age category were excluded. After excluding this category, no significant differences between survey years for vision were observed (Table 2).

Discussion

Results from a comparison of 2 cross-sectional Canadian population surveys revealed significant differences in HRQOL in individuals with stroke from 1996 to 2005 as measured by overall and single-attribute scores on the HUI3. A statistically and clinically important reduction in overall HUI3 scores and statistically increased burden in dexterity and cognition were observed over this time period. These findings suggest that, despite advances in the medical management of stroke, overall HRQOL and HRQOL specific to impairment in dexterity and cognition have worsened over time in Canadians experiencing the effects of stroke.

The results of this study are consistent with longitudinal data demonstrating that stroke has a lasting impact on HRQOL. In a prospective study, Jonkman et al reported that reduced quality-of-life scores after stroke at 3 months remained highly abnormal at 1 year. Hopman et al showed that, although gains in HRQOL occurred for their study sample during inpatient rehabilitation, significant declines in several domains of quality of life followed postdischarge, suggesting that short-term improvements in quality of life poststroke may not be sustained. The significant decline in mean overall HUI3 for stroke respondents observed between surveys in this study indicates that stroke has a long-term effect on HRQOL in the Canadian population and the magnitude of this effect represents a clinically important reduction in overall HRQOL. Thus, despite improved clinical and functional outcomes in the initial phases of stroke recovery, overall HRQOL is not improving after stroke.

It is perhaps not entirely surprising that reduced HRQOL in this study was specific to the domains of dexterity and cognition. Several previous studies have shown that stroke significantly reduces HRQOL, particularly for physical and cognitive function. Hackett et al reported significantly lower physical functioning scores in stroke survivors compared with the general population and Clarke et al showed that Canadian community-dwelling stroke survivors were more likely to have impaired physical and cognitive function than other community-dwelling seniors. Other work has also shown that individuals with stroke perceive impairments in both physical function and cognition well beyond the initial stage of acute stroke. Deficits in arm dexterity persist long after the initial event; 5 years poststroke, 37% of individuals have mild motor disability and 29% have moderate losses of arm and hand function. In a clinical study of patients with severe stroke, mean self-reported HUI3 scores were lowest for the domains of ambulation and dexterity at both baseline and 6-month follow-up. Further, ample data show the importance of cognition for recovery of function after stroke. Losses in cognitive function relate to falls incidence, the ability to learn new motor skills, and recovery of language skills in people with aphasia.

One possible explanation for these findings is confounding by disease severity. Reduced stroke mortality rates increase the likelihood that individuals are living with residual stroke morbidity. Robust evidence indicates that increased stroke severity is associated with major motor symptoms, and our finding of increased impairment in dexterity from 1996 to 2005 is consistent with the notion that Canadians with stroke may be living with more severe motor deficits. Thus, it is possible that improvements in acute management may result in greater poststroke morbidity and lead to decreases in overall HRQOL for dexterity and cognitive function. The dichotomization of single-attribute HUI3 variables in the present study limited our ability to detect differences in the severity of impairment in each domain. Future investigations are necessary to investigate changes in the severity of domain-specific

### Table 1. Weighted Frequencies and Proportions (%) of Demographic Characteristics and Clinical Comorbidities for Respondents With Stroke From the NPHS and CCHS Stratified by Survey Year

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Categorical variables, frequency (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>363 (53.8)</td>
<td>88 (51.0)</td>
</tr>
<tr>
<td>Female</td>
<td>311 (46.2)</td>
<td>85 (49.0)</td>
</tr>
<tr>
<td>Age, years*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–49</td>
<td>103 (15.3)</td>
<td>18 (10.7)</td>
</tr>
<tr>
<td>50–79</td>
<td>461 (68.4)</td>
<td>108 (62.3)</td>
</tr>
<tr>
<td>80+</td>
<td>110 (16.3)</td>
<td>47 (27.0)</td>
</tr>
<tr>
<td>Marital status*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/common law</td>
<td>387 (57.4)</td>
<td>107 (62.0)</td>
</tr>
<tr>
<td>Single</td>
<td>61 (9.1)</td>
<td>52 (29.9)</td>
</tr>
<tr>
<td>Widowed/separated/divorced</td>
<td>226 (33.5)</td>
<td>14 (8.1)</td>
</tr>
<tr>
<td>SES (level of education)*</td>
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<td></td>
</tr>
<tr>
<td>Less than secondary</td>
<td>296 (44.3)</td>
<td>52 (30.0)</td>
</tr>
<tr>
<td>Secondary graduation</td>
<td>117 (17.6)</td>
<td>24 (14.1)</td>
</tr>
<tr>
<td>Some postsecondary</td>
<td>79 (22.8)</td>
<td>13 (7.4)</td>
</tr>
<tr>
<td>Postsecondary graduation</td>
<td>176 (26.3)</td>
<td>84 (48.5)</td>
</tr>
<tr>
<td>Arthritis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>296 (43.9)</td>
<td>74 (42.7)</td>
</tr>
<tr>
<td>No</td>
<td>378 (56.1)</td>
<td>99 (57.3)</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>124 (18.4)</td>
<td>31 (18.1)</td>
</tr>
<tr>
<td>No</td>
<td>550 (81.6)</td>
<td>142 (81.9)</td>
</tr>
<tr>
<td>Heart disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>226 (33.5)</td>
<td>57 (33.1)</td>
</tr>
<tr>
<td>No</td>
<td>448 (66.5)</td>
<td>115 (66.9)</td>
</tr>
<tr>
<td>Cataracts</td>
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<td></td>
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<tr>
<td>Yes</td>
<td>80 (11.9)</td>
<td>25 (14.5)</td>
</tr>
<tr>
<td>No</td>
<td>594 (88.1)</td>
<td>148 (85.5)</td>
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<tr>
<td>Continuous variables, mean (SD)</td>
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<td></td>
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<tr>
<td>Depression scale</td>
<td>0.26 (1.26)</td>
<td>0.39 (1.47)</td>
</tr>
</tbody>
</table>

*P<0.05 for weighted chi-square test.
impairment and would benefit from the inclusion of the full HUI3 vectors not available in public use data files.

In interpreting these results, it is important to consider if these effects are due to artifact or represent actual differences in HRQOL during the time period between these surveys. A number of strong features of the present study support our results. The HUI3 is a valid and reliable measurement of HRQOL and has also been specifically validated as a measure of HRQOL in Canadian stroke populations. The use of the same HUI3 measurement tool in all surveys enabled the investigation of changes in HRQOL between the categories of survey year. In addition, although these analyses were restricted to a subset of the overall surveys, the data are representative of a large population-based sample.

Despite these strengths, this study has a number of inherent limitations. The limitations of self-reported data are well-described and information biases may have had a particular impact on certain variables such as the proxy for SES and depression. These analyses may also have been subject to confounding due to differences or overlap between the sampling populations. However, as described, the results of sensitivity analyses accounting for potential overlap had no impact on the results for the majority of domains. In addition, survey data in this study were from community-dwelling samples of stroke respondents and, as a result, the burden of stroke in these samples is likely underestimated. Future investigations may benefit from the inclusion of data from institutional samples.

Results of this study demonstrate that, although advances in stroke diagnosis, management, and rehabilitation have led to improved clinical and functional outcomes, HRQOL after stroke is not improving, particularly for the domains of dexterity and cognition. Evidence for decreased overall and domain-specific HRQOL suggests that increased stroke burden, potentially due to decreased mortality rates and advances in acute intervention, has resulted in reduced HRQOL over time in Canadians with stroke. Findings from this study serve to generate hypotheses regarding the potential impact of new management on quality of life after stroke and identify domains of quality of life that may benefit from future study in stroke populations.

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### Disclosures

None.

### References


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