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Risk Indicators for Falls in Institutionalized Frail Elderly

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The aim of this study was to identify individual predisposing risk indicators for falls in a sample of institutionalized frail elderly in southern Germany. The design was a prospective observational study with a 1-year follow-up (October 1998–September 1999). The study population included 472 long-term-care residents whose mean age was 84 years; 77% were female. Risk indicators for accidental falls were analyzed by using logistic regression. Residents were found to have an incidence density rate of falls of 2,558 per 1,000 resident-years. Multiple logistic regression analysis revealed short-term memory loss, transfer assistance, urinary incontinence, positive fall history, and use of trunk restraints as predictors of falls. In a further logistic regression analysis, depressive symptoms, transfer assistance, urinary incontinence, and positive fall history were associated with frequent falls. Using these risk indicators as a screening procedure to identify fallers would be easy to administer and could be accomplished by nursing staff. Study results encourage specifically addressing urinary incontinence, cognitive impairment, use of restraints, depression, and transfer difficulties as modifiable predisposing risk factors for falls. Fall history represents an important nonmodifiable marker to identify residents at high risk.

accidental falls; aged; institutionalization; long-term care; risk factors

Abbreviation: CI, confidence interval.

Falls remain a major health problem despite several successful intervention trials to reduce the number of falls (1). The incidence of falls and related severe injuries is particularly high in institutionalized elderly. Identification of risk indicators for falls has been the aim of several studies and reviews of community dwellers (2–6) and nursing home residents (7–12). The risk indicators examined include demographic factors, neuromuscular function, disease and fall history, psychological impairments, types and numbers of medications, the physical environment, functional disabilities, and social handicaps. The Resident Assessment Instrument is the mandated care assessment tool in US nursing homes. This instrument mentions fall history, mechanical restraints, dizziness, wandering, and prescription of antidepressants or anxiolytic medication as the most important risk factors for falls (13). However, this topic has not been studied adequately and is based on expert opinion. An interesting approach including fall history, impression regarding general care, and examination of a dual task was used by a Swedish group looking at elderly living in residential care settings, but it seems to be difficult to apply in nursing homes (14).

Interventions to eliminate the aforementioned risk indicators have been only partly successful in the long-term-care setting. Only very few intervention studies have reported a favorable outcome (15–17). The successful studies have used multifaceted approaches including exercise to improve strength and balance, environmental adaptations, staff training, resident counseling, appropriate use of psychoactive drugs, and maintenance of walking aids and wheelchairs. Unfortunately, the magnitude of the effect of each component of the multifaceted intervention is unknown because of the design of these studies.

The aim of the present study was to develop a simple and stratified fall risk screening tool. This tool should ensure that time, effort, and cost are as low as possible. The procedures should be easy to perform, be adminis-

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TABLE 1. Crude odds ratios for fallers and frequent fallers in long-term care (*n* = 472), Ulm, Germany, October 1998–September 1999

Part*	Variable	No fall	1–2 falls	>2 falls	No fall vs. ≥1 fall		≤2 falls vs. >2 falls	
					OR†	95% CI†	OR	95% CI
	Cognitive patterns							
	Memory							
B2	Short-term memory‡							
	Intact (reference)	114	47	40				
	Problem	86	77	67	2.2§	1.5, 3.2	1.7§	1.1, 2.6
	Not assessable	24	10	7	0.9	0.5, 1.8	0.8	0.3, 2.0
	Memory/recall ability							
B3	Current season							
	Yes (reference)	145	70	61				
	No	79	64	53	1.6§	1.1,2.4	1.3	0.9,2.0
B3	Location of own room							
	Yes (reference)	152	79	68				
	No	72	55	46	1.5	1.0, 2.1	1.2	0.8, 1.9
	Communication							
C4	Making self understood							
	Understood (reference)	154	73	74				
	Usually or sometimes or never	70	61	40	1.5	1.0, 2.2	0.9	0.6, 1.5
	Vision patterns							
D1	Vision‡							
	Adequate (reference)	148	73	63				
	Impaired	41	40	37	2.0§	1.3, 3.1	1.6	0.9, 2.6
	Highly or severely impaired	35	21	14	1.1	0.6, 1.8	0.9	0.5, 1.7
	Mood and behavior patterns							
E1sum	Depression any symptom‡							
	Not exhibited (reference)	128	72	47				
	At least one sign exhibited	96	62	67	1.4	1.0, 2.1	1.8§	1.2, 2.8
E4sum	Behavior any symptom‡							
	Not exhibited (reference)	185	98	78				
	At least one sign exhibited	39	36	36	1.9§	1.2, 3.0	1.7§	1.1, 2.8
	Verbal expression of distress							
E1	Negative statements							
	Not exhibited (reference)	198	121	98				
	Exhibited ≥1 day/week	26	13	16	1.0	0.6, 1.7	1.3	0.7, 2.5
E1	Repetitive questions							
	Not exhibited (reference)	203	120	102				
	Exhibited ≥1 day/week	21	14	12	1.1	0.6, 2.1	1.1	0.5, 2.2
E1	Repetitive verbalization							
	Not exhibited (reference)	213	126	100				
	Exhibited ≥1 day/week	11	8	14	1.9	0.9, 4.0	2.5§	1.2, 5.2
E1	Persistent anger with self or others							
	Not exhibited (reference)	203	126	104				
	Exhibited ≥1 day/week	21	8	10	0.8	0.4, 1.5	1.1	0.5, 2.3
E1	Self-deprecation							
	Not exhibited (reference)	203	124	99				
	Exhibited ≥1 day/week	21	10	15	1.1	0.6, 2.0	1.6	0.8, 3.1

Table continues

TABLE 1. Continued

Part*	Variable	No fall	1–2 falls	>2 falls	No fall vs. ≥1 fall		≤2 falls vs. >2 falls	
					OR	95% CI	OR	95% CI
E1	Expressions of what appear to be unrealistic fears							
	Not exhibited (reference)	199	121	97				
	Exhibited ≥1 day/week	25	13	17	1.1	0.6, 1.9	1.5	0.8, 2.7
E1	Recurrent statements that something terrible is about to happen							
	Not exhibited (reference)	217	128	110				
	Exhibited ≥1 day/week	7	6	4	1.3	0.5, 3.5	1.0	0.3, 3.0
E1	Repetitive health complaints							
	Not exhibited (reference)	203	127	102				
	Exhibited ≥1 day/week	21	7	12	0.8	0.4, 1.5	1.4	0.7, 2.8
E1	Repetitive anxious complaints or concerns, nonhealth							
	Not exhibited (reference)	201	119	101				
	Exhibited ≥1 day/week	23	15	13	1.1	0.6, 2.0	1.1	0.6, 2.1
	Sad, apathetic, anxious appearance							
E1	Sad, pained, worried facial expressions							
	Not exhibited (reference)	175	108	84				
	Exhibited ≥1 day/week	49	26	30	1.0	0.7, 1.6	1.3	0.8, 2.2
E1	Crying, tearfulness							
	Not exhibited (reference)	188	116	82				
	Exhibited ≥1 day/week	36	18	32	1.3	0.8, 2.1	2.2§	1.3, 3.6
E1	Repetitive physical movements							
	Not exhibited (reference)	204	111	93				
	Exhibited ≥1 day/week	20	23	21	2.2§	1.3, 3.9	1.7	0.9, 2.3
	Behavioral symptoms							
E4	Wandering							
	Not exhibited (reference)	211	121	97				
	Exhibited at least 1 time	13	13	17	2.2§	1.1, 4.4	2.2§	1.2, 4.3
E4	Verbally abusive							
	Not exhibited (reference)	200	122	97				
	Exhibited at least 1 time	24	12	17	1.1	0.6, 2.0	1.6	0.9, 3.0
E4	Physically abusive							
	Not exhibited (reference)	212	126	104				
	Exhibited at least 1 time	12	8	10	1.4	0.7, 2.9	1.6	0.7, 3.6
E4	Socially inappropriate or disruptive behavior							
	Not exhibited (reference)	218	125	108				
	Exhibited at least 1 time	6	9	6	2.3	0.9, 6.1	1.3	0.5, 3.4
E4	Resists care							
	Not exhibited (reference)	208	119	100				
	Exhibited at least 1 time	16	15	14	1.7	0.9, 3.2	1.5	0.8, 2.9
	Physical functioning and structural problems							
	ADL† performance							
G1	Transfer‡							
	Independent (reference)	120	61	55				
	Supervision or assistance	38	44	43	2.4§	1.5, 3.7	1.7§	1.1, 2.8
	Total dependence or did not occur	66	29	16	0.7	0.4, 1.1	0.6	0.3, 1.0

Table continues

TABLE 1. Continued

Part*	Variable	No fall	1–2 falls	>2 falls	No fall vs. ≥1 fall		≤2 falls vs. >2 falls	
					OR	95% CI	OR	95% CI
G1	Walking in room							
	Independent (reference)	142	81	72				
	Supervision or assistance	21	28	24	2.3§	1.3, 4.0	1.5	0.9, 2.6
	Total dependence or did not occur	61	25	18	0.7	0.4, 1.0	0.6	0.4, 1.1
G1	Locomotion on unit							
	Independent (reference)	85	37	30				
	Supervision or assistance	44	37	34	2.0§	1.2, 3.4	1.7	1.0, 3.0
	Total dependence or did not occur	95	60	50	1.5	1.0, 2.2	1.3	0.8, 2.2
G1	Dressing‡							
	Independent (reference)	78	33	22				
	Supervision or assistance	75	60	62	2.3§	1.5, 3.6	2.3§	1.3, 4.0
	Total dependence or did not occur	71	41	30	1.4	0.9, 2.3	1.4	0.7, 2.5
G1	Toilet use							
	Independent (reference)	100	47	36				
	Supervision or assistance	48	42	43	2.1§	1.3, 3.4	2.0§	1.2, 3.3
	Total dependence or did not occur	76	45	35	1.3	0.8, 1.9	1.2	0.7, 2.0
	Test for balance							
G3	Standing position‡							
	Maintained position (reference)	96	47	35				
	Unsteady/partial physical support	56	52	59	2.3§	1.5, 3.6	2.2§	1.4, 3.6
	Not able without physical support	72	35	20	0.9	0.6, 1.4	0.8	0.4, 1.4
	Walking aids							
G5	Modes of locomotion							
	Nothing appropriate (reference)	81	41	38				
	Cane and/or wheeled self and/or wheelchair	142	93	74	1.2	0.8, 1.8	1.0	0.6, 1.6
	Continence in last 14 days							
H2	Bladder continence‡							
	Continent (reference)	109	41	28				
	Incontinent	115	93	86	2.5§	1.7, 3.6	2.2§	1.4, 3.6
	Disease diagnoses							
I	Cerebrovascular diseases (ICD-10† codes I60–I69)							
	No (reference)	180	111	98				
	Yes	45	23	16	0.7	0.5, 1.2	0.7	0.5, 1.2
I	Parkinson's disease (ICD-10 codes G20–G21)							
	No (reference)	208	123	102				
	Yes	17	11	12	1.3	0.6, 2.4	1.4	0.7, 2.8
	Health conditions							
	Problem conditions							
J1	Dizziness or vertigo‡							
	No (reference)	183	107	73				
	Yes	41	27	41	1.7§	1.1, 2.6	2.4§	1.5, 3.8

Table continues

trable by nursing staff, and focus on potentially amenable items to encourage implementation and application.

Our main interest was not primarily to identify new indicators but to improve the process of identifying persons at risk. Moreover, we hypothesized that the risk of falling could

TABLE 1. Continued

Part*	Variable	No fall	1–2 falls	>2 falls	No fall vs. ≥1 fall		≤2 falls vs. >2 falls	
					OR	95% CI	OR	95% CI
	Pain symptoms							
J2	Frequency							
	No pain (reference)	123	76	59				
	Less then daily/daily	100	57	54	1.0	0.7, 1.5	1.2	0.8, 1.8
	Accidents							
J4	Fall‡							
	No fall (reference)	201	99	55				
	Fall in last 180 days	23	35	59	5.3§	3.2, 8.8	5.5§	3.5, 8.8
J4	Fracture							
	No (reference)	215	124	107				
	Yes	9	10	7	1.8	0.8, 4.0	1.2	0.5, 2.9
	Medications							
O1	No. of medications							
	0–4 (reference)	142	83	63				
	≥5	82	51	51	1.2	0.8, 1.8	1.4	0.9, 2.1
O4	Antipsychotic‡							
	No (reference)	164	78	70				
	Yes	60	56	44	1.8§	1.3, 2.7	1.3	0.8, 2.0
O4	Antianxiety							
	No (reference)	217	129	110				
	Yes	7	5	4	1.2	0.4, 3.2	1.0	0.3, 3.3
O4	Antidepressant							
	No (reference)	198	118	93				
	Yes	26	16	21	1.3	0.7, 2.3	1.7	1.0, 3.0
O4	Hypnotic							
	No (reference)	199	121	97				
	Yes	25	13	17	1.1	0.6, 1.9	1.5	0.8, 2.7
	Special treatments and procedures							
	Devices and restraints							
P4	Bed rails							
	No (reference)	152	103	83				
	Yes	72	31	31	0.7	0.5, 1.1	0.9	0.6, 1.5
P4	Restraint‡							
	No (reference)	218	120	102				
	Yes	6	14	12	4.3§	1.7, 0.5	2.0	0.9, 4.2
	Hospital stay							
P5	Hospital stay with an overnight stay in the last 90 days‡							
	No (reference)	201	119	92				
	Yes	23	15	22	1.5	0.9, 2.7	2.0§	1.1, 3.6

* Part of the coding system used in the Minimum Data Set of the Resident Assessment Instrument.

† OR, odds ratio; CI, confidence interval; ADL, activities of daily living; ICD-10, *International Classification of Diseases*, Tenth Revision.

‡ Risk indicators included in the multiple logistic regression analysis.

§ Important risk indicators.

increase with moderate impairments and disability levels but could decrease with very severe limitations in several domains. Therefore, we included polytomous risk indicators whenever possible and sensible. Another aim of the study was to identify indicators for fallers in general and for frequent fallers in particular.

MATERIALS AND METHODS

Population and setting

Subjects included in this prospective observational study were aged 60 years or older (n = 472) and were living in three long-term-care institutions in a city in southern Germany (Ulm) during the 12-month study period (October 1998–September 1999). The residents were members of a control group within a cluster-randomized fall prevention trial.

In this area of Germany, the proportion of the elderly population living in the community as well as in long-term care is very similar to that in the nation. At the time of the study, 15.6 percent of the city population was older than age 65 years and 3.9 percent was aged 80 years or older; 5 percent of the population aged 65 years or older lived in a long-term-care setting.

According to current legislation, access to long-term care is restricted to residents who need a minimum of 1.5 daily hours of assistance with activities of daily living and have an expected duration of such assistance of more than 6 months (18). This need is preassessed by state-employed nurses and long-term-care physicians. Hospice and posthospital rehabilitation candidates were not included in the analysis.

Measurements

Fall risk indicators were assessed cross-sectionally by study staff. Used were definitions of fall risk indicators according to the operationalized terms in version 2.0 of the Minimum Data Set of the Resident Assessment Instrument (19). Risk indicators in this instrument are either dichotomous, polytomous, or continuous variables. This instrument formerly was not used in this setting and was translated from a version by Morris et al. (20).

Falls were defined as "unintentionally coming to rest on ground or lower level regardless of a loss of consciousness." Multiple fallers were predefined as residents having three or more falls. We considered single and dual fallers as a different entity whose falls were more likely to be caused by time-dependent risk factors such as, for example, acute illness or use of new medications. The study nurse checked the completeness of the fall calendars. Each ward kept a calendar counting the number of falls. Each fall had to be documented on a separate case report form that included details on location, time, and injuries. Falls were counted for all residents regardless of their mobility status. Residents who moved to the facility during the study period were included in the analysis to avoid selection bias. Data were collected prospectively.

Statistical analysis

All data were entered into a database and were controlled by a second independent person. For quantitative variables, the median, minimum, maximum, mean, and standard deviation were calculated. For categorical variables, absolute and relative frequencies were reported. For all potential risk indicators for falls, crude odds ratios with corresponding 95 percent confidence intervals were calculated. Odds ratios were determined for the risk of falling at least once (falls in general) and for the risk of falling three or more times (frequent falls). Crude odds ratios and their confidence intervals were used to preselect risk indicators. Additionally, Cramer's V was calculated to assess interdependences between risk indicators. In case of highly related risk indicators (Cramer's V >0.5), only one risk indicator was considered for the logistic regression analysis to avoid multicollinearity problems. Thereby, the variable with the highest clinical relevance was chosen. The resulting variables were then included in a multiple logistic regression analysis (21). To select important risk indicators, backward elimination (selection level, 5 percent) was used. Odds ratios, 95 percent confidence intervals, and p values are presented here. Interaction terms were not considered because of numerical problems and because the main aim was to develop an easily applicable screening tool. We did not intend to further improve the fit of the logistic regression model by adding interaction terms that would have been helpful and essential. Sensitivity, specificity, and positive and negative predictive values were calculated with corresponding 95 percent confidence intervals. Receiver operating characteristic curves were plotted to describe the sensitivity and specificity of the selected risk indicators. Additionally, the area under the curve was determined. Statistical analyses were conducted by using SAS statistical software, version 8.2 (SAS Institute, Inc., Cary, North Carolina).

Consent and approval

All participants or their legal guardians had to give informed consent to participate in the study. The study was approved by the ethical committee of the University of Ulm.

RESULTS

The mean age of participants was 84 years (standard deviation, 7.0; median, 85; minimum–maximum, 60–104), and most subjects were female (77 percent). The 1-year mortality rate was 17.4 percent. Total follow-up time for the 472 residents was 383 resident-years. A total of 331 (70 percent) participants were followed for 10–12 months, 50 participants (11 percent) for 7–9 months, 59 participants (13 percent) for 4–6 months, and 27 participants (6 percent) for up to 3 months. For five residents, the time of discharge was not recorded. Overall, 980 falls (2,558 falls per 1,000 resident-years) for 247 fallers (645 fallers per 1,000 resident-years) were recorded. The number of frequent fallers was 115 (300 fallers per 1,000 resident-years).

Crude odds ratios

Crude odds ratios and 95 percent confidence intervals are shown in table 1. Of the 46 potential risk indicators considered, 21 seemed strongly associated with the risk of falling and/or the risk of experiencing multiple falls. All polytomous risk indicators were associated with a remarkably higher risk of falling related to moderate impairment versus very severe impairment. Some indicators were closely related to others. Therefore, to avoid multicollinearity problems in the logistic regression model, contingency coeffi-

TABLE 2. Results of multiple logistic regression analysis of participants in long-term care (n = 472), Ulm, Germany, October 1998–September 1999

	No fall vs. ≥1 fall			≤2 falls vs. >2 falls		
	OR*	95% CI†	*p* value	OR*	95% CI	*p* value
Transfer						
Independent (reference)	1.0			1.0		
Supervision or assistance	1.6	0.9, 2.6	<0.001	1.2	0.7, 2.0	0.002
Total dependence or did not occur	0.4	0.2, 0.7		0.4	0.2, 0.7	
Bladder continence						
Continent (reference)	1.0			1.0		
Incontinent	2.0	1.3, 3.2	0.003	2.1	1.2, 3.6	0.007
Fall						
No fall (reference)	1.0			1.0		
Fall in last 180 days	4.9	2.9, 8.4	<0.001	5.2	3.2, 8.5	<0.001
Short-term memory						
Intact (reference)	1.0					
Memory problem	1.6	1.1, 2.6	0.045			
Not assessable	0.9	0.4, 2.0				
Trunk restraint						
No (reference)	1.0					
Yes	4.7	1.6, 13.3	0.004			
Depression any symptom						
Not exhibited (reference)				1.0		
At least one exhibited				1.6	1.0, 2.6	0.049

* Odds ratios (OR) were adjusted for other variables in the model.
† CI, confidence interval.

cients were calculated. Of those risk indicators showing a strong interdependence, only one was included in the logistic regression analysis (short-term memory instead of temporal orientation, transfer instead of walking in the room or locomotion on unit, dressing instead of toilet use). All items concerning depressive symptoms and disruptive behavioral patterns were summarized in two group indicators. Thus, 13 risk indicators (identified in table 1) were preselected for the multiple logistic regression analysis.

Multiple logistic regression analysis

Variable selection with backward elimination in the two binary multiple logistic regression models revealed the results presented in table 2. Important risk indicators for predicting falling at least once (model 1) were short-term memory loss, transfer assistance, urinary incontinence, positive fall history, and use of trunk restraints. To discriminate frequent fallers from residents experiencing at most two falls (model 2), the pool of important risk indicators selected was slightly different and consisted of the following variables: depressive symptoms, transfer assistance, urinary incontinence, and positive fall history.

Receiver operating characteristic curves are shown in figure 1. The area under the curves was calculated as 0.756 for model 1 and 0.755 for model 2. Where the sum of sensitivity and specificity is maximal in the two curves, sensitivity and specificity were 78.2 percent (95 percent confidence interval (CI): 72.6 percent, 83.2 percent) and 60.3 percent (95 percent CI: 53.5 percent, 66.7 percent), respectively, in model 1 and 69.3 percent (95 percent CI: 60.0 percent, 77.6 percent) and 70.4 percent (95 percent CI: 65.4 percent, 75.1 percent), respectively, in model 2. The positive predictive value for falling in general (model 1) was 68.6 percent (95 percent CI: 62.3 percent, 73.9 percent). The negative predictive value was 71.4 percent (95 percent CI: 64.4 percent, 77.8 percent). For the frequent-faller group, the positive predictive value was 42.7 percent (95 percent CI: 35.5 percent, 50.1 percent) and the negative predictive value was 87.8 percent (95 percent CI: 83.5 percent, 91.4 percent). Residents without any of the indicators selected in model 1 had a probability of falling of 29 percent (95 percent CI: 22 percent, 38 percent). However, identifying residents at high risk of falling according to the presence of at least one risk indicator from model 1 led to a sensitivity of 92 percent (95 percent CI: 87 percent, 95 percent).

DISCUSSION

The cohort of long-term-care residents we examined had the expected high prevalence of cognitive dysfunction, depressive symptoms, and physical limitations. The inci-

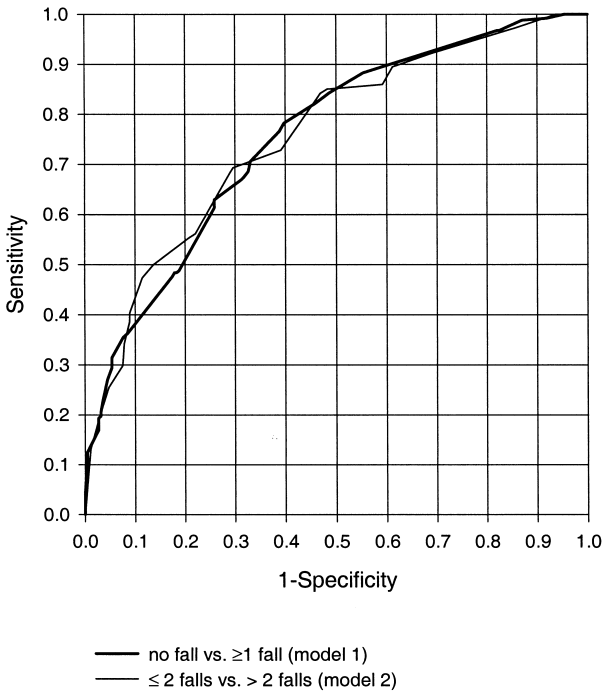

FIGURE 1. Receiver operating characteristic curve for predicting falls according to the risk indicators of transfer, bladder incontinence, fall, short-term memory, trunk restraint, and any depression symptom among urban long-term-care residents in Ulm, Germany (n = 472), October 1998–September 1999.

dence of falls was within the reported range of most epidemiologic studies that included long-term-care residents. Age, sex, and mortality were representative for a nursing-home population.

In a multiple logistic regression analysis, short-term memory loss, transfer assistance, urinary incontinence, positive fall history in the past 6 months, and use of trunk restraints were selected as important risk indicators for falls. Depressive symptoms, transfer assistance, urinary incontinence, and positive fall history were selected when frequent falls were considered. The described predisposing indicators had considerable sensitivity and specificity to discriminate between frequent fallers, single fallers, and nonfallers in long-term care. Positive and negative prediction was moderate.

Most research groups have used more sophisticated and multidisciplinary procedures applied by interdisciplinary teams to assess the risk of falling (14). Doing so would not have been applicable in our sample, since only 30 percent of the residents had access to regular physiotherapy, and most physicians were routinely available only biweekly. Therefore, we chose an instrument that could be applied by nursing staff with a modest training effort, was simple to administer, and required less than 15 minutes to fill in the forms. Screening could be conducted by nursing staff given minimal training. Acceptance by staff was high because only information that had to be obtained for care planning purposes was processed.

In contrast to some other studies on fall prevention in long-term-care settings, we entered polytomous risk indicators into our model because we hypothesized that severe physical limitations could lead to a decrease in mobility and thus a reduction in the risk of falling. For items such as transfer, we observed that moderately dependent residents had a higher incidence of falls than residents needing no help or those who were severely dependent. This relation would not have been discovered if assessment instruments had consisted of only dichotomous risk indicators.

Given the small numbers of successful intervention studies in long-term-care settings, it was encouraging to find that several risk indicators are potentially modifiable but have not been routinely addressed in previous intervention trials. Urinary incontinence is a treatable condition but has only recently been mentioned as an intervention target for fall prevention. Nocturia and urge incontinence seem to be the major problems in this context (22). Behavioral disorders, misuse of restraints, wandering, motor agitation, and inappropriate psychoactive medication have been addressed in several studies, with promising results (17, 22). The fall risk associated with depression and antidepressant medication remains a matter of debate (23). The incidence of falls has not been documented adequately in drug intervention trials. Therefore, it remains unsettled whether use of antidepressants causes falls or whether the increased physical activity associated with an improvement in depressive symptoms increases the probability of falls per meters walked. More than 50 percent of the falls in long-term care are transfer related. If vertical movements such as standing up from a chair or bed yield a higher risk than horizontal movements for long-term-care residents, the content of exercise programs should be questioned, which possibly should be more task specific. Medical treatment of cognitive impairment might reduce fall rates by improving attention and orientation, but this issue has not been studied adequately up to now. Controlled trials on restraints are lacking. Previous observational studies on physical restraints and bed side rails did not demonstrate a protective effect against falls. Conversely, removal of restraints has not been associated with a reduction in fall rates even though it is desirable for other reasons (4).

We are aware that our model has limitations and certainly can be improved. Time-dependent factors (precipitating factors) such as overdemanding activities, acute illness, or new medications were not documented adequately for the time period when the fall occurred. Social factors such as staff time per resident, staff motivation, and administrative processes were also not included in this study. Environmental factors such as footwear, lighting conditions, and inadequate bed height at the time of the accident were insufficiently documented. Since the participants were members of a control group of an intervention trial, we cannot rule out the possibility that this factor influenced staff and resident behavior during the study period. In addition, information bias has to be considered, especially because demented residents are difficult to assess. This limitation might have led to an underestimation of, for example, vision problems or

depressive symptoms in this group. Selection bias is less likely, since admittance is open to all segments of the population because of a standardized reimbursement scheme secured by a mandated long-term-care insurance system.

The generalizability of our results remains to be demonstrated since access, finances, and the role of long-term care are different in health care systems. It is possible that risk indicator profiles will change when successful intervention strategies are implemented and eliminate or compensate for risk factors. Fall risk identification should be a dynamic process. Moreover, we would not recommend using cutoff scores. The presence of any of the risk indicators in the multiple logistic regression model is already indicative of high risk. Consideration of increasing the sensitivity of the screening process must include the capacity of the long-term-care system to handle a higher number of false positives. Therefore, it must be stressed that not all fall preventive measures are free of side effects. Measures might include advice to avoid certain activities or lead to an additional burden such as wearing a hip protector that increases the risk of incontinence and/or dressing difficulties (16).

In conclusion, the observational design of the study did not prove the causal role of the risk indicators. Properly designed intervention trials must be conducted to demonstrate the effects of removing or compensating for the identified risk indicators on fall rates.

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