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ORIGINAL RESEARCH

Low admission Norton scale scores are associated with falls long after rehabilitation in the elderly with hip fractures

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Background: In this study, we investigated if low admission Norton scale scores (ANSS) are associated with falls, fractures, hospitalizations, and death, after rehabilitation in the elderly with hip fractures.

Methods: This prospective historical study followed consecutive elderly patients (≥65 years) who were admitted for rehabilitation following hip fracture surgery during 2009 and followed up in January or February 2012. The incidence of falls, number of falls, incidence of fractures, number of hospitalizations, and death rates were compared between patients with low (≤14) and high (≥15) ANSS.

Results: The final cohort included 174 patients of mean age 83.6 ± 6.2 years, with 133 (76.4%) being women. Fifty-seven (27.0%) patients died during follow-up. Of the remaining 127 patients, 44 (34.6%) fell at least once and 15 (11.8%) suffered fractures. Overall, 81 (46.6%) patients had a low ANSS. Relative to patients with a high ANSS, they had a higher incidence of falls (odds ratio 3.3, 95% confidence interval 1.5–7.1; $P = 0.002$) and fell more times (1.2 ± 1.8 versus 0.6 ± 1.7; $P = 0.002$). Regression analysis showed that ANSS (as a parametric variable) as well as a low ANSS (as a nonparametric variable) were independently associated with falls ($P = 0.002$ and $P = 0.009$, respectively). There were no differences between patients with low and high ANSS in terms of incidence of fractures, number of hospitalizations, and death rates.

Conclusion: The Norton scoring system may be used for predicting falls long after rehabilitation in the elderly with hip fractures.

Keywords: falls, hip fracture, Norton scale, rehabilitation

Introduction

Elderly patients are at risk for falls, secondary fractures, hospitalizations, and death following hip fracture surgery.[1–7] Accordingly, it would be valuable to be able to predict complications and mortality after rehabilitation in the elderly with hip fractures. The Norton scoring system is a well-known scale used by nurses to evaluate the risk of pressure ulcers.[8] It includes five domains that concern fundamental aspects of well-being, ie, physical condition, mental condition, activity, mobility, and continence. These features are also included in the comprehensive geriatric assessment made by geriatricians. Because the comprehensive geriatric assessment is a diagnostic as well as a prognostic tool,[9] one may assume that the Norton scoring system would have prognostic features other than merely predicting the risk of pressure ulcers. Indeed, we have previously shown that low admission Norton scale scores (ANSS) are associated with postoperative complications and inhospital mortality in elderly patients following hip fracture surgery.[10] We have also shown that a low ANSS is associated with prolonged

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rehabilitation and a poor rehabilitation outcome in elderly patients following any type of hip surgery.[11] In this study, we sought to evaluate if a low ANSS is also associated with falls, fractures, hospitalizations, and death after rehabilitation in the elderly with hip fractures.

Materials and methods

Study design and measurements

This was a historical prospective study conducted in the Department of Geriatrics at Sourasky Medical Center, a tertiary medical facility in Tel-Aviv, Israel. The study was approved by the local ethics committee. The electronic medical charts of consecutive elderly patients (≥65 years) admitted for rehabilitation following hip fracture surgery during 2009 were reviewed. Data concerning demographics, comorbidities, routine admission laboratory tests, ANSS, and Mini-Mental State Examination (MMSE) scores, were retrieved from the charts. Patients were followed up with a phone call made by one of the researchers (EH) between January and February 2012. The incidence of falls, number of falls, number of recent falls (<6 months), incidence of fractures, number of hospitalizations, and deaths during the follow-up period were compared between patients with low and high ANSS. Except for death rates, which were extracted from the Israeli General Register Office database, all other follow-up measurements were self-reported. In order to overcome forgetfulness, patients, their spouses, and/or their caregivers were interviewed. A fall was defined as an unplanned descent to the floor with or without injury.

Inclusion and exclusion criteria

The preliminary study included 245 elderly patients. Excluded were patients in whom ANSS was not documented (n = 3). Also excluded were non-weight-bearing patients (n = 23), those with severe systemic complications during rehabilitation (n = 19), those with concurrent fractures other than hip fractures (n = 12), those who did not become ambulatory during rehabilitation (n = 7), those who chose to withdraw from rehabilitation earlier than scheduled (n = 2), and those who died during rehabilitation (n = 1). Four patients were lost to follow-up.

The Norton scoring system

ANSS was measured routinely for all patients by their nurses. Each of the five domains of the Norton scoring system was assessed on a scale between 1 and 4 points (see Appendix). Hence, the final score ranged between 5 and 20 points. A final score ≤ 14 points was considered low and represented high risk for pressure ulcers. A final score ≥ 15 points was considered high and represented low risk for pressure ulcers.[8] Patients with low ANSS were encouraged by their nurses to change position frequently in order to prevent pressure ulcers. The sensitivity and specificity of the Norton scoring system in predicting pressure ulcers was 63% and 70%, respectively.[12]

Statistical analysis

Continuous variables were expressed as the mean ± standard deviation, median, range, and interquartile range. The Student's *t*-test was used to compare the mean values of continuous variables with parametric distributions. The Mann-Whitney test was used to compare the mean values of continuous variables with nonparametric distributions. Fisher's Exact test was used to compare the prevalence of categorical variables. Correlations between parametric variables were calculated using Pearson's coefficients. Correlations between nonparametric variables were calculated using Spearman's coefficients. Nominal regression analysis was used to identify which variables were independently associated with falls and death. Two-tailed $P < 0.05$ was considered to be statistically significant. SPSS statistical software version 17.0 (SPSS Inc, Chicago, IL) was used for all statistical analyses.

Results

The final cohort included 174 patients, of which 133 (76.4%) were women, with the mean age being 83.6 ± 6.2 (median 83 years, range 65–101, interquartile range 80–87) years. The three most common comorbidities were hypertension, diabetes mellitus, and ischemic heart disease (Table 1). Most patients (n = 109, 62.6%) underwent open reduction and internal fixation hip surgery, while 63 (36.2%) had hemiarthroplasty and two (1.1%) patients had total hip replacement. The patients were followed for 29.8 ± 3.7 (median 30, range 23–36, interquartile range 26–33) months. Overall, 47 (27.0%) patients died during this time. There were no statistical differences between the overall cohort and the remaining 127 patients in terms of clinical characteristics. Of the surviving patients, 44 (34.6%) fell at least once, and 15 (11.8%) had secondary fractures (Table 1).

The mean ANSS was 14.7 ± 1.8 (median 15, range 10–20, interquartile range 13–16), with 81 (46.6%) patients having a low ANSS. Relative to patients with a high ANSS, those with a low ANSS were older, had lower albumin levels and

Table 1 Clinical characteristics of the cohort

Comorbidities	Whole cohort (n = 174)	Surviving patients (n = 127)	*P* value
Hypertension, n (%)	131 (75.3)	94 (74.0)	0.893
Diabetes mellitus, n (%)	38 (28.1)	27 (21.3)	0.999
Ischemic heart disease, n (%)	35 (20.1)	23 (18.1)	0.768
Pressure ulcer, n (%)	24 (13.8)	18 (14.2)	0.999
Stroke, n (%)	20 (11.5)	13 (10.2)	0.852
Parkinson's disease, n (%)	10 (5.7)	5 (3.9)	0.596
Albumin levels, Mean ± SD, mg%	33.4 ± 3.4	36.7 ± 3.6	0.747
MMSE scores, Mean ± SD	23.2 ± 5.8*	24.1 ± 5.5**	0.295
During follow-up			
Falls, n (%)	NA***	44 (34.6)	NA
Falls, Mean ± SD	NA***	0.8 ± 1.8	NA
Recent falls, Mean ± SD	NA***	0.4 ± 1.0	NA
Secondary fractures, n (%)	NA***	15 (11.8)	NA
Hospitalizations, Mean ± SD	NA***	0.6 ± 1.1	NA
Death, n (%)	47 (27.0)	NA	NA

Notes: *Data available for 109 patients; **data available for 82 patients; ***data was not available for deceased patients.
Abbreviations: MMSE, Mini-mental state examination; NA, not applicable; SD, standard deviation.

MMSE scores, had a higher likelihood of at least one fall, and fell more often (Table 2). ANSS correlated negatively with the number of falls, while controlling for age, albumin levels, and MMSE scores (Figure 1). There were no differences between patients with low and high ANSS in terms of incidence of fractures, incidence of recent fractures, number of hospitalizations, and death rate.

Regression analysis showed that ANSS (as a parametric variable), low ANSS (as a nonparametric variable), and pressure ulcers were independently associated with falls, regardless of age, gender, comorbidities, albumin levels, and MMSE scores (Table 3). ANSS and low ANSS were not independently associated with fractures, hospitalizations, or mortality risk (data not shown).

The sensitivity and specificity of a low ANSS in predicting falls was 61.4% and 67.5%, respectively. The positive predictive and negative predictive values were 50.0% and 76.7%, respectively.

Table 2 Characteristics of patients with low and high admission Norton scale scores

	High ANSS (n = 93)	Low ANSS (n = 81)	OR (95% CI)	*P* value
Demographics and comorbidities				
Age, mean ± SE, years	82.1 ± 6.3	85.4 ± 5.6	NA	<0.0001
Female gender, n (%)	69 (74.2)	64 (79.0)	1.3 (0.6–2.7)	0.479
Hypertension, n (%)	66 (70.9)	65 (80.2)	1.6 (0.8–3.4)	0.164
Diabetes mellitus, n (%)	20 (21.5)	18 (22.2)	1.0 (0.5–2.1)	0.999
Ischemic heart disease, n (%)	15 (16.1)	20 (24.7)	1.7 (0.8–3.6)	0.187
Pressure ulcer, n (%)	11 (11.8)	13 (16.0)	1.4 (0.6–3.4)	0.510
Stroke, n (%)	11 (11.8)	9 (11.1)	0.9 (0.4–2.4)	0.999
Parkinson's disease, n (%)	3 (3.2)	7 (8.6)	2.8 (0.7–11.4)	0.191
Albumin levels, mean ± SE, mg%	34.1 ± 3.5	32.5 ± 3.2	NA	0.002
MMSE scores*, mean ± SE	24.9 ± 4.8	21.4 ± 6.2	NA	0.001
During follow-up				
Falls**, n (%)	17 (18.3)	27 (33.3)	3.3 (1.5–7.1)	0.002
Falls**, mean ± SE	0.6 ± 1.7	1.2 ± 1.8	NA	0.002
Recent falls**, mean ± SE	0.4 ± 1.2	0.5 ± 0.8	NA	0.086
Secondary fractures**, n (%)	9 (9.7)	6 (7.4)	0.9 (0.3–2.7)	0.999
Hospitalizations**, mean ± SE	0.4 ± 1.0	0.7 ± 1.1	NA	0.106
Death, n (%)	20 (21.5)	27 (33.3)	1.8 (0.9–3.6)	0.089

Notes: *Data available for 109 patients; **data available for 127 patients who did not die.
Abbreviations: ANSS, admission Norton scale scores; CI, confidence interval; MMSE, Mini-mental state examination; NA, not applicable; OR, odds ratio; SE, standard error.

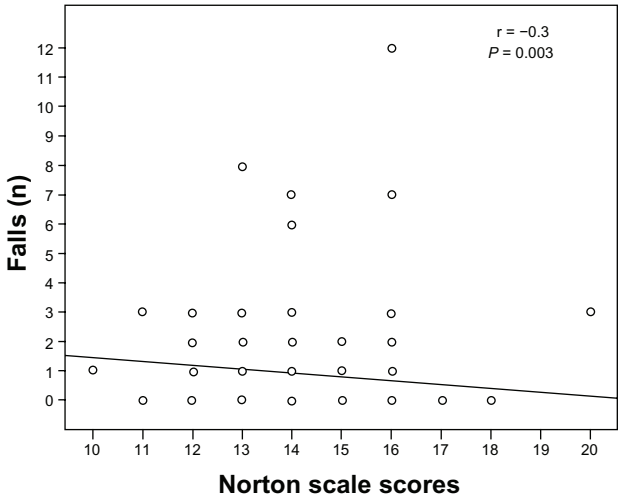

Figure 1 Pearson's correlation between admission Norton scale scores and the number of falls.

Discussion

It is of great clinical importance to be able to predict falls, secondary fractures, hospitalizations, and death after rehabilitation in the elderly with hip fractures. Overall, 32%–56% of patients report one or more falls following hospital discharge for hip fracture surgery,[1–3] 3%–14% sustain a secondary fracture,[4–7] and 15% die within a year.[7] The incidence of falls, the incidence of fractures, and death rates in our study have all been consistent with these observations. Hence, our cohort represents the elderly with hip fractures well. In this study, we have shown for the first time that the Norton scoring system may be used for predicting falls long after rehabilitation in the elderly with hip fractures.

Pressure ulcers are a major problem associated with morbidity and mortality in elderly immobile patients. Risk assessment scales, such as the Norton scoring system, have been available for more than 50 years for assessing the risk of pressure ulcers, but their usefulness in preventing these ulcers remains uncertain.[13,14] The current study adds to the evidence showing that it is too early to abandon the Norton scoring system, given that it can be used for purposes other than predicting the risk of pressure ulcers, including predicting postoperative complications and inhospital mortality in elderly patients following hip fracture surgery,[10] predicting postoperative complications in elderly patients following spine fracture surgery,[15] and predicting the duration and outcome of rehabilitation in elderly patients following any type of hip surgery,[11] stroke,[16] or hospital-associated deconditioning.[17]

Age, congestive heart failure, poor quality of life, poor nutritional status,[3] fear of falling,[18] use of a gait device, and slow walking during rehabilitation[2] are all associated with falls in the elderly following hip fracture surgery. Except for age, most of these risk factors are difficult to measure. On the other hand, Norton scale scores are simple to measure and, accordingly, can be used as a geriatric screening assessment tool by nurses and physicians who are not familiar with traditional geriatric and rehabilitation scales. There are few well-studied scales used for assessing the risk of falls in the elderly, including the falls risk assessment tool,[19] Berg balance scale,[20] and timed up and go test.[21] Relative to these scales, the Norton scoring system is not time-consuming. Most importantly, it is already being used successfully throughout the world right now.

In a recently published study, we have shown that the Norton scoring system may be used for predicting mortality in the elderly long after rehabilitation following any type of hip surgery, stroke, and hospital-associated deconditioning.[22] In the current study, ANSS and low ANSS were not associated with death long after rehabilitation in the elderly with hip fractures. This discrepancy may be explained in two ways, ie, the current study included elderly patients with a history of hip fractures, while the other study included elderly patients with a history of hip fractures as well as elderly patients with a history of elective total hip replacement, stroke, and hospital-associated deconditioning. Moreover, the follow-up period in the current study was more than a year longer than that in the previous study. There is a place to study the predictive value of the Norton scoring system in terms of mortality long after rehabilitation separately for elderly patients following total hip replacement, stroke, and hospital-associated deconditioning.

One may claim that it should be no surprise that a low ANSS is independently associated with falls in the elderly with hip fractures, given that patients who develop pressure ulcers are more likely to fall, being partially immobile in the first place. However, regression analysis showed that ANSS as well as a low ANSS are independently associated with falls in the elderly with hip fractures, regardless of the appearance of pressure ulcers.

Another limitation is the sample size being too small for making population-based conclusions regarding lower ANSS cutoffs. Although an ANSS of 14 represents a high risk for pressure ulcer,[8] it is possible that a lower ANSS is more sensitive and specific in predicting falls. Accordingly, it would be valuable to study the association between a lower ANSS and falls in the future in large-scale populations. In the meantime, in order to overcome this limitation, the regression analysis in Table 3 has included low ANSS as a nonparametric variable as well as ANSS as a parametric variable.

Another limitation is the observational nature of this study. Future studies should include interventional measures

Table 3 Regression analysis showing which variables were independently associated with falls*

	OR	95% CI		*P* value
		Lower boundary	Upper boundary	
Independent variables				
Age	1.011	0.913	1.120	0.835
Female gender	2.214	0.443	11.064	0.333
Hypertension	0.297	0.075	1.176	0.084
Diabetes mellitus	0.496	0.132	1.863	0.299
Ischemic heart disease	0.955	0.167	5.467	0.958
Pressure ulcer	0.097	0.008	1.213	0.070
Stroke	0.382	0.041	3.594	0.400
Parkinson's disease	2.899	0.130	64.461	0.501
ORIF	0.380	0.116	1.242	0.109
Albumin levels	1.053	0.899	1.233	0.523
MMSE scores	1.037	0.929	1.156	0.519
Low ANSS (nonparametric)	5.133	1.513	17.411	0.009
Independent variables				
Age	1.003	0.906	1.111	0.948
Female gender	2.210	0.425	11.498	0.346
Hypertension	0.243	0.059	1.001	0.050
Diabetes mellitus	0.469	0.121	1.815	0.273
Ischemic heart disease	1.501	0.233	9.694	0.669
Pressure ulcer	0.067	0.005	0.969	0.047
Stroke	0.432	0.047	3.947	0.457
Parkinson's disease	2.662	0.098	72.619	0.562
ORIF	0.381	0.113	1.285	0.120
Albumin levels	0.975	0.822	1.157	0.770
MMSE scores	1.022	0.914	1.142	0.703
ANSS (parametric)	1.906	1.272	2.856	0.002

Note: *Data available for 82 patients.
Abbreviations: ANSS, admission Norton scale scores; CI, confidence interval; MMSE, Mini-mental state examination; OR, odds ratio; ORIF, open reduction and internal fixation.

used to prevent falls and fractures in elderly patients with a low ANSS, ie, bisphosphonates and vitamin D supplementation.[23]

Conclusion

We propose that in addition to predicting pressure ulcer risk, the Norton scoring system should be added to the tools used for predicting falls in the elderly with hip fractures. However, there is still a need to study these findings in large cohorts in a prospective manner.

Disclosure

The authors report no conflicts of interest in this work.

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Appendix

Appendix Norton scoring system

Domains	Scores
Physical condition	4 = Good
	3 = Fair
	2 = Poor
	1 = Very bad
Mental condition	4 = Alert
	3 = Apathetic
	2 = Confused
	1 = Stuporous
Activity (in daily living)	4 = Independent
	3 = Slightly dependent
	2 = Very dependent
	1 = Fully dependent
Mobility	4 = Ambulant
	3 = Walks with help
	2 = Chair bound
	1 = Bedridden
Incontinence	4 = None
	3 = Occasional
	2 = Usually urinary
	1 = Urinary and fecal