A CAUSAL MODEL OF REHABILITATION RESOURCE USE FOR SUBJECTS WITH SPINAL CORD INJURY IN TAIWAN

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Objective: **The aim of this study was to construct an adequate causal model of rehabilitation resource use based on a Taiwanese rehabilitation database system.**

Design: **Cross-sectional analysis of data from a Taiwanese rehabilitation database system.**

Subjects: **Records from 68 patients (51 men, 17 women; mean age 43 years) with spinal cord injuries were used in the study.**

Methods: **Path analysis was used to identify a better-fitted model for patients with spinal cord injuries.**

Results and conclusion: **The results showed that the final causal model fits the data well. The findings also reveal that activities of daily living have the largest total effect on length of stay, whereas subjective well-being and gender have indirect effects on length of stay, mediating through activities of daily living and subjective well-being, respectively. The impact of subjective well-being on the length of stay in hospital for patients with spinal cord injuries deserves special attention, as the quality of life issue plays a vital role in rehabilitation of these patients. The influence of subjective well-being on activities of daily living suggests that therapy targeted at improving patients' subjective well-being is necessary. Additionally, the impact of sexual dysfunction of patients with spinal cord injuries should be investigated further.**

Key words: spinal cord injuries, rehabilitation, length of stay, activities of daily living, well-being.

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INTRODUCTION

Taiwan implemented a national health insurance plan in 1995. Ten medical centres in Taiwan offer medical care for a population of 23 million. They provide professional rehabilitation services for people with any type of disability resulting from disease or trauma, as well as more intensive care services. There are also sub-acute rehabilitation institutions, rehabilitation wards in local hospitals, and nursing homes to provide rehabilitation services. Patients who need rehabilitation receive physical therapy, occupational therapy and speech therapy tailored to their individual needs. The purpose of this study is to develop a model of resources used for inpatient rehabilitation in Taiwan, based on literature reviews and related models (e.g. Anderson's model of service utilization) (1–5).

The goal of medical rehabilitation is to promote maximal independence in the clients served (6–7). In order to provide effective rehabilitation services, clinicians need to understand factors related to clients' independence. Rehabilitation services can then be targeted at functions pertinent to clients' independence. In the past decade, several studies investigating the predictive factors relevant to rehabilitation outcomes have revealed that age, gender, severity of illness, duration of onset, diagnosis, functions of daily living, cognitive functions and psychological well-being are related to the length of rehabilitation hospitalization (8–11). Other authors (12–17) found that the type of injury may affect the rehabilitation outcome for patients with spinal cord injuries (SCI). Researchers have further indicated that sociability, marital status, occupation and career planning are the factors which affect satisfaction and quality of life for patients with SCI (10–11). As a result, these variables might be important for the adjustment of disease and quality of life for patients with SCI (9–11). Since improving quality of life of patients with SCI would be an ultimate goal of rehabilitation, these factors should be examined for their relationship to quality of life.

Using a database to assess the efficacy of rehabilitation programs is the first step toward the establishment of a feasible model. Experience from western countries indicates that a database system approach can be used to achieve these aims (18–19). However, there is no standard database system available in Taiwan. Therefore, the Taiwanese Rehabilitation Database System (TaRDS) was established to facilitate inter-institution comparisons of the intervention efficacy, to conduct further outcome research and to be a baseline data for health care reimbursement (20–21). It can also provide a consistent database for future use in program evaluation and quality assurance.

TaRDS consists of 3 main parts: the patient's demographic data; the patient's scores on the Taiwanese Rehabilitation Functional Scale (TaRFS); and related outcome information (20–21). The TaRFS encompasses 3 domains: activities of daily living (ADL); cognitive-social skills (CSS); and subjective well-being (SWB) (22). The integration and progression of these

functions of the patients will empower them to live independently and satisfactorily in their environment (21). This instrument is supported by its test-retest reliability across times and raters and shows its construct validity (21–22).

The causal model of this study was developed according to literature relevant to the prediction of rehabilitation outcomes (12–17). Four key predictors for rehabilitation service use are proposed in the study. They include personal characteristic variables, ADL, CSS and SWB. These variables were derived due to their extensive use throughout previous research and their theoretical and empirical relevance to the area of concern (23). Length of stay (LOS) was used as the proxy variable for rehabilitation outcome because it is closely related to resource consumption for each client. Moreover, patients usually discharge upon recovery of the functions; therefore, LOS in hospital is a proxy for the rehabilitation outcome.

Gender differences influence the level of assistance needed for basic ADL (24). Data from major national surveys confirmed the association between age and disability (24). Hence, we considered age and gender as predicting variables in the model. Others also proposed predictors pertaining to the functional needs of rehabilitation patients. The relationship between the severity of SCI and patients' functional status was high (9), therefore, functional status of patients was used as predictor for rehabilitation resource use. Functions of the clients include ADL, CSS and SWB. Since the patients with cognitive impairment were not included in the study, CSS was not considered in the model. Basic ADL ability is the most powerful factor in prediction studies (8, 16–17). We thus hypothesized that they will continue to show the predictive validity in explanation of the variance of LOS. Finally, the proposed predictive model for patients with SCI is shown in Fig. 1, showing the relationship among these variables and the directions of correlation. The assumptions for the hypothesized model are as follows:

- Age, gender, ADL and SWB are predictive variables for LOS.
- ADL of the patients would directly affect LOS negatively. Namely, LOS increases as the severity of ADL limitation increases.
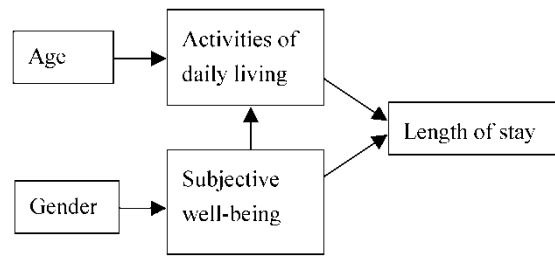- As SWB improves, ADL improves.

Fig. 1. Initial path model.

- As age increases, ADL decreases.
- Gender is an exogenous variable influencing SWB.

SUBJECTS AND METHODS

Subjects

Sixty-eight patients (51 men, 17 women; mean age 43 years) with SCI were recruited from 2 rehabilitation units in university-affiliated hospitals in northern Taiwan. Rated as the first-class medical centres in Taiwan, these hospitals served a variety of patients regardless of diagnoses, severity and complications. Patients admitted to manage the problems of infections or ulcers, as well as those who were diagnosed as having cognitive deficits were excluded from the study.

Procedures

In order to document the outcome of rehabilitation intervention, a reliable functional status measure is needed (25). Since instability of the rater's ratings will contaminate the data (26), a proper rater training protocol is necessary. This study adapts a training protocol comprising 2 sessions of lecturing and discussion. Each session takes about 3 hours. The contents of the course contain: (i) introduction of the TaRFS background and rating principles; (ii) introduction of the TaRFS item definition and administration instruction; and (iii) pilot testing and feedback. All patients were tested on TaRFS and were interviewed to secure relevant database information at the first week upon admission to the rehabilitation wards.

Instrumentation

The TaRFS was developed based on the consensus that functional status is an important predictor of outcome for inpatient rehabilitation (6, 12–13). Since the functional status measure encompasses multiple domains (6, 18–19), a multidimensional assessment is needed to obtain a comprehensive view of the patient (6–7). Several related scales used worldwide were reviewed (27–29); of these, the Functional Independence Measure (FIM) (18), Level of Rehabilitation Scale (LORS) (19), Beck Depression Scale (30), Medical Outcome Study and Short Form 36 (31) were influential in the construction of the TaRFS. The TaRFS

Table I. *Taiwanese Rehabilitation Functional Scale*

ADL subscale	Cognitive-social subscale	Subjective well-being subscale
1. Feeding	1. Orientation	1. Health perception
2. Grooming	2. Problem solving—specific	2. Mood
3. Dressing-Upper body	3. Problem solving—general	3. Influence on social interaction
4. Dressing-Lower body	4. Comprehension	4. Recovery expectation
5. Transfer-chairs	5. Expression	5. Perceived competency
6. Transfer-toilet		
7. Toileting		
8. Bathing		
9. Mobility		
10. Stairs		

ADL = activities of daily living.

Table II. *Correlation matrix among variables in path model*

Variable	Age	Gender	ADL	SWB	LOS
Age	1.00000				
Gender	0.16003	1.00000			
ADL	−0.21394	0.00788	1.00000		
SWB	−0.02069	−0.21329	0.24294	1.00000	
LOS	0.05644	−0.04814	−0.36716	−0.25582	1.00000

ADL = activities of daily living; SWB = subjective well-being; LOS = length of stay.

differs from the Barthel Index, FIM and LORS in several aspects: first, items related to bowel and bladder control were not included because these items may represent functions more closely related to physiological aspects (21); second, the definitions of individual items are designed to suit the customs and rules in Taiwan; third, the SWB subscale was constructed to represent additional dimension of function. The difference between the TaRFS and the FIM can also be found in the references (20–22). Items related to mood, health perception and perceived competency were included (31–33) for the SWB subscale in particular, since there were few functional instruments addressing this issue. In addition to the sampling of related items from these scales, specific cultural background and tools were addressed in the assessment. For example, for the ADL item "feeding", the use of chopsticks was regarded as one of the abilities to be performed in evaluation; for the item "bathing", to take a bath on a bench or chair was regarded as acceptable. The item "illness's influence on social interaction" was included in the SWB subscale since the Chinese perceive "saving face" as an important inherent value (33), and getting ill seemed to be regarded as "losing face" by some families. Consequently, many patients will choose not to disclose their illness and disability to their relatives and friends, and this may have a huge impact on patients' social interaction.

The TaRFS consists of 20 items covering 3 constructs: ADL, CSS and SWB. Each item of the TaRFS is rated on a 7-point rating scale based on suggestions from Streiner and Norman (26). For the ADL and CSS scales, the rating scale ranges from totally dependent (score of 1) to totally independent (score of 7). Occupational therapists rated these 2 scales. For the SWB scale, the range of the scale is from "totally disagree with the statement" (score of 1) to "totally agree with the statement" (score of 7). Patients rated it themselves. The scores of the TaRFS represent the amount of assistance needed for the clients to perform specific activity and the degree of perception on his/her own health and psychological state. Moreover, since actual observation of the performance could provide accurate information about the patient, the TaRFS was designed to rate patient's performance by actual observation of patient's performance within the hospital ward environment (13–15).
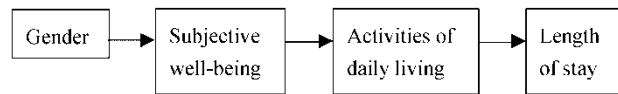

Fig. 2. Final path model.

The manual provided administration instruction and rating definition. Table I lists the individual items of the TaRFS.

Statistical analyses

Statistical analyses of the study include the descriptive statistics for each variable in the causal model, the computation of correlation coefficients among all variables and the application of path analysis to validate the causal model. Variables used in this study include age, gender, LOS, ADL and SWB. The definition of LOS is the stay duration from admission to discharge during the rehabilitation stage. ADL is the sum of item scores in the ADL subscale. Similarly, SWB is the sum of item scores in the SWB subscale. Path analysis is the generalization of multiple regression. The p-value is set at 0.05 for the overall F statistics and individual T statistics obtained at each step and each path.

Path analysis was introduced by Sewell Wright and popularized by Duncan (35–36). The merits of this method are to interpret linear relationships among a set of variables and to deconstruct the correlation into direct and indirect effect (36). Results of path analysis enable us to determine the effect of predictive variables on LOS and the relative importance of each predictor in the causal model. They are accomplished with standardized path coefficients. A better-fitting model can be obtained through appropriate T-values, p-value of χ^2 test, and goodness of fit indices (GFI) (37). All analyses were performed using Statistical Analysis System 6.12 (38) and LISREL 8.3 (39).

RESULTS

The average LOS was 41 days. The correlation matrix for variables used in the causal model can be found in Table II.

Table III shows the regression coefficients and standardized coefficients for initial causal model, which is depicted in Fig. 1. The path (age to ADL) was not significant. The causal relationship between age and ADL was small and not significant. SWB is as important as ADL for patients with SCI in the causal model. In addition, the path (gender to SWB) is marginally

Table III. *Path analysis for the initial model*

Dependent variable	Independent variable	Standardized coefficient	Regression coefficient	p-value	R^2
SWB	Gender	−0.213[+]	−2.828[+]	0.0807[+]	0.045
ADL	Age	−0.209[+]	−0.202[+]		
	SWB	0.238*	0.710*	0.0003*	0.104
LOS	ADL	−0.324*	−0.483*		
	SWB	−0.177	−0.785	0.0006*	0.165

*p-value <0.05, [+]p-value <0.1. ADL = activities of daily living; SWB = subjective well-being; LOS = length of stay.

Table IV. *Path analysis for the final model*

Dependent variable	Independent variable	Standardized coefficient	Regression coefficient	p-value	R^2
SWB	Gender	−0.213[+]	−2.828[+]	0.0807[+]	0.059
ADL	SWB	0.243*	0.722*	0.0003*	0.045
LOS	ADL	−0.367*	−0.547	0.0006*	0.135

*p-value <0.05, [+]p-value <0.1. ADL = activities of daily living; SWB = subjective well-being; LOS = length of stay.

Table V. *Breakdown of the total effects*

Bivariate relationship	Total	Direct effect	Indirect effect	Causal effects	Non-causal effects
(Gender, SWB)	−0.213	−0.213	0	−0.213	0
(Gender, ADL)	0.008	0	−0.052	−0.052	0.06
(Gender, LOS)	−0.048	0	−0.019	−0.019	−0.029
(SWB, ADL)	0.243	0.243	0	0.243	0
(SWB, LOS)	−0.256	0	−0.089	−0.089	−0.167
(ADL, LOS)	−0.367	−0.367	0	−0.367	0

ADL = activities of daily living; SWB = subjective well-being; LOS = length of stay.

significant. We kept this path because male patients showed a higher variation in SWB score than did female patients (10–11).

Fig. 2 shows the revised causal model 2. Table IV shows the result of path analysis for the revised models. ADL is the only direct predictor, which affects LOS. Both SWB and gender affect LOS indirectly through other predictors. The good-fitting models should have GFI >0.9 and AGFI >0.9. Failure to reject the null hypothesis will lead to the conclusion that the revised model fits the data. The results showed GFI = 0.991 > 0.9, AGFI = 0.965 > 0.8, and *p*-value = 61% > 5%. It suggests that the revised causal model fit the data well.   Table V is the result of a break down of direct, indirect, causal and non-causal components of the path model. SWB and ADL have a strong direct relationship with ADL and LOS, respectively. ADL is the only direct predictor for LOS and has a moderate negative effect on LOS. Namely, LOS increases as ADL deteriorates. This indicates that SWB has a remote relationship with LOS mediated by ADL. Clients with a high (good) SWB score will tend to perform better on ADL, which results in a shorter LOS.

DISCUSSION

This study represents the first attempt to establish a model for understanding the phenomenon of inpatient rehabilitation resource use in Taiwan. The model can serve as a framework to comprehend the dynamics of the interrelationship among predictors and LOS. The awareness of these relationships can guide the treatment team to focus on those pertinent clinical factors and set up treatment priorities for the patients congruent with the model. The path coefficients used in the current study can be understood as indices of the direct effects of each of the independent variables on the dependent variables. In our model, a unit change in ADL will result in 0.367 units of decrease in LOS.

Some of the findings of the initial path model deserved special attention. Firstly, age does not have a significant effect on ADL. Although there is some evidence of the effect of age on functional ability in the literature, no causal relationship was established in the past studies (23). This is probably because the majority of SCI patients are young, thus age does not affect LOS. Secondly, ADL has the largest total effect on LOS. This is consistent with the results from previous studies in the literature (9, 15). It means that the independence of the ability of ADL for patients will affect LOS of the patients. Moreover, the ADL indicator is the most significant predictor on resource use for

patients with SCI; the effect is about 1.4 times the influence of SWB on LOS. The results of the ADL effect on LOS provide evidence that in Asian culture also, the rehabilitation of patients with SCI needs to be targeted at ADL functions as has been shown in western countries.

Thirdly, SWB has direct effects on ADL, indirect effects on LOS and the total effect is −0.256. The impact of SWB on the LOS of the patients deserves special attention from medical practitioners as the quality of life issue plays a vital role in the field of rehabilitation. It might suggest that the improvement of patients' psychological well-being may pay off in reducing the LOS of the patients. Fourth, the gender effect on SWB is close to statistical significance. When we investigated further for this relationship, we found that male patients showed a higher variation in SWB score (21). We thought that this might indicate the transient nature of their adaptation process since they are uncertain about their prognosis and possible trajectory of the illness. We further found that Asian male patients might experience a further negative effect of the illness on rehabilitation outcome (21). This might be explained by the traditional nature of the male role in Asian society, as the main wage earner and head of the household. In addition to above, the sexual dysfunction of male patients might contribute to the devastating factors of the outcome, which we did not include as a specific factor in the model but which may contribute to the ratings in the SWB subscale.

With the exception of the path from gender to SWB, all paths are statistically significant in the final causal model. The GFI suggest that the revised causal model fits the data well. ADL has the largest total effect on LOS. Because SWB has the second largest total effect on LOS, the impact of SWB on the LOS of the patients deserves special attention from medical practitioners. Furthermore, intervention therapy for helping patients to cope with the disease stage should be considered. The final causal model indicates that ADL, SWB and gender predict LOS for the SCI patients. The current path model offers rehabilitation professionals a careful way to design treatment plans for clients with SCI or to refer them to programs that are more appropriate. The consideration of these factors in the reimbursement system of the National Health Insurance Plan could further facilitate the achievement of rehabilitation outcomes for clients with SCI.

As Taiwan is trying to revise the reimbursement system of National Health Insurance, the results of this study offer the following possible directions: (i) they support the trend to establish function-related groups for the reimbursement system

due to significant contribution of ADL in the causal model (40); (ii) the standardized regression coefficients in the model can be utilized as a basis for assessing relative weight for different predictors; and (iii) the contribution of SWB in the model suggests that payment for rehabilitation counselling for psychosocial aspects may pay off in the long term for patients with SCI.

Note the 2 limitations of this study. First, patients with SCI may have problems with sexual function; however, this perspective was not investigated in detail. Second, the sample was too small to divide clients into different severity or sub-diagnostic groups so that in-depth results for subgroups were not available.

In summary, the contribution of the current study to clinical practice is the provision of scientific data of various predictors on resource use in patients with SCI, and a reminder of the influence of SWB in the proposed model. The validation of the model with different sets of patient records should be considered in future studies.

ACKNOWLEDGEMENTS

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