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Prognosis of Functional Recovery 1 Year After Hip Fracture: Typical Patient Profiles Through Cluster Analysis

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Background. Many investigators have identified distinct medical, demographic and psychosocial prefracture conditions that influence the functional outcome of patients surgically treated for a fracture of the hip. However, to design efficient intervention care programs addressing the needs of these patients, at optimal economic and social costs, more information is required on the typical combinations of prognostic determinants actually encountered.

Methods. Data on specific descriptors of the prefracture status and on mobility and functioning 1 year after surgical intervention were collected by interview from 253 consecutive patients hospitalized for a fracture of the proximal femur. Cluster analysis was used to form homogeneous groups of patients with similar profiles in terms of the 13 predictive variables and the 7 outcome variables significantly interrelated. The modeling procedure generated four clusters of patients with a typical profile sharply contrasted by their structure.

Results. Subjects of two clusters could walk without difficulty and were functionally independent prior to their hip fracture. One year later, however, mobility and functioning were only fully recovered by the members of one cluster. The majority of predictors were of less favorable prognostic value for the members of the second cluster. The other two clusters regrouped patients with impaired prefracture mobility that were either unaltered or even aggravated 1 year later.

Conclusions. Cluster analysis identified typical profiles of elderly hip fracture patients. Close scrutiny of their respective global structure, in terms of combined prognostic determinants and outcomes, may help to develop specific management strategies that are more efficiently adapted to these different groups of patients.

A fracture of the proximal femur is the most dramatic consequence of osteoporosis in terms of disability, mortality, and hospital and institutional care (1). With the increasing proportion of older people in the general population, fractures of the hip are becoming a major public health problem (2). Many investigators have studied hip fracture patients hospitalized for surgical treatment and identified various predictors of functional recovery at different post-discharge times (3–12).

In the conventional research approach, patient characteristics significantly associated with a given outcome are identified through bivariate or multivariate analyses. The same statistical procedures are repeated to recognize predictors of any other outcome variable. This means that although the prognosis is multifactorial when several outcome indicators are involved, the standard analyses can only separately estimate the independent prognostic determinants significantly correlated to each outcome of reference, but do not allow the simultaneous estimation of all predictive variables for a combination of outcome measures.

However, the development of appropriate and efficient prevention, intervention, and rehabilitation programs needs to identify groups of patients characterized by common health conditions, as well as demographic and socioeconomic features that are liable to benefit from such treatment. A more holistic approach is therefore required to create specific categories that differentiate patients into groups with similar prefracture and follow-up characteristics.

In this study, we attempt to classify older patients with a hip fracture according to clearly identified prefracture profiles associated with their overall outcome, as evaluated by measuring a number of critical indicators at the end of a 1-year follow-up period.

Methods

Patients

This prospective longitudinal study included 253 consecutive patients aged 65 years or older with a fracture of the proximal femur admitted to the Geneva University Hospital and the District Hospitals of Sion, Sierre, and Monthey, Switzerland in 1995. Data were collected through structured questionnaires administered in an interview with the patient (assisted by a proxy when necessary) during the first week of hospitalization and, subsequently, at 3 months and 1 year after surgical intervention. Five subjects refused the second or third interview and contact was lost with five other subjects. An additional 36 patients died during the year of fol-

low-up, leaving 207 patients for evaluation of functional restoration 1 year after hip fracture.

Outcome Variables

Seven variables evaluated at 1-year follow-up were used for the assessment of functional rehabilitation (Appendix 1). Some of these outcome variables reflect the patient's status at time of observation, whereas others assess the relative change that occurred during the year of follow-up. Mortality during the period of observation is another important outcome of posthospital discharge, and that evaluation will be treated separately.

Predictive Variables

The independent variables included in this study (Appendix 2) are the 20 descriptors of the prefracture status that revealed to be significantly correlated to at least one of the seven outcome variables assessed for all the patients who survived 1 year. Gender was not a predictor of the outcome variables assessed for the 1-year postdischarge survivors, but was significantly correlated to mortality during the follow-up period of observation.

Statistical Analysis

All the data collected were computerized and processed with programs provided by the Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL) (13).

The statistical procedure called "cluster analysis" was used to form homogeneous groups of patients with similar profiles in terms of both independent and dependent observed variables. With this technique, cases are grouped on the basis of their closeness. The combined measure of distance over all of the variables was the squared Euclidean distance based on the standardized variables. The method used to form clusters was the agglomerate hierarchical clustering, and the complete linkage or furthest neighbor technique was applied to determine which cases or clusters should be combined at each step.

Because the component of the overall heterogeneity attributable to the within-cluster variability decreases with diminishing cluster size, smaller groups will include more homogeneous and typical patients, and the between-cluster variability will constitute the largest part of the remaining heterogeneity. However, because the number and size of clusters are inversely related for a population of given dimension, empirical criteria need to be considered in fixing the number of procedure steps, so that a useful and conclusive interpretation can be made on distinctive typological categories of patients representative of the population under review.

The variables selected to serve as the basis for cluster formation were all the outcomes measured at the end of the follow-up period and their predictors that were significantly identified through multivariate analysis. In bivariate analyses, statistical significance was tested using the following: (i) the chi-square test or the Fisher's exact probability test, when both categorical variables were dichotomized; (ii) the Mantel-Haenszel chi-square analysis to test the linear association between two ordinal variables; (iii) the Pearson correlation coefficient when both variables were continuous; and (iv) the analysis of variance to test the association between a nominal or ordinal variable and a continuous variable.

Stepwise multiple linear regression analysis was used to determine the independent variables with statistically significant joint impact on the ordinal or continuous outcome variables, whereas the relationship of predictive variables to dichotomized outcomes was established through stepwise multiple logistic regression. Logarithm transformation was applied to the length of hospital stay to normalize the distribution.

All reported p values are two-tailed, and the null hypothesis of no difference was rejected at a p level of $<.05$.

RESULTS

Construction of the Typological Model

As shown in Table 1, five independent variables (age, marital status, leisure activities, comorbidity, and coping attitude) were significant predictors of all the seven outcomes according to the bivariate analysis. Three other variables were markers of five outcomes, but the majority were predictors of only three or four outcomes. Because many of the independent variables were strongly correlated, seven of the latter were not retained by the multivariate analysis. Comorbidity and age were the most powerful predictors and were significantly associated with seven and six outcomes, respectively. The other 11 independent variables were simultaneously associated with no more than one to four outcomes.

Conversely, the number of independent variables that were significant predictors of outcome is displayed in Table 2. The bivariate analysis showed that five outcomes were predicted by at least half of the 20 independent variables included in the model. After elimination of redundancy due to correlation between independent variables, the multivariate analysis indicated that the activities of daily living (ADL) score, the number of hospital days in the follow-up year, and walking ability appeared to be the outcomes significantly predicted by the largest number of prefracture characteristics (respectively, eight, seven, and six independent variables). The selected variables included in the cluster analysis were the 13 predictive variables retained by the multivariate approach among those listed in Table 1 and the seven predicted outcomes listed in Table 2.

The relationship between the number and size of clusters at successive forming steps is displayed in Figure 1. The first subdivision of the total population ($n = 207$) created a typological model consisting of an extremely homogeneous cluster ($n = 79$) that would not break up until the seventh forming step. The second cluster ($n = 128$) was sufficiently heterogeneous to already subdivide at the second step into a small group of 39 patients and a larger one ($n = 89$), which generated at the third forming step two more homogeneous and stable clusters of 62 and 27 subjects, respectively. The next step of the procedure affected only the smaller of the two clusters that was created at the second step ($n = 39$) and resulted in a fifth group of no more than 11 patients (5% of the total study population). Therefore, the analysis and discussion will concentrate on the findings of the typological model with four clusters.

Table 1. Significant Predictors of One or More Outcomes Recognized by Bivariate and Multivariate Analyses

	Number of Predicted Outcomes‡							
	Bivariate Analysis				Multivariate Analysis			
Predictive Variables†	$p < .05$	$p < .01$	$p < .001$	Total	$p < .05$	$p < .01$	$p < .001$	Total
Mean age	—	1	6	7	1	1	4	6
Married (%)	4	2	1	7	1	1	—	2
Living in a nursing home (%)	—	1	4	5	1	1	1	3
With higher education (%)	1	2	—	3	—	—	—	—
With higher income (%)	1	2	—	3	1	—	—	1
Mean number of leisure activities	—	1	6	7	1	2	—	3
Fracture after spontaneous fall (%)	2	2	1	5	1	—	—	1
Falls in the prior 3 mo (%)	1	—	—	1	—	—	—	—
Previous fractures (%)	2	—	—	2	—	—	—	—
One or more comorbidities (%)	—	3	4	7	—	2	5	7
Two or more drugs prescribed (%)	1	—	—	1	1	—	—	1
Use of sleeping pills (%)	1	—	—	1	—	—	—	—
Use of antidepressants (%)	4	—	—	4	—	—	—	—
Mean prefracture ADL score	—	—	4	4	—	1	1	2
Prior walking without difficulty (%)	1	—	4	5	—	—	1	1
Good self-rated health (%)	—	1	3	4	—	—	—	—
Good health compared with others (%)	—	3	1	4	1	—	—	1
Disoriented (%)	—	1	2	3	2	—	—	2
Mean depression score	2	1	1	4	—	—	—	—
Mean coping score	1	—	6	7	3	—	1	4

Note: ADL = activities of daily living.
†Evaluated at admission in the study.
‡Out of seven outcome measures evaluated after 1-y follow-up (listed in Table 2).

Typical Patient Profiles

The profile of the total study population (Table 3) is characterized by the 20 variables predictive of at least one of the seven outcome measures evaluated at the end of the follow-up period, plus one additional variable (gender) that appeared to be a significant predictor of survival. The proportion of men was only 12.6% among the survivors, but reached 30.6% among those who did not survive. Those patients who died during the 1-year follow-up had significantly diminished prefracture leisure activities, increased disorientation, more comorbidities, greater use of drugs, and unfavorable levels of prefracture ADL scores and relative perceived health. These were all significant predictors of mortality.

The overall profile of the survivors (Table 3, column 2) covers the seven outcome indicators evaluated at 1-year follow-up. In Table 4, we see the profiles of the typological categories resulting from the breakdown through cluster analysis of the survivors into four homogeneous groups. In terms of recovery prognosis, the best combined pattern of both predictive and outcome variables characterizes the first and largest cluster (cluster 1), grouping almost 40% of the surveyed patients. Out of the 79 members of this cluster, 77 (97.5%) could walk without difficulty before hip fracture and 78 (98.7%) 1 year later, with no patient having been confined to wheelchair or bed. Practically all patients were functionally independent prior to hospitalization for their hip fracture (ADL score of 6.1) as well as at the end of the follow-up period (ADL score of 6.3). Only 5% of these patients had been residing in a nursing home, and in only 10%

Table 2. Number of Significant Predictors for Each Outcome Recognized by Bivariate and Multivariate Analyses

	Number of Predictors‡							
	Bivariate Analysis				Multivariate Analysis			
Predicted Outcomes†	$p < .05$	$p < .01$	$p < .001$	Total	$p < .05$	$p < .01$	$p < .001$	Total
Mobility self-reported as recovered (%)	4	3	6	13	—	1	—	1
Confined to wheelchair or bed (%)	5	2	8	15	1	2	1	4
Mean ADL score	2	4	11	17	4	1	3	8
Walking without difficulty (%)	2	4	11	17	3	1	2	6
Level of ADL score regained (%)	1	1	3	5	1	—	3	4
Level of walking ability regained (%)	4	2	1	7	1	—	3	4
Mean number of hospital d/y	3	4	3	10	3	3	1	7

Note: ADL = activities of daily living.
†Evaluated after 1-y follow-up.
‡Out of 20 predictive variables evaluated at admission in the study (listed in Table 1).

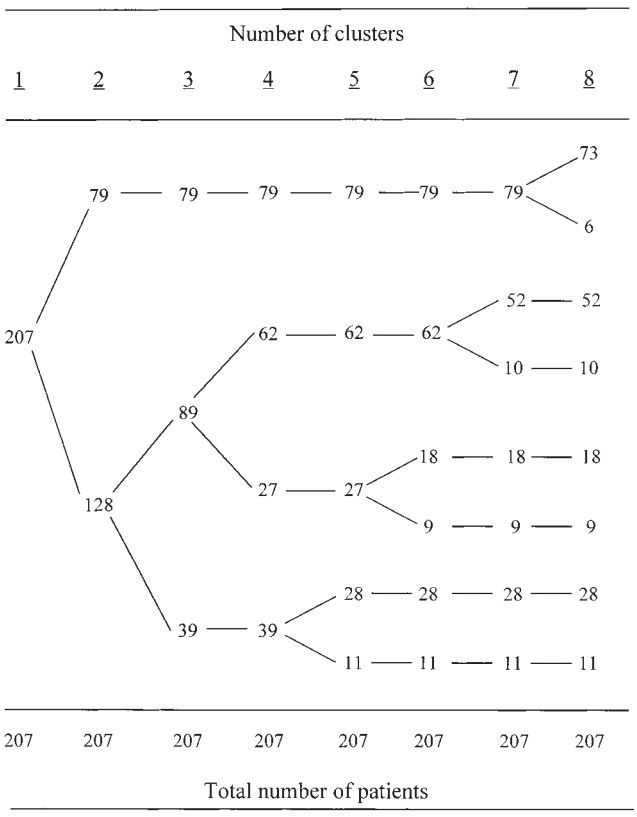

Figure 1. Number and size of clusters at successive forming steps.

of cases was the prefracture health status perceived as not good. On average, they did not stay more than 1-1/2 months (45.8 days per patient) in hospitals during the follow-up year.

The second cluster, almost one third of the subjects, appears in some respects quite similar to the first one with good prognostic values for essential features like prefracture capacity to walk (95.2% walking without difficulty), functional independence (ADL score of 6.7), self-rated health as good (85.5%), and place of residence (only 4.8% with residence in nursing home). However, in spite of these similarities, the outcome of cluster 2 was particularly unfavorable. There was not one patient who could walk again without difficulty, and 13% of the cluster members were confined to a wheelchair or bed. Their mean ADL score was still as high as 12.6, and they stayed, on average, more than 3 months in hospitals during the follow-up period. In sharp contrast with cluster 1, no member of cluster 2 effectively regained his or her level of functional autonomy, including walking ability. Further scrutiny of the profiles of the first two clusters shows that, apart from those mentioned above, the majority of predictors were of less favorable prognostic value for the second cluster. In particular, members of cluster 2 were older, more prone to falls, more frequently sustained a hip fracture after a spontaneous fall, had a higher number of comorbidities, and about half as many were married.

The remaining two clusters, or one third of the surviving patients, represent the older patients with very low potential for recovery. Cluster 4, 19% of the subjects, is particularly typical in this regard. With a mean age of 86 years, almost two thirds were living in a nursing home prior to fracture, more than 50% sustained their hip fracture after a spontaneous fall, 72% presented comorbid problems, practically 40% were disoriented, and the same proportion had poor opinion of their health status. They also had the most unfavorable mean scores for depression and coping strategy, and less than 8% were still married. Although one third of these patients (35.9%) could walk without difficulty prior to the hip fracture, none recovered total ambulatory capacity 1 year later, and 80% of them were confined to a wheelchair or bed. Furthermore, the levels of their mean ADL score show that functionally they were already seriously dependent before hip fracture (12.0) and almost completely dependent at the end of the follow-up period (16.4).

Cluster 3 is the smallest cluster (13%) and presents some profile similarities with cluster 2. However, similar to cluster 4, it is essentially characterized by a reduced prefracture functional independence (mean ADL score of 11.4) and a low proportion of patients (11.1%) able to walk without difficulty. One year later, only 1 out of 27 patients (3.7%) could again walk without difficulty, but no more than 2 (7.4%) were actually confined to a wheelchair or bed. The mean ADL score had not worsened, remaining close to the relatively poor prefracture level (12.1).

In spite of the poor recovery performances of members of clusters 3 and 4, a substantial proportion regained their prefracture levels of ADL score and walking ability. This reflects the fact that the majority of these patients were already functionally dependent before their hip fracture and remained so after the surgical intervention. The gradient changes from cluster 1 to cluster 4, in values of predictive and outcome variables, express prognostic deterioration, with the most unfavorable levels for cluster 4. Overall changes in ambulatory mobility and functional independence are schematically summarized for each cluster in Table 5.

DISCUSSION

The costs of hip fractures include direct financial costs for acute treatment and long-term care, as well as the consumption of society's resources for the management of this often devastating injury. These costs are already considerable and will increase dramatically in the near future. In a report by Cooper and his associates (14), it was estimated that the number of hip fractures occurring in the world would increase from the 1.66 million noted in 1990, to 6.26 million by the year 2050. This is almost a fourfold increase and will of course become a global problem requiring adaptive preventive strategies from the health services concerned.

The acute management of this injury is usually without debate because of the painful and completely disabling nature of a fracture of the hip; surgical intervention is required. Even in cases where family and physician see little potential for functional recovery, surgery is ethically indicated for relief of pain, mobilization out of bed, and nursing care. Such treatment requires limited-term resources, that is, a brief period of acute hospitalization and surgery and then a return to long-term care.

Table 3. Profile of Hip Fracture Patients According to Potential Predictors of Outcomes

	Total $N = 243$ (100.0%)	1 y Survivors $n = 207$ (85.2%)	Dead at 1 y $n = 36$ (14.8%)	p Value
Predictive variables[†]	(1)	(2)	(3)	
Mean age (y) (*SD*)	82.3 (7.7)	82.1 (7.7)	83.6 (7.7)	NS
Married (%)	24.3	26.1	13.9	NS
Men (%)	15.2	12.6	30.6	<.01
Living in nursing home (%)	22.2	20.3	33.3	NS
With higher education (%)	21.8	21.7	22.2	NS
With higher income (%)	51.4	52.2	47.2	NS
Mean number of leisure activities (*SD*)	2.4 (1.4)	2.5 (1.4)	1.7 (1.5)	<.01
Fracture after spontaneous fall (%)	38.7	37.2	47.2	NS
Falls in the previous 3 mo (%)	28.0	28.5	25.0	NS
Previous fractures (%)	46.5	47.3	41.7	NS
One or more comorbidities (%)	38.3	34.8	58.3	<.01
Two or more drugs prescribed (%)	72.4	69.6	88.9	<.05
Use of sleeping pills (%)	36.2	36.7	33.3	NS
Use of antidepressants (%)	7.8	7.7	8.3	NS
Mean prefracture ADL score (*SD*)	8.3 (3.6)	8.1 (3.4)	9.4 (4.2)	<.05
Prior walking without difficulty (%)	72.0	73.9	61.1	NS
Good self-rated health (%)	80.7	81.2	77.8	NS
Good health compared with others (%)	75.7	81.2	44.4	<.001
Disoriented (%)	17.3	14.5	33.3	<.01
Mean depression score (*SD*)	6.7 (1.4)	6.7 (1.4)	6.8 (1.4)	NS
Mean coping score (*SD*)	4.2 (1.5)	4.2 (1.5)	4.4 (1.6)	NS
Outcome variables[‡]				
Mobility self-reported as recovered (%)	—	49.3	—	
Confined to wheelchair or bed (%)	—	19.8	—	
Mean ADL score (*SD*)	—	10.9 (4.3)	—	
Walking without difficulty (%)	—	38.2	—	
Level of ADL score regained (%)	—	41.5	—	
Level of walking ability regained (%)	—	54.6	—	
Mean number of hospital d/y (*SD*)	—	65.6 (2.0)	—	

Notes: NS = not significant; ADL = activities of daily living.
[†]Evaluated at admission in the study.
[‡]Evaluated after 1-y follow-up.

There are, however, a number of patients who can benefit from a more aggressive approach following surgery in terms of an active well-structured rehabilitation program. These are the elderly persons who are functionally independent prior to their fracture and who have the potential and ability to return to such an existence. Methods and guidelines are needed to help identify this group of patients, because we do not have sufficient resources to provide all patients with such a program. A study by Jensen and his associates (15) of 518 patients with a fracture of the hip followed for 6 months, noted use of 17% of the total number of hospital beds for orthopedic surgery in an area of 500,000 inhabitants. The total rehabilitation course was longest for the most dependent patients. They concluded that the goal in treatment of hip fractures in elderly persons is to apply the method with the smallest consumption of resources that leads to the safest technical results, while maintaining the social and functional independence of the patients to the maximum degree possible.

In our preliminary study, we have tried to determine which groups of patients would most benefit from functional rehabilitation postsurgery. The conventional methodological evaluation approaches have largely contributed to the identification of individual predictors. However, further knowledge is needed on the structure of typical patient groups in terms of combination of predictive and outcome variables. As a first step in this direction, we submitted our population to an appropriate cluster analysis and generated a typological model with four different patient categories characterized by highly contrasting patterns. The considerable underlying heterogeneity of the investigated population is easily put in evidence by a comparison of the overall survivors' profile (Table 3, column 2) with the corresponding profiles of the four typical components of the surviving population (Table 4). More than two thirds of the subjects were members of the first two clusters. They were all functionally independent and able to walk without difficulty prior to hip fracture, were still living in their private home, and had a good perceived feeling of their health status. However, the outcome pictures of the two clusters differ totally. After a 1-year follow-up, members of the first cluster (38% of the total sample) had recovered their walking capacity and functional independence, but not those of the second cluster. Precisely distinguishing these two types of patients is of paramount importance for the establishment of efficient intervention programs, and further research is

Table 4. Profile of Four Homogeneous Clusters of Hip Fracture Patients Grouped According to Outcomes and Their Predictors

	Cluster 1 $n = 79$ (38.2%)	Cluster 2 $n = 62$ (30.0%)	Cluster 3 $n = 27$ (13.0%)	Cluster 4 $n = 39$ (18.8%)	*p* Value
Predictive variables†					
Mean age (y) (*SD*)	78.2 (7.7)	83.8 (6.2)	84.0 (8.2)	85.9 (6.3)	<.001
Married (%)	40.5	22.6	18.5	7.7	<.001
Living in nursing home (%)	5.1	4.8	37.0	64.1	<.001
With higher education (%)	30.4	25.8	14.8	2.6	<.01
With higher income (%)	63.3	58.1	29.6	35.9	<.01
Mean number of leisure activities (*SD*)	3.3 (1.3)	2.4 (1.1)	2.0 (1.2)	1.3 (0.9)	<.001
Fracture after spontaneous fall (%)	25.3	40.3	37.0	56.4	<.01
Falls in the previous 3 mo (%)	21.5	35.5	29.6	30.8	NS
Previous fractures (%)	51.9	51.6	51.9	28.2	NS
One or more comorbidities (%)	13.9	33.9	44.4	71.8	<.001
Two or more drugs prescribed (%)	63.3	62.9	92.6	76.9	<.05
Use of sleeping pills (%)	25.3	38.7	51.9	46.2	<.05
Use of antidepressants (%)	2.5	8.1	11.1	15.4	NS
Mean prefracture ADL score (*SD*)	6.1 (0.6)	6.7 (1.7)	11.4 (2.7)	12.0 (4.3)	<.001
Prior walking without difficulty (%)	97.5	95.2	11.1	35.9	<.001
Good self-rated health (%)	93.7	85.5	66.7	59.0	<.001
Good health compared with others (%)	89.9	93.5	63.0	56.4	<.001
Disoriented (%)	6.3	16.1	0.0	38.5	<.001
Mean depression score (*SD*)	6.2 (0.7)	6.8 (1.5)	7.1 (1.6)	7.2 (1.9)	<.001
Mean coping score (*SD*)	3.7 (1.0)	4.5 (1.8)	4.1 (1.4)	4.9 (1.6)	<.001
Outcome variables‡					
Mobility self-reported as recovered (%)	93.7	24.2	37.0	7.7	<.001
Confined to wheelchair or bed (%)	0.0	12.9	7.4	79.5	<.001
Mean ADL score (*SD*)	6.3 (0.7)	12.6 (2.8)	12.1 (2.3)	16.4 (1.6)	<.001
Walking without difficulty (%)	98.7	0.0	3.7	0.0	<.001
Level of ADL score regained (%)	81.0	0.0	44.4	25.6	<.001
Level of walking ability regained (%)	98.7	0.0	81.5	33.3	<.001
Mean number of hospital d/y (*SD*)	45.8 (1.7)	96.1 (1.7)	60.3 (2.5)	78.2 (2.1)	<.001

Notes: NS = not significant; ADL = activities of daily living.
†Evaluated at admission in the study.
‡Evaluated after 1-y follow-up.

clearly needed to identify more specific and sensitive predictors of a bad prognosis for the large number of patients in the second cluster (almost one third of the total sample) who were fully independent before hip fracture, but who had not yet recovered their functional autonomy 1 year later.

We are facing a different situation with the last two clusters, which together included one third of the subjects. The functional outcomes of their members were as poor as of those of cluster 2, but, contrary to the latter, the subjects of clusters 3 and 4 already had ambulation problems before their hip fracture and were largely dependent in their ADLs. It seems relatively clear that, apart from the palliative surgical intervention, there is little to be gained from the use of an intensive rehabilitation program.

We acknowledge some limitations in our study. First, there is the question of the specific type of treatment the patients received after their acute hospitalization. This includes the treatment provided during their stay in rehabilitation institutions and nursing homes, as well as for those who returned home. Specifically, we are lacking information regarding the type of functional rehabilitation the patients received, and we acknowledge that this could have had an effect on the eventual functional outcome. Another limitation is our inability to precisely identify those exact prefracture variables that could have accounted for the poor results in cluster 2, compared with cluster 1. In fact, the most surprising finding of our study was the different outcomes between these two groups, who were similar in many prefracture

Table 5. Schematic Classification of Patients According to Mobility and Functionality

			Ambulatory Mobility		Functional Independence	
Cluster No.	Mean Age	Population Fraction	A	B	A	B
1	78 y	38%	Complete	Complete	Complete	Complete
2	84 y	30%	Complete	Reduced	Complete	Reduced
3	84 y	13%	Reduced	Lost	Reduced	Reduced
4	86 y	19%	Reduced	Lost	Reduced	Lost

Notes: A = before hip fracture; B = 1 y after surgical intervention.

variables. However, there were several variables that, when examined closely, appear to be of predictive value in differentiating these two groups. A higher proportion of patients in cluster 1 were married ($p < .05$) and had fewer comorbidities ($p < .01$) than those in cluster 2. And although there was a trend for a greater percentage of patients in cluster 2 to be disoriented and to have sustained their fracture after a spontaneous fall, this was not statistically significant as compared with cluster 1. Clearly, this is an area that requires further study.

In view of our findings, cluster analysis seems to be a promising starting point for further research in the direction of a more effective hip fracture treatment program for the frail elderly population. It appears that careful consideration of the identified typical profile categories of hip fracture patients could help select the most appropriate intervention approach. For efficient decision making, this implies an extensive overall pretreatment geriatric evaluation to optimize all aspects of management, including reduction of stress, controlling pain, and possible restoration of prefracture mobility, while limiting direct and indirect costs.

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APPENDIX 1
OUTCOME VARIABLES

1. Mobility status self-reported through answer to the question: Can you walk or transfer as well as before having fractured your hip?

2. Mode of transfer rated on a 7-point scale (1 = walks alone and uses stairs, 2 = walks alone but does not use stairs, 3 = needs one or two canes, 4 = needs an assistive device, 5 = needs a wheelchair, 6 = is confined to chair, 7 = is confined to bed).

3. ADLs including bathing, dressing, grooming, walking, eating, and toileting, with ability rated on a 3-point scale for each activity (1 = without any difficulty, 2 = with some difficulty, 3 = complete inability). The ADL score, defined as the sum of the 6-item codes, ranges from 6 (total independence) to 18 (complete dependence).

4. The ADL item concerning walking ability, rated as indicated previously.

5. Recovery in ADL score, a dichotomous measure considered positive if the ADL score at 1 year was equal or lower than the prefracture ADL score, as derived from the first interview.

6. Recovery in walking ability, a dichotomous measure considered positive if the code of the corresponding ADL item was, at 1 year, equal to or lower than before fracture.

7. Total number of hospital days during the year of follow-up obtained by summing all lengths of hospitalization, either for acute or chronic conditions including convalescence and rehabilitation.

APPENDIX 2
PREDICTIVE VARIABLES

1. Age (mean age and standard deviation in years)
2. Marital status (percent married)
3. Type of residence (percent living in nursing home)
4. Education (percent having received college or university education)
5. Income (percent receiving more than 2000 Swiss francs per month)
6. Leisure activities (mean number and standard deviation; the seven regular activities assessed were: excursions, physical exercise, gardening or manual work, volunteer work, listening to radio or watching television, reading newspapers or books, traveling 3 days or more)
7. Type of fall having caused the hip fracture (percent having sustained fractures consecutive to unexplained spontaneous fall, in contrast to accidental fall)
8. History of fall (percent having fallen within the 3 prefracture months)

9. History of fractures (percent having already been hospitalized for one or more other fractures)

10. Chronic conditions (percent with one or more comorbid disorders recorded in the hospital medical file)

11. Drugs (percent with two or more drugs prescribed prior to hip fracture)

12. Sleeping pills (percent using sleeping pills)

13. Antidepressants (percent using antidepressants)

14. ADLs (mean prefracture ADL score and standard deviation; this composite predictive variable is identical to the ADL outcome defined in Appendix 1, but refers to the prefracture status of the patient)

15. Walking ability (percent who walked without difficulty prior to hip fracture; this variable is the ADL item concerning walking ability)

16. Perceived absolute health level (percent in self-rated good health)

17. Perceived comparative health level (percent in self-rated health as good as other persons of same age)

18. Disorientation (percent having not answered correctly all four questions on age, birthday, year of birth, and home address)

19. Depressive signs (mean depression score and standard deviation); the instrument includes six questions rated on a 2-point scale (1 = never or sometimes, 2 = often): "Do you feel alone?"; "forgotten?"; "unnecessary?"; "Do you long for company?"; "Are you tired of life?"; and "worried about the future?" The depression score, defined as the sum of the 6-item codes, ranges from 6 to 12.

20. Coping strategy (mean coping attitude score and standard deviation); the instrument includes three attitude statements rated on a 3-point scale (1 = certainly, 2 = perhaps, 3 = not at all): "I convince myself that it could have been much worse" (for problem redefinition); "I try to adapt my objectives and wishes to the circumstances" (for self-concept modification); "I convince myself that I already faced many more serious situations" (for self-concept bolstering). The coping attitude score, defined as the sum of the 3-item codes, ranges from 3 (most positive attitude) to 9 (most negative attitude).