Research Paper ■

Rehabilitation Outcome and Socioeconomic Inequality – a Preliminary Study in Slovenia

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Abstract. Though inequality in health has lately been extensively studied in Slovenia, the possible association of rehabilitation outcome with socioeconomic inequality has not been previously explored. The data on all adult inpatients discharged from the University Rehabilitation Institute in Ljubljana in a year were analysed. Seven categorical variables were available: the binary outcome (achievement of functional independence), basic demographic and medical characteristics, and insurance type (as a proxy for socioeconomic status). Multiple logistic regression, classification tree (CHAID) and Bayesian dependence modelling were applied. All analyses corroborated the relevance of insurance type as predictor of rehabilitation outcome. In further work, we will update and extend the dataset and apply more sophisticated statistical methods.

Izid rehabilitacije in socioekonomska neenakost – uvodna raziskava v Sloveniji

Izvleček. Čeprav se v zadnjem času veliko preučuje neenakosti v zdravju v Sloveniji, možna povezanost izida rehabilitacije s socioekonomsko neenakostjo še ni raziskana. Analizirali smo podatke o vseh odraslih pacientih, odpuščenih z bolnišnične rehabilitacije na Univerzitetnem rehabilitacijskem inštitutu – Soča v Ljubljani v enem letu. Na voljo je bilo sedem opisnih spremenljivk: dvojiški izid (dosežena funkcijska neodvisnost), osnovne demografske in klinične značilnosti ter vrsta zavarovanja (ki je služila kot nadomestna spremenljivka za socioekonomski status). Podatke smo analizirali z multiplo logistično regresijo, klasifikacijskim drevesom (CHAID) in bayesovskim modelom odvisnosti. Vse analize so potrdile pomembnost tipa zavarovanja kot napovednega dejavnika izida rehabilitacija. V nadaljnjih raziskavah nameravamo posodobiti in razširiti nabor podatkov ter za njihovo analizo uporabiti najsodobnejše metode statistične analize.

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Introduction

The requirements of people for medical rehabilitation following major accidents, and acute or chronic disease, leading to disability, are increasing considerably, especially with the added geriatric problems of an aging population and the increased survival from acute illness and trauma.[1,2] Rehabilitation services and resources are usually limited and the provision of healthcare services has been shown to differ not only by gender and age, but also by social status.[3-5]

Rehabilitation attempts to reduce levels of disability and facilitate return to active and productive life. The focus of rehabilitation interventions aimed at achieving post-hospital participation requires careful consideration of the specific domain of participation that is being targeted.[6] So far, social factors and their contribution to the rehabilitation outcome have not been studied at greater length,[7] though according to the International Classification of Functioning, Disability and Health (ICF),[8] patients' functioning is now seen in association with personal and environmental factors.

The University Rehabilitation Institute, Republic of Slovenia is the only tertiary hospital in the field of physical medicine and rehabilitation in Slovenia. There, we regularly monitor and analyse a number of medical and demographic factors and measures in relation to patients' functional independence, demandingness of rehabilitation, and rehabilitation efficiency and effectiveness.[9,10,11] However, the possible association of rehabilitation outcome with socioeconomic inequality had not been previously explored despite the fact that inequality in health has been extensively studied in Slovenia over the last decade.[12-17] For these reasons, we conducted the presented study as a preliminary test of availability of the data and feasibility of the chosen analytical methods.

Methods

Data

The data on all adult inpatients discharged from our Institute in 2006 were analysed. This comprised 1592 patients aged 18-97 years (mean 57.5, median 61.0, SD 18.2, IQR 45-72 years), among them 641 (40.3 %) women and 951 (59.7 %) men. After the data exploration, aggregation, cleaning and the necessary discretisation and/or recoding, the dataset comprised the following seven variables (none of which had any missing values):

- Outcome (remained dependent, became independent);
- Gender (male, female);
- Age (up to 50 years, 51 years or more);
- Impairment type (spinal cord injury – SCI, stroke, multiple sclerosis / other neurologic disease, traumatic brain injury – TBI, peripheral nerve injury – PNI / rheumatic disease, lower limb amputation);
- Rehabilitation duration (1-30 days, 31-90 days, 91 days or more);
- Episode within the admission (first, second or subsequent);
- Health insurance type (A – active employees, B – farmers / foreigners or their family members / none, C – family members of active employees, D – pensioners or their family members / publicly funded or their family members / stateless persons).

Hence, in addition to the outcome variable, there were six potential predictors, among which insurance type was the proxy for (the effect of) socioeconomic status beyond the (possible confounding effect of) demographic characteristics and medical status.

Statistical Analysis

Multiple logistic regression and binary classification tree (exhaustive CHAID with Bonferroni adjustment; minimum branch size set to 40, minimum node size set to 20) were used to model achieved functional independence at discharge (yes/no) based on patient characteristics. Those analyses were performed using IBM SPSS Statistics 20.0.0.1 (IBM Corp., Somers, NY, USA). In addition, Bayesian modelling of pairwise conditional dependencies was performed with all the seven variables using B-Course web-based data analysis tool for Bayesian modelling[18] (D-trail for dependency modelling, http://b-course.cs.helsinki.fi/obc/depend.html).

Results

The results of the logistic regression model are summarised in Table 1. The model fitted the data significantly better than the null model (likelihood ratio test: $p<0.001$). The observed data did not differ significantly from the model prediction (Hosmer-Lemeshow test: $p=0.103$) and the explanatory power of the model was noteworthy given the data and modelling limitations (Nagelkerke pseudo-$R^2=0.168$). In addition to rehabilitation duration and impairment type, insurance type turned out to be a statistically significant predictor, whereby it is reassuring that a potentially vulnerable category (C – family members of active employees) was identified as having significantly higher odds of a favourable rehabilitation outcome in comparison with the baseline (i.e., the most frequent, hence chosen as such) category of active employees (A).

The obtained classification tree is presented in Figure 1. Like in the logistic regression model, the main finding in the light of the aim of our study is that insurance type was among the predictors identified as significantly related to the outcome. The CHAID model also highlights the need to consider interactions among predictors if one wants to meaningfully forecast rehabilitation outcome. At the same time, it is reassuring from the public health point of view that even within the node of the resulting classification tree with the highest proportion of the patients who remained functionally dependent after rehabilitation (Node 7), becoming independent was still the prevailing category (and would thus be predicted for all the patients if the simple majority rule were applied across the tree).

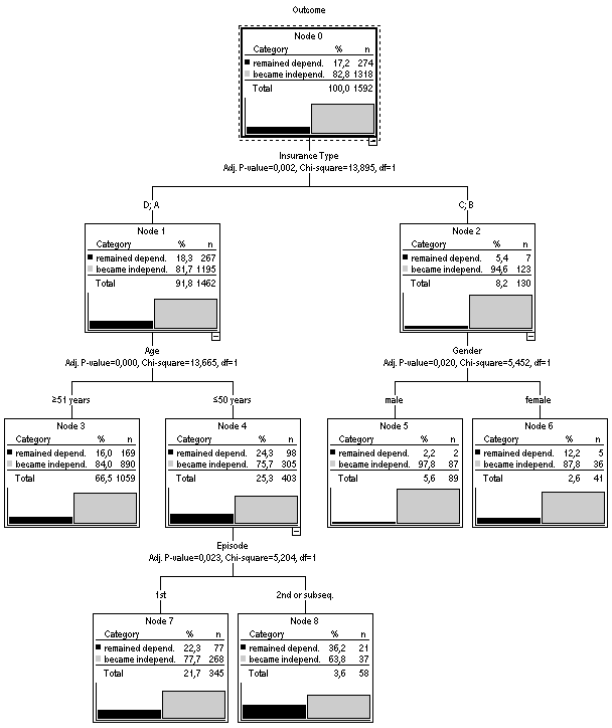

Figure 1 The obtained binary classification tree (exhaustive CHAID with Bonferroni adjustment; minimum branch size set to 40, minimum node size set to 20).

Table 1 Summary of logistic regression model for predicting achieved independence after rehabilitation.

Predictor	*b* (SE)	*p*	OR (95% CI)
Episode (2nd or subseq. vs. 1st)	-0.358 (0.220)	0.104	0.699 (0.454-1.076)
Age (≥51 years vs. ≤50 years)	0.168 (0.174)	0.333	1.183 (0.842-1.664)
Rehabilitation Duration		0.032	
31-90 days vs. 1-31 days	0.387 (0.159)	0.015	1.472 (1.078-2.010)
≥91 days vs. 1-30 days	-0.117 (0.335)	0.726	0.889 (0.461-1.715)
Gender (female vs. male)	-0.049 (0.148)	0.742	0.952 (0.713-1.273)
Insurance Type		0.007	
B vs. A	1.876 (1.038)	0.071	6.530 (0.854-49.903)
C vs. A	1.100 (0.465)	0.018	3.003 (1.206-7.477)
D vs. A	-0.208 (0.198)	0.293	0.812 (0.551-1.197)
Impairment Type		<0.001	
stroke vs. SCI	0.030 (0.248)	0.904	1.030 (0.634-1.675)
MS/neurologic vs. SCI	0.514 (0.275)	0.061	1.672 (0.976-2.865)
TBI vs. SCI	0.781 (0.300)	0.009	2.184 (1.213-3.933)
PNI/rheumatic vs. SCI	1.273 (0.271)	<0.001	3.572 (2.101-6.072)
LL amputation vs. SCI	2.541 (0.324)	<0.001	12.689 (6.721-23.956)

Note: *b* – estimated coefficient; SE – standard error of *b*; OR – estimated odds ratio; CI – confidence interval.

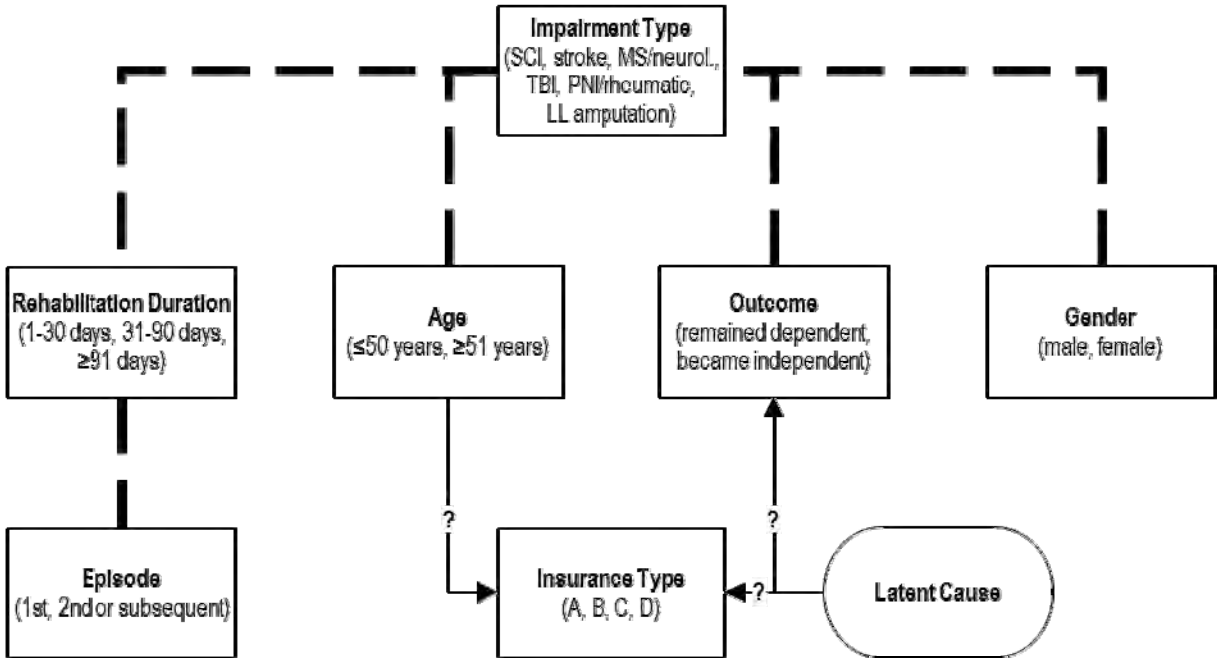

Figure 2 The most probable model identified by Bayesian dependence modelling.

The final result of Bayesian dependence modelling is presented in Figure 2. It represents the most probable model, interpreted in non-naïve causal way. Causation is inferred by allowing every observed dependence to be caused by a latent variable while imposing the restriction that every latent variable is a parent of exactly two observed variables and none of the latent variables has parents. The dashed lines represent undeterminable causation (akin to correlation), meaning that there is a likely dependency between the variables (X and Y), but one cannot know whether X causes Y, Y causes X, or there is a latent cause of them both. For the connections of

uncertain nature between age and insurance type and between insurance type and rehabilitation outcome, there are two possibilities – either X is cause of Y or there is a latent cause for both X and Y. However, it is reasonable to assume and depict the former for the connection between age and insurance type, and the later for the connection between insurance type and rehabilitation outcome.

Discussion

The sole emphasis of our study was on methodological aspects, i.e., data collection and analysis. A number of limitations and simplifications were imposed by the available data, the chosen analytical methods and/or the preliminary nature of the study. From the statistical point of view, the main limitations are associated with categorisation, most notably of rehabilitation outcome and age, whereby the age dichotomisation could be confounding the effect of insurance type in the classification models (i.e., logistic regression and CHAID tree), as also suggested by the Bayesian dependence model. In addition, predictive accuracy of the classification models was neither assessed nor tuned because of the demonstrational nature of the study. Nevertheless, the results provide sufficient indication that the situation in Slovenia regarding the possible influence of socioeconomic inequality on inpatient rehabilitation outcome is amenable to – and worthy of – quantitative research.

However, our study does not touch a key issue regarding social inequality in health, namely the inequality in the access to health services (including inpatient rehabilitation). For example, the provision of stroke care services in England was shown to differ by social characteristics such as gender, age and social status (even though the exact processes by which such differences arose remained unclear).[4] As another illustrative example, older women and employees in manual or lower-grade non-manual jobs were found to predominate in the rehabilitation groups in Finland, while the proportion of temporary employees receiving rehabilitation was low.[19] In principle, we might have addressed such issues on the basis of the insurance type data; but in addition to exceeding the scope of our study, such an attempt would have required population data (official statistics, epidemiological data and registry-based information) that would probably be either inaccessible due to various legal restrictions or of insufficient quality.

Broadly speaking, our preliminary results are in line with the seemingly conflicting previous findings regarding the role of age. The classification tree as an evidence of interaction effects agrees with the observation that stratification of patients by age is useful to determine predictors of function at discharge for stroke outcome and to improve their accuracy of prediction.[20] On the other hand, the lack of significance of age in the logistic regression model agrees with the finding that admission functional status, employment and living at home before stroke but not age per se are predictors of a good outcome following stroke rehabilitation, and with the corresponding conclusion that intensive rehabilitation should not be withheld in stroke patients simply because of advanced age because older patients show comparable improvement during rehabilitation.[21]

While we found considerable evidence of the relevance of insurance type as a proxy predictor of rehabilitation outcome, we must underline that functional independence status at admission to rehabilitation was not controlled for. Including this information in our future research on the topic might be essential because a previous study found no evidence of inequalities in access to specialised rehabilitation services on the basis of gender, race, age, and health insurance type after controlling for the level of functional independence of the patients.[22]

Further work should also introduce other improvements, refinements and extensions. For example, because it has been found that differences in outcome and levels of distress over

role changes after TBI may occur in those from culturally and linguistically diverse backgrounds independent of socioeconomic background and access to rehabilitation, cultural factors might be researched in terms of beliefs, coping style, and emotional response to injury.[23] Apart from technical statistical modelling improvements[24] (which are at least partly conditional upon extending the data), recommendations include a formal approach to assessment of a client's economic environment and use of available financial resources,[25] and grounding of statistical modelling in conceptual models.[26]

Conclusion

We demonstrated that the influence of socioeconomic inequality on inpatient rehabilitation outcome can – and should – be comprehensive explored in Slovenia. Some possible data analytic strategies were successfully presented.

In the future, we must gather more recent and comprehensive data,[27] preferably also from our outpatient rehabilitation service and thus addressing a major open question in the field of rehabilitation,[28] namely in which setting (i.e., inpatient, outpatient or community-based rehabilitation programs) should different patients ideally be treated. At the same time, we are planning to apply more sophisticated statistical methods, e.g., to include interaction terms and splines and to take into account the temporal dimension and dependence between observations in the regression models.

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