Online Exclusive Article

Predictors of a Fall Event in Hospitalized Patients With Cancer

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Purpose/Objectives: To determine predictors of fall events in hospitalized patients with cancer and develop a scoring system to predict fall events.

Design: Retrospective medical record review.

Setting: A 1,200-bed tertiary care hospital in northeastern Ohio.

Sample: 145 patients with cancer who did not have a fall event were randomly selected from all oncology admissions from February 2006–January 2007 and compared to 143 hospitalized patients with cancer who had a fall event during the same period.

Methods: Multivariable logistic regression models predicting falls were fit. Risk score analysis was completed using bootstrap samples to evaluate discrimination between patients who did or did not fall and agreement between predicted and actual fall status. A nomogram of risk scores was created.

Main Research Variables: Fall episodes during hospitalization and patient characteristics that predict falls.

Findings: While patients were hospitalized for cancer care, their predictors of a fall episode were low pain level, abnormal gait, cancer type, presence of metastasis, antidepressant and antipsychotic medication use, and blood product use (all $p < 0.02$); risk model c-statistic was 0.89.

Conclusions: For hospitalized patients with cancer, predictors reflecting greater fall episode risk can be assessed easily by nursing staff and acted on when the risk is sufficiently high.

Implications for Nursing: Understanding specific risk factors of falls in an adult oncology population may lead to interventions that reduce fall risk.

Fall prevention for hospitalized patients is an important nursing quality indicator. About 23%–42% of inpatient falls result in injury, with 2%–9% resulting in serious events including fractures, subdural hematoma, excessive bleeding, and death (Chelly et al., 2008; Enloe et al., 2005; Fisher et al., 2005; Hitcho et al., 2004). Wong et al. (2011) found that patients who fell and sustained serious injuries incurred $13,806 more cost and had a 6.9-day longer length of stay compared to matched patients who did not fall. Fall-related lawsuits generated against facilities and healthcare providers also can increase costs. In addition, fall injuries have cost implications for hospitals because Medicare reimbursement is eliminated for secondary diagnoses related to hospital-acquired fall injuries (Centers for Medicare and Medicaid Services, 2012).

Among hospitalized patients, those being treated for cancer have higher fall frequencies and injury rates than patients without cancer (Alcee, 2000; Hitcho et al., 2004; O'Connell, Baker, Gaskin, & Hawkins, 2007). In addition to general fall-risk factors, people with cancer have cancer-specific fall-risk factors, including neurologic and nutritional deficits as a result of cancer treatments, polypharmacy, and deconditioning from cancer-related fatigue (Dean et al., 1995; Holley, 2000; Holley & Borger, 2001). Cancer care is a highly prevalent reason for hospitalization; therefore, nurses need to understand evidence-based fall predictors so that processes and interventions can be developed and implemented to decrease patient risk.

Based on a review of the literature and previous research conducted by the authors, some characteristics of hospitalized patients with a cancer diagnosis who fell were similar to those of general medical-surgical hospitalized patients who fell. For example, mean age of adult patients with cancer who fell was 62.4 years (Capone, Albert, Bena, & Morrison, 2010) and mean age of adult medical-surgical inpatients in academic and nonacademic hospitals was 62–72 years (Krauss et al., 2007). Weakness was a prominent general characteristic in 80% of patients with cancer (Capone et al., 2010) and adult medical-surgical inpatients without cancer who had a fall event (Alcee, 2000; Byers, Arrington, & Finstuen, 1990; Janken, Reynolds, & Swiech, 1986).

Some differences were noted in the literature between hospitalized patients with cancer who fell and the general medical-surgical population. In medical-surgical patients, male gender and confusion were significant fall-risk factors (Alcee, 2000; Fisher et al., 2005; Krauss et al., 2007; Sherrington et al., 2010), but neither factor had high prevalence rates in patients with cancer (Capone et al., 2010). When cancer treatments and other cancer-related variables were assessed to determine their prevalence among patients who fell (N = 143), 21% of patients with cancer reported some level of pain prior to a fall event, and opiates were the most frequent medication class used within 24 hours of the fall (Capone et al., 2010). Temperatures were higher than 37°C in 24%, and 7% received blood products during their hospital stay (Capone et al., 2010). Research literature on characteristics of patients with cancer who did not fall was unavailable; therefore, whether characteristics identified in patients with fall events were important was unknown.

The purpose of this study was to fill the gap in fall event literature by examining factors of hospitalized patients with cancer who did and did not fall to determine variables associated with falling. The specific objectives were to use readily available clinical data to identify predictors of a fall event in hospitalized patients with cancer and to develop a user-friendly and practical fall-risk score (prediction tool) for hospitalized patients with cancer that could be used in routine clinical practice.

Methods

Design, Setting, and Sample

This retrospective medical record review was conducted at a 1,200-bed tertiary care medical center in northeastern Ohio, following approval from the institutional review board of the Cleveland Clinic. The hospital has a national reputation in cancer care and provides medical, surgical, radiologic, and palliative care services to patients requiring hospital care. Hospitalized patients with cancer who had a fall event were identified by a computerized incident-reporting system. The sample included those with a fall event occurring from February 2006–January 2007. Patients with cancer who did not have a fall event were randomly selected from an administrative database of all hospitalized patients with cancer admitted during the same period. In total, data from 145 randomly selected hospitalized patients with cancer who did not fall were compared to 143 patients with cancer who had at least one fall event during the same period.

Variables

Patient characteristics collected that could be predictors of a fall event were age, comorbidities, impairments, disabilities, medical treatments or effects of treatments (e.g., urgency, sepsis, pain, pain treatment, radiation), details of the fall event itself, and environmental factors and events occurring before a patient fall (e.g., call light use, lighting, location, patient equipment, vital signs including pain score, medication classes, laboratory data). A data collection tool for cancer fall variables believed to be important was based on review of the literature and expert opinion, as previously described in Capone et al. (2010). Cancer-related factors included cancer diagnosis or service based on four groupings of cancer type (e.g., hematology with or without bone marrow transplantation, solid tumor, brain tumor), presence of metastases, anemia, cancer treatments (e.g., radiation, chemotherapy), and anticipated events from cancer treatments (e.g., low hemoglobin level, sepsis, intracerebral bleeding).

For patients with cancer who had a fall event, some variables (e.g., pain, hemoglobin, hematocrit, temperature) were collected at the time of admission as close to the fall event as possible, when available. For example, pain scores generally are available every eight hours; therefore, the pain score was collected within eight hours of the fall event. For patients with cancer who did not have a fall event, the reference point of data collection was within 24 hours of admission. Medications of interest and blood products were recorded on the case report form if administered anytime during the hospital stay. Variable definitions were created to ensure consistency in interpretation. As previously described in Capone et al. (2010), content validity of variables was completed prior to initial data collection from patients with a fall event.

Data Collection

For patients with cancer who had a fall event, staff members who witnessed the fall or found the patients after the event provided data on the fall by completing the online event report tool. Nurse managers and assistant nurse managers who were trained in data collection provided fall-specific data using information in the event report system and by interviewing staff. In addition, nurses working in the quality department collected the non–fall-specific data on the case report form developed for this study. For patients with cancer who did not have a fall event, graduate nursing students completing a research practicum collected data retrospectively from electronic medical records. Study investigators trained all data collectors. Assessment of inter-rater reliability in data collection was intermittently completed to ensure consistent interpretation of variable definitions and data collection accuracy by the team.

Data Analysis

Categorical measures were summarized using frequencies and percentages. Continuous measure distributions were described with means and standard deviations, percentiles (i.e., median, first quartile, and third quartile), and minimum and maximum values. Univariable comparisons used Pearson chi-square tests, or Fisher exact test (in factors that occurred rarely) for unordered categorical factors, and Mantel-Haenszel chi-square tests when response levels were ordered. Continuous variables were compared using the Wilcoxon rank sum test. Hemoglobin and hematocrit levels were compared between patient groups and also after adjusting for age and gender using linear models.

Multivariable logistic regression models predicting falls were fit using the fall status as the response variable and controlling for length of hospital stay. Length of stay was chosen for control because fall risk increases with that variable. Factors that were significant univariably were considered for the model. However, history of falls within six months prior to hospitalization, use of a walking aid, metastasis in multiple sites, and temperature or febrile status were excluded because of excessive missing values. In addition, variables that measured dementia, brain or central nervous system metastasis, drug score, and liver dysfunction were highly associated with other variables during multicolinearity check and were excluded from the models. For variables with few missing values (less than 10%), multiple imputation techniques were used to create a complete dataset. Backward selection was performed to identify factors that were statistically significant. Based on the reduced logistic model, a risk score was calculated, and a nomogram showing the risk score was created.

Predicted probabilities were calculated and then adjusted by the fall rate in the population according to the method described by Whittemore (1995). Internal validation of the model was performed using 1,000 bootstrap samples to evaluate the discrimination (between patients with falls and those without falls) and calibration (agreement between predicted and actual fall status) of the model. Validation was summarized using the concordance index (c-statistic), which measured the probability that a randomly chosen patient with a fall event had a higher probability of falling than a randomly chosen patient without fall events from the model. Analysis was completed using SAS®, version 9.1, and R, version 9.2. A significance level of 0.05 was assumed for all tests.

Findings

Patient Characteristics

Of the total sample of 288 patients, mean age was 60.9 years (SD = 13.7) and most were men. The mean age of the 143 patients with a fall event was 62.1 years (SD = 14), whereas mean age of the 145 patients with no fall event was 59.8 years (SD = 13.3) ($p = 0.072$). The first and third quartiles for age were 54 and 72 years for patients with a fall event and 51 and 68 years for patients with no fall event, respectively. The most common cancer type was a solid tumor.

Of 5,111 total patients with cancer admitted during the study period, 143 had fall events, equating to a fall rate of 3%. Length of stay was significantly longer for patients with a fall event ($\bar{X}$ = 15.1 days, SD = 13) than for those with no fall event ($\bar{X}$ = 7.1 days, SD = 9.1) ($p < 0.001$). No difference was found in the prevalence of a fall event by patient gender, hearing impairment, use of a hearing aid, dizziness, problems of urinary urgency, urinary frequency or diarrhea, or comorbidities (i.e., from Parkinson disease, osteoporosis, gout, peripheral vascular disease, diabetes mellitus, chronic pulmonary disease, seizures, arthritis, depression, peptic ulcer, or peripheral neuropathy). Hematocrit level obtained before the fall event was not significantly different than admission hematocrit level of patients with no fall event, but hemoglobin level was lower in patients with a fall event (see Table 1).

Patients with a fall event had lower pain scores, reflecting perceptions of less pain than patients without a fall event (see Table 2). Patients with a fall event were more likely to have a history of a fall within the past six months; were unable to follow simple directions; used a walking aid; and had a medical history of heart disease, dementia, anemia, and renal insufficiency. Medication classes delivered during the hospital stay that were significantly higher in the fall group were benzodiazepenes, sedatives, antidepressants, antipsychotics, and

Table 1. Continuous Measures Data in Patients With and Without Fall Events

		Fall Event			No Fall Event			
Characteristic	N	Mdn	Q1	Q3	Mdn	Q1	Q3	p[a]
Weight (kg)	256	73.5	62.3	90.1	77.4	65.9	90.2	0.38
Hemoglobin (g/dl)	286	10.5	9.4	12.1	11.3	9.8	12.5	0.033
Hematocrit (%)	286	32.1	28.9	36.8	33.7	29.6	37.6	0.13
Temperature (°C)	182	37.4	37.1	37.9	36.5	36.1	37.1	< 0.001
Hospital length of stay (days)	288	11	7	18	5	3	8	< 0.001

[a] Wilcoxon rank sum test

Mdn—median; Q1—first quartile; Q3—third quartile

Table 2. Characteristics of Patients With and Without Fall Events During Hospitalization

	Total			Fall Event			No Fall Event			
Characteristic	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**	**p[a]**
Gender										0.29
Male	288	166	58	143	78	55	145	88	61	
Female	288	122	42	143	65	45	145	57	39	
Ability to follow simple commands (mental status)										< 0.001
Able	263	240	91	119	100	84	144	140	97	
Unable	263	23	9	119	19	16	144	4	3	
Medical history[b]										
Chronic heart disease	288	135	47	143	77	54	145	58	40	0.019
Dementia (any type)	288	12	4	143	11	8	145	1	1	0.003
Anemia	288	45	16	143	29	20	145	16	11	0.031
Renal insufficiency or failure	288	24	8	143	17	12	145	7	5	0.03
Gait pattern										< 0.001[c]
Nonambulatory	270	5	2	125	2	2	145	3	2	
Impaired	270	64	24	125	48	38	145	16	11	
Weak	270	71	26	125	51	41	145	20	14	
Normal	270	130	48	125	24	19	145	106	73	
General										
History of falls within six months before hospitalization	184	21	11	91	18	20	93	3	3	< 0.001
Use of any type of walking aid	204	25	12	112	23	21	92	2	2	< 0.001
Febrile (37°C or higher)	182	13	7	39	8	21	143	5	3	0.001[d]
Pain level of 4 or higher (on a scale from 0–10)	274	115	42	129	19	15	145	96	66	< 0.001

[a] Pearson chi-square test except where specified

[b] Patients could have more than one condition, and not all patients had these conditions.

[c] Wilcoxon rank sum test

[d] Fisher exact test

Note. Because of rounding, not all percentages total 100.

corticosteroids (see Table 3). Use of diuretics, anxiolytics, antihypertensives or anticoagulants, and opiates was not significantly different between groups. Patients with a fall event were more likely to have had hematologic cancer or brain tumor, cancer metastasis, blood product transfusion, chemotherapy, and a complication during the hospital stay.

Predictors of Fall Events

Of all factors studied, 21 predicted a fall event (see Table 4). Using the statistically significant variables for fall events, two multivariable logistic regression models were created, with and without controlling for hospital length of stay, as previously discussed. However, length of stay did not contribute to model discrimination. Variables with missing values excluded were history of falls prior to hospitalization, use of a specific walking aid, and prefall temperature. Highly associated variables identified and removed with multicolinearity checking were type of nursing unit, comorbid conditions of dementia and liver dysfunction, metastasis to the central nervous system, hematologic conditions requiring bone marrow transplantation, and brain cancer. After controlling for hospital length of stay, seven predictor variables remained significant predictors of a fall event: lower levels of pain, impaired gait patterns, cancer diagnosis, presence of metastasis, antidepressant use, antipsychotic use, and blood product use.

Risk Score

A fall-risk score was established using seven predictor variables identified in the multivariable model, excluding length of hospital stay. The probability of a fall can be estimated for an individual by summing points assigned to the value of each predictor variable, with the maximum point summation of 365 indicating a 96% fall probability (see Figure 1). The risk score model demonstrated very good discrimination (c-statistic of 0.89) and calibration.

Discussion

The Cleveland Clinic–Capone Albert (CC-CA) fall-risk score predicts falls in patients hospitalized with cancer using seven clinical factors routinely collected at the time of admission or during the hospital stay. Lower level of pain, presence of metastasis, use of antidepressants and antipsychotics, weak or impaired gait, hematologic diagnosis requiring bone marrow transplantation or brain tumor, and blood product use predicted an increased fall-event risk during hospitalization.

Some predictors such as pain level, use of opiates, and cancer types identified in the current study represent novel findings, as they have not been well described in the literature in relation to fall events and were not studied in combination previously. In previous studies, pain level had mixed results regarding association with falls. In a community-dwelling population aged 70 years or older with chronic musculoskeletal pain, fall risk was higher in patients with more pain (Leveille et al., 2009); however, in another study of community-dwelling older adult cancer survivors, pain was associated with fewer falls (Spoelstra, Given, von Eye, & Given, 2010a). The current study's findings may indicate that higher pain levels alerted patients to move more deliberately, slowly, or carefully, which might have reduced the likelihood of a fall event. Pain may have been associated with other symptoms of distress that created greater caution when moving. Alternate explanations could be that patients with lower reported pain levels received less nursing attention because of a misperception of lower acuity, or those patients were more independent in activities of daily living, including ambulation. As a result, the risk of a fall event was higher. Although use of opiates or other pain-relieving medications was not significantly different between patients with and without fall events in the current study, lower pain levels may have reflected lower acuity or improved health-related quality of life, both of which could have increased patients' desire to be active and, therefore, the risk of falls. Pain, including acute and chronic cancer pain, being a protection against falls is a complex finding. Treatment of pain is an important nursing intervention. As pain decreases, nurses may need to encourage patients to seek assistance or use assistive devices when ambulating to decrease fall risk. Future research in patients with cancer on pain type, other symptoms, interventions for pain relief, change in pain score, and fall risk may add to the knowledge base and aid in the creation of best evidence in pain treatment and patient safety.

In medical-surgical populations, falls were more likely in people with more comorbid conditions (Halfon, Eggli, Van Melle, & Vagnair, 2001; Morse, Morse, & Tylko, 1989; Morse, Tylko, & Dixon, 1987), but a cancer diagnosis was not a predictor of falls (Spoelstra et al., 2010b). In the current study, noncancer comorbid conditions were not related to fall events after controlling for

Table 3. Disease-Related Characteristics of Patients With and Without Fall Events During Hospitalization

	Total			Fall Event			No Fall Event			
Characteristic	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**	**p[a]**
Cancer diagnosis										< 0.001[b]
Solid tumor	288	223	77	143	92	64	145	131	90	
Hematologic without bone marrow transplantation	288	44	15	143	35	24	145	9	6	
Brain tumor	288	14	5	143	10	7	145	4	3	
Hematologic with bone marrow transplantation	288	7	2	143	6	4	145	1	1	
Metastasis beyond primary site[c]										
Any site	283	124	44	143	88	62	140	36	26	< 0.001
Bone	281	29	10	143	21	15	138	8	6	0.014
Brain or central nervous system	282	35	12	143	30	21	139	5	4	< 0.001
Liver	282	36	13	143	21	15	139	15	11	0.33
Other site	282	78	28	143	53	37	139	25	18	< 0.001
Multiple sites	230	42	18	92	30	33	138	12	9	< 0.001
Complications										
Cerebral infarction	269	5	2	124	5	4	145	–	–	0.02[b]
Intracranial bleeding	268	5	2	123	5	4	145	–	–	0.019[b]
Sepsis (any type)	273	14	5	128	13	10	145	1	1	< 0.001
Hospital-delivered therapies										
Chemotherapy	281	27	10	136	18	13	145	9	6	0.046
Head or neck radiation	280	8	3	136	6	4	144	2	1	0.16[b]
Radiation (not to head or neck)	281	13	5	137	9	7	144	4	3	0.13
Blood product transfusion	263	80	30	120	56	47	143	24	17	< 0.001
Hospital-delivered medication[c]										
Antidepressants	284	50	18	139	35	25	145	15	10	0.001
Antipsychotics	285	29	10	140	24	17	145	5	3	< 0.001
Benzodiazepines	284	60	21	139	43	31	145	17	12	< 0.001
Corticosteroids	286	100	35	141	68	48	145	32	22	< 0.001
Opiates	286	211	74	141	109	77	145	102	70	0.18
Sedatives	284	69	24	139	48	35	145	21	14	< 0.001

[a] Pearson chi-square test

[b] Fisher exact test

[c] Multiple responses could be selected.

Note. Because of rounding, not all percentages total 100.

Table 4. Predictors of Fall Status in the Current Sample

Variable	OR	95% CI	p
Cancer diagnosis[a]			0.005
Hematologic without BMT	3.53	[1.54, 8.1]	0.003
Brain tumor	3.91	[1.15, 13.34]	0.029
Hematologic with BMT	1.35	[0.12, 14.92]	0.81
Gait pattern[b]			< 0.001
Weak	9.65	[4.76, 19.58]	< 0.001
Impaired	11.64	[5.53, 24.5]	< 0.001
Nonambulatory	2.47	[0.38, 15.93]	0.34
General characteristics			
Had fall event within past six months	9.51	[2.64, 34.22]	< 0.001
Use of walking aid	11.34	[2.52, 50.94]	0.002
Febrile (37°C or higher)	7.19	[2.06, 25.11]	0.002
Unable to follow simple commands	5.78	[1.85, 18.06]	0.003
Blood product transfusion	2.36	[1.25, 4.46]	0.008
Liver dysfunction	0.18	[0.04, 0.8]	0.025
Dementia (any type)	10.51	[1.3, 84.81]	0.027
Pain level of 4 or higher (on a scale of 0–10)	0.09	[0.05, 0.17]	< 0.001
Hospital-delivered medication			
Antidepressants	2.85	[1.42, 5.73]	0.003
Antipsychotics	4.92	[1.75, 13.84]	0.003
Benzodiazepines	2.15	[1.09, 4.23]	0.026
Corticosteroids	2.85	[1.65, 4.9]	< 0.001
Sedatives	2.54	[1.37, 4.71]	0.003
Drug score[c]	1.65	[1.3, 2.09]	< 0.001
Metastasis beyond primary site			
Any site	4.76	[2.78, 8.17]	< 0.001
Bone	2.73	[1.12, 6.66]	0.027
Brain or central nervous system	7.52	[2.76, 20.46]	< 0.001
Other site	2.68	[1.5, 4.79]	< 0.001
More than one site	5.35	[2.5, 11.42]	< 0.001

[a] Solid tumor was a reference category.

[b] Normal gait was a reference category.

[c] Drug score was composite (sum) score of the number of medication classes prescribed per patient in the following areas during hospital stay: antidepressants, anxiolytics, benzodiazepines, corticosteroids, opiates, and sedatives.

BMT—bone marrow transplantation; CI–confidence interval; OR—odds ratio

Note. P values are from the logistic regression model. Models with fewer than five responses were not fit.

univariable factors. However, type of cancer (hematologic requiring bone marrow transplantation or brain tumor) and presence of cancer metastasis increased the likelihood of falls. In other studies on falls in patients with cancer, cancer etiology and presence and location of metastasis were not studied for their association with falls. Knowledge gained in the current study should be replicated in other research. Although cancer etiology and metastasis are not modifiable, their presence is easily monitored and should heighten awareness of fall risk in hospitalized patients.

In the current study, use of antidepressants and antipsychotics and weak or impaired gait were associated with fall events. In other studies of falls in patients with and without cancer, depression (Anstey, Burns, von Sanden, & Luszcz, 2008; Spoelstra et al., 2010a), cognitive dysfunction (Inouye, Studenski, Tinetti, & Kuchel, 2007; Spoelstra et al., 2010a), and gait and balance deficits (Chen et al., 2008) were predictors of fall events. Therefore, routine screening for depressive or psychological symptoms or use of prescriptions for antidepressants and antipsychotics as markers of risk may be important. Gait deficits are assessed routinely on admission and should automatically trigger a heightened need to intervene to promote safety.

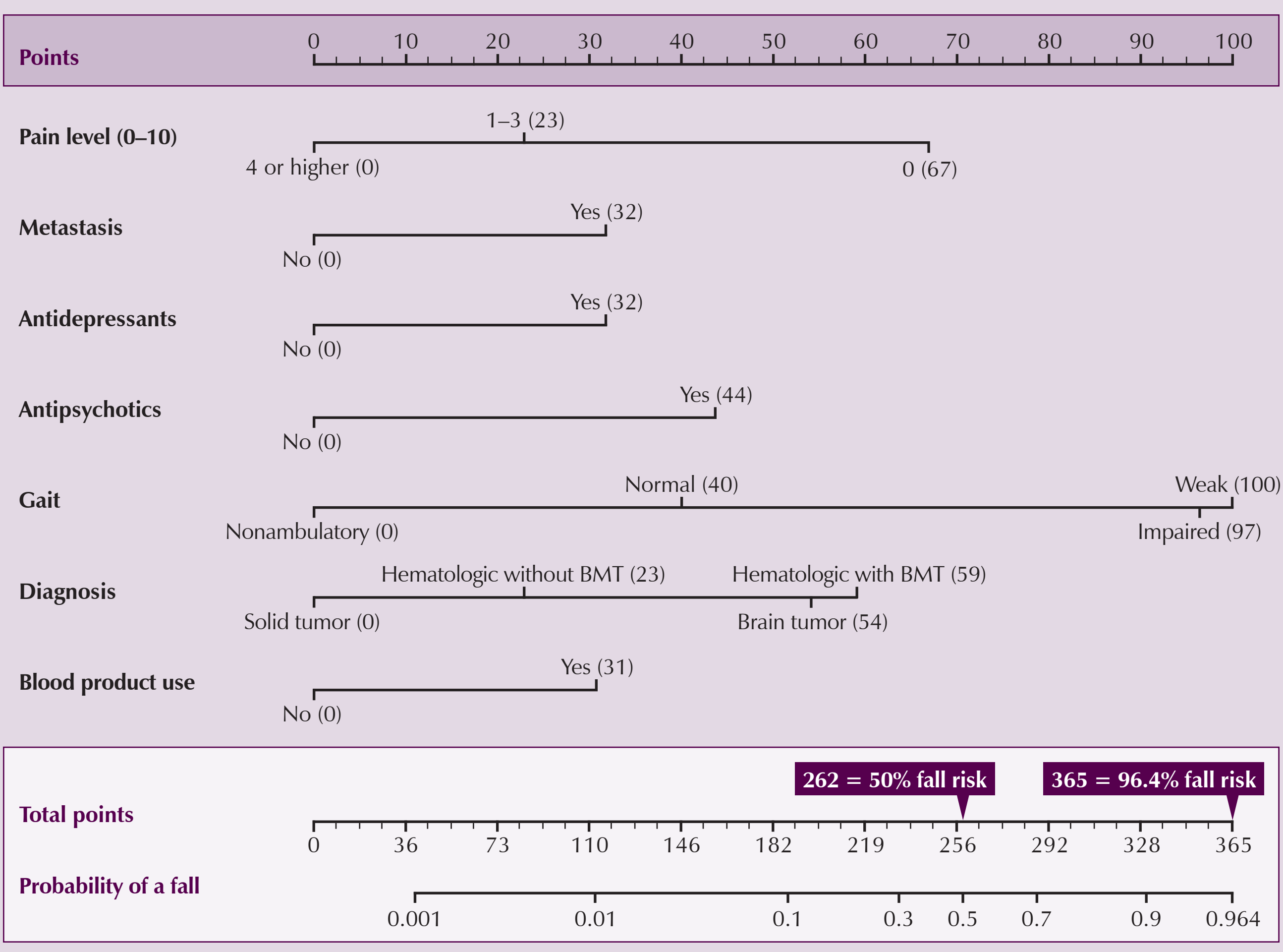
Use of any blood product during the hospital stay was not commonly studied in hospital medical-surgical fall-risk studies. Low hemoglobin or hematocrit level was associated with fall events (Byers et al., 1990; Dharmarajan, Avula, & Norkus, 2006), but an abnormally high hematocrit level also was associated with falls (Byers et al., 1990). In the current study, all patients had a mean hemoglobin level below 12 g/dl, and patients with fall events had a significantly lower mean hemoglobin level; however, no difference existed in mean hematocrit level by fall events. Although the rationale for hematocrit level not being associated with falls is unknown, hydration, which was not studied, may have been a factor. Dehydration can be inflated in hospitalized patients with cancer as a response to the chemotherapy-induced gastrointestinal effects of vomiting and diarrhea. Additional research is needed in patients with cancer to determine whether low hemoglobin is a marker of cancer diagnosis and treatment and a mediator of falls or whether the direct effects of low hemoglobin level (e.g., fatigue, shortness of breath with activity) affect fall rates. New knowledge in this area may prompt optimal fall prevention. In addition, hemoglobin level should be monitored, and a low hemoglobin level in conjunction with other predictors of fall risk should trigger interventions to either raise the hemoglobin level or ensure patient safety.

Of note, age was not a predictor of falls in the current sample. The finding was similar to that of other studies involving fall-risk assessment tools for hospitalized patients in which age was not found to be an important variable. Examples include the Morse Fall Scale Assessment (Morse et al., 1989), St. Thomas Risk Assessment Tool in Falling Elderly Inpatients (Oliver, Britton, Seed, Martin, & Hopper, 1997), Hendrich II Fall Risk Model (Hendrich, Bender, & Nyhuis, 2003), and others (Salameh, Cassuto, & Oliven, 2008). An explanation could be that, in the current sample, few patients were older than 70 years. Therefore, younger age and the lack of participants older than 80 could have influenced the results.

Limitations

Certain factors should be considered in the interpretation of the current study. First, data on patients without fall events were collected retrospectively via chart reviews (patients were not actually seen or assessed). Nondocumented and, therefore, nonstudied patient factors such as current depression or anxiety level and fall events more than six months prior to admission could have been meaningful but were not available for study.

Data on continuous measures were collected at a specific time point during the hospital episode (e.g., on admission) and may not reflect an average or overall description of the patient's experience with each variable. The CC-CA fall-risk score was not validated in a separate population. However, because of the large sample size, the authors were able to perform a robust validation in a randomly selected sample of patients with cancer without fall events, and actual fall-event rates were accurate because of the mandatory reporting of all hospital falls. Much of the data were collected from the medical record and were dependent on the accuracy of documentation in the record. History of falling prior to the current hospitalization was one of only three variables removed because of missing data. History of falling is a factor often included in other fall risk-assessment scales, and whether inclusion of that variable would have altered the results is unknown. However, history of falling may be difficult to measure in patients who do not use the same hospital for care over time, are confused, have a poor memory, or do not have family who can provide data at admission. In addition, most tools that use previous history of falling as a variable do not provide a definition of the scope of the variable; therefore, conformity may be lacking among nurses who complete assessments that include history of falling. Finally, data were gathered from one urban



BMT—bone marrow transplantation

Figure 1. Nomogram Predicting Fall Risk

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tertiary care site and may not be generalizable to other settings of hospitalized patients with cancer.

Implications for Nursing

Fall prevention in hospitals requires accurate and timely information about patients' fall risk, understanding and timely communication of intervention strategies, and resources and teamwork to implement strategies (Dykes, Carroll, Hurley, Benoit, & Middleton, 2009). The fall-risk score research was based on the presence or absence of patient characteristics at varying points in time to reflect the entire hospital stay, not just one point in time, although a patient's fall risk is dynamic. Nurses typically complete fall-risk assessment on admission, daily, and with change in patient status. The CC-CA fall-risk assessment uses seven distinct factors. Although pain level and patient gait can change over the course of hospitalization, the authors assessed both factors using admission data. Diagnostic confirmation of type of cancer and presence of metastasis also were factors obtained at admission. Use of antidepressants, antipsychotics, or blood products can change over time, and their presence was documented at any time in the hospitalization of the sample. Most risk scores have been developed by assessing data at admission or over the course of a hospitalization, similar to the current study's research methodology. Therefore, the frequency in which data should be collected to decrease fall risk is specific to the environment. Hospitals or hospital units have their own policies regarding fall-risk assessment and may wish to conduct additional research to determine whether daily assessment is associated with a decrease in fall rates compared to one-time admission assessment.

The highest possible CC-CA fall-risk score is 365, which predicts a 96% probability of a fall. Assessing the change in score from one day to the next may be important to guide interventions; however, additional research is needed for the CC-CA tool and all other available fall-risk scoring tools. The CC-CA tool is one-page and easy to use; however, incorporation into an electronic medical record might save nursing documentation time. In addition, if trends were available, interpretation of the findings may have been enhanced.

As with other fall-risk tools, hospital personnel will need to determine specific actionable CC-CA risk scores and fall-prevention measures for their patients with cancer. A CC-CA score of 262, reflecting a 50% fall risk, may be a reasonable indication to trigger standard fall-risk interventions. In addition, clinical nurses should use their judgment to consider a patient's specific fall injury risk. If the risk is high, the CC-CA fall-risk score threshold for a possible fall event should be lowered (e.g., from 50% to 30% for patients with critically low platelet levels or severe osteopenia). Prospective research and routine clinical use of the CC-CA tool will provide new data to optimize a risk-score threshold.

The CC-CA fall-risk score provides accurate risk prediction that could be heightened if risk-score findings are disseminated widely among the care team, including nurse aides. In addition, supervisory clinicians may use the total CC-CA fall-risk score to identify high-risk patients and apply resources judiciously rather than using an all-or-none approach. The CC-CA fall-risk score for in-hospital fall events is supported by several strengths, such as being derived using a contemporary cohort of population-based patients with diverse demographic characteristics, comorbidities, and cancer diagnoses.

Conclusions

Fall risk for hospitalized patients, particularly those with cancer, is a major safety issue. The CC-CA fall-risk score uses routinely collected clinical data to predict the risk of a fall event during hospitalization for patients with cancer. Application of the risk score could influence the quality of care provided to patients by informing clinical decision making. In addition, the CC-CA fall-risk score provides an evidence-based approach to fall assessment that may improve fall prevention.

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