Hospital-Acquired Pressure Ulcers and Risk of Death

David R. Thomas, MD, Patricia S. Goode, MD, Paige Huber Tarquine, and Richard M. Allman, MD

OBJECTIVE: To evaluate the impact of in-hospital pressure ulcer development on mortality among older, high-risk, hospitalized patients up to 1 year post-hospital discharge, after adjusting for baseline patient characteristics, disease severity, hospital complications, and discharge activity level.

DESIGN: A prospective, inception, cohort study.

SETTING: An urban, tertiary, acute care, university teaching hospital.

PATIENTS: A total of 286 patients aged 55 or older, expected to be confined to bed or chair for at least 5 days, who were admitted to the hospital without a Stage 2 or greater pressure ulcer.

MEASUREMENTS: The primary outcome measurement was time to death from admission to 1-year post-hospital discharge. Baseline information included demographic, medical, functional, and nutritional variables known to be associated with increased mortality. Measures of global disease severity and co-morbidity included the admitting physician's estimate of illness severity and life expectancy, the acute physiology score of APACHE II, the Co-morbidity Damage Index, and the Medicus Nursing Classification Score. Baseline infections, incident infections, and noninfectious hospital complications were determined. Functional activity level was determined at hospital discharge. Post-discharge vital status was determined by telephone interviews at 3, 6, 9, and 12 months after discharge and confirmed by death certificate review.

MAIN RESULTS: Development of an in-hospital pressure ulcer was associated with greater risk of death at 1 year (59.5% vs 38.2%, $P = .02$). However, pressure ulcer development did not remain independently associated with decreased survival after adjusting for other predictors of mortality. Predictors of mortality at hospital admission by multivariate Cox regression analysis included weight loss in the 6 months before admission (RR 2.4, CI 1.6,3.6), physician estimate of life expectancy (RR 2.1, CI 1.7,2.6), and the Co-morbidity Damage Index (RR 1.1, CI 1.0,1.2). Multivariate predictors of 1-year mortality at discharge included physician estimate of life expectancy (RR 2.2, CI 1.8,2.6), weight loss in the 6 months before admission (RR 2.2, CI 1.5,3.2), remaining confined to bed or chair (RR 1.9, CI 1.2,3.1), and the total number of hospital complications (RR 1.3, CI 1.2,1.5).

CONCLUSIONS: Pressure ulcers that develop during acute hospitalization are not associated with reduced 1-year survival among high risk older persons after adjusting for nutritional and functional status, global measures of disease severity and co-morbidity, and noninfectious hospital complications. **J Am Geriatr Soc 44:1435–1440, 1996.**

Pressure ulcers have been associated with increased mortality rates in both acute and long-term care settings. Death has been reported to occur during acute hospitalization in 67% of patients who develop a pressure ulcer compared with 15% of at-risk patients without pressure ulcers.[1] Patients who develop a new pressure ulcer within 6 weeks after hospitalization are three times as likely to die as patients not developing a pressure ulcer.[2] Residents in a skilled nursing facility who had pressure ulcers experienced a 6-month mortality rate of 77.3%, whereas patients without pressure ulcers had a mortality rate of 18.3%.[3] Patients whose pressure ulcers healed within 6 months had a significantly lower mortality rate (11% vs 64%) than patients whose pressure ulcers did not heal.[4]

Despite this association with death rates, it is not clear how pressure ulcers contribute to increased mortality. Pressure ulcers may add directly to mortality through complications such as osteomyelitis or sepsis.[5,6] On the other hand, pressure ulcers may not cause death directly, but their association with mortality may be attributable to their occurrence in otherwise frail, sick patients. In these patients a new pressure ulcer may be only a marker for increased mortality.

While the association of pressure ulcers and increased mortality is strong, a number of co-existing morbid conditions complicate mortality analysis in these patients. The trend toward shorter hospital stays could also confound the association of pressure ulcers with hospital mortality. Limiting observations to in-hospital deaths may introduce systematic bias into the relationship between pressure ulcer development and mortality.

For editorial comment, see p 1476

We performed an inception, cohort study of incident pressure ulcers in a high-risk, hospitalized population and observed the effect on mortality from admission to 1 year post-hospital discharge. The contribution of an incident pres-

From the Center for Aging and the Division of Gerontology and Geriatric Medicine, University of Alabama at Birmingham, and the Department of Veterans Affairs Medical Center, Birmingham, Alabama.

This research was supported by grants from the National Institute of Aging (5-RO1-AG07178-03) and Support Systems International, Inc. Charleston, South Carolina.

Address correspondence to David R. Thomas, MD, CHSB 219, 933 19th St. South, Birmingham, AL 35294.

0002-8614/96/$3.50

sure ulcer to mortality was examined after adjustment for baseline demographic, medical, nutritional, and functional characteristics. The effect of a new pressure ulcer on mortality was then evaluated when total hospital complications and discharge functional activity level were added to the model.

METHODS

The methods for this study were described previously in detail.[7] In brief, computer-generated admission logs were used to identify all adult admissions to a 790-bed tertiary, acute care, urban teaching facility from December 1988 through June 1991. Patients were eligible for the study if they were aged 55 years or older and their attending physician expected them to be alive, in hospital, and confined to bed or chair for at least 5 days. Patients with a hip fracture who were expected to be alive and hospitalized for at least 5 days were also included. A research nurse assessed each potentially eligible patient and confirmed the inclusion/exclusion criteria. Informed consent was obtained from the patient or the appropriate family member using procedures approved by the Institutional Review Board. The skin of each patient was then examined for existing conditions. All included patients were free of pressure ulcers by clinical examination at the time of entry. Patients were excluded if they had an active skin disease that might interfere with assessment of pressure ulcer development. All baseline information was collected within 3 days of admission. Friday admissions were excluded from the study because baseline information could not be collected within 3 days. Patients who had been enrolled previously in the study were not re-enrolled.

Baseline Data Collection

Baseline data for each patient included demographic, medical, functional, and nutritional status. Chart review was used to obtain the demographic variables of age, race, marital status, and residence before admission. The smoking status of the patient was determined. Whether the patient was admitted to the medical or surgical service was recorded as well as whether a surgical procedure occurred during the baseline period. Infectious complications, including pneumonia, surgical wound infection, primary bloodstream infection, sepsis, or osteomyelitis, were identified at baseline. To assess the study populations' risk for developing a pressure ulcer, the Norton Score was calculated.[8]

A modification of the Activities of Daily Living Scale,[9] was used to assess functional status. Patients were classified as dependent or independent in relation to seven activities of daily living (ADLs): feeding, grooming, ambulation, bathing, transferring, toiletting, and dressing. The ADL score was calculated with zero indicating dependence in all functional areas and seven indicating independence in all areas. Whether or not the patient was confined to bed more than 1 week before admission was also recorded. Patients were dichotomized into either alert or other levels of consciousness.

Nutritional variables were obtained from estimates of the patient's food intake by the patient's primary nurse using the nutritional subscale of the Braden Scale.[10] Body weight was measured directly by the nursing staff, and the height was obtained from the chart or reported by the patient. When a reported height could not be obtained, study nurses measured the height with a measuring tape with the patient lying on his/her left side. A history of weight loss over the past 6 months was determined by questioning the patient directly. If the patient was unable to answer, the study nurses consulted, in the following order, the patient's caregiver, a nurse or physician familiar with the patient, or the medical record to look for documented weight loss. Weight loss was expressed as a percent of baseline body weight. Ideal body weight was determined from the 1983 Metropolitan Height and Weight Tables.[11] Measurements of triceps skinfold thickness and mid-arm circumference were obtained using standard methods. Triceps skinfold measurements and mid-arm circumference measurements were divided into severely deficient, borderline, and normal groups.

Global measures of severity of illness and co-morbidity included the Acute Physiology Score (APS) of the APACHE II system[12] and the Co-Morbidity Damage Index of Charlson.[13] In addition to APS laboratory values, serum albumin levels were determined on admission. The Glasgow Coma Score was obtained for all patients, and the scores were grouped into greater than 13 or 13 or less.[14] The Medicus Nursing Classification Score was recorded as a global measure of patient acuity.[15] The patient's primary physician was asked to estimate two other severity variables: the patient's severity of illness on an ordinal 5-point scale (not ill to moribund) and an estimate of life expectancy (<6 months, 6 months-<1 year, 1–5 years, >5 years). Estimates of life expectancy were dichotomized into less than 5 years and greater than or equal to 5 years. The physician's estimate of severity of illness was dichotomized into moribund/severely ill and moderately/not ill.

In-Hospital Outcome Assessment

Skin assessments for the development of pressure ulcers were done weekly until discharge or for up to 8 weeks of hospitalization. The staging system recommended by the National Pressure Ulcer Advisory Panel was used to stage newly developed pressure ulcers on a 4-point scale.[16] Stage 1 pressure ulcers, or nonblanchable erythema of intact skin, were excluded from the definition of pressure ulcer used in the study. Stage 2, 3, and 4 pressure ulcers met the study definition for pressure ulcer.

A Total Incident Complication Score was developed using 13 possible conditions with predefined criteria, including gastrointestinal bleeding, hyponatremia, falls, cardiac arrest, hypotension, acute renal failure, diarrhea, pneumothorax, aspiration, drug reaction, cerebrovascular accident, pulmonary embolism, and deep vein thrombosis. When one of these conditions was present at baseline evaluation, the condition was not counted as an incident complication. Only the complications that occurred after the baseline evaluation were counted in the total number of complications. Thus, a patient with none of these complications present at admission could develop all 13 complications while in the hospital and have 13 total incident complications. Major surgery subsequent to the baseline evaluation period was recorded.

Subsequent activity level was determined weekly by nursing assessment of whether the patient was still bedridden. A patient was classified as bedridden if the patient was expected to be confined to bed or chair, except to use the bedside commode, for at least one subsequent week. Activity level by this method was determined at discharge.

Post-Discharge Outcome Assessment

Post-discharge telephone interviews were conducted for study participants or their caregivers at 3, 6, 9, and 12

months. At each interval, the participant's vital status was determined. For participants who had died, the date and place of death were obtained from the family, and mortality was confirmed with death certificates.

Statistical Analyses

Statistical analysis was performed using the Statistical Analyses System (SAS Institute Inc., Cary, NC). Univariate associations were tested using the Wilcoxon rank-sum test for continuous variables and by the method of chi-square for dichotomous variables. Product-limit estimates of survival using the Kaplan-Meier method were constructed to display the probability of survival with increasing time when various patient characteristics were present. The log-rank test was used to determine if these characteristics were significantly associated with survival. All baseline variables associated with shorter time to death ($P < .05$ by the log-rank test) were entered into a Cox-regression model. The variables with the least degree of statistical significance were removed using a backward, stepwise procedure. The significance and independence of the association of hospital complications with 1-year mortality were then evaluated using this same method, adjusting for baseline factors found to be predictive in the first Cox regression model and including incident pressure ulcers. A final model was developed by adding discharge activity level to a model containing incident pressure ulcers and independent predictors from the second model.

RESULTS

Patient characteristics:

Consent to participate in the study was obtained from 286 patients or their appropriate legal representatives. The characteristics of the patients are described in Table 1. The average age of the study participants was 73.7(± 8.6) years. One hundred eighteen subjects (41.3%) were black, and 167 (58.4%) were white. One hundred seventy-four (60.8%) of the participants were female. Study eligibility criteria were successful in identifying a severely functionally impaired population at high risk for pressure ulcer development evidenced by a mean ADL score of 0.3 and a mean Norton Score of 12.7.

Table 1. Study Population at Baseline (N = 286)

Age (years)	73.7 ± 8.6*
Sex	
Male	112 (39.2%)
Female	174 (60.8%)
Race	
Black	118 (41.3%)
White	167 (58.4%)
Baseline Body Weight (kg)	70.9 ± 18.8
Acute Physiology Score	10.5 ± 5.4
MD Assessment of Severity of Illness	
Moribund/severely ill	110 (38.5%)
Moderately/not ill	176 (61.5%)
Co-morbidity Damage Index Score	2.81 ± 2.2
Medicus Nursing Classification Score	95.3 ± 42.4
Activity of Daily Living Score	0.3 ± 0.8
Norton Score	12.7 ± 2.8
Admitted from nursing home	15 (5.2%)

*Mean ± standard deviation.

Pressure Ulcer Incidence

The cumulative incidence for Stage 2 or greater pressure ulcers while in hospital was 12.9% (37/286). Thirty-three of these 37 (89.2%) had Stage 2 ulcers, whereas only four individuals (10.8%) developed Stage 3 ulcers. No Stage 4 ulcers developed. Two hundred forty-nine subjects (87.1%) did not develop in-hospital pressure ulcers.

Mortality

Forty study participants (14.0%) died before discharge, and 77 patients (26.9%) died during the 1-year post-discharge follow-up period. Ten patients (3.5%) who completed one or more post-discharge follow-up interviews and were alive at last contact were dropped from the study after their last telephone interview. Only one patient (0.3%) was lost to all post-discharge follow-up. One hundred fifty-eight patients (55.2%) remained alive and participated in the full year of post-discharge follow-up.

Of the patients who developed in-hospital pressure ulcers, 24.3% (9/37) died in hospital and 46.4% (13/37) died after hospital discharge. Of 249 patients who did not develop pressure ulcers, 12.4% (31/249) died while in hospital, and 29.4% (64/249) died after hospital discharge. Thus, 59.5% (22/37) of patients developing a pressure ulcer died within 1 year compared with 38.2% (95/249) of patients without pressure ulcers. ($\chi^2 = 5.20$, $P = .02$).

Predictors of Mortality by Univariate Analysis

Factors associated with increased mortality by Kaplain-Meir survival analysis ($P < .05$ by log-rank test) are shown in Table 2. Pressure ulcer development was a significant predictor for increased mortality from admission through 1 year after hospital discharge by the log-rank test ($P = .02$). In addition to pressure ulcers, Kaplan-Meir analysis showed several other factors to be predictors of mortality. Demographic and functional status factors included male sex, current or former cigarette smoking, confinement to bed more than 1 week before admission, and decreased level of consciousness. Nutritional predictors of mortality included lymphopenia, history of weight loss in the past 6 months, reported body weight loss of more than 10% of baseline weight, depleted triceps skin fold thickness, and deficient mid-arm circumference. Among the global measurements of disease severity of illness and co-morbidity, the admitting physician's estimate of severity, physician's estimate of life expectancy, Acute Physiology Score of APACHE II, Glasgow Coma Score, and the Co-morbidity Damage Index predicted mortality. Major surgery during baseline evaluation, development of a nosocomial infection, and remaining confined to bed or chair at discharge were univariate predictors of mortality.

Predictors of Mortality by Multivariate Analysis

The variables were divided into factors that were known at hospital admission and conditions known at hospital discharge. Using these two groups, three models for risk of mortality were analyzed. Only the significant univariate pre-

Table 2. Factors Examined in Relation to Time to Death by Univariate Analysis

Factors	*P* Value
Demographic/Medical factors	
Age group by decade	.305
Male sex	.002
Race	.969
Marital status	.217
Smoker (current vs former vs never)	.008
Living alone before admission	.102
Living in nursing home	.842
Admitted to medical vs surgical service	<.001
Major surgery during baseline evaluation	<.001
Infection at baseline evaluation*	.223
Functional status	
ADL Score >1	.764
Confined to bed before admission	.033
Altered or decreased level of consciousness	<.001
Nutritional status	
Inadequate food intake estimate by nurses	.085
Calorie intake as % of basal energy expenditure	.101
Protein intake as % of RDA	.191
History of any weight loss in last 6 months	<.001
Depleted Triceps skin folds (<4 mm men, <5 mm women)	.018
Deficient mid-arm circumference	.002
Anemia (<113 gm/L)	.265
Hypoalbuminemia (<30 gm/L)	.172
Lymphopenia (<1500 cells/mL)	.006
Global Measures of Disease Severity and Co-morbidity	
APACHE APS Score	<.001
Co-morbidity Damage Index quartiles	<.001
Glasgow Coma Scale (dichotomized ≤13 vs >13)	.009
Nursing Classification Score	.962
Severity estimate by physician	<.001
Life expectancy <5 years estimated by physician	<.001
Hospital complications	
Incident Pressure Ulcer	.019
Total Incident Complications Score	<.001
Major surgery subsequent to baseline evaluation	.254
Activity level	
Bed- or chair-bound at discharge	<.001

*Pneumonia, surgical wound infection, primary blood infection, sepsis, or osteomyelitis.

dictors of time-to-death known at hospital admission and development of a subsequent pressure ulcer were used to construct the first Cox regression model for independent association with mortality. After a stepwise backwards logistic regression analysis, all variables were eliminated except weight loss reported in the 6 months before admission (RR 2.4, 95% Confidence Intervals 1.6,3.6), the admitting physician's estimate of life expectancy of less than 5 years (RR 2.1, CI 1.7,2.6), and the Co-morbidity Damage Index Score (RR 1.1, CI 1.0,1.2) (see Table 3).

A second model was then developed to examine the effect of pressure ulcers on mortality when total hospital complications were known. In the second model those factors independently associated with mortality in the first model were included along with incident pressure ulcer and Total Incident Complications Score. All variables, including incident pressure ulcer, were eliminated except for physician estimate of life expectancy (RR 2.3, CI 1.9,2.8), history of weight loss in 6 months before the index hospitalization (RR 2.3, CI 1.5,3.3), and Total Incident Complications Score (RR 1.3, CI 1.2,1.5). In this model, complications developing during hospitalization added to the prediction equation, but incident pressure ulcer development did not. The Co-morbidity Damage Index was no longer an independent predictor. (See Table 4).

A third model was constructed to examine the independent effect of bed- or chair-bound status at the time of discharge. This model included incident pressure ulcers and bed-bound status at discharge as well as the independent predictors from the second model (history of weight loss, Total Complications Score, and physician estimate of life expectancy). The independent predictors of mortality in this final model were physician estimate of life expectancy (RR 2.2, CI 1.8, 2.6), history of weight loss in the previous 6 months (RR 2.2, CI 1.5,3.2), bedridden status at discharge (RR 1.9, CI 1.2,3.1), and the Total Incident Complications Score (RR 1.3, CI 1.2,1.5). Again, incident pressure ulcers did not have an independent effect on mortality. In this model the addition of bedridden status at the time of discharge added to the prediction of mortality. (See Table 4).

DISCUSSION

This study demonstrates that patients with activity limited to bed or chair are at high risk for hospital mortality and death up to 1 year post-discharge. Fourteen percent died in-hospital, and another 26.9% died in the year after discharge.

The development of a new pressure ulcer in this study predicted death within 1 year. This observation confirms previous reports of the association of pressure ulcers and mortality.[1,2,4,5,17] Yet the association of pressure ulcers and mortality is complex. Although Berlowitz and Wilking found a 3-fold increase in mortality with the development of a new

Table 3. Factors at Admission Associated with Increased 1-Year Mortality by Multivariate Cox Regression

Variable	Risk Ratio	95% Confidence Limits	*P* Value
Any weight loss in last 6 months	2.4	1.6, 3.6	<0.001
MD Assessment of Life Expectancy <5 Years	2.1	1.7, 2.6	<0.001
Co-morbidity Damage Index	1.1	1.0, 1.2	0.01

Table 4. Factors at Hospital Discharge Associated with Increased 1-Year Mortality

Variable	Risk Ratio	95% Confidence Limits	*P* Value
When total incident complications are known			
MD Assessment of Life Expectancy <5 Years	2.3	1.9, 2.8	<.001
Any weight loss	2.3	1.5, 3.3	<.001
Total Incident Complications Score	1.3	1.2, 1.5	<.001
When discharge bed-bound status is known			
MD Assessment of Life Expectancy <5 Years	2.2	1.8, 2.6	<.001
Any weight loss	2.2	1.5, 3.2	<.001
Confined to bed or chair at discharge	1.9	1.2, 3.1	.01
Total Incident Complications Score	1.3	1.2, 1.5	<.001

pressure ulcer, patients with Stage II pressure ulcers were equally likely to die as patients with Stage IV pressure ulcers.[2] In other words, the severity of the pressure ulcer was not associated with mortality. In a prospective study of residents of 51 nursing homes, pressure ulcers were associated with an increased rate of mortality, but not with acute hospitalization.[18]

The presence and severity of co-existing conditions may account for the association of pressure ulcers with death. Few reports have simultaneously assessed co-existing conditions and mortality. When variables to adjust for severity of illness are included in risk models for mortality in this study, the development of a new pressure ulcer is not an independent predictor of 1-year mortality. This study suggests that global measures of disease severity and co-morbidity and a history of weight loss are more important predictors of mortality at 1 year than development of a new pressure ulcer.

The optimum measure of severity of illness is controversial. While several scales have been designed for specific conditions,[14,19] few scales measure across disease categories.[20] The Acute Physiology Score of the APACHE II system for intensive care patients and the Co-morbidity Index of Charlson, were used in this study. The APACHE system has proven utility in critical care units, but has been less valid in predicting outcomes in other settings.[21] Although the APS was associated univariately with a higher mortality in this study, it did not add to the predictive model for mortality after adjusting for other variables. The Co-morbidity Damage Index of Charlson is weighted to reflect disease severity and was predictive of mortality in the model using baseline variables. However, the Charlson Damage Index does not predict mortality as well as physician estimate of disease severity.[22] When hospital complications or bedridden status at discharge were added to the model, the Co-morbidity Damage Index at admission was no longer a predictor of 1-year mortality. Using either a global assessment of patient status by physician estimate of prognosis or a weighted co-morbidity index scale eliminates the effect of pressure ulcers in this risk model.

The predictor with the highest risk ratio for mortality in this study was the admitting physician's estimate of life expectancy. Physician's estimates of survival have been shown in several studies to be very powerful predictors of subsequent mortality.[22,23] In this study, physician estimate of life expectancy remained an independent predictor of mortality at 1 year in all three models. This finding confirms the value of the admitting physician's judgment of illness severity and suggests that physicians may be able to identify subjects unlikely to benefit from subsequent interventions designed to increase survival in this population.

A history of weight loss was an important risk factor in all models. Abnormal nutritional indices have been reported to be risk factors for both pressure ulcers[24] and mortality.[25] Weight loss has been associated with mortality in several studies.[26,27] In these studies, other nutritional parameters, including decreased triceps skin fold thickness, decreased mid-arm circumference, and decreased lymphocyte count, have been shown to be predictors of mortality in addition to weight loss. While these nutritional indices were each associated with increased mortality in univariate analysis, only a history of weight loss in the 6 months before admission was an independent predictor for mortality. This finding is important because of all the nutritional variables studied, a variable available by history on admission was the only one that remained predictive of mortality. A history of weight loss as a predictive variable suggests that nutritional interventions may be important.

Total incident complications during hospitalization was an independent predictor of survival after discharge. Of the 13 possible complications evaluated during hospitalization, seven — hyponatremia, falls, aspiration, drug reaction, diarrhea, pulmonary embolism, and deep vein thrombosis — are potentially preventable. This points out the hazards of hospitalization for older adults.

Other researchers employing 1- or 2-year post-discharge outcomes have found low Activities of Daily Living scores to be significant predictors of mortality at hospital discharge.[28] Bed- or chair-bound status, as a measure of functional status, is associated significantly with the presence of pressure ulcers, the formation of new pressure ulcers, and the failure of pressure ulcers to improve.[2,29] This study did not find admission Activities of Daily Living scores to be significantly associated with time to death. However, this study was targeted to a functionally impaired cohort with extremely low ADL scores. The effect of targeting may have diluted the effect of admission ADL scores on mortality. Nevertheless, activity level at hospital discharge was strongly associated with mortality and was an independent predictor of 1-year mortality when added to the Cox regression model. Since both continued confinement to bed or chair and Activities of Daily Living scores are measures of functional ability, patients with diminished functional ability at discharge may have an increased risk of death. Such data suggest the need to test rehabilitation measures to improved subsequent survival of patients admitted to the hospital with limitations in functional status.

The ability of this study to determine the impact of pressure ulcer development as a significant predictor of decreased survival rates may have been limited by the fact that most incident pressure ulcers in the study hospital were Stage 2. Very few Stage 3 ulcers and no Stage 4 ulcers developed.

Pressure ulcers at different stages may or may not have different effects on mortality. Because this study involved Stage 2 pressure ulcers predominantly, the effect of more severe pressure ulcers (Stages 3 and 4) on survival rates cannot be established.

This study suggests that bed- and chair-bound older patients have increased risk of death when they have a history of weight loss, experience greater numbers of hospital complications, and remain confined to bed or chair at discharge. New pressure ulcers appear to be markers for coexisting illnesses, impaired nutrition, and functional status rather than independent risk factors for increased mortality.

At hospital admission, simple measures of life expectancy, a history of weight loss, and co-morbidity within the first 3 days of hospitalization can predict subsequent 1-year post-hospital survival. At discharge, when incident hospital complications and continued confinement to bed or chair on the day of hospital discharge are known, these factors add to the predictive model. Targeting such patients for nutritional interventions, reducing hospital complications, and rehabilitation efforts may improve survival. On the other hand, when non-reversible co-morbid factors are present, or clinical judgment of life expectancy is low, survival may not be increased despite interventions. Future studies of such interventions are warranted.

REFERENCES

1. Allman RM, Laprade CA, Noel LB, et al. Pressure sores among hospitalized patients. Ann Intern Med 1986;105:337–342.
2. Berlowitz DR, Wilking SVB. The short-term outcome of pressure sores. J Am Geriatr Soc 1990;38:748–752.
3. Michocki RJ, Lamy PP. The problem of pressure sores in a nursing home population: Statistical data. J Am Geriatr Soc 1976;24:323–328.
4. Reed JW. Pressure ulcers in the elderly: Prevention and treatment utilizing the team approach. Md State Med J 1981;30:45–50.
5. Sugarman V, Hawes S, Musher DM et al. Osteomyelitis beneath pressure sores. Arch Intern Med 1983:143:683–688.
6. Galpin JE, Chow AW, Bayer AS, Guze LB. Sepsis associated with decubitus ulcers. Am J Med 1976;61:346–350.
7. Allman RM, Goode PS, Patrick MM et al. Pressure ulcer risk factors among hospitalized patients with activity limitation. JAMA 1995;273:865–870.
8. Norton D, McLaren R, Exton-Smith AN. An investigation of geriatric nursing problems in hospitals, 2nd Ed. Edinburgh: Churchill Livingstone, 1975 pp 193–238.
9. Katz S, Ford AB, Moskowitz RW et al. Studies of illness in the aged: The index of ADL: A standardized measure of biological and psychosocial functioning. JAMA 1963;185:914–919.
10. Braden BJ. Clinical utility of the Braden Scale for predicting pressure sore risk. Decubitus 1989;2:44–46, 50–51.
11. 1983 Metropolitan Height and Weight Tables. Stat Bull Metropolitan Life Insurance Co. 1983;64:2.
12. Knaus WA, Draper EA, Wagner DP, Zimmermann JE. APACHE II. A severity of disease classification system. Crit Care Med 1985;13:818–829.
13. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis 1986;40:373–383.
14. Jennet B, Bond M. Assessment of outcome after severe brain damage. Lancet 1975;1:480–484.
15. Medicus System Corporation. Fifth Patient Type Classification Tool. Overview of the Validation Process. Evanston IL: Medicus System Corporation, 1985.
16. National Pressure Ulcer Advisory Panel. Pressure ulcers: Incidence, economics, risk assessment. Consensus development conference statement. Decubitus 1989;2:24–28.
17. Allman RA. Pressure ulcers among the elderly. N Engl J Med 1989;320:850–853.
18. Brandeis GH, Morris JN, Nash DJ, Lipsitz LA. The epidemiology and natural history of pressure ulcers in elderly nursing home residents. JAMA 1990;264:2905–2909.
19. Killip T, Kimball JT. Treatment of myocardial infarction in a coronary care unit: A two year experience with 250 patients. Am J Cardiol 1967;20:457–464.
20. Stein REK, Gortmaker SL, Perrin EC et al. Severity of illness: Concepts and measurements. Lancet 1987;2:1506–1509.
21. Knaus WA, Vagner DP, Draper EA. The value of measuring severity of disease in clinical research on acutely ill patients. J Chronic Dis 1984;37:455–463.
22. Charlson ME, Sax FL, MacKenzie CR et al. Assessing illness severity: Does clinical judgment work? J Chronic Dis 1986;39:439–452.
23. Kruse JA, Thill-Baharozian MC, Carlson RW. Comparison of clinical assessment with APACHE II for predicting mortality risk in patients admitted to a medical intensive care unit. JAMA 1988;260:1739–1742.
24. Pinchofsky-Devin GD, Kaminski MV Jr. Correlation of pressure sores and nutritional status. J Am Geriatr Soc 1986;34:435–440.
25. Thomas DR, Verdery RB, Gardner L et al. A prospective study of outcome from protein-energy malnutrition in nursing home residents. JPEN 1991;15:400–404.
26. Volkert D, Kruse W, Oster P, Schlierf G. Malnutrition in geriatric patients: Diagnostic and prognostic significance of nutritional parameters. Ann Nutr Metab 1992;36:97–112.
27. Larsson J, Unosson M, Ek AC et al. Effect of dietary supplement on nutritional status and clinical outcome in 501 geriatric patients — A randomized study. Clin Nutr 1990;9:170–184.
28. Incalzi RA, Gemma A, Capparella O et al. Predicting mortality and length of stay of geriatric patients in an acute care general hospital. J Gerontol 1 192;47:M35–39.
29. Berlowitz DR, Wilking SVB. Risk factors for pressure sores: A comparison of cross-sectional and cohort derived data. J Am Geriatr Soc 1989;37:1043–1050.