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# Functional decline at hospital discharge in elderly surgical patients

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# Functional Decline at Hospital Discharge in Elderly Surgical Patients

A Thesis Submitted to the Yale University
School of Medicine in Partial Fulfillment of the
Requirement for the Degree of
Doctor of Medicine

by
Anthony S. Burns
1994

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FUNCTIONAL DECLINE AT HOSPITAL DISCHARGE IN ELDERLY SURGICAL PATIENTS. Anthony S. Burns and Raye Wagner (Sponsored by Sharon Inouye). Section of Geriatrics, Department of Internal Medicine, Yale University, School of Medicine, New Haven, CT.

The struggle to maintain independence is one of the most pervasive problems facing elderly people. Hospitalization and surgery can mark the start of a continual downward spiral. Often, discharged elderly patients never regain their pre-hospitalization level of functioning, resulting in the need for in-home care or long-term placement. This study examines the incidence of and risk factors for loss of function at hospital discharge. The cohort consisted of 117 patients (age $\geq$ 70) admitted to surgical services at Yale-New Haven Hospital, New Haven, CT. Baseline level of functioning, determined shortly after hospital admission, was assessed by self-reported ability to perform activities of daily living (ADLs) two weeks prior to hospital admission. At discharge, ability to perform ADLs was again assessed (by nurse interview). Loss of function was defined as a decrease in the ability to perform at least one of five ADLs (feeding, bathing, grooming, dressing, toileting). The overall rate of functional decline for the study cohort was 54/117 (46%). Utilizing univariate analysis, many variables emerged with statistically significant associations. They included the following: age, nursing home residency, admission physical functioning, mini-mental score, presence of baseline

delirium, body mass index, traumatic injury, nature of surgical problem, primary discharge diagnosis, religious support, restraint use at baseline interview, narcotics, digoxin, # daily medications, surgical status, type of surgical procedure, and hip surgery. Utilizing the guidelines of clinical significance, quantitative significance (RR>1.5), or statistical significance (p-value<.05 or 95% CI excluding one); eleven variables were selected for stepwise multivariable relative risk modeling. Two variables emerged as potentially important causes of functional decline: 1) body mass index $\leq$ 20.5 and 2) admission for traumatic injury. These two variables could be targeted for intervention in an attempt to lower the incidence of functional decline at discharge in elderly surgical patients.

# I. Introduction:

## A. Background:

Elderly people in our culture are faced with a variety of unique problems which significantly compromise their quality of life. One of the more pervasive problems is the struggle to maintain independence. Due to a marked decline in mortality rates, the elderly comprise one of the fastest growing segments of the U.S. population (1). People older than 75 are the fastest growing age group (2). This phenomena, however, has been accompanied by an increase in the prevalence of chronic illness and long-term disability (3).

Ideally, hospitalization would enable the patient to return home able to perform common, daily tasks independently. Instead, hospitalization often marks the start of a continual downward spiral (4). Older patients are much more likely than their younger counterparts to die during hospitalization, be discharged to other health care facilities, face readmission to the hospital, and become functionally dependent (5). During hospitalization, the elderly are at increased risk for medical and iatrogenic complications. In one study, 72% of elderly patients on medical wards developed at least one complication. The comparable rate for younger patients was 30% (6).

All too often, the discharged elderly patient never regains his or her pre-hospitalization level of functioning. Instead, the elderly patient is discharged from the hospital with significant impairment from his or her baseline level of functioning. According to recent studies, anywhere from 28-50% of elderly patients may experience functional decline, defined as a deterioration in basic care skills, during acute hospitalization (7-9). The patient populations for these studies ranged from just general medicine patients to medicine, surgery, and psychiatric patients. Three studies are summarized below.

McVey (9) examined the effects of a geriatric consult service on the functional status of 178 elderly men admitted to surgical, medical, and psychiatric services at a VA hospital. Approximately 60% of the patients had some degree of functional impairment on admission. Among the intervention group (n=88), at discharge the functional status of 38% was unchanged, 34% improved, and 28% declined. Among the control group (n=90), the discharge functional status of 39% was unchanged, 26% improved, and 36% declined. Both the intervention and control groups displayed significant rates (28% and 36%) of functional decline at hospital discharge.

Warshaw (8) performed a cross-sectional survey of the functional status of 279 patients at a random point during their hospitalization. The study cohort consisted of patients age 70 or older, from medical and surgical services at a community hospital.

54% of patients, 85 or older, were moderately or severely disoriented. Including all study subjects, 34% had impaired hearing, 40% impaired vision, and 25% impaired speech. 65% of patients were not able to ambulate independently. More than 50% of patients 75 or older needed assistance with activities of daily living (mobility, feeding, dressing). Due to the cross-sectional nature of the study, the course of patients' functional levels throughout hospitalization were not evaluated.

Hirsch (10) also investigated functional decline in older patients. Between baseline and day two, statistically significant deteriorations occurred for the overall functional score and for the individual scores for mobility, transfering, toileting, feeding, and grooming. These scores failed to improve significantly by discharge. For example, 65% of the patients experienced a decline in mobility between baseline and day two. Between day two and discharge, 67% showed no improvement, and another 10% deteriorated further.

A variety of adverse outcomes in the elderly have been shown to be related to compromised functional status. Maguire (11) found that, with elderly patients, a decreased ability to perform everyday activities following hospital admission was associated with a longer average length of stay. Glass (12) showed a decreased ability to perform ADLs was associated with a higher incidence of non-medical hospital days. Wachtel (13) demonstrated that patient ability to perform ADLs was an important predictor of nursing home

placement following hospitalization. Winograd (14) found compromised functional status was associated with nursing home placement. In a population of elderly patients in residential care, Donaldson (15) found a relationship between decreased functional capacity and increased mortality.

The frequency of in-patient stays is greatly increased in the elderly. With advancing age, hospitalization rates, hospitalization days per 1,000 persons, and average length of stay all increase. Nearly half of all health care expenditures for the elderly are associated with hospitalization (16). In summary, functional loss associated with hospitalization is an important problem in need of further study.

**B. Study Purpose:**

The purpose of this study was to investigate the influence of a large number of variables on the incidence of functional decline at hospital discharge in elderly patients admitted to surgical services. Prior studies have not restricted their focus to surgical patients. There may be distinct variables effecting the incidence of loss of function at discharge in this particular patient population.

Functional status was determined utilizing the patient's ability to perform Activities of Daily Living (ADLs). Katz (17-19) introduced the concept of ADLs in 1959. The idea was that there are rudimentary tasks such as feeding, bathing, etc., that everyone in our

society has to perform on a daily basis in order to function effectively and independently. The ability of a person to perform these "activities of daily living" could be formally evaluated. This formalized Index of ADL provided clinicians with a useful way to assess, quantify, and compare the functional status of patients. Since this method of determining functional status is centered around common, everyday activities; it has a particularly strong relevance to the "real world". Since it's inception, the concept of ADLs has been modified in various ways by many researchers, but the core concept remains intact.

Five ADLs were utilized when defining the study outcome: functional decline at hospital discharge. They were feeding, bathing, grooming, dressing, and toileting. Two additional ADLs, ambulating and transferring, were used to determine one of the study variables: baseline ability to perform ADLs. It was of interest whether patients admitted with baseline impairments are more prone to further functional impairments at discharge than their counterparts.

By identifying variables that show a strong association with an increased incidence of functional decline at hospital discharge, one could provide clinicians with a useful way to identify patients that are at particularly increased risk for this adverse outcome. Specific intervention could be directed toward these high-risk patients. In an age of diminishing resources, this is essential if available funds are to be allocated efficiently.

Previous studies have focused on ways of targeting special geriatric services towards patients most likely to benefit. Winograd (5) reviews criteria previously used to select appropriate patients. Age has been widely used since it tends to correspond with increasing morbidity and mortality. Impaired functional status is another widely used criterion. The presence of geriatric conditions has also been employed to select patients. These conditions include falls, incontinence, polypharmacy, and confusion. Degree (i.e. # of diagnoses) and type (i.e. major motor disabilities, chronic illness) of physical illness have also been utilized as selection criteria. Psychosocial conditions such as living alone, recent bereavement, low income, and poor health of caregiver form yet another set of criteria for targeting potential patients. The perceived need for services has also been employed. Other criteria used to select candidates for specialized geriatric services include a recent hospitalization, admission from a long-term facility, a predicted long length of stay, and the receipt of home care support prior to admission. Furthermore, investigators have used various combinations of the above mentioned selection criteria.

This study utilized univariate analysis in an effort to identify variables associated with an increased incidence of functional decline at hospital discharge. Multivariate analysis was also employed. The intent was to distinguish direct causes of the study outcome from variables which were merely associated with an increased incidence of the outcome. In the future, targeting these

direct causes for intervention might serve to increase the level of functioning in elderly patients discharged from surgical services.

Hopefully, the study can serve as a productive step towards reducing the problem of decreased independence in the elderly following hospitalization. Ignoring this problem will only increase the financial and emotional burden on society caused by the higher utilization of institutional care and in-home assistance. Currently, the elderly are consuming a disproportionate share of health resources. They utilize short-stay hospitals more frequently and longer than other age groups (20). Annually, 30-50% of hospital beds are occupied by persons older than 65 (21). Effectively addressing the issue would decrease the cost to society in general while also increasing the quality of life for the individual.

# II. Methods:

## A. Background:

The majority of the data for this study was collected as part of a larger study conducted at Yale-New Haven Hospital, New Haven, CT, which addressed many geriatric issues and was funded by the Hartford Foundation. The principal investigators were Sharon Inouye, MD and Leo Cooney, MD. Study results have not been published to date.

Patients, greater than seventy years of age, on both the medical and surgical services were consecutively enrolled in the study in order of their admission to the hospital. Enrollment was contingent on informed consent being obtained from the patient or legal guardian as well as attending physician. Patients were assigned to a medical or surgical category based on the clinical service they were admitted to.

Following enrollment in the study, extensive interviews as well as regular physical examinations were conducted by specially trained research assistants. All interviews and examinations were completed following the format of structured questionnaires. Within forty-eight hours of admission, a baseline interview and examination of the patient was completed. This was followed by bi-weekly patient interviews and examinations throughout the entire

hospital admission. Nurse interviews were also conducted at baseline and biweekly during the hospitalization.

At discharge, both patient and nurse discharge interviews were conducted. In addition, medical records were reviewed and an extensive medical record extraction questionnaire was completed. Medications received during hospitalization, medical complications, and other important data was recorded here.

Records of the patient interviews, medical record extractions, and physical examinations are maintained on file at the Center for Geriatric Research on 45 College Street, New Haven, CT. Patients in the study were assigned numerical codes to preserve confidentiality of patient information. Patient files are identified solely by numerical code. Patient names do not appear anywhere on study records.

**B. Determination of Cohort:**

Subjects from the surgical category of the Hartford Study comprised the cohort for this study: "Functional Decline at Hospital Discharge in Elderly Surgical Patients." Study subjects were enrolled for the period of July 1990 - August 1991. If for any reason, the service to which the patient was admitted was unclear, the patient was assigned to a cohort based on the service of their attending physician during hospitalization. The criteria of whether or not a patient had a surgical procedure performed during

hospitalization was not used to assign patients to either a medical or surgical category. It is important to note that some patients admitted to surgical services do not undergo surgical procedures, likewise, a significant number of patients admitted to medical services do undergo surgery.

Surgical patients who had total impairments in all five ADLs at baseline were excluded from the study. Patients at admission who were already impaired in all five ADLs would be unable to suffer further functional decline, according to our outcome criteria. In addition, individuals who could not be interviewed for various reasons (i.e. intubation, coma, severe aphasia, terminal condition) were ineligible for inclusion. Other reasons for exclusion included the refusal of the patient to participate, an impending discharge within 48 hours, the refusal of the attending physician to grant consent, prior enrollment in the study, and the inability to communicate in English. The final study cohort consisted of 117 patients (age $\geq$ 70).

**C. Definition of Outcome:**

The outcome being examined in this study is the presence of functional decline at hospital discharge when compared to baseline functioning. All interviews were conducted by trained clinical researchers utilizing structured questionnaires.

A baseline level of physical functioning was subjectively determined for each individual within 48 hours of hospital admission. This was accomplished during the baseline interview by questioning the patient on his or her ability to perform ADLs (feeding, bathing, grooming, dressing, toileting) two weeks prior to admission. For each individual ADL, the patient rated whether he or she required no assistance, some assistance, or total assistance to perform the given task. This system of grading patient ability to perform ADLS has been previously used (12).

At the time of hospital discharge, the patient's primary nurse was queried regarding the patient's ability to perform ADLs. Prior studies have used the subjective impressions of nurses to categorize patient ability to perform activities of daily living or rate physical functioning (13, 22). The nurse subjectively rated whether the patient required no assistance, some assistance, or total assistance to perform the specific task. A decrease from baseline ability to perform any of the five ADLs was considered a loss of function ("functional decline"). A change could be from independent to requiring partial or total assistance with an ADL as well as from requiring partial to requiring total assistance. If a functional deficit developed during hospitalization, but resolved prior to discharge; it was not considered a loss of function. A decline in any ADL from baseline that was present at discharge was considered a functional loss.

The use of patient self-report to determine the baseline level of functioning was necessitated by the logistical impossibility of having the caregiver (i.e. nurse) assess functioning prior to hospital admission. Patient self-report has previously been used to assess independence or dependence in basic activities of daily living (ADL) among the non-hospitalized elderly (23).

Four patients died during the course of their hospital admission. Those who developed a functional deficit which persisted until their demise were counted as having a functional decline.

**D. Univariate Analysis:**

The initial stage of the study involved identifying and investigating variables postulated to have an effect on the incidence of functional decline at discharge in our patient population. Variables were subjectively organized under six main axes. The six axes were **demographic**, **physical functioning**, **cognitive functioning**, **biomedical**, **psychosocial**, and **in-hospital**. The axes just served as a useful way of organizing similar potential contributors to functional decline.

All data analysis was performed by Anthony Burns, Yale Medical Student, and Raye Wagner, Graduate Student in the Department of Epidemiology and Public Health. An overall rate of functional decline at discharge was determined for the study cohort.

In addition, the incidence of functional decline for each individual variable was determined. Relative risk ratios, 95% confidence intervals, and p-values were also calculated for each variable. Calculations were performed utilizing the IBM compatible software SAS (SAS Institute, Cary, North Carolina).

Relative risk ratios are calculated by dividing the rate of functional decline for the set of patients with the variable under question by the rate of functional decline for the patients without that particular variable. For example, female patients might experience functional decline at a rate of 60%. If the rate of functional decline for males was 40%, the relative risk would be 1.5 (60/40).

For a relative risk of greater than 1.2, patients with a particular characteristic have a likelihood of having functional decline at hospital discharge which is at least 20% higher than for the set of patients without the characteristic. Likewise, a relative risk greater than 1.5 means the probability of a specific outcome is at least 50% greater for a particular set.

95% confidence intervals (CI) and p-values were also calculated. The 95% confidence interval allows one to state that there is less than a 5% probability that the true value of a calculated value falls outside the calculated confidence interval. For relative risk ratios, a 95% CI exceeding 1.0 (ie 1.46, 2.86) means

that one can state with 95% certainty that a given set of patients is more likely to experience functional decline than a comparison group; since there is only a 5% probability that the relative risk ratio is less than 1.00. A relative risk ratio < 1.00 is protective; meaning the group being studied is less likely to experience functional decline than the comparison group. A p-value of less than .05 means the probability of a calculated value being solely due to chance is less than 5%.

For variables with greater than two risk categories and where outcome incidence was expected to increase in a predictable fashion with increasing variable values, a chi-square for linear trend was substituted for the traditional chi-square value. The chi-square for linear trend is a useful way of determining the statistical significance of a trend of increasing or decreasing outcome incidence dependent on the variable value.

The majority of the data utilized for these calculations was obtained from the extensive questionnaires and medical record extractions completed during the Hartford Study. Additional information was obtained from individual medical record reviews and by request from the computerized data base maintained by the Clinical Information Service at the Yale-New Haven Medical Center, New Haven, CT. Data regarding anesthetic agents received during surgical procedures was obtained from the Department of Anesthesia, Yale School of Medicine.

The six axes along with the associated individual variables investigated are discussed below.

## E. Definition of Study Variables:

Demographic Axis:

1. Age- The variable age was examined in two ways. First, patients were grouped into age groups spanning 5 years: 70-74, 75-79, 80-84, 85-90, >90*. Secondly, patient age was investigated simply as < 85 vs. ≥ 85. A cutpoint of ≥ 80 years of age was also examined.

2. Sex- Examined as male vs. female.

3. Education- Educational levels were designated as completion of some elementary school (grades 2-8), completion of some high school (grades 9-12), and completion of some post-high school study (higher than grade 12). Education was also examined as failure to complete high school (< grade 12), completion of high school (grade 12), and completion of some post-high school study (> grade 12).

4. Income- Current patient incomes were investigated as being < $20,000 annually vs. ≥ $20,000 annually.

*age range was not limited to 5 years due to the low number of patients exceeding 90 years of age.

5. Current Marital Status- Examined as married vs. unmarried (includes widowed and divorced).

6. Living Situation- Patients who lived alone were compared to those who lived with other individuals.

7. Nursing Home- Patients who resided in nursing homes were compared to those with other living arrangements.

Physical Function Axis:

*The following two variables, baseline ADL status and baseline IADL status, were utilized to assess whether patients who already had impairments at the time of hospital admission, were more prone than their counterparts to develop further impairments during hospitalization.

1. Baseline Ability to Perform ADLs*- As mentioned previously, two additional ADLs (ambulating and transferring) were used to determine functional status at admission in addition to the original five ADLs used to define the study outcome. Ambulating and transferring were not utilized to assess the onset of new functional impairments during the course of hospitalization. It was felt the prevalence of bed rest orders and restraints in the hospital would prevent the accurate assessment of new declines in these two particular ADLs.

Utilizing two sets of criteria, patients were categorized as being functionally independent or dependent. The first set of criteria defined independence as no impairment in any of seven ADLs and dependence as impairment in any of the seven ADLs. Secondly, independence was defined as impairment in one or less of seven ADLs and dependence as impairment in two or more of the seven ADLs. Again, the seven ADLs examined were ambulating, bathing, grooming, dressing, feeding, transferring, and toileting. On admission, study subjects were questioned about their ability to perform each of the above activities. For each individual ADL, subjects responded they needed help, no help, or were unable to perform. Responses of *help* or *unable to perform* were defined as impairment for that particular ADL.

2. Baseline Ability to Perform Instrumental Activities of Daily Living (IADLs)*- Similar to Activities of Daily Living, Instrumental Activities of Daily Living (IADLs) are tasks routinely performed by individuals during their daily existence (24). They too can be assessed utilizing established criteria in order to determine the functional status of a person. The tasks measured are more complicated than ADLs and therefore tap a higher level of functioning. They provide a useful alternative when trying to evaluate the everyday functional competence of an individual.

Similar to the ADLs, patients were labeled as being functionally independent or dependent according to two sets of

criteria. The first set of criteria defined independence as no impairment in any of seven IADLs (instrumental activities of daily living) and dependence as impairment in any of the seven IADLs. Utilizing the second set of criteria, independence was defined as impairment in one or less of seven IADLs and dependence as impairment in two or more of the seven IADLs. The seven IADLs were telephone usage, grocery shopping, utilization of transportation other than walking, meal preparation, performance of household chores, ability to independently take medications, and management of finances. For each individual IADL, subjects responded they needed help, no help, or were unable to perform. Responses of *help* or *unable to perform* were defined as impairment for that particular IADL.

3. Mobility- Mobility was assessed in two ways. Patients responded yes/no to whether they could climb one flight of steps without help and to whether they could walk half a mile without help.

4. Hearing- Hearing impairment was defined as hearing 6 or less numbers out of 12 with both ears utilizing the whisper test.

5. Vision- Vision impairment was considered present if the subject had worse than 20/40 corrected vision utilizing the Jaeger Test (25) for binocular near-vision testing.

Cognitive Function Axis:

1. Mini-Mental Exam (MMSE)- At admission, each study subject was administered a Mini-Mental State Examination (26). Maximum scoring was 30. Cutpoints of $\geq$ 20, $\geq$ 22, and $\geq$ 24 were examined. Crum (27) investigated a number of norms regarding the MMSE. The median score for individuals with 0-4 years of schooling was 22. Utilizing a cutpoint of 23, the sensitivity and specificity were 87% and 82% for detecting delirium and dementia in hospitalized patients. In an editorial, Cummings (28) suggest that a cutoff score of 19 is appropriate for those with 0-4 years of education and a cutoff score of 23 is more appropriate for those with 5-8 years of education. Bassett (29) utilized a cutpoint of $\leq$ 23 to indicate cognitive impairment in her study population.

2. Baseline Delirium- At hospital admission, subjects were assessed for the presence of delirium utilizing the Confusion Assessment Method (CAM) criteria (30). The diagnosis of delirium requires the presence of acute mental status changes, inattentiveness, and either disorganized thinking or an altered level of consciousness.

Biomedical Axis:

1. Body Mass Index (BMI)- Body mass index ($kg/m^2$) was used as an indicator for lean body mass and potential obesity. BMI ($kg/m^2$) = (wt[lb]/ht[in.]$^2$) x 703.1. Cutpoints of $\geq$ 20.5 and $\geq$ 22 were studied. A BMI of $<$ 22 has previously been associated with increased mortality in the elderly (31). Andres (32) reports a range of 20 to 25 $kg/m^2$

has been frequently recommended as the standard of normality for body weight.

2. Smoking Status- Subjects responded yes/no when queried on whether or not they had smoked within the past two years.

3. Alcohol Consumption- Subjects responded yes/no when questioned whether they currently consumed alcohol. In addition, CAGE (33) criteria was administered. The CAGE questionnaire consists of four questions: 1) Have you ever felt you should *cut* down on your drinking?, 2) Have people *annoyed* you by criticizing your drinking?, 3) Have you ever felt bad or *guilty* about your drinking?, and 4) Have you ever had a drink first thing in the morning to steady your nerves of get rid of a hangover (*eye-opener* )?. Patients answering yes to any of the CAGE criteria were considered positive outcomes for potential alcohol abuse.

4. APACHE- The Acute Physiology and Chronic Health Evaluation System (APACHE) represents a method of estimating patient severity of illness (34). It consists of three primary components: 1) the acute physiology score, 2) the age score, and 3) the chronic health evaluation score. The Acute Physiology Score is a sum of twelve measured physiological variables such as vital signs and laboratory tests. Chronic Health Points are assigned according to a history of severe organ system insufficiency or immuno-

comprimization. A higher score is associated with greater severity of illness and increased risk of mortality.

5. Incontinence- Incontinence was defined as the presence of urinary incontinence or chronic catheter use for incontinence by baseline patient self-report.

6. Decubiti- Measured by direct observation. Considered present if there was at least superficial skin breakdown at any one of twelve potential pressure points, including bilateral heels, ankles, knees, hips, buttocks, and sacrum.

7. Previous Hospitalization- During the initial patient interview, study subjects were questioned regarding whether they had been hospitalized during the previous year.

8. # of Diagnoses- Number of diagnoses was used as a marker of general illness severity. The number of all diagnoses (past & current) as well as the number of active diagnoses during the current hospitalization were examined. The cutpoints were $\geq$ five for # diagnoses and $\geq$ four for # active diagnoses.

9. Trauma Index- Any patient with a primary diagnosis of hip fracture, upper extremity fracture, lower extremity fracture, lacerations, soft tissue injuries, or any condition falling into the

injury category according to International Classification of Diseases (ICD) codes was assigned to the trauma group.

10. Nature of Surgical Problem- Subjects were designated depending on whether the nature of the surgical problem, which led to admission, was abdominal, vascular, genito-urinary, orthopedic, or other.

11. Discharge Primary Diagnosis- The nature of the primary diagnosis established at discharge and its effect on functional decline incidence was determined.

Psychosocial Axis:

1. Depression- The Geriatric Depression Scale was administered at initial evaluation to screen study subjects for potential depression. The Geriatric Depression Scale (GDS) was devised by Yesavage (35) in 1983. The scale utilized here is modified and consists of fifteen questions. Scoring extended from 0-15. Cutpoints of $\geq 5$ and $\geq 7$ were examined.

2. Social Activity Level- Subjects were questioned regarding their monthly participation in 10 possible activities. These activities are listed below: 1) participation in sports or regular exercise, 2) gardening or yard work, 3) hobbies, 4) outings to a movie, play, concert, restaurant, museum, or sporting event, 5) reading books, magazines, or newspapers, 6) working at a job, either a paid job or

volunteer work, 7) regularly playing cards, games, or bingo, 8) going to religious services or activities, 9) visiting relatives or friends, and 10) participating in any group such as a senior center, social group, or community group. Active was established as at least monthly participation in four or more activities, inactive as participation in three or less.

3. Social Supports- Social Support was investigated in two ways. The number of the subject's social supports was estimated by the sum of the number of children, close relatives and friends seen at least once a month. Also, three social support types were rated as present or absent: instrumental support, emotional support, and presence of a confidante. Fewer support types were indicated by the presence of two or less of these support types.

4. Religious Support- Patients were asked to rate as none, a little, or a great deal the amount of comfort and strength they derived from their religious beliefs.

In-Hospital Axis:

1. Restraint Use at Baseline- Patients in restraints during the initial evaluation were noted by the interviewer.

2. Medicines- From the extensive medical record extraction following the conclusion of the hospital admission, data were collected on many families of drugs as well as individual agents

that study subjects received. First, these families and individual agents were examined. Next, the average number of daily medications that patients received was examined in two ways. It was examined utilizing four groupings based on medications received (0-2, 3-5, 6-8, 9+) and a cutpoint of $\geq$ 6.

3. Anesthesia- Since this cohort consisted of patients admitted to a surgical service, many underwent procedures that required anesthesia. Categories of anesthesia studied included no surgery, general, spinal, IV, epidural, and local.

4. Surgical Status- The effect of having surgery and the type of surgery on the incidence of functional decline was examined in several ways. First, patients were simply classified according to whether or not they had surgery. The nature of the surgery (ie orthopedic, vascular) and specific types (ie aortic, hip replacement) were also investigated.

5. Duration of Hospitalization- The relationship between number of hospitalization days and incidence of functional decline was examined. After reviewing continual data, a cutpoint of $\geq$ 10 days was investigated.

**F. Multivariate Analysis:**

Following completion of the univariate analysis, the data were used to select variables for inclusion in a multivariate model.

Criteria used for inclusion included clinical significance (subjective), quantitative (rr > 1.5), and statistical significance (p-value < .05 or 95% CI exceeding one). Many of the potential contributing variables to functional decline were investigated in several ways. If a variable met the criteria for inclusion in more than one way; only one was selected for the stepwise multivariable relative risk modeling. For example, age could have been examined as $\geq$ 85 (p-value = 0.001) or $\geq$80 (p-value = 0.000). The decision was reached to use $\geq$ 80 since the p-value was smaller. Decisions were based on factors such as the number of subjects with the variable present, the exact p-value, and the magnitude of the relative risk.

The purpose of the multivariate analysis was to identify factors which contribute directly to functional decline at discharge while controlling for the confounding effects of other variables in the model. The intent was to differentiate true causal relationships from associations. The variables emerging from the model could be used to formulate a future predictive model for functional decline in elderly surgical patients.

# III. Results:

## A. Univariate Analysis:

The variables being investigated as potential causes of functional decline at discharge were previously described in the methods section. Many of the variables were examined utilizing several different sets of criteria. Utilizing the IBM compatible software SAS (SAS Institute, Cary, North Carolina), relative risk ratios (rr), 95% confidence intervals (CI), and p-values were determined for potential causes.

The overall rate of functional decline at hospital discharge was 46% (54/117). For the individual ADLs, the rates of functional decline at discharge were as follows: 5% (6/117) for feeding, 30% (35/117) for bathing, 16% (19/117) for grooming, 30% (35/117) for dressing, and 25% (29/117) for toileting. 32% (37/117) of the study subjects were discharged with a loss of function in more than one ADL. Results for the individual variables are discussed below under the organization of the five axes: **demo-graphic**, **physical functioning**, **cognitive functioning**, **biomedical**, **psychosocial**, and **in-hospital**. These results are summarized in Appendix A (statistically significant variables are in bold type).

Demographic Axis:

Age showed a statistically significant association with functional decline. As age increased so did the outcome incidence

and relative risk ratios. For the three ways we examined this variable, the p-values ranges from 0.000-0.001. Individuals older than 80 were more than twice as likely (rr > 2.00) as their younger counterparts to have functional decline at hospital discharge.

Study subjects admitted from nursing homes were also significantly (p-value = 0.030) more likely to experience functional decline even though this group included only seven individuals. The incidence rate was approximately 86% (6/7) and the relative risk ratio was 1.96.

Two variables revealed trends towards increasing functional decline that were almost statistically significant. The incidence rate for female study subjects was approximately 50% greater (rr = 1.48) than for males, and the p-value was 0.052. As years of formal education decreased, the rate of functional decline increased. The rate for individuals who completed grades 2-8 was 58%, compared to 37% for those whose formal education advanced beyond grade 12. The p-value was 0.074.

Variables which were not significant also included income, marital status, and living alone. Income status was hindered by the fact that a large number of study subjects (#57) declined to report this information.

Physical Functioning Axis:

When independence was defined as 0-1 ADL impairment and dependence as 2-7 ADL impairments, baseline ADL status was associated with a statistically significant increased outcome rate. The rr was 1.66 and the p-value was 0.021. Baseline IADL status was significant both ways it was defined. The rr ranged from 1.55 to 1.94. The two p-values were 0.038 and 0.001. Mobility, hearing acuity, and vision acuity all failed to show significant relationships to increased functional decline at hospital discharge.

Cognitive Functioning Axis:

Scores on the Mini-Mental Status Examination were strongly associated with the study outcome regardless of the cutpoint utilized. For the cutpoints $\geq$ 20, $\geq$ 22, and $\geq$ 24, the relative risk ratios were 2.04, 1.71, and 1.66. The p-values were 0.001, 0.009. and 0.010 respectively. The presence of baseline delirium also substantially increased the likelihood of functional decline at hospital discharge. The rr was 1.82 while the p-value was 0.018.

Biomedical Axis:

Body Mass Index (BMI) emerged from the univariate analysis as a variable with a significant influence on the incidence of functional decline. A low BMI significantly increased the likelihood of this outcome. For $\leq$ 20.5, the rr was 1.82 and the p-value was 0.006. For $<$ 22, the rr was 1.70 and the p-value was 0.008.

Traumatic injury more than doubled the study outcome incidence. Persons with this type of injury suffered functional decline at a rate of 71% compared to 32% for the other study subjects. The accompanying rr and p-value were 2.23 and 0.000 respectively. The nature of the surgical problem (p-value = 0.044) and the primary discharge diagnosis established at discharge (p-value = 0.017) also had statistically significant influences on the outcome incidence.

There was no significant association between functional decline and the following variables: smoking status, alcohol consumption, CAGE criteria, APACHE, incontinence, decubiti, recent hospitalization, # previous diagnoses, and # active diagnoses.

Psychosocial Axis:

The only significant variable to emerge from this axis was religious support. Interestingly, as the degree of subjective comfort patients derived from their religious beliefs declined, the rate of functional decline at discharge increased. The following were the rates and relative risk ratios based on magnitude of religious comfort: a lot (38%, -), a little (59%, 1.58), and none (62%, 1.64). The p-value based on the chi-square for linear trend was 0.027%.

Other variables organized under this axis and which were investigated included depression, social activity level, # social supports, and social support types.

In-Hospital Axis:

Although only seven patients were observed in restraints during the initial interview and evaluation, they all were discharged with some degree of functional decline. The relative risk ratio was 2.34 and the p-value was 0.003.

Many individual pharmaceutical agents were investigated for their role in the incidence of the study outcome. Agents emerging with statistical significance are listed below along with the incidence rates, rr, and p-values:

narcotics (51%, 1.85, 0.049)

digoxin (74%, 1.81, 0.009)

Ranitidine was almost significant with a p-value of 0.063 and the following 95% CI (1.03, 2.29)

The average number of daily medications was also studied. Utilizing categories of 0-2, 3-5, 6-8, and 9+, the p-value was 0.014. Subjects receiving greater than nine daily medications, had a rr of 2.33 when compared to subjects receiving 0-2. With a cutpoint of $\geq$ 6, the relative risk was 1.56 with a p-value of 0.025. Both average daily medication variables were significant.

The potential role of anesthesia in the incidence of functional impairment was of interest. Categories investigated included no surgery, general, spinal, IV, epidural, and local. Examined in this way, anesthesia was non-significant.

The relatively straightforward variable of whether or not study subjects had surgery was found to be important. The incidence rate for patients who underwent surgery was 53% (46/87) compared to 27% (8/30) for those who didn't. This resulted in a relative risk of 1.98 and a p-value of 0.013. The type of surgical procedure was also found to be of importance. Categories were no surgery, general, vascular, genito-urinary, and orthopedic. The associated p-value was 0.009. In addition, patients having hip surgery were compared to their counterparts who didn't. The calculated rr and p-value were 2.13 and 0.000 respectively. The accompanying rates were: no surgery (35%), hip surgery (75%).

The length of stay was very close to being statistically significant with a p-value of 0.056. The cutpoint was $\geq$ 10 days. The rr was 1.54.

**B. Multivariate Analysis:**

Table 1 - Selection Criteria for Multivariate Analysis

1) Quantitative Significance (rr $\geq$ 1.5)
2) Statistical Significance (p-value $\leq$ .05 or 95% CI excluding one)
3) Clinical Significance (subjective importance)

Utilizing the criteria in Table 1 (directly above), eleven variables from the initial univariate analysis were selected for

stepwise multivariable relative risk modeling. These variables are listed in Table 2 (below).

Table 2 - Variables in Multivariate Model

1. Age (≥80, <80)
2. Education (13+, 12-9, 8-2)
3. Living Situation (nursing home vs other)
4. Baseline IADL status (0-1 ind., 2-7 dep.)
5. Mini-Mental Status Examination (≥20, <20)
6. Body Mass Index (≤20.5, >20.5)
7. Religious Support (a lot, a little, none)
8. Restraint Use at Baseline Interview (no vs yes)
9. Medications (# average daily meds ≥6, <6)
10. Anesthesia (general/spinal/epidural vs other)
11. Surgery (trauma index vs other)

Univariate analysis allows one to identify variables associated with a higher incidence of functional decline at discharge; although, the identified variables might not be direct causes of the outcome. The purpose of the multivariate model was to determine the statistical significance of each variable as a possible contributor to functional decline at discharge in elderly surgical patients; while controlling for the potentially confounding effect of the other variables in the model. The program cycled repeatedly; dropping the least significant variable from the model at each step until a

desired endpoint was reached. The endpoint for this study was when the remaining variables had relative risk ratios with a 95% CI exceeding one. Utilizing this criteria, two variables emerged from the modeling: low body mass index (rr = 1.44, 95% CI = 1.005, 2.074) and traumatic injury (rr = 2.07, 95% CI = 1.390, 3.078).

# IV. Discussion:

## A. Incidence of Functional Decline:

Using two different sets of criteria, the degree of functional impairment already present at hospital admission ranged from 53-68%. This is remarkably close to a prior study (9) which found approximately 60% of study subjects had some degree of functional disability at admission.

Utilizing the study outcome definition, 46% (54/117) of the patients in our cohort were discharged from the hospital with a decreased ability from baseline to perform at least one of the five ADLs examined. As previously noted, in previous studies the occurrence of functional decline during hospitalization has ranged from 28-50% (7-9). Our figure is on the high side of this range. It is important to not that none of these studies focused exclusively on surgical patients. It is quite possible that surgical patients are more likely than their medicinal counterparts to experience functional decline during hospitalization.

Every adult has to effectively perform Activities of Daily Living (bathing, grooming, feeding, toileting, transferring) on a daily basis if they are to function independently in our society. The incidence of functional decline at hospital discharge (46%) means many elderly patients are being discharged from surgical services with a compromised ability to perform rudimentary tasks. Patients

without appropriate in-home care or other discharge arrangements might find it extremely difficult to re-integrate themselves into their community as independent adults.

**B. Variables Associated with Functional Decline:**

Many patient characteristics were found to be associated with an increased incidence of functional decline from baseline at the time of hospital discharge (rr $\geq$ 1.5). Many had p-values less than .05. Previously, McVey (9) examined variables such as age, pre-admission living arrangement, admission service, length of stay, mental status, depression, admission ADL performance, and place of origin. No significant association with improved, maintained, or worsened discharge functional status was found.

Our study revealed a number of interesting findings. As age increased there was an accompanying trend of increasing functional decline at hospital discharge. This was statistically significant. As individuals age their physiological reserves diminish which in turn could make them more susceptible to functional decline during a hospitalization (4). Also, age has previously been shown to be an important predictor of outcomes related to functional status such as institutionalization (36).

Admission from a nursing home seems to predispose patients to functional decline at the time of hospital discharge. It has been theorized that being a nursing home resident can have an

infantilizing effect (37). This might be due to the loss of control over daily life and frequent staff assistance for tasks older people could perform for themselves.

Subjects with an impaired baseline ability to perform instrumental activities of daily living (IADLs) had a higher incidence of the study outcome. Using assistance to perform IADLs has been shown to be an effective predictor of institutionalization, a frequent end result of declining functional status (36).

Impaired cognitive function demonstrated a strong association with an increased incidence of functional decline at hospital discharge. Basset (29) also found a strong association between cognitive impairment (MMSE $\leq$ 23) and functional disability utilizing ADL, IADL, and Mobility scales. In addition, cognitive impairment along with number of current physical illnesses, emotional distress, neurological status, and number of current medications emerged from multivariate analysis as independent predictors of functional disability. Similarly, our study also revealed a significant association between average number of daily medications and functional decline. There was no significant association with number of diagnoses (active or past). It is also important to note that Bassett's study focused on a community sample with ages ranging from 19-89.

Our study revealed a U-shaped relationship between body mass index (BMI) and functional decline. A higher incidence of functional decline was observed in heavier and leaner individuals when compared to individuals in the mid-range. Interestingly, prior studies have demonstrated a U-shaped relationship between BMI and mortality (31, 32). In our study, the correlation between low BMI and increased outcome incidence was particularly marked. Low BMI has previously been shown to also be associated with increased mortality (31).

Although, the effect of social supports on functional status had not been examined, the relationship to increased mortality had been investigated (38-40). One study produced age-adjusted relative risks of 2.3 for men and 2.8 for women over a nine year period (38). The Durham County study (40) revealed relative mortality risks of 3.40 for impaired social support (self-perceived), 2.04 for impaired roles and attachments, and 1.88 for low frequency of social interaction. Our findings failed to demonstrate a significant relationship between social supports and functional decline.

Restraint use showed a significant association with functional decline. Restraint use in hospitalized patients has previously been associated with undesirable outcomes such as greater mortality, longer hospital stays, increased occurrence of nosocomial infections and decubitus ulcers, and continued falls and injuries (41-47).

Immobility also results in decreased joint range of motion, loss of muscular strength, loss of bone mass and strength, cardiovascular deconditioning, decreased respiratory function, metabolic disturbances, decreased urinary and GI function, and psychological effects (48). Immobilization has also been documented to cause changes in cognitive performance and electroencephalogram (EEG) (49).

We found that individuals undergoing surgery were significantly more likely than their counterparts to experience functional decline (rr = 1.98, p-value = 0.013). The type of surgical procedure was also important. One could conclude that certain types of surgical procedures predispose patients to functional decline.

Patients having hip surgery had a particularly increased risk of functional decline (rr = 2.13, p-value = 0.000). It has been previously found that 30%-60% of patients with hip fractures are discharged to nursing homes with 20%-30% of them still residing in nursing homes 1 year later (50-53). Another study showed only 20% of patients returned to preoperative functional level following repair of a hip fracture (54).

Other variables demonstrated significant associations to functional decline at hospital discharge for which related findings were not found in the existing literature. They include the following: baseline ADL status, baseline delirium, traumatic injury,

nature of surgical problem, primary discharge diagnosis, religious support, narcotics, digoxin, and surgical status. Variables with significant associations to the study outcome are summarized in Table 3 (directly below).

Table 3 - Variables with Significant Associations to Study Outcome

Demographic
1 ) Age
2 ) Nursing Home Residency

Physical Functioning
1 ) Baseline ADL status
2 ) Baseline IADL status

Cognitive Functioning
1 ) Mini-Mental Score
2 ) Presence of Baseline Delirium

Biomedical
1 ) Body Mass Index
2 ) Traumatic Injury
3 ) Nature of Surgical Problem
4 ) Primary Discharge Diagnosis

Psychosocial
1 ) Religious Support

In-Hospital
1 ) Restraint Use at Baseline
2 ) Narcotics
3 ) Digoxin
4 ) Average Daily Medications
5 ) Surgical Status (yes vs no)
6 ) Surgical Procedure
7 ) Hip Surgery

An association with a particular outcome does not mean a variable plays a direct role in causing a particular outcome. Individuals with a particular variable just tend to have a higher incidence of the outcome. For example, individuals of a particular

race may experience a higher incidence of a particular outcome when the true cause of a particular condition may be lower socioeconomic status. This is because race and socioeconomic status often show a high degree of correlation. This is precisely why multivariate analysis is so useful. It allows one to examine the relationship of a specific variable to a particular outcome while controlling for the effects of other variables.

Variables emerging from the univariate analysis are still very important. Although they might not be direct causes of functional decline, patients with these particular characteristics are more likely to have functional decline at hospital discharge. Therefore, these variables could help clinicians identify high-risk patients. This would aid in the cost-efficient delegation of specialized services to patients most likely to benefit.

**C. Potential Causes of Functional Decline:**

The preliminary univariate analysis allowed us to screen a large number of variables as potential causes of functional decline in elderly patients discharged from surgical services. Eleven of the more promising variables were selected for stepwise multivariable relative risk modeling. This analysis was meant to control for the potentially confounding effects of other variables. Variables which were direct contributors to the increased outcome could be differentiated from those which were only associated markers.

**Two variables** emerged from the stepwise multivariable relative risk modeling with 95% confidence intervals for relative risks ratios which exceeded one: patients with a **body mass index ≤ 20.5** and patients in the **trauma category**. Any patient with a primary diagnosis of hip fracture, upper extremity fracture, lower extremity fracture, lacerations, soft tissue injuries, or any condition falling into the injury category according to International Classification of Diseases (ICD) codes was assigned to the trauma group.

One can conclude that having a less than ideal body weight or suffering a traumatic injury significantly contributes to an increased incidence of functional decline at hospital discharge in elderly patients admitted to surgical services. Theories could be constructed to explain these results.

Conceivably, thin patients might not recovery as rapidly or completely from surgery as heavier patients. Even in patients that did not undergo surgery, a low BMI might lower resistance to the iatrogenic complications that occur during hospitalization. In either case, elderly patients might fail to return to their baseline level of physical functioning by hospital discharge.

Patients admitted with an injury falling into our trauma category are also at an increased likelihood of being discharged at a level of functioning below baseline. Due to the initial injury, some

patients might be considered incapable of returning to a level where they could effectively perform activities of daily living. This is most likely uncommon and applicable only in cases such as severe trauma. The nature of the treatment trauma patients receive is probably important. According to our definition, hip fractures would be included under the trauma designation. We found that patients undergoing hip surgery had a statistically significant increase in the incidence of functional decline. The variable hip surgery was not included in the multivariate model. A decision was made to include only one variable related to surgery (trauma).

The current trend toward a faster discharge from the acute setting might be leading to the disposition of some patients before they have had the opportunity to fully recovery from their hospitalization. The Health Care Financing Administration conducted research on the declining average length of stay between 1982 and 1985 (55). The declining length of stay was associated with a 7.8% drop in the proportion of Medicare patients with no dependencies in activities of daily living (ADLs) at discharge and a rise in the proportion with dependency in all ADLs (from 23.4% to 29.2%).

**D. Recommendations:**

In general, elderly inpatients may benefit from the early involvement of special geriatric services such as a geriatric evaluation unit or geriatric consultation team. These services attempt to improve functional performance and prevent functional

decline by providing interdisciplinary treatment and rehabilitation (56).

Some of the components of an ideal geriatric unit are outlined below (8, 57, 58). Goals should focus on (1) increasing orientation, decreasing confusion, and encouraging social interaction, (2) allowing for self-care, and (3) maintaining functional ability. Services should be oriented towards higher risk patients: age $\geq$ 75, confusion, stroke, impaired mobility, and limited functional status. Private rooms are replaced by small wards to allow continual direct observation of patients. Nursing emphasizes regular patient surveillance, increased socialization, careful attention to toileting, and encouragement of self-care in ADLs. Patients are nursed out of bed and wear their own clothing. Patients are encouraged and aided in moving about. An attempt is made to minimize isolation. Instead, patients eat communally and interact with each other (59). Physical therapy and rehabilitation efforts are integrated into daily activities (60). In addition, discharge planning is initiated early.

Studies that evaluated the effectiveness of geriatric consultation services have in general failed to demonstrate a significant improvement in patient outcomes (9, 61-63). In contrast, studies focusing on the effectiveness of geriatric inpatient units have shown significant improvements in the functional status of elderly patients (22, 64-66). An importance difference being that the units were involved in the direct delivery

of medical services versus just providing consultation services. Other possible differences include intensive rehabilitation, positive staff attitudes, improved diagnosing, more accurate goal setting, and longitudinal follow-up (9).

Specialized geriatric units could help ameliorate some of the variables found to be associated with functional decline at hospital discharge. These units aim to minimize the confusion and disorientation which can lead to a lower functional status. The significant associations of mini-mental score and delirium to our study outcome support the potentially important role of confusion and disorientation. Furthermore, many medications lead to altered mental status. We found that as the number of average daily medications increases, so does the outcome incidence. Geriatric units also attempt to minimize the use of restraints which we found to be significantly associated with the study outcome.

It is likely that surgical patients are currently being discharged before appropriate recovery has taken place. Certain patients (ie victims of trauma or patient undergoing hip surgery) might benefit from a stay in a geriatric unit following stabilization on the surgical floor. During the post-op or post-injury recovery phase, more consistent and intense usage of modalities such as physical therapy might increase the ability of elderly patients to effectively carry out ADLs at discharge. These services could be

effectively delivered in a geriatric unit or directly on the surgical ward by consult services.

More attention should also be focused on markedly underweight patients on the surgical wards. Targeting patients with this particularly risk factor at admission might improve the outcome at discharge. This might consist of emphasizing the early involvement of a nutritionist and closely monitoring body weight throughout hospitalization.

The questions of why low BMI or traumatic injury lead to decreased physical functioning at discharge in elderly surgical patients could be the topic of future studies. Further investigation could also focus on how intervention aimed at modifying these factors could improve the outcome in this patient population.

**E. Study Limitations:**

Although, the study produced a great deal of useful information there were a few potential problems in the study format. One revolved around the fact that the initial baseline functional assessment was conducted through patient interview and the discharge functional assessment was conducted through nurse interview. The fact that two different raters (patient, nurse) of functional assessment were involved could lead to questions of inter-rater reliability . Although a concern, differences in how raters might perceive ability to perform tasks was most likely

minimized due to the straightforward nature of the tasks performed and the simple rating scale employed (no help, some help, unable to perform). The logistical impossibility of having the primary nurse rate patient ADL performance two weeks prior to admission made the two rater system a necessity.

The cohort size (n=117) might have resulted in potentially important variables not being statistically significant at both steps of the analysis: univariate and multivariate. In addition, only one multivariate model was run. Increasing cohort size and varying the variables included in multivariate models might result in the identification of other significant contributors to functional decline in elderly surgical patients at hospital discharge.

## V. Conclusion:

This study examined the incidence of functional decline at hospital discharge in a cohort of elderly patients admitted to surgical services. We found an outcome incidence of 46% in our study population. Univariate analysis revealed a variety of variables with significant associations to an increased incidence of functional decline (refer to Table 3 - pg 39). These variables could help clinicians identify patients at high-risk for this adverse outcome. This would aid in the efficient selection of appropriate patients for specialized services.

In addition, two variables emerged from stepwise multivariable relative risk modeling: low body mass index and traumatic injury. These are contributors to functional decline which could be targeted for intervention.

The relatively high incidence of functional decline suggests that elderly inpatients might benefit greatly from specialized geriatric services as discussed earlier. This could take the form of geriatric consult services or geriatric inpatient units, although the inpatient units have to this point been more effective. These specialized services tend to place a strong emphasis on maintaining the functional status of frail elderly patients.

Other measures which could be implemented in an effort to reduce functional decline in older surgical patients include monitoring the weight of potential surgical candidates more closely. More emphasis should be placed in the outpatient setting on maintaining the weight of elderly patients. In the hospital, methods of improving the nutritional status of the aged should be investigated. Rehabilitative services should become involved early during the hospitalization, particularly in patients who have had a traumatic injury. Physicians should be concerned with restoring functional capacities as well as achieving medical stability.

# Appendix A - Univariate Analysis:

| Variable | Outcome Rate (%) | RR | 95% CI (RR) | P-Values |
|---|---|---|---|---|
| DEMOGRAPHIC | | | | |
| **Age** | | | | 0.000t |
| 70-74 | 10/34 (29.41) | - | - | |
| 75-79 | 12/34 (35.29) | 1.20 | - | |
| 80-84 | 14/26 (53.85) | 1.83 | - | |
| 85-89 | 14/17 (82.35) | 2.80 | - | |
| 90+ | 4/6 (66.67) | 2.27 | - | |
| **Age** | | | | 0.001 |
| <85 | 36/94 (38.30) | - | - | |
| ≥85 | 18/23 (78.26) | 2.04 | (1.46, 2.86) | |
| **Age** | | | | 0.000 |
| <80 | 24/73 (32.88) | - | - | |
| ≥80 | 30/44 (68.18) | 2.07 | (1.41, 3.05) | |
| Sex | | | | 0.052 |
| male | 22/59 (37.29) | - | - | |
| female | 32/58 (55.17) | 1.48 | (0.99, 2.22) | |
| Education | | | | 0.074t |
| 12+ | 13/35 (37.14) | - | - | |
| 9-12 | 18/43 (41.86) | 1.13 | - | |
| 2-8 | 22/38 (57.89) | 1.56 | - | |
| Education | | | | 0.214t |
| 12+ | 13/35 (37.14) | - | - | |
| 12 | 14/30 (46.67) | 1.26 | - | |
| <12 | 26/51 (50.98) | 1.37 | - | |
| Income | | | | 0.740 |
| ≥20,000 | 9/24 (37.50) | - | - | |
| <20,000 | 12/36 (33.33) | 0.88 | (0.45, 1.78) | |
| Marital Status | | | | 0.291 |
| married | 18/45 (40.00) | - | - | |
| unmarried | 36/72 (50.00) | 1.25 | (0.82, 1.91) | |
| Living Situation | | | | 0.500 |
| alone | 19/45 (42.22) | - | - | |
| w/ others | 35/72 (48.61) | 1.15 | (0.76, 1.75) | |
| **Nursing Home** | | | | 0.030 |
| no | 48/110 (43.64) | - | - | |
| yes | 6/7 (85.71) | 1.96 | (1.36, 2.84) | |
| PHYSICAL FUNCTIONING | | | | |
| Baseline ADL Status | | | | 0.330 |
| indep.(0) | 34/79 (43.04) | - | - | |
| dep.(1-7) | 20/38 (52.63) | 1.22 | (0.83, 1.81) | |
| **Baseline ADL Status** | | | | 0.021 |
| indep.(0-1) | 39/95 (41.05) | - | - | |
| dep.(2-7) | 15/22 (68.18) | 1.66 | (1.14, 2.41) | |
| **Baseline IADL Status** | | | | 0.038 |
| indep.(0) | 18/51 (35.29) | - | - | |
| dep.(1-7) | 36/66 (54.55) | 1.55 | (1.00, 2.38) | |

| | | | | | |
|---|---|---|---|---|---|
| **Baseline IADL Status** | | | | | 0.001 |
| indep.(0-1) | 23/69 | (33.33) | - | - | |
| dep.(2-7) | 31/48 | (64.58) | 1.94 | (1.31, 2.87) | |
| Mobility - Stairs | | | | | 0.563 |
| yes | 40/88 | (45.45) | - | - | |
| no | 13/25 | (52.00) | 1.14 | (0.74, 1.78) | |
| Mobility - 1/2 Mile | | | | | 0.293 |
| yes | 23/55 | (41.82) | - | - | |
| no | 29/56 | (51.79) | 1.24 | (0.83, 1.85) | |
| Hearing | | | | | 0.124 |
| good | 27/68 | (39.71) | - | - | |
| poor | 26/48 | (54.17) | 1.36 | (0.92, 2.02) | |
| Vision | | | | | 0.318 |
| good | 22/54 | (40.74) | - | - | |
| poor | 31/62 | (50.00) | 1.23 | (0.82, 1.84) | |
| COGNITIVE FUNCTIONING | | | | | |
| **Mini-Mental Score** | | | | | 0.001 |
| ≥ 20 | 36/94 | (38.30) | - | - | |
| < 20 | 18/23 | (78.26) | 2.04 | (1.46, 2.86) | |
| **Mini-Mental Score** | | | | | 0.009 |
| ≥ 22 | 34/87 | (39.08) | - | - | |
| < 22 | 20/30 | (66.67) | 1.71 | (1.19, 2.46) | |
| **Mini-Mental Score** | | | | | 0.010 |
| ≥ 24 | 26/71 | (36.62) | - | - | |
| < 24 | 28/46 | (60.87) | 1.66 | (1.13, 2.44) | |
| **Baseline Delirium** | | | | | 0.018 |
| no | 44/104 | (42.31) | - | - | |
| yes | 10/13 | (76.92) | 1.82 | (1.25, 2.64) | |
| BIOMEDICAL | | | | | |
| **Body Mass Index** | | | | | 0.004 |
| 13.8-20.5 | 18/27 | (66.67) | 3.22 | - | |
| 20.6-23.5 | 14/26 | (53.85) | 2.60 | - | |
| 23.7-26.2 | 6/29 | (20.69) | - | - | |
| 26.3-33.3 | 10/27 | (37.04) | 1.79 | - | |
| **Body Mass Index** | | | | | 0.006 |
| > 20.5 | 30/82 | (36.59) | - | - | |
| ≤ 20.5 | 18/27 | (66.67) | 1.82 | (1.23, 2.69) | |
| **Body Mass Index** | | | | | 0.008 |
| ≥ 22 | 26/72 | (36.11) | - | - | |
| < 22 | 27/44 | (61.36) | 1.70 | (1.16, 2.50) | |
| Smoking Status | | | | | 0.068 |
| within 2yrs | 4/16 | (25.00) | - | - | |
| not in 2yrs | 50/101 | (49.50) | 0.51 | (0.21, 1.21) | |
| Alcohol Consumption | | | | | 0.358 |
| no | 41/84 | (48.81) | - | - | |
| yes | 13/33 | (39.39) | 0.81 | (0.50, 1.30) | |
| CAGE criteria | | | | | 0.363 |
| no | 43/91 | (47.25) | - | - | |
| yes | 6/17 | (35.29) | 0.75 | (0.38, 1.47) | |

| | | | | | |
|---|---|---|---|---|---|
| APACHE score | | | | | 0.472 |
| ≤10 | 26/60 | (43.33) | - | - | |
| ≥10 | 28/56 | (50.00) | 1.15 | (0.78, 1.71) | |
| Incontinence | | | | | 0.513 |
| no | 41/92 | (44.57) | - | - | |
| yes | 12/23 | (52.17) | 1.17 | (0.74, 1.84) | |
| Decubiti | | | | | 0.799 |
| no | 49/107 | (45.80) | - | - | |
| yes | 5/10 | (50.00) | 1.09 | (0.57, 2.10) | |
| Hospitalization w/in last year | | | | | 0.120 |
| no | 37/73 | (50.68) | - | - | |
| yes | 15/42 | (35.71) | 0.70 | (0.44, 1.12) | |
| # Diagnoses | | | | | 0.472 |
| < 5 | 26/60 | (43.33) | - | - | |
| ≥ 5 | 28/56 | (50.00) | 1.15 | (0.78, 1.71) | |
| # Active Diagnoses | | | | | 0.802 |
| < 4 | 24/53 | (45.28) | - | - | |
| ≥ 4 | 30/63 | (47.62) | 1.05 | (0.44, 1.89) | |
| **Traumatic Injury** | | | | | 0.000 |
| absent | 24/75 | (32.00) | - | - | |
| present | 30/42 | (71.43) | 2.23 | (1.52, 3.27) | |
| **Nature of Surgical Problem+** | | | | | 0.044 |
| abdominal | 10/30 | (33.33) | 0.72 | - | |
| vascular | 6/14 | (42.86) | 0.93 | - | |
| GU | 7/22 | (31.82) | 0.69 | - | |
| ortho | 31/50 | (62.00) | 1.34 | - | |
| other | 0/1 | (00.00) | 0.00 | - | |
| **Primary Discharge Diagnosis+** | | | | | 0.017 |
| vascular | 4/10 | (40.00) | 0.87 | - | |
| respiratory | 1/1 | (100.00) | 2.17 | - | |
| renal-urinary | 3/17 | (17.65) | 0.38 | - | |
| GI | 8/24 | (33.33) | 0.72 | - | |
| rheumatic | 3/9 | (33.33) | 0.72 | - | |
| neurologic | 1/1 | (100.00) | 2.17 | - | |
| oncologic | 5/9 | (55.56) | 1.20 | - | |
| derm. | 0/3 | (0.00) | 0.00 | - | |
| gen. surg. | 1/2 | (50.00) | 1.08 | - | |
| vascular | 1/1 | (100.00) | 2.17 | - | |
| ortho | 3/6 | (50.00) | 1.08 | - | |
| injury | 24/33 | (72.73) | 1.58 | - | |
| PSYCHOSOCIAL | | | | | |
| Depression | | | | | 0.248 |
| < 5 | 35/82 | (42.68) | - | - | |
| ≥ 5 | 18/33 | (54.55) | 1.28 | (0.86, 1.91) | |
| Depression | | | | | 0.754 |
| < 7 | 46/101 | (45.54) | - | - | |
| ≥ 7 | 7/14 | (50.00) | 1.10 | (0.62, 1.93) | |

| | | | | |
|---|---|---|---|---|
| Social Activity Level | | | | 0.273 |
| active | 28/67 (41.80) | - | - | |
| inactive | 26/50 (52.00) | 1.24 | (0.84, 1.84) | |
| Social Supports | | | | 0.762 |
| 0 - 3 | 17/35 (48.57) | - | - | |
| 4 - 7 | 19/42 (45.24) | 0.93 | - | |
| 8 - 41 | 18/40 (45.00) | 0.93 | - | |
| Support Types | | | | 0.307 |
| all 3 | 46/95 (48.42) | - | - | |
| < 3 | 8/22 (36.36) | 0.75 | (0.42, 1.36) | |
| **Religious Support** | | | | 0.027(t) |
| a lot | 27/72 (37.50) | - | - | |
| a little | 19/32 (59.38) | 1.58 | - | |
| none | 8/13 (61.54) | 1.64 | - | |
| IN-HOSPITAL | | | | |
| **Restraint use at baseline** | | | | 0.003 |
| no | 47/110 (42.73) | - | - | |
| yes | 7/7 (100.00) | 2.34 | (1.89, 2.91) | |
| Steriods | | | | 0.121 |
| no | 50/112 (44.64) | - | - | |
| yes | 4/5 (80.00) | 1.79 | (1.10, 2.91) | |
| Ranitidine | | | | 0.063 |
| no | 41/97 (42.27) | - | - | |
| yes | 13/20 (65.00) | 1.54 | (1.03, 2.29) | |
| Anti-histamines | | | | 0.110 |
| no | 30/74 (40.54) | - | - | |
| yes | 24/43 (55.81) | 1.38 | (0.94, 2.02) | |
| **Narcotics** | | | | 0.049 |
| no | 6/22 (27.27) | - | - | |
| yes | 48/95 (50.53) | 1.85 | (0.91, 3.77) | |
| Tranquilizers | | | | 0.278 |
| no | 45/100 (45.00) | - | - | |
| yes | 9/15 (60.00) | 1.33 | (0.84, 2.13) | |
| Anti-convulsants | | | | 0.167 |
| no | 49/110 (44.55) | - | - | |
| yes | 5/7 (71.43) | 1.60 | (0.96, 2.68) | |
| Levodopa | | | | 0.278 |
| no | 53/116 (45.69) | - | - | |
| yes | 1/1 (100.00) | 2.19 | (1.80, 2.67) | |
| **Digoxin** | | | | 0.009 |
| no | 40/98 (40.82) | - | - | |
| yes | 14/19 (73.68) | 1.81 | (1.26, 2.59) | |
| NSAIDs | | | | 0.177 |
| no | 43/97 (44.33) | - | - | |
| yes | 10/16 (62.50) | 1.41 | (0.91, 2.19) | |
| Anti-cholinergics | | | | 0.906 |
| no | 42/90 (46.67) | - | - | |
| yes | 12/25 (48.00) | 1.03 | (0.65, 1.64) | |
| Beta-blockers | | | | 0.305 |
| no | 38/86 (44.19) | - | - | |
| yes | 16/29 (55.17) | 1.25 | (0.83, 1.87) | |

| | | | | |
|---|---|---|---|---|
| Anti-hypertensives | | | | 0.693 |
| no | 48/99 (48.48) | - | - | |
| yes | 6/14 (42.86) | 0.88 | (0.47, 1.67) | |
| Cimetidine | | | | 0.851 |
| no | 36/75 (48.00) | - | - | |
| yes | 18/39 (46.15) | 0.96 | (0.64, 1.45) | |
| Anti-emetics | | | | 0.947 |
| no | 39/82 (47.56) | - | - | |
| yes | 15/32 (46.88) | 0.99 | (0.64, 1.52) | |
| Quinidine | | | | 0.370 |
| no | 53/111 (47.75) | - | - | |
| yes | 1/4 (25.00) | 0.52 | (0.10, 2.89) | |
| Anti-depressants | | | | 0.199 |
| no | 48/108 (44.44) | - | - | |
| yes | 6/9 (66.67) | 1.50 | (0.90, 2.49) | |
| Sedative-Hypnotics | | | | 0.786 |
| no | 19/39 (48.72) | - | - | |
| yes | 35/76 (46.05) | 0.95 | (0.63, 1.42) | |
| **Average Daily Medications** | | | | 0.014(t) |
| 0 - 2 | 5/16 (31.25) | - | - | |
| 3 - 5 | 19/48 (39.58) | 1.27 | - | |
| 6 - 8 | 22/41 (53.66) | 1.72 | - | |
| 9 + | 8/11 (72.73) | 2.33 | - | |
| **Average Daily Medications** | | | | 0.025 |
| <6 | 24/65 (36.92) | - | - | |
| ≥6 | 30/52 (57.69) | 1.56 | (1.05, 2.32) | |
| Anesthesia | | | | 0.181 |
| no surgery | 8/30 (26.67) | - | - | |
| general | 25/46 (54.35) | 2.04 | - | |
| spinal | 15/29 (51.72) | 1.94 | - | |
| IV | 3/7 (42.86) | 1.61 | - | |
| epidural | 1/1 (100.00) | 3.75 | - | |
| local | 1/3 (33.33) | 1.25 | - | |
| **General/Spinal/or Epidural** | | | | 0.012 |
| other | 12/40 (30.00) | - | - | |
| yes | 42/77 (54.55) | 1.82 | (1.09, 3.04) | |
| General Anesthesia | | | | 0.103 |
| other | 28/70 (40.00) | - | - | |
| yes | 26/47 (55.32) | 1.38 | (0.94, 2.03) | |
| **Surgical Status** | | | | 0.013 |
| no surgery | 8/30 (26.67) | - | - | |
| surgery | 46/87 (52.87) | 1.98 | (1.06, 3.71) | |
| **Surgical Procedure** | | | | 0.009 |
| no surgery | 8/30 (26.67) | - | - | |
| general | 8/20 (40.00) | 1.50 | - | |
| vascular | 4/13 (30.77) | 1.15 | - | |
| GU | 7/14 (50.00) | 1.87 | - | |
| orthopedic | 27/40 (67.50) | 2.53 | - | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Surgical Categories+ | | | | | | 0.057 |
| cholecystectomy, pancreatic surg. | 3/9 | (33.33) | 0.72 | - | | |
| colostomy, bowel surg. | 3/7 | (42.86) | 0.93 | - | | |
| vascular, aortic surg. | 3/6 | (50.00) | 1.08 | - | | |
| GU | 2/8 | (25.00) | 0.54 | - | | |
| Hip Surg. | 24/32 | (75.00) | 1.63 | - | | |
| Knee, UEx, LEx Surg. | 2/5 | (40.00) | 0.87 | - | | |
| **Hip Surgery** | | | | | | 0.000 |
| no | 30/85 | (35.29) | - | - | | |
| yes | 24/32 | (75.00) | 2.13 | (1.50, | 3.02) | |
| Vascular/Aortic | | | | | | 0.846 |
| no | 51/111 | (45.95) | - | - | | |
| yes | 3/6 | (50.00) | 1.09 | (0.48, | 2.48) | |
| Length of Stay | | | | | | 0.056 |
| < 10 days | 14/41 | (34.15) | - | - | | |
| ≥ 10 days | 40/76 | (52.63) | 1.54 | (0.96, | 2.48) | |

Notes:
The number of study subjects under some variables fails to total 117 due to occasional missing data. Significant variables are in bold type.

+ Due to the lack of a clear standard of comparison, the rate of functional decline for the entire cohort (46%) was utilized to calculate relative risk ratios.

t For variables were greater than two risk categories and where outcome incidence was expected to increase in a predictable fashion with increasing values, the chi-square value for linear trend was substituted for the traditional chi-square value.

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