How predictable is rehabilitation after hip fracture?

A prospective study of 134 patients

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In a prospective study of 134 consecutive patients treated for hip fracture, rehabilitation was influenced by sociomedical factors, but not by fracture type or treatment. Success of rehabilitation was to a large extent predictable using mental and general health status. Discharge of the patients to their prefracture residence was accurately predicted in 80/89 of successful and 11/28 of failed rehabilitations. Four months after the fracture, 86/92 successful and 11/17 failed rehabilitations were predicted. More accurate prediction of rehabilitation is limited by the complexity of the rehabilitation process.

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Because the immediate results of surgery for hip fracture have become uniformly good, rehabilitation is largely determined by other patient-related factors. In various prospective studies age, living with someone, health, mental status, and functional status have been identified as factors that are relevant for rehabilitation (Baker et al. 1978, Ceder et al. 1980, Thorngren et al. 1986, Wallace et al. 1986, Broos et al. 1988, Borgquist 1990).

In the present prospective study, we assessed to what extent rehabilitation could be predicted using sociomedical- and fracture-related parameters.

Patients and methods

This prospective study included 134 consecutive patients with a fresh hip fracture who were admitted between April 1987 and October 1988 to our department from their own homes or from old people's homes, where independently functioning elderly persons live in their own apartments, but supported when necessary by some professional help. Excluded were patients from nursing homes and patients with pathologic fractures. If there was a contralateral fracture during the time of the study, only the first fracture was included.

There were 27 men and 107 women in the study. Their mean age was 79 (25–98) years, and they had 71 cervical and 63 trochanteric fractures (Table 1).

Predictor variables

All the variables (Table 2) concerning the prefracture situation were scored within 24 hours of admission, usually by the same author. Information was obtained from the patient, and in appropriate cases from relatives and health professionals. To enable a comparison, several factors were scored in accordance with a Swedish study (Ceder et al. 1980a). Independence of daily living was considered present when patients could wash and dress without assistance. General health was assessed in accordance with Ceder et al. (1980a). Dementia was scored as present when patients showed at least definite impairment of short-term memory. Mobility and independence of ADL were also assessed 3 weeks after admission.

Treatment

Conservative treatment (n 12) was applied in nondisplaced fractures and when there were contraindications for operative treatment. Cervical fractures in patients under aged 60 years were treated by cannulated screw fixation (n 7), and in older patients by total hip replacement (n 57).

Lateral femoral neck, trochanteric and subtrochanteric fractures, were treated with the AO dynamic hip screw (n 44). In a few cases stable two fragment trochanteric fractures were treated by Ender nailing (n 14).

Unless contraindicated, the patients received oral anticoagulants aiming at a prothrombin time of 10

Table 1. Observations in 134 patients with a hip fracture

Case	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	84	F	23	0	1	1	1	0	2	2	0	0	0	0	0	0
2	65	F	48	1	0	0	0	0	1	1	1	1	1	0	0	0
3	81	F	40	1	0	1	0	0	1	1	0	1	1	0	0	0
4	80	F	16	0	1	0	1	1	2	2	0	1	1	0	0	0
5	69	F	50	1	0	1	0	0	1	1	1	1	1	1	2	2
6	81	M	28	1	0	0	1	1	1	2	0	1	1	1	0	0
7	79	M	25	0	1	0	0	1	2	2	0	1	0	0	0	0
8	73	F	16	0	0	0	0	0	1	2	0	0	0	0	0	0
9	8	F	17	0	0	1	0	0	1	1	0	0	0	0	0	0
10	78	M	18	1	0	1	0	0	1	1	0	0	0	0	0	0
11	85	F	34	0	1	0	1	1	1	2	0	1	0	0	1	1
12	91	F	46	0	1	0	1	1	1	2	1	1	1	1	2	2
13	82	F	19	1	1	1	1	0	2	2	1	1	1	1	2	2
14	69	F	19	0	0	0	0	0	1	2	0	0	0	0	0	0
15	91	F	18	0	1	1	1	1	2	2	0	1	1	0	0	0
16	83	F	17	1	0	1	0	0	2	1	0	0	0	1	0	0
17	30	F	24	0	0	0	0	0	1	2	1	0	0	0	0	0
18	80	F	15	0	0	1	1	0	2	2	0	1	0	0	0	0
19	90	F	2	0	1	1	1	0	2	1	0	2	2	2	2	2
20	84	F	13	1	1	1	1	0	2	1	0	1	0	1	1	0
21	91	F	13	1	0	0	1	1	1	1	0	2	2	2	2	2
22	83	M	28	0	0	0	0	0	1	2	0	0	0	0	0	0
23	87	F	17	1	1	0	1	0	2	2	0	1	0	0	0	1
24	71	M	15	0	0	0	0	0	2	1	0	0	0	0	0	0
25	83	F	27	1	0	1	0	0	2	1	0	0	0	0	0	0
26	75	F	17	0	1	1	0	0	2	1	0	1	0	0	0	0
27	76	F	19	0	0	0	0	0	1	1	0	0	0	0	0	0
28	82	M	1	1	0	0	0	0	1	1	0	2	2	2	2	2
29	79	M	13	1	1	1	1	1	2	2	1	2	2	2	2	2
30	78	M	42	1	0	0	0	1	1	1	0	1	1	0	0	0
31	80	F	17	0	1	1	1	0	2	1	0	0	0	0	0	0
32	84	M	29	0	0	0	0	0	1	2	0	1	0	0	0	0
33	77	M	32	0	1	0	1	1	2	2	0	1	1	2	2	2
34	78	F	15	0	0	1	0	0	1	1	0	0	0	0	0	0
35	93	F	50	1	1	1	1	1	2	2	0	1	1	1	1	2
36	81	F	17	0	0	1	0	0	1	1	0	0	0	0	0	0
37	71	F	18	0	0	0	0	0	1	1	0	0	0	0	0	0
38	78	F	14	1	1	1	1	1	2	1	0	1	0	0	0	0
39	58	F	24	0	0	0	0	0	1	2	0	0	0	0	0	0
40	82	F	21	0	0	0	0	0	1	1	0	0	0	0	0	0
41	65	M	20	1	0	1	0	0	2	1	0	0	0	0	0	0
42	93	F	14	1	1	1	1	1	1	1	0	1	1	1	1	1
43	79	F	31	0	0	0	0	0	2	2	1	1	1	1	0	0
44	90	F	34	1	1	1	0	0	2	1	0	1	0	0	1	0
45	74	F	21	0	1	1	0	0	1	1	0	0	0	0	0	0
46	96	F	30	0	1	1	0	0	2	2	1	1	1	0	0	2
47	82	F	62	1	1	0	0	0	1	1	0	1	1	1	2	2
48	87	F	15	0	1	1	1	0	2	1	0	0	0	0	0	2
49	72	M	58	1	1	1	0	0	2	1	0	1	1	1	1	2
50	73	F	18	0	0	1	0	0	1	1	0	0	0	0	0	0
51	84	F	34	1	1	1	1	1	2	2	0	1	1	0	1	1
52	96	M	17	1	1	1	1	1	2	1	0	2	2	2	2	2
53	81	F	20	0	0	0	0	0	1	1	0	0	0	0	0	0
54	83	F	33	1	0	1	0	0	1	2	0	0	0	0	0	0
55	89	F	6	0	1	1	1	1	2	1	0	2	2	2	2	2
56	82	F	18	0	0	0	0	0	2	1	0	0	0	0	0	2
57	82	F	15	0	0	1	0	0	1	1	0	0	0	0	0	0
58	75	M	18	1	1	1	1	1	2	2	0	1	1	0	0	0
59	75	M	48	0	0	1	0	0	2	2	0	0	0	1	0	0
60	80	M	30	0	1	0	1	1	1	2	0	1	1	2	2	2
61	56	M	41	1	0	0	0	0	1	1	1	1	1	0	0	0
62	81	F	19	0	1	0	0	0	2	2	0	0	0	0	0	0
63	58	M	44	0	0	0	0	0	1	1	1	1	1	0	0	1
64	82	M	30	1	0	0	0	0	2	2	1	0	0	0	0	0
65	73	F	14	0	0	1	0	0	1	1	0	1	0	1	0	0
66	83	M	31	1	1	1	0	1	1	1	0	1	1	0	2	2
67	85	F	55	1	1	0	0	0	1	1	0	1	0	1	1	1
68	79	F	22	1	0	0	0	0	1	2	0	0	0	0	0	0
69	84	F	43	1	1	0	1	1	2	1	0	1	1	2	2	2
70	87	M	21	1	0	0	0	0	2	1	0	2	2	2	2	2

Case	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
71	97	F	18	0	1	1	1	1	2	2	1	2	2	2	2	2
72	75	F	28	0	1	0	1	1	2	2	0	1	0	0	0	0
73	95	M	29	1	0	1	0	0	1	2	1	0	0	0	0	0
74	58	F	40	0	0	0	0	0	1	2	1	1	1	0	0	0
75	95	F	5	0	1	0	0	1	1	2	0	2	2	2	2	2
76	78	F	18	1	1	1	1	1	2	2	0	1	1	1	1	1
77	81	F	22	0	1	1	0	1	2	1	0	1	1	1	0	0
78	62	F	46	0	0	0	0	0	1	1	1	1	1	0	0	0
79	72	M	22	1	0	0	0	0	1	2	0	0	0	0	0	0
80	78	F	20	0	0	1	0	0	1	1	0	0	0	0	0	0
81	74	M	30	1	0	0	0	0	1	1	1	1	1	0	0	0
82	81	F	18	0	1	0	0	0	1	1	0	0	0	0	0	0
83	91	F	24	0	0	1	0	0	1	1	0	0	0	0	0	0
84	71	M	23	0	0	0	0	0	1	2	0	0	0	0	0	0
85	81	F	47	1	0	1	1	1	2	2	1	1	1	0	0	0
86	84	F	30	0	1	0	0	0	2	2	1	1	1	1	0	1
87	83	F	37	1	0	0	0	0	2	2	1	1	1	1	1	1
88	80	F	48	1	0	1	0	0	2	1	0	1	0	0	0	0
89	73	F	120	1	0	1	1	0	1	1	0	1	1	1	1	2
90	84	F	37	1	1	1	0	0	2	1	0	1	1	0	0	0
91	69	F	36	1	1	1	1	1	2	1	0	1	1	1	1	1
92	85	F	17	0	1	1	0	1	2	2	0	1	0	0	0	0
93	81	F	196	1	1	1	1	1	2	1	0	1	1	1	1	2
94	82	F	22	1	0	0	0	1	1	1	0	1	0	0	0	0
95	42	M	48	0	0	0	0	0	1	1	1	1	1	0	0	0
96	79	F	24	0	0	1	0	0	1	2	0	1	0	1	0	0
97	84	F	21	0	0	1	0	0	1	2	0	0	0	1	0	1
98	78	F	53	0	1	1	0	0	1	1	0	1	0	1	1	1
99	83	F	20	0	0	1	0	0	2	1	0	0	0	0	0	0
100	80	F	28	1	0	1	0	0	1	1	0	0	0	0	0	0
101	68	F	19	0	0	0	0	0	1	1	0	0	0	0	0	0
102	98	F	18	0	1	1	0	0	2	2	0	0	0	0	2	2
103	62	F	18	0	0	0	0	0	1	1	1	1	1	1	0	0
104	78	F	48	0	1	1	0	0	1	1	0	0	0	0	0	0
105	82	F	5	1	0	1	1	1	2	2	1	1	1	0	0	0
106	25	M	40	0	0	0	0	0	1	1	1	1	1	0	0	0
107	82	M	28	0	1	0	0	0	2	1	0	1	1	2	2	2
108	91	F	14	0	0	0	1	1	2	1	0	1	1	0	0	0
109	65	F	2	1	1	0	0	1	2	2	1	1	1	1	1	1
110	84	M	17	0	0	0	0	0	1	2	0	0	0	0	2	2
111	84	F	26	1	1	0	0	0	2	2	0	0	0	0	0	0
112	92	F	21	0	0	1	0	0	2	2	0	1	0	0	0	2
113	85	F	26	0	0	1	0	0	2	1	0	0	0	0	0	0
114	87	F	14	1	1	1	1	0	2	2	0	1	1	0	0	0
115	90	F	65	0	1	0	0	0	1	1	0	1	1	0	0	1
116	73	F	2	1	1	1	1	1	2	1	0	2	2	2	2	2
117	76	F	46	0	0	0	0	0	1	2	1	1	1	0	0	0
118	70	F	11	1	0	0	0	1	1	2	1	2	2	2	2	2
119	84	F	21	0	0	0	0	0	2	1	0	0	0	0	0	0
120	60	F	46	0	0	0	0	0	1	1	1	1	1	0	0	0
121	90	F	28	0	0	1	0	0	2	2	0	1	1	0	0	0
122	70	F	19	0	0	0	0	0	1	2	0	0	0	0	0	0
123	83	F	17	0	0	0	0	0	2	1	0	0	0	0	0	0
124	79	F	54	0	0	1	0	0	1	2	1	1	1	0	0	0
125	71	F	39	1	0	0	0	0	1	2	0	1	0	0	2	2
126	90	F	31	0	1	1	0	0	2	2	0	1	1	1	1	1
127	87	F	29	0	0	0	0	0	1	2	0	1	1	0	0	0
128	84	F	11	1	1	0	1	1	2	1	0	2	2	2	2	2
129	84	F	24	0	1	1	1	0	2	1	0	0	0	0	0	0
130	90	F	64	0	1	1	1	1	2	2	1	1	1	1	1	1
131	71	M	30	0	0	0	0	0	1	2	0	0	0	0	0	0
132	85	F	41	0	1	1	1	1	2	2	1	1	1	2	2	2
133	81	F	70	0	0	1	0	0	2	2	0	1	0	0	0	0
134	85	F	21	0	0	0	0	0	1	2	0	0	0	0	0	0

A Age
B Sex
C Hospital days (acute)
D Healthy
E Demented
F Living with someone
G Visiting someone
H Ability to manage ADL
D–H 0 yes, 1 no

I Type of residence
1 own home
2 old people's home
J Type of fracture
1 cervical
2 trochanteric
K Immediate weight bearing
0 yes, 1 no
L Managed ADL within 3 weeks post-surgery

M Ability to walk within 3 weeks post-surgery
N Rehabilitation successful at discharge
O Rehabilitation successful 4 months after admission
P Rehabilitation successful 12 months after admission
L–P 0 yes
1 no
2 died

percent. Antibiotic prophylaxis (cefuroxime) was given for 1 day. Full weight bearing was usually allowed after 7 days, except in patients with cannulated screw fixation (n 7), and in patients whose fracture stabilization was considered inadequate for full weight bearing (n 23).

All the patients were mobilized with the help of a physiotherapist and the nursing team. The aim was rehabilitation to their own residence. Placement in special rehabilitation centers is difficult in our region due to long waiting lists, and was only considered if immediate rehabilitation proved impossible.

Outcome variables

A follow-up was done in all the cases after 4 and 12 months. The data were obtained from personal interviews with the patient's general practitioner, and, where relevant, with the health care staff at the old people's homes. Outcome variables were survival and residence immediately after discharge, after 4 months, and after 1 year. The rehabilitation was considered successful only if the patient was living in his/her prefracture residence.

Statistics

The relation between the variables was measured using cluster analysis. The relation between variables and success of rehabilitation was assessed using the chi-square test with Yates' correction. Stepwise logistic regression was used to study predictive factors for success of rehabilitation. BMDP software was used (programs 4F, 1M, LR, BMDP Statistical Software Inc., Los Angeles, CA, U.S.A.).

Results

The predictor variables were often interrelated, and the interrelation was complex (Figure 1). Factors with an interdependence of 70 percent and higher were considered to indicate interrelation. Prefracture functional variables and mental status were interrelated, and these were related to the functional status 3 weeks after admission.

Medical condition and sex were more or less independent.

Another cluster was formed by age and social variables.

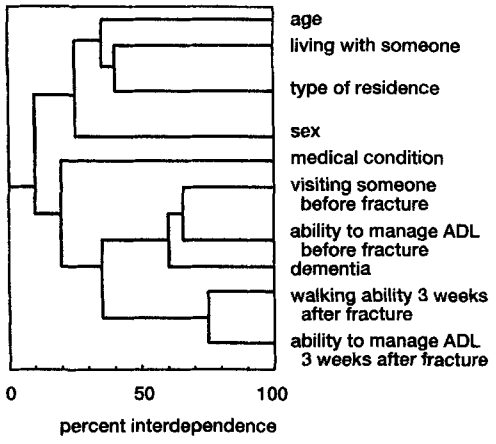

Figure 1. Interdependence of various predictor variables of patients with hip fractures, derived by cluster analysis. A high percentage of interdependence (70 percent and above) means a high degree of interrelation.

Survival

Seventeen patients died during the hospital stay. At 4 and 12 months after admission, this had increased to 25 and 33, respectively.

Rehabilitation

Totally, 89 of the 117 surviving patients returned directly to their prefracture habitat. At 4 and 12 months after the fracture, respectively 93 of the 109, and 88 of the 101 surviving patients were at their prefracture home.

The influence of the predictor variables on the success of rehabilitation was variable (Table 2):

Age, sex, and type of residence: These had hardly any influence on rehabilitation.

General medical and mental condition: Both variables were very important for rehabilitation. The difference between medical condition Ceder classes A and B was small. Both classes were prognostically favorable. Problems with rehabilitation were found in class C: at 4 months, only 26 of the 53 patients were successfully rehabilitated. This effect was independent of age (Figure 1).

Mental status was crucial for rehabilitation. At 4 months, 68 of the 70 surviving patients with no signs of dementia were successfully rehabilitated, while only 24 of the 39 patients with some signs of dementia were in their preadmission habitat.

Social factors: Those who had a partner had better rehabilitation chances at both 4 and 12 months.

Table 2 . Predictive factors for rehabilitation. Total number of patients and number of patients living at follow-up at prefracture residence. Influence of sociomedical- and fracture-related variables as present on admission for hip fracture, as well as ability to walk and to manage ADL 3 weeks after admission

		Months after admission		
	Total	Discharge	4	12
Healthy	81	61 *	66 ***	58
Not healthy	53	28	26	27
Not demented	77	62 **	68 ***	64 ***
Demented	57	27	24	21
Living with someone				
Yes	72	53 *	53 *	48
No	62	36	39	37
Visiting	94	72	76 ***	70 *
Not visiting	40	17	16	15
Ability to manage ADL independently				
Yes	96	74	78 **	71 *
No	38	15	14	14
Age < 85	108	75	80	77 *
Age > 85	26	14	12	8
Home				
Own	68	51	52	49
Old people's	66	38	40	36
Cervical	71	47	49	47
Trochanteric	63	42	43	38
Immediate weight bearing				
Yes	104	72	72	68
No	30	17	20	17
Ability to manage ADL within 3 weeks after admission				
Yes	50	47 ***	48 ***	45 **
No	72	42	44	40
Ability to walk within 3 weeks after admission				
Yes	70	62 ***	62 **	59 **
No	64	27	30	26
Total (survival)	134	117	109	101

*** $P < 0.001$, ** $0.001 < P < 0.01$, * $0.01 < P < 0.05$.

Functional factors: Those patients who before the fracture were independent for some ADL activities and those who could make visits at least once a month, had better rehabilitative chances. Both variables were interrelated (Figure 1).

Type of fracture and treatment had no influence on the success of rehabilitation. The subgroup of patients who were not allowed immediate weight bearing did not undergo a less favorable rehabilitation.

Table 3. Results of stepwise logistic regression analysis of variables influencing success of rehabilitation at discharge, at 4 months, and at 12 months (goodness of fit [C. C. Brown] of the regression models: $P = 1.00$). Independent variables given in text

	P	Coefficient *SE*	
At discharge			
Dementia	0.004	0.6 *0.2*	Success 80/89
Health	0.03	0.5 *0.2*	Failure 11/28
At 4 months			
Dementia	0.000	1.5 *0.4*	Success 86/92
Health	0.000	1.2 *0.4*	Failure 11/17
At 12 months			
Dementia	0.000	1.3 *0.3*	Success 64/85 Failure 13/16

Table 4. Diagnostic value of presence (+) or absence (–) of dementia (D) and good general health (H) in 109 surviving patients 4 months after admission

	Failure	Success	Total	Likelihood ratio
D+ H–	11	6	17	9.9
D+ H+	4	18	22	1.2
D– H–	2	20	22	0.54
D– H+	0	48	48	0
Total	17	92	109	

Walking ability and independence for ADL 3 weeks after the fracture: Both factors were strongly interrelated, related with prefracture functional status, and related with successful rehabilitation.

Prediction of rehabilitation

At discharge and 4 months after admission for the fracture, logistic regression revealed two variables influencing rehabilitation, while the other variables did not contribute to an increase in the number of correct classifications.

Using the two variables medical condition and mental condition, 80/89 successes and 11/28 failures in surviving patients were correctly predicted at discharge (cutoff point of predicted probability $P = 0.5$); at 4 months, 86/92 successes and 11/17 failures in surviving patients were correctly predicted using these variables. The predictive value of these two factors is illustrated by the relevant likelihood ratios (Table 4). At 12 months, only dementia contributed significantly to the classification, and 64/85 successes and 13/16 failures in surviving patients were correctly predicted (Table 3).

Excluding dementia from the analysis, other prognostic variables were identified: at discharge, living with someone and health (accurate prediction of 76/89 successes and 11/28 failures); at 4 months, health and ability to visit (predicting 87/92 successes and 8/17 failures). At 12 months, only ability to manage ADL independently contributed to the classification.

There were almost no differences between the patients coming from their own home or old people's homes; only prediction of rehabilitation at discharge of patients coming from their own homes was more accurate using ability to visit and the presence of a partner (predicting 50/51 successes and 4/12 failures).

Discussion

This study shows that with the presently available operative treatment options, rehabilitation after hip fractures is now predominantly influenced by sociomedical factors, whereas fracture type, treatment, and ability for immediate weight bearing were not associated with success. A range of factors has been shown to influence rehabilitation. The value of multivariant techniques in predicting rehabilitation is obvious (Ceder et al. 1980a, b).

We found that mental status in particular was an important indicator. This factor was not used in the Swedish study. The present study largely confirms the Ceder et al. (1980a, b) studies, which identified age, the presence of a partner, and general health as the best set of predictors.

Using the Swedish variables, we obtained a less accurate prediction. The results of the cluster analysis are also somewhat different.

It is likely that differences between the study populations were responsible: we suppose that our population included more patients who were already functioning at the border of independence. This was the case particularly in old people's homes, where some patients rely heavily on help from health care personnel.

Rehabilitation at discharge was in our study influenced by the presence of alternatives to hospitalization, such as rehabilitation centers. A rapid discharge to such a center suggests a failed rehabilitation, whereas a longer rehabilitation in the hospital might have enabled some of these patients to return home.

Rehabilitation status 4 months after admission is a more reliable measure of the rehabilitation process, and was the most predictable measure.

Although nine sociomedical factors were studied, prediction of success 4 months after the fracture was possible for 86 of the 92 patients, while prediction of failure was only possible for 11 of the 17 patients.

Prediction of rehabilitation is limited by the complexity of the process. It is questionable whether assessment of more variables will increase the accuracy.

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