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Trends in survival and recovery from stroke: Evidence from the NLTCS/Medicare data

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Abstract

BACKGROUND AND PURPOSE—Improvement in recovery rates may contribute to increase in healthy life expectancy. It is unclear, however, whether such changes take place because health researchers traditionally deal with changes in incidence and survival from diseases. The purpose of this paper is to test the presence of time trends in the recovery rate from stroke.

METHOD AND DATA—We compared age patterns of recovery rates from stroke evaluated in two subsequent sub-cohorts represented in the NLTCS data linked with the Medicare service use files.

RESULTS—We found statistically significant increase in recovery rate between 1994 and 1999 for females, but not for males.

CONCLUSION—Time trends in recovery rate from stroke exist and can be detected from available data. The roles of influential factors and causes of gender difference in recovery improvement deserve further studies.

Keywords

recovery trends; sensitivity analyses; healthy life span; compression of morbidity; survival after stroke

Despite the noticeable decline in mortality from stroke between 1981 and 2004 the causes of this decline remain controversial[1–5]. Earlier we found that survival from stroke significantly improved, while incidence rate almost did not change between 1984 and 2001 among the U.S. elderly[4, 5]. Recent study[6] provided evidence that long-term outcome after first ischemic stroke depends on the quality of treatment and subsequent rehabilitation, indicating that under appropriate conditions functional recovery from stroke is possible. Improvement in recovery from disease would contribute to increasing the quality of life for stroke victims, by increasing their healthy life span. At the population level, the progress in recovery would reduce disease burden and contribute to public health improvement. To our knowledge, no studies of temporal changes in the recovery rate from stroke have been performed so far. In this paper we introduce working definition of the recovery from stroke, evaluate time trends in recovery rates, and investigate sensitivity of findings to different factors, including variable definitions of recovery and incidence rates, age- and co-morbidity structures in

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Conflicts of Interest/Disclosures
None

compared cohorts using the Medicare files linked with the National Long Term Care Survey (NLTCS) data.

Data and Methods

The NLTCS file contains longitudinal and cross-sectional data on a nationally-representative sample of about 49,000 U.S. elderly persons aged 65+ years. All NLTCS records are linked to Medicare data for 1982–2005 to allow for tracking mortality, morbidity, and HMO/MCO enrollment/disenrollment. Individual medical histories of stroke including information on life span were reconstructed from Medicare files linked with the NLTCS data, using records containing respective ICD-9 codes: 431.xx, 433.x1, 434.x1, and 436.xx and ages at onset of stroke and subsequent recovery were identified. Then, two cohorts of patients having the disease onset between 1994–1996 and 1999–2001 have been formed to investigate time trends in the recovery rates. Patients in these two cohorts were followed-up until death or the recovery event. An individual was considered to be in recovery (or sustained remission) if he/she did not have a Medicare record containing the respective ICD code(s) during one year after the last inpatient or outpatient visit related to this disease. Age at death that happened before recovery and ages of the last available data (at the end of 2005) were treated as censoring variables for the recovery time.

Survival and not-yet-recovery (i.e., the analogue of survival function constructed for recovery events) functions were calculated using the Kaplan-Meier approach. The difference between survival functions in the two sub-cohorts was tested using the log-rank test.

Results

The analyses revealed statistically significant improvement in the recovery rate between 1994 and 1999 for females, but not for males. Fig. 1 (left panel) shows the graphs of the two not-yet-recovery functions constructed using two recovery rates evaluated for patients with stroke in the two (1994–1996 and 1999–2001) sub-cohorts for males and females, respectively. This figure shows that respective recovery rate is higher for the 1999–2001 sub-cohort than that for the 1994–1996 sub-cohort. The total numbers of subjects in each sub-cohort, the percents of recovery and censored events, as well as the median values with respective 95% confidence intervals, are shown in the tables below the graphs.

The survival functions after stroke (where the occurrences of recovery were treated as censoring times) for the same sub-cohorts did not reveal substantial changes during the five year period for each gender (right panel of Fig. 1). Together with the results shown in Fig. 1, left panel, these indicate that the progress in coping with the disease was mainly due to changes in recovery from this disease in females.

Sensitivity analyses

To test sensitivity of our findings to different factors capable of affecting trends in recovery rate, we repeated our calculations using i) several different operational definitions of recovery and incidence rates, ii) explicit representation of observed heterogeneity effects stratifying individuals on age, comorbidity (Charlson index[7]), or disability (the numbers of self-reported ADL/IADLs), and iii) other approaches to censoring strategies, selection of individuals, and study design effects. The results of the analyses, presented in Table 1 for both genders, indicate that positive trends in the recovery rate from stroke take place in all cases independently from the definition of such rates. One source of bias in findings could be partial coverage by HMO which may reduce the number of stroke diagnoses in Medicare records. In our calculations this source of uncertainty could be important because the fraction of coverage by HMO is different for two considered time periods. So, in 1994 the

fraction of person-months additionally covered by HMO was at the level of 3–5% while in 1999 the fraction exceeds 15%.

Note that the definition of recovery index used in this paper does not take into account some important factors affecting the recovery rate, such as rehabilitation therapy. These details, however, were not among the goals of this study focused on detecting the presence of positive *trends* in the recovery from stroke. An important property of our results is that they are robust to changes in definitions of recovery or incidence events, as well as to many other potential confounders. Note that the estimate of an increase in healthy life span would be more sensitive to the definitions of incidence and recovery events.

Conclusion

Time trends in the recovery rate from stroke exist and can be detected from available data. The detected gender difference in such trends may partly be caused by different attitude towards the use of health care services in males and females[6], as well as a small time difference between compared sub-cohorts. Note that gender differences are also documented in stroke incidence and case-fatality[8]. More studies are needed to evaluate the changes in the quality of life in post-stroke individuals.

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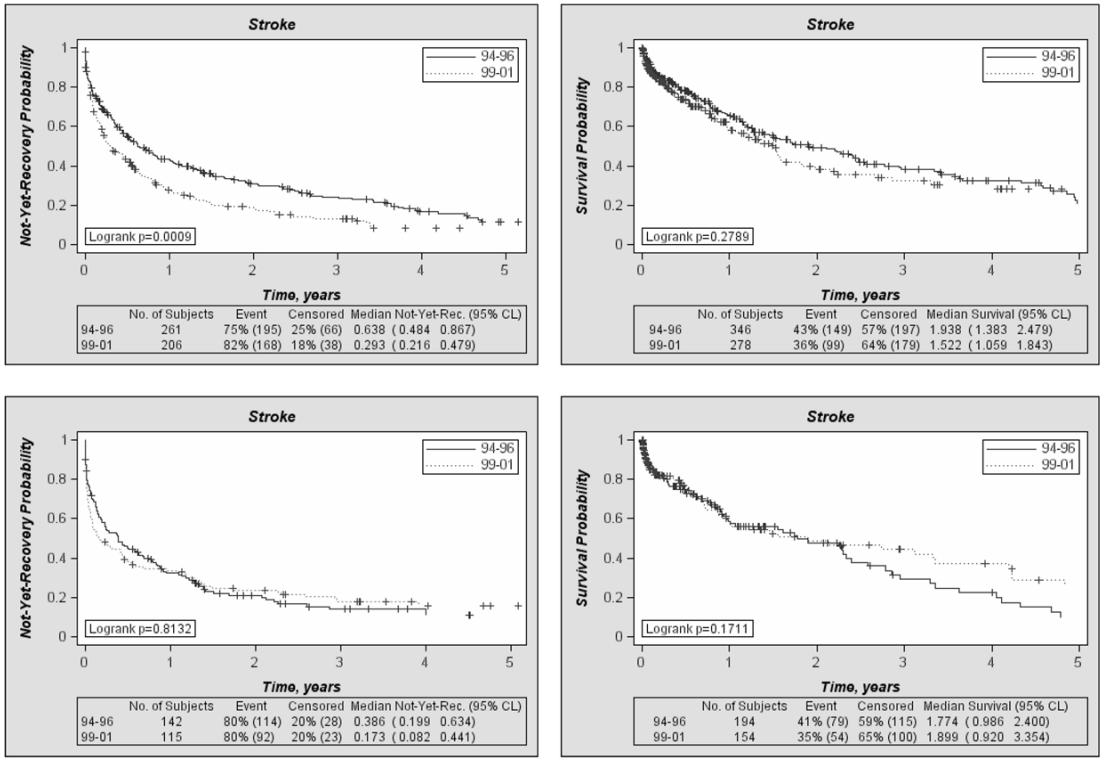

Figure 1.

Not-yet-recovery probability functions (left panels) and survival probabilities (right panels) for females (top panels) and males (bottom panels) in the two sub-cohorts of the NLTCS participants having age at onset of stroke in 1994–1996 and in 1999–2001.

Table 1

Results of sensitivity analysis (N_{94} and N_{99} shows the size of the cohorts of respective years)

	Females				Males			
	N_{94},N_{99}	log-rank	Median (years)		N_{94},N_{99}	log-rank	Median (years)	
			94–96	99–01			94–96	99–01
Base calculation	**261,206**	**0.0009**	**0.64**	**0.29**	**142,115**	**0.8132**	**0.39**	**0.17**
1. Approaches to identification of recovery events								
Time to recovery (1.5 years)	237,192	0.0049	1.05	0.36	135,109	0.9988	0.69	0.41
Time to recovery (0.5 years)	286,223	0.0043	0.34	0.21	155,129	0.9686	0.24	0.17
Alzheimer's disease and dementia	261,206	0.0178	0.61	0.41	142,115	0.4345	0.42	0.17
2. Approaches to identification of incident cases								
All Medicare sources used	286,221	0.0013	0.64	0.31	159,125	0.6977	0.39	0.24
Keeping not only primary diagnoses	323,269	0.0009	0.49	0.24	182,145	0.4876	0.36	0.09
No requirement of second visit	523,416	0.0111	0.09	0.05	276,242	0.4220	0.05	0.01
Acceptable lag of pre-diagn.=0.5year	261,206	0.0009	0.64	0.29	146,117	0.8363	0.39	0.20
Only 436 ICD-9 code included	228,182	0.0017	0.61	0.25	123,90	0.8276	0.39	0.24
Exclude hemorrhagic (ie, 431) stroke	258,202	0.0016	0.62	0.29	141,109	0.7406	0.39	0.25
Only hemorrhagic (i.e., 431) stroke	13,14	0.5680	0.016	0.063	10,12	0.1711	0.227	0.027
Include ICDs: 430–432	23,28	0.0871	0.112	0.067	20,20	0.6478	0.153	0.114
Exclude not completely covered	229,188	0.0041	0.61	0.27	136,108	0.5108	0.39	0.14
3. Factors of observed heterogeneity								
65≤Age≤72	56,43	0.0140	0.61	0.21	31,31	0.4543	0.25	0.32
73≤Age≤84	139,110	0.0096	0.72	0.30	95,66	0.8493	0.39	0.20
85≤Age	66,53	0.4828	0.61	0.46	16,18	0.3374	0.15	0.09
Charlson Index=0	107,77	0.0522	0.61	0.24	55,36	0.9565	0.18	0.23
1≤Charlson Index≤3	120,95	0.0232	0.76	0.36	66,56	0.7897	0.46	0.14
Charlson Index≥4	34,34	0.1317	0.61	0.25	21,23	0.8836	0.79	0.25
Disability group=1	143,128	0.0007	0.60	0.24	97,87	0.4733	0.39	0.13
Disability group=2	47,27	0.0504	1.01	0.21	22,13	0.4767	0.13	0.28
Disability group=3	71,51	0.9775	0.80	0.90	23,15	0.5246	1.32	1.49
4. Censoring strategies								

	Females				Males			
	N_{94},N_{99}	log-rank	Median (years)		N_{94},N_{99}	log-rank	Median (years)	
			94–96	99–01			94–96	99–01
Cases of death are recovery cases	261,206	0.0059	0.50	0.25	142,115	0.4704	0.39	0.16
Cases of death are never recovered	346,278	0.0478	2.61	0.93	194,154	0.5400	1.20	1.17
5. Disenrollment from Medicare and coverage by HMO								
All covered by HMO are included	284,215	0.0125	0.61	0.33	149,124	0.8593	0.37	0.17
Fraction of HMO enrollment≤0.3	264,209	0.0015	0.62	0.31	145,118	0.9811	0.39	0.17
6. Study Design effect								
Using NLTCS weights	472524, 427500		0.62	0.31	270628, 255493		0.39	0.13