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Fall Risk in Community Dwelling Elderly Cancer Survivors—A Predictive Model for Gerontological Nurses

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Abstract

The aim of this predictive study was to test a structural model to establish predictors of fall risk. An aging and nursing model of care was synthesized and used to examine 6912 older adult participants who are low income, using the Minimum Data Set in a community setting in the Midwest. Data analysis established relationships among age, race, a history of a previous fall, depression, pain, and ADLs, IADLs, incontinence, vision, and cognitive status. Factors leading to fall risk can direct nursing activities that have the potential to prevent falls, improving quality of life.

Keywords

Structural Equation Modeling; Falls; Older Adults; Community dwelling

Introduction

In the older adults, about one third of persons over age 65 fall (Center for Disease Control, 2007; Davison & Marrinan, 2007), and the number of fall-related injuries increases with age (Lim & Chutka, 2006), leading to functional decline, institutionalization, higher health care costs, and decreased quality of life (J. Chen, Chan, Kiely, Morris, & Mitchell, 2007). Additionally, some evidence suggests that older adults with cancer fall at a higher rate than those persons without a history of cancer.

Cancer survivors are living longer, encountering physical, psychosocial, and economic impacts. Consequently, the older adults are a special group in relation to cancer, because they carry the greatest burden, with a higher rate of occurrence (Hewitt, Rowland, & Yancik, 2003). The likelihood that an elderly cancer survivor experiences falls may be influenced by their cancer history, however little is known, overall, about the role of cancer in fall risk. A need exists to better understand if the disease or treatment of cancer may contribute to fall risk in older adults.

Studying falls in cancer survivors is significant because 20% of the population in the United States are 65 years of age and older;(Center for Disease Control and Prevention, 2006) and there are 6 million cancer survivors (National Cancer Institute, 2007). In 2006, health care utilization for older adults resulting from falls included more than 1.8 million treated in emergency departments and more than 421,000 hospitalized (Center for Disease Control and Prevention, 2006)

Description of the Problem

Evidence is beginning to emerge that individuals with cancer fall at a higher rate than individuals without a history of cancer (Overcash, 2007; Pautex, Herrmann, & Zulian, 2008; Pearse, Nicholson, & Bennett, 2004). Existing models and theories provide insight into factors predicting fall risk, but do not address the possibly important role that cancer plays in influencing the risk of a fall.

The purpose of this study was to test a theoretical model with the hypothesis that fall risk is predicted through physiological and contextual patient characteristics, physical and cognitive status, and symptoms. This study examined characteristics of cancer, age, sex, and race or ethnicity; physical status of activities of daily living (ADLs), vision, incontinence, and falls; cognitive status of instrumental activities of daily living (IADLs) and cognition; and symptoms of pain and depression. The intent of this study was to lay a foundation for intervention studies to reduce fall risk in cancer survivors.

Conceptual Framework

This study was guided by a synthesis of the Life-Course Conceptual Model of aging (Freedman, Martin, Schoeni, & Cornman, 2008), and the HRQoL Model (Ferrans, Zerwic, Wilbur, & Larson, 2005). Early-life intrinsic biologic factors and mid-life medical care influence late-life health and disablement (Freedman et al., 2008). Figure 1 delineates a mechanism for the study of falls in older adults with cancer. This conceptual framework was used to derive four hypotheses.

Hypotheses

Biologic characteristics of age, sex, and race or ethnicity are hypothesized to influence fall risk (Hypothesis 1). During the course of aging older adults experience symptoms of pain and depression that are likely to compound and increase fall risk (Hypothesis 2). Additionally, physical and cognitive factors, IADLs, cognition, ADLs, vision, incontinence, and falls influence fall risk (Hypothesis 3). Therefore, cancer was hypothesized to influence the relationship having a negative effect on fall risk (Hypothesis 4).

Literature Review

A number of risk factors for falls in older adults are supported by evidence in the literature. Threats to mobility are perhaps the greatest risk factors for falls. Gait and balance deficits (J. S. Chen, Simpson, March, Cameron, Cumming, Lord et al., 2008), cognitive function (Inouye, Studenski, Tinetti, & Kuchel, 2007), depression (Anstey, Burns, von Sanden, & Luszcz, 2008), poor vision (Szabo, Jannsen, Khan, Potter, & Lord, 2008), incontinence (de Rekeneire, Visser, Peila, Nevitt, Cauley, Tylavsky et al., 2003), delirium (Inouye et al., 2007), weight loss (Agostini, Han, & Tinetti, 2004), peripheral neuropathy, Parkinson's disease, and stroke (Rubenstein, Kenny, Eccles, Martin, & Tinetti, 2002) are associated with falls in older adults. Environmental factors such as foot-ware (Rubenstein et al., 2002), and greater than 4 medications (Agostini et al., 2004), are also associated with falls in older adults.

Men are 50% more likely to die from a fall than women (Center for Disease Control, September 21, 2007), while women are 67% more likely than men to have a nonfatal fall injury (Center for Disease Control, September 21, 2007). Rates of fall related fractures among older adults are more than twice as high for women as for men (Stevens, Corso, Finkelstein, & Miller, 2006). For example, 72% of all older adults admitted to a hospital for a hip fracture were women (CDC, 2007).

The risk of being seriously injured in a fall increases with age. The rates of fall injuries for older adults 85 years of age and over were four to five times that of adults aged 65 to 75 years (Stevens et al., 2006). Nearly 85% of deaths from falls were among people 75 and older (Center for Disease Control, September 21, 2007).

Fatal fall rates differ little between whites and African Americans from ages 65 to 75 years of age (Center for Disease Control, September 21, 2007). After age 75, white men have the highest fatality rates, followed by white women, African American men, and African American women (Center for Disease Control, September 21, 2007). White women have significantly higher rates of fall related hip fractures than African American women; and among older adults, non-Hispanics have higher fatal fall rates than Hispanics (Stevens & Sogolow, 2005).

Older adults are a special group with respect to rising incidence rates of cancer (Hodgson, 2002). Cancer survivors are living longer but are continuing to encounter physical, psychosocial, and economic impacts until the end of life. Disparities in the occurrence of falls among cancer survivors are beginning to emerge in the literature (Hewitt et al., 2003; Keating, Narredam, Landrum, Huskamp, & Meara, 2005; Koroukian, Murray, & Madigan, 2006; Sweeney, Schmitz, Lazovich, Virnig, Wallace, & Folsom, 2006; Yabroff, McNeel, Waldron, Davis, Brown, Clauser et al., 2007). Therefore, there is a need to understand whether a diagnosis of cancer increases the risk of falls, independently or in interaction with certain other health problems. Additionally, translational research could begin to identify mechanism for nurses to refine and standardize approaches to fall-risk assessment (Hurria, Lichtman, Gardes, Li, Limaye, Patil et al., 2007) and to integrate behavioral and psychological interventions to prevent the occurrence of falls into practice (DeSanto-Madeya, Bauer-Wu, & Gross, 2007), reducing adverse outcomes.

Methods

Sample and Setting

The target population is persons who are 65 years of age and older, low income and community-dwelling. A convenience sample of eligible subjects 65 years of age and older enrolled in the home and community based waiver Home and Community Based Services (HCBS) program in Michigan in 2007 was examined. Members of health maintenance organizations were excluded. Eligibility for admittance to the HCBS program includes persons below 300% of the Federal Poverty Level. Additionally, the person must meet the nursing facility level of care requirements, which includes a combination of assistance required for ADL and IADL needs (CMS, 2008). The HCBS program offers an array of

services that assist Medicaid beneficiaries in the community to avoid institutionalization (CMS, 2008).

Instrument

The Minimum Data Set (MDS) in the HCBS program was developed in 1993, to inform and guide comprehensive care and service planning for community-dwelling older adults (InterRai, 2008). The MDS is a person-centered assessment with uniform standards for the collection of minimum essential nursing data, enabling clinicians to assess multiple domains (InterRai, 2008). The instrument covers domains of: service use, function, health, and social supports (Morris, Fries, Steel, Ikegami, Bernabei, Carpenter et al., 1997). Further, the MDS provides a standardized mechanism to identify persons who could benefit from further evaluation of a specific problem or risk for functional decline over time to support care planning (Hirdes, Fries, Morris, Ikegami, Zimmerman, Dalby et al., 2004). The information on the MDS contains a combination of self-report by the patient and clinical validation by a Registered Nurse, which is collected in person, in the patient's home every six months (CMS, 2008). The MDS validity and reliability is reported in an international trial, with independent dual assessment of 241 patients using 780 assessments, finding an overall Kappa of .74 (Morris et al., 1997).

Key Variables within the MDS

Measures for key variables are presented and organized according to the hypothesized theoretical model and include demographic characteristics, physiological patient characteristic, symptoms, functional status, and cognitive status (see Figure 1.). Variables of interest in this study are explained individually.

Demographic characteristics included: age reported as date of birth, sex, and race or ethnicity categorized as Caucasian, African American, or other. The presence or absence of the following characteristic was measured on the MDS. Physiological characteristic included the presence coded as 1 or absence of cancer coded as 0. Symptoms included measures of: pain (an unpleasant sensory and emotional perception described in terms of experience associated with actual or potential tissue damage) coded as 0 or no pain, 1 for pain less than daily, and 2 for pain daily; and depression (a feeling of sadness or being depressed, that life is not worth living, that nothing matters that he or she is of no use to anyone or would rather be dead) coded as 0 not present, 1 present not subject to treatment, or 2 present subject to treatment. Functional status included measures of: a fall (to drop or descend under the force of gravity, as to a lower place through loss or lack of support) coded a 0 for no falls, and 1 to 9+ for the number of falls in the past 6 months; bathing (to include shower, full tub or sponge bath) coded as 0 independent, 1 supervision, 2 limited assistance, 3 extensive assistance, and 4 dependent; vision (the ability to see in adequate light and with glasses) coded as 0 adequate, 1 impaired, 2 moderately impaired, 3 highly impaired, and 4 severely impaired; and incontinence (the inability to control the flow of urine from the bladder) coded as 0 continent, 1 usually continent, 2 occasionally incontinent, 3 frequently incontinent, and 4 incontinent. Cognitive status included measures of: how difficult is it (or would it be) for a client to do activity on own coded 0 for no difficulty and 1 for difficulty;

and daily decision making (how well the client made decisions about organizing the day) coded 0 for no difficulty and 1 for difficulty.

Design

Secondary data analysis was conducted using data from the MDS. The MDS data were obtained from an assessment closest to the date of December 31st, 2007. A Data Use Agreement was obtained from the State Department of Community Health. Approval of the research study from the university and state Institutional Review Boards was obtained prior to receipt the dataset.

Data Analysis

Data analysis first involved frequencies to assess the distribution of each variable. Analysis of the model developed here was completed using structural equation modeling (SEM) techniques. SEM is an analytical tool that can provide necessary but not sufficient evidence of causality using cross-sectional data about longitudinal processes. Thus, it is an alternative to experimentation for examining the plausibility of hypothesized models (Kline, 2005).

SEM allows for the testing of unobserved latent variables that were integral to the proposed model, allows for multiple observed variables to be associated with a single latent construct (fall risk), and allows for a precise estimation of the indirect effects of exogenous variables (ADLs, vision, incontinence, falls, IADLs, and cognitive status) on endogenous variables (cancer, age, sex, and race or ethnicity). Additionally, SEM explicitly models error variance, allowing the analysis to separately account for unreliability of measures and for unexplained variance in latent variables (Kline, 2005). A full SEM model shows the hypothesized causal and correlation links among theoretical variables.

The sample covariance matrix was used as input, and a maximum likelihood solution sought. A two-step approach was taken, with, the measurement model tested for fit before the full structural model was tested (Jöreskog & Sörbom, 2004). Both absolute and relative fit indices were used to evaluate model fit. Absolute fit indices included the chi square statistic, and the chi-square divided by degrees of freedom χ^2/df (CMIN/df), with CMIN/df values less than 2 considered desirable (Kline, 2005). Comparative Fit Index (CFI), a relative fit index was used. It takes sample size into account with values .95 indicating good fit. The root mean square error of approximation (RMSEA) also was calculated. RMSEA indicates the discrepancy in fit per degree of freedom and thus “adjusts” for sample size; a RMSEA<.05 indicates good fit. The 90% confidence interval of the RMSEA index is also reported. If the RMSEA is smaller than .08 or if the left endpoint of the confidence interval is markedly smaller than .08, then the model provides a reasonable approximation of the data (Kline, 2005).

LISREL student version 8.80 statistical software package was utilized to model data and SPSS 14.0 statistical software package was used to describe the data. For this study, 79.1% (6912 of 8735) of the individuals had complete data for each measure to be studied. Estimation and imputation were not conducted, as the remaining cases were more than

sufficient power for generalizability of the study and the missing data points were missing at random.

Results

The analysis was completed on 6912 community dwelling older adults. Physiological and contextual patient characteristics and descriptive statistics for the main study variables are shown in Table 1. Patients ranged in age from 65 to 109 years, with a mean of 79.5 years; 76% were women; 22% African American with 76% Caucasian; and 13% with cancer. A total of 1901 (27.5%) experienced a fall.

Bivariate Correlations among Main Study Variables

Bivariate correlations among the main study variables were conducted. In a bivariate logistic regression model, sex, African American, depression, pain, falls, ADLs, vision, incontinence, IADLs, and cognitive status each was significantly associated with falls $p < 0.01$. Age and race other were not found to be significant factors for prediction of falls $p > 0.05$. These relationships were taken into account for the SEM model.

SEM Results: Testing the Fit of the Hypothesized Theoretical Model

Patient characteristics and main study variables were selected based on past research, and the theoretical framework. These variables were selected because they could be significant in the final analyses of theory testing. The measurement model was tested to examine overall fit. Although the proposed model solution did not converge, the fit of the model was somewhat acceptable ($\chi^2 = 1582.32$, $p = 0.0$, $df = 58$, RMSEA = .061, lower bound of 90% CI = .058, upper bound of 90% CI = .064, CFI = .75, GFI = .97, AIC = 1613.98). Chi-square is often high with a large sample size, RMSEA was within the desired CI range, the GFI was greater than 0.90 but the desired CFI of $> .9$ was not attained.

Sample size, size of factor loadings, and the number of indicators can influence convergence of a model (Kline, 2005). The model was improved by adding error covariance among variables that had not been taken into account in the first solution was included in the model. Lastly, a modification of the iterative approximation occurred. Both removing and including paths was based on the evaluation of parameter estimates, modification indices, goodness-of-fit tests, and theoretical considerations.

The paths in the first model were tested with a single latent variable (cancer, age, sex, race or ethnicity, ADLs, vision, incontinence, falls, IADLs, and cognitive status). The overall model fit measures were $\chi^2 = 1813.31$, $p = 0.0$, $df = 57$, RMSEA = .07, lower bound of 90% CI = .065, upper bound of 90% CI = .070, CFI = .70, GFI = .96, AIC = 182.0. The CFI was less than the expected value of 0.90, demonstrating inadequate fit. The next step was to use a step wise process to enter one error covariance into the model at a time to improve model fit. Error covariance, specifying the correlations in the observation errors between all possible pairs of vertical levels were examined to allow for assimilation of model fit and convergence (Kline, 2005).

This process led to the inclusion of eight residual covariance's to attain a CFI > .90 in the parsimonious model. Strong positive correlations included: age and cognitive status (.91). Moderate positive correlations included: pain and depression (.07), IADL and ADL (.11), sex and incontinence (.10), and sex and pain (.03). Strong negative correlations included: pain and cognitive status (−.17), age and depression (−.60), and age and pain (−.74). Finally, moderate negative correlations included: African American and falls (−.06). This covariance was expected based on the literature (Davison & Marrinan, 2007; Harrison, Booth, & Algase, 2001; Rubenstein, 2006).

The paths in the final parsimonious model are shown in Figure 2. The model converged and the fitting measures indicated a good fit, improved over the original model ($\chi^2 = 604.77$, $p = 0.0$, $df = 49$, $RMSEA = .04$, lower bound of 90% CI = .038, upper bound of 90% CI = .043, CFI = .91, GFI = .99, AIC = 182.0). RMSEA was within the CI range, the GFI was greater 0.90, and the desired CFI of > .9 was attained.

The Final Model and Hypothesized Results

The model tested 4 contextual paths and 9 direct paths finding 3 contextual paths and 8 direct paths to be significant (Figure 2). Being female, aged and African American accounted for 11% of risk. Cognitive status, vision, incontinence, depression, ADLs, and IADLs, were significantly related to fall risk. Pain had a strong inverse relationship with fall risk. A history of prior falls correlated perfectly with fall risk; and removal of prior falls produced a similar model. The presence of a cancer did not influence fall risk in this sample. These results will be further discussed by hypothesis.

Hypothesis 1: Physiological and Contextual Patient Characteristic Increase Risk of Falls

Analysis revealed being female, African American, and aged had a greater fall risk. It is well known that older adult women have more frequent fall injuries yet fall less often than older adult men, but little is known about the African American race as lacking predictor of fall risk. Knowing that these patient characteristics lead to greater fall risk allows the clinician to anticipate need and offer fall prevention measures. For instance, a fall risk assessment could be completed on each individual to determine interventions to manage conditions or symptoms.

Hypothesis 2: Symptom Influence on Fall Risk

In the final model, it was revealed that the relationship between fall risk and pain and depression was present. The findings suggest a strong negative influence of pain on fall risk; meaning a patient with more pain had a higher risk of falling based on patient evaluation of some pain versus continuous pain. In addition, a strong positive association between depression and fall risk indicated that a patient who felt more depressed had a higher fall risk. The findings support symptoms influencing fall risk (Landi, Onder, Cesari, Russo, Barillaro, & Bernabei, 2005) with pain and depression contributing significantly. Clinicians could begin to screen all patients for pain and depression, while simultaneously evaluating fall risk.

Hypothesis 3: Functional and Cognitive Status Influence on Fall Risk

The final model revealed that the relationship between fall risk and ADLs, vision, incontinence, falls, cognitive status and IADLs was present. As expected, moderate to strong limitations in each of these factors influences fall risk as supported in the literature (Davison & Marrinan, 2007). Thus, clinicians can begin to take into account a patient's functional status, when determining if fall risk is evident, and select appropriate interventions.

Hypothesis 4: The Influence of Cancer on Fall Risk

In all models, no significant associations were found that support the hypothesis that a relationship exists between cancer and fall risk. Although surprising and contrary to other studies in the literature (Pautex et al., 2008), this finding may be due to the nature of the data available for this study or possibly the sample in this population. Further research is needed, however, to understand if cancer type, stage, treatment, or time since diagnosis may influence fall risk.

Discussion

The purpose of this study was to test and re-specify a model of fall risk in community dwelling older adults, and to examine the extent to which a diagnosis of cancer influenced fall risk. Multiple models were tested in order to fit a model that was statistically significant, and supported theoretically. In line with the theoretical predictions based on the earlier literature (Davison & Marrinan, 2007; Rubenstein, 2006), the results of this study offer evidence to suggest that there is a relationship between assessed factors and fall risk, with the exception of cancer in this sample. Although the results did not confirm that cancer statistically predicts fall risk, the clinical significance of this finding is important.

Structural equation models are often used to test theories about how different theoretical constructs are related (Kline, 2005). Given the nature of these data, this was an appropriate choice for the present study as well. During the modeling process, the researchers tested multiple models, beginning with the one implied by the theoretical model, keeping in mind the goal of modeling in nursing research: to generate theoretically as well as clinically meaningful models (Fawcett, 2005). If the model is rejected by the data, the problem is to determine what is wrong with the model and how the model should be modified to fit the data better (Kline, 2005). Theoretically the most suitable model was the first model developed. In statistical terms the fit of the final model to the data was most satisfactory. However, it was clear that the final model was better in terms of its statistical characteristics when an error covariance was added between multiple factors. This suggests that one variable, or health condition, may influence another when examining fall risk.

Limitations

One significant limitation of this study included the inability to determine whether a specific cancer diagnosis, such as lung, breast, prostate, or colon cancer placed individuals at a higher risk for falls. Similarly, the nature of the MDS dataset prevented us from examining the impact of other important cancer-related variables such as cancer stage, reoccurrence, and treatment phase, on fall risk. A final limitation of this study was the inability to

determine comorbidities that may have placed individuals at a higher risk for falls. These limitations should be considered in future nursing research. Because the study revealed a high fall rate, future studies will be designed to accommodate a broader array of data to establish a more fully specified model of fall risk among community dwelling older adults.

Clinical Implications and Relevance for Nursing Practice

Although this study did not find that a diagnosis of cancer influences the occurrence of fall in this population, the clinical implications for nursing practice are significant, as many older adult patients fall. Often clinicians accept the occurrence of falls and fall injuries, in part because the primary goal may be focused on eradication of the cancer, managing symptoms, or dealing with the patient's chief complaint. This perspective neglects the persistent and deleterious effects of falls.

In addition to alterations in social, family roles, and quality of life, the risks of increased falls requires clinicians to assess physical function before, during, and after cancer and cancer treatment and to intervene appropriately—an area where nursing can make a difference. Competing clinical demands exist, and the multi-factoral nature of falls requires coordination, and a multifaceted approach that does not adhere to the traditional disease model that drives most medical care (Inouye et al., 2007). A compelling amount of evidence, including more than 60 randomized clinical trials, supports the effectiveness of approaches to reducing the prevalence of falls (Gellispie, Gellispie, Robertson, Lamb, Cumming, & Rowe, 2003), and nursing is in a position to focus on this problem, using evidence to improve clinical practice by instituting fall prevention strategies.

By explicating the pathways through which the variables in the model lead to fall risk, this study adds to our knowledge of these mechanisms and can direct nursing activities that have the potential to prevent falls. Clinically, the results of the model provide important information on characteristics that increase fall risk and thus could be used to increase the quality of care for community dwelling older adults, both with and without a cancer diagnosis.

The development, refinement, and testing of the model was based exclusively on a sample of HCBS patients, however, these findings have potential value to gerontological nursing practice in general. The model now needs to be tested in different samples in order to determine whether this is a general nursing model or specific to community dwelling older adults. The fall risk model can serve as a theoretical framework for further nursing research.

Findings from this study will be used to shape a future studies. Ultimately, findings from the study of this topic will be used to provide useful approaches for nursing practice to assess those who are at risk. Additionally, findings will be used to allocate valuable nursing time towards those patients who “need” more intense management of preventive measures. Finally, findings will be used to design effective models of care that will assist older adults, both with and without a cancer diagnosis, to live in the community.

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Figure 1.
Theoretical Framework of Fall Risk for this Research Study

Figure 2.

Final parsimonious theoretical model coefficients and variance explained standard errors of estimates (numbers above are parameter estimates [standard error estimates], and t-values are in parenthesis). Fit: ($\chi^2 = 604.77$, $df = 49$, $p = 0.0$, $RMSEA = .04$, lower bound of 90% CI = .038, upper bound of 90% CI = .043, CFI = .91, GFI = .99, AIC = 182.0). REMSA = root mean square error of approximation. Solid line means significant path ($t \geq \pm 2.0$). Dashed line means a non significant direct pat ($t < 2.0$). The numeric values represent standardized path coefficients. Not depicted are the estimates of error covariances.

Table 1

Physiological, Contextual, and Descriptive Patient Characteristics (n = 6912)

Characteristic	n	%
Age Groups		
65-69	1061	15.4
70-74	1075	15.5
75-79	1271	18.4
80-84	1482	21.4
85-89	1156	16.7
90-94	303	4.4
95	564	8.2
Sex		
Female	5270	76.2
Male	1642	23.8
Race or ethnicity		
Caucasian	5267	76.2
African American	1517	21.9
Other	131	1.9
Cancer		
No cancer	6001	86.8
Cancer present	911	13.2

Measure	M (SD)	Potential Range	Skewness (Kurtosis)
Age	79.5 (8.4)	65 109	.15 (−.69)
Cancer	.2 (.51)	0—3	2.71 (6.12)
Depression	.3 (.53)	0-2	1.73 (2.09)
Pain	1.2 (.84)	0-2	−.47 (−1.42)
Falls	.6 (1.4)	0—9	3.80 (16.79)
ADL	2.5 (1.3)	0-5	−.90 (−.42)
Vision	.6 (.91)	0—4	1.75 (3.00)
Incontinence	1.5 (1.4)	0—4	.38 (−1.30)
IADL	1.8 (.43)	0—2	−2.00 (3.23)
Cognitive	1.0 (.95)	0—3	.50 (−.82)