Mortality Rates and Geriatric inpatient units - Is there a relationship?

by

Albert J. Kirshen, MD, FRCPC

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of

Masters of Science

Department of Community Health Sciences
University of Manitoba
Winnipeg, Manitoba

ISBN 0-612-13255-2

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MORTALITY RATES AND GERIATRIC INPATIENT UNITS-

IS THERE A RELATIONSHIP?

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A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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A. J. Kirshen, MD, FRCPC

Abstract

The ability of Geriatric Medicine inpatient services to modify mortality rates is well established in efficacy studies of duration of 1 year or less. Experience in real world effectiveness is lacking. A cohort model was used to explore mortality among all Manitobans aged 65 or more by March 31, 1990, who used hospital-based health care services in the interval April 1, 1988 through March 31, 1990. Using the Manitoba Health data set a prospective analysis of service utilization for the index contact was compared between users and non-users of Geriatric Medicine inpatient services in Winnipeg Manitoba. This resulted in a sample size of 23,568 people. The index contact was defined as the first inpatient stay on a Geriatric unit during the study interval. Where such did not exist, the initial inpatient admission was used. Survival analysis demonstrated that mortality rates are higher for users of Geriatric Medicine inpatient services, having accounted for age at admission, income decile, interaction of marital status and gender, Charlson index of comorbidity, marital status and gender. Most of the effect is due to a difference in early survival times. These results expand upon the position statements of the American Geriatrics Society that Geriatric services decreased mortality rates among older people involved in Randomized Controlled Trials.

Acknowledgments

Thanks to one's friends, mentors and colleagues inevitably are inadequate to express the depth of meaning their support has meant to an author. Should one begin by thanking one's parents for their formative efforts and love, or one's spouse and children for their patience and understanding for those missed weekends and evenings? What about one's colleagues for their flexibility, critiques of work in progress, and friendship? Finally, what about one's thesis committee members for carefully reviewing repeated drafts of incomplete and complete data and their careful and considerate support?

Posterity will likely forget the names of the people who helped in this small effort, but I won't. Merci bien.

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Chapter 1: Purpose of the research

Many old people become increasingly frail with increasing age (Rockwood, Fox et al., 1994). The specialty of Geriatric Medicine was organized in order to meet the needs of this frail population. Geriatric Medicine services apply the unique sciences of the biology, physiology, psychology and sociology of aging in order to meet expectations of patients and professionals. These services provide a comprehensive assessment within a multidisciplinary framework. Knowledge of the natural history of treated disease, and the experience necessary to determine which one or ones among a wide panoply of illnesses are amenable to stabilization or reversal, play a key role in such service provision. Appropriate service utilization, and limitation of inappropriate use may also be expected of the specialty.

Ethical concerns arise when establishing limits to using services. *Distributive justice* issues demonstrate the principle of equity and frequently arise in the decision making process. In the face of limited resources, how are competing needs balanced, e.g. between high and low technology services? The ethical tenet of non-maleficence, *Primum non nocere* is the doctrine of *First, do no harm.* Do Geriatric Medicine services harm or help? If the American Geriatrics Society is correct that the specialty prolongs life, (Rubenstein, Stuck et al., 1991) and if Roos and others (Roos, Havens et al., 1993; Guralnik, 1991; Manton, Corder et al., 1993; Rice, 1992) are equally correct that life prolongation among the elderly has led to increased

disability, does Geriatric Medicine promote a longer life with more burden of disability? What other outcomes can users of such services reasonably expect, and with what frequency?

Arguments abound as to the optimal service composition and characteristics of Geriatric units. They are expensive. Doubts have been raised about the effectiveness of some of their components, such as Day Hospital (Eagle, Guyatt et al., 1991). The statement by the American Geriatrics Society (Rubenstein, Stuck et al., 1991) about life prolongation, coupled with increasing concerns about the association with increasing disability, adds further cause for concern about scarce resources in times of fiscal constraint.

Health care professionals and policy analysts are faced with the daunting tasks of reconfiguring our health care system across the country. Evidence based medicine is rapidly becoming the carrot used by governments and standards bodies alike to assist in managing costs and resource utilization (Evidence Based Medicine Working Group, 1992). Geriatric Medicine services are repeatedly asked to prove their efficacy and worth.

This study used a 2 year follow-up period to evaluate the effect of Geriatric Medicine inpatient services. It extends the literature beyond its existing bounds of 6 months to 1 year follow-up periods.

Chapter 2: Literature Review

Outcomes Research

Background

The system of assessing the outcomes of service utilization has spawned the field of Outcomes Research. Outcomes Research is the term used to describe research relating measures of a particular process to the resulting outcomes. Such research seeks to emulate physiology, wherein a specific action results in an outcome. The outcome is reflected back to that action by way of a feedback loop, modifying the process and improving the outcome. In discussing systems of health care, the action is typically an event or an episode of care. The process is the means by which care is provided. The outcome is the result of the action and the process acting on an individual or population. Regrettably, the response loop in health care is in its earliest stages of development. Outcomes Research seeks to provide information about a process and an outcome, in order to facilitate effective functioning of the feedback loop, through modifications in health care practice, policy decisions, etc.

Increasingly, as a result of outcomes research, questions arise about the effectiveness of medical interventions. Driving these concerns are two key elements: a trend to the practice of evidence-based medicine (Evidence Based Medicine Working Group, 1992; Guyatt, Sackett et al., 1993; Oxman, Sackett et al., 1993; Guyatt, Sackett et al., 1994; Jaeschke, Guyatt et al., 1994a;

Jaeschke, Guyatt et al., 1994b; Levine, Walter et al., 1994) and increasing economic concerns over cost in the face of a global downturn in the economy. Some would suggest that outcomes research is driven by considerations about the effectiveness and efficiency of specific interventions, as well as by questions about cost containment (Shapiro, 1994). Interest in outcomes research has been prompted by initiatives such as those funded by the Agency for Health Care Policy and Research (AHCPR) in the United States, and the National Health Research and Development Program (NHRDP) in Canada.

An early contribution to outcomes research first appeared in the literature with the publication of a sentinel article in 1978 by Roos et al on outcomes, questioning the effectiveness and need for tonsillectomy (Roos, Jr., Roos et al., 1978). Krahn and Naylor challenged the effectiveness of aggressive versus less aggressive policies for cholesterol screening and treatment (Krahn, Naylor et al., 1991). Roos et al raised concerns about open versus transurethral prostatectomy for benign prostatic hyperplasia (Roos, Wennberg et al., 1989c). Both Barer et al (Barer, Evans et al., 1987) and Roos et al (Roos, Havens et al., 1993) have questioned overall health care practices in the care of the elderly.

The outcome of mortality has been the subject of an article in a recent supplement to the Journal of the American Geriatrics Society (JAGS). Mortality reduction was causally related to use of a Geriatric service (Rubenstein, Stuck et al., 1991). In that meta-analysis Rubenstein and

colleagues combined the results of a variety of randomized controlled trials in a multiplicity of settings and reviewed the effect of Geriatric service use on mortality. They stated:

> "Meta-analysis of 6-month mortality demonstrates a 39% reduction of mortality for inpatient consultation services ... and a 37% reduction of mortality for inpatient GEM units." (Rubenstein, Stuck et al, 1991, p. 8S) (GEM=Geriatric Evaluation and Management)

The authors furthered their position by a more broadly based meta-analysis with the same result (Stuck, Siu et al., 1993). The literature review component of this thesis reviews the evidence behind Rubenstein et al's statements, analyzing Manitoba hospital abstracts and Vital Statistics to determine whether the AGS statements can be expanded to routine clinical usage.

Factors in Service Use

An evaluation of service demand was one of the items used by Rubenstein's group in evaluating health care. Service utilization results from many different factors. These include proximity to death, age, physician practice patterns, and utilization patterns of individual consumers.

Proximity to death

Proximity to death is widely believed to influence service use and that good prevention strategies can delay or avoid morbidity and subsequent

demand for service. This philosophy of prevention might suggest that adequate attention to preventive tactics might result in improved morbidity. Such an idea was developed by Fries in 1980 (Fries, 1980). In essence, Fries suggested that it may be possible for more old people to live somewhat longer than at present. He posited that attempts at delaying chronic infirmity, maintaining vitality, and slowing deterioration should lead to deferring the onset of morbidity. This, in turn, would lead to a rectangularization of the mortality curve, and would result in reaching a maximum human lifespan of 85 years. People would then fall apart in the end like Holmes' (1905) One-Hoss Shay.

Have you heard of the wonderful one-hoss-shay,

That was built in such a logical way

It ran a hundred years to a day,

And then, or a sudden, it - ah, but stay,

I'll tell you what happened without delay,

Scaring the parson into fits, (Holmes, 1905, p.12)

...

You see, of course, if you're not a dunce,

How it went to pieces all at once, --

All at once, and nothing first, --

Just as bubbles do when they burst.

End of the wonderful one-hoss-shay.

Logic's logic. That's all I say. (Holmes, 1905, p.29)

Fries reiterated this hypothesis in a subsequent article (Fries, 1989) despite the absence of confirmatory evidence. Isaacs et al. (Isaacs, Gunn et al., 1971), Barer and colleagues (Barer, Evans et al., 1987), and Montgomery and colleagues (Montgomery, Kirshen et al., 1988) are among those who have clearly demonstrated the association of impending death with high service use. These groups affirmed part of Fries' hypothesis where multiple systems failure occurs at or near the end of life.

Guralnik attempted to validate Fries' unproved theory of decreasing mortality with increasing age (Guralnik, 1991). He used predictive models

derived from various U.S. censuses to demonstrate that the proportion of the population aged 85 or more and disabled would rise over the coming 40 - 50 years. Having set the goal for geriatrics and public health of increasing "the number of years of life lived in the independent state", and recognizing that "the prevalence of disability increases markedly with increasing age within the older population", he predicted a progressive expansion in both the percent of the final 3 years of life disabled, and the total years of disability. According to Guralnik it would take a substantial reduction in disease burden in the population aged 85 or more to decrease morbidity à la Fries.

In order to determine whether Fries' hypothesis could be verified from available information Kaplan (1991) presented data from the 1965 and 1974 Alameda County, California "Human Population Laboratory Studies". This study demonstrated a decrease in mortality with age with "major declines in age-specific mortality in the 9 year period between these two cohorts". Limitations in self-care and mobility were more prominent in the oldest cohort, aged 80 or more. The study suggested that there was an "increase in the ability to detect diseases and their manifestations and to keep people with these diseases alive. There seems to be increased disability associated with this increased survival." (Kaplan, 1991, p. 165)

Decreased service use due to increasing attention to prevention should be demonstrable from longitudinal utilization data sets. Roos and colleagues used the Manitoba Longitudinal Study on Aging to document the poorer health of the elderly in two cohorts of elderly interviewed 12 years apart

(Roos, Havens et al., 1993). The authors found that the very elderly were longer lived without any demonstrable compression of morbidity. They demonstrated that members of their 1983 sample were significantly more limited at follow-up in activities of daily living, were significantly more likely to report five or more health problems in the 3 year period prior to death, and were more likely to be admitted to hospital with a high risk condition than were members of the 1971 sample. Service use and morbidity are rising rather than falling, as would be predicted by Fries. Together, these studies suggest that our population is aging and is accumulating an increasing burden of disability as it ages.

Age

Data exist to support the effect of changing demographics on health care utilization. Barer et al commented on predicted service utilization and a relationship to age in an analysis of British Columbia usage patterns (Barer, Evans et al., 1987). "The proportion of the population in the older age groups will increase dramatically over the next four decades. Furthermore, current per capita rates of hospital and medical care utilization rise sharply with age beyond the age of about 55. However, demographic trends alone do not imply health care cost increases in excess of what is supportable by normal economic growth. A 'cost crisis' will only occur if per capita rates of utilization among the elderly increase faster than for the general population." (Barer, Evans et al., 1987, p. 851)

Barer and colleagues went on to calculate the actual increment in utilization attributable to age (Barer, Pulcins et al., 1989). Changes in the demographic composition of British Columbia included an increase in the number of British Columbians aged 65 or more years. Other factors accounted for a 5.5% increase in service use by the elderly over age 75. Age alone accounted for only 0.4% per year of the absolute increase in service use from 1974 to 1986. The authors reported that "The area with the fastest growth in use by the elderly was specialist care, particularly diagnostic services." (Barer, Pulcins, et al., 1989, p.39) Mendelson and Schwartz (1993) confirmed this observation. Service use is affected by age, but even then only to a small extent.

Physician practice patterns

Differences in the practice patterns of individual physicians affect patterns of service utilization. Roos (1992) used small area analysis techniques to identify wide variations in practice across urban and rural sites, and by age and specialty of physician. Physician factors clearly contributed to service utilization.

Patient use patterns

It would appear that differences in patient usage patterns also affect overall service use. In a paper in the Milbank Quarterly 1989, Roos et al reported on data tracking which linked the Manitoba Longitudinal Study on Aging (Mossey, Havens et al., 1981; Roos & Shapiro, 1981) with the

reported on data tracking which linked the Manitoba Longitudinal Study on Aging (Mossey, Havens et al., 1981; Roos & Shapiro, 1981) with the Manitoba Health database (Roos, Shapiro et al., 1989b). Utilization was monitored for the 16 year period 1970 through 1985 for 4,209 Manitobans aged 65 or more years.

Table 1: Manitoba Hospital Expenditures study over 16 years

	Hospital expenditures	Personal Care Home days
Single year studies 1972 and 1973.	5% of the population consumed 68% of hospital expenditures	5% consumed 98.8% of nursing home days
Replication of single year study - 1974	5% of the elderly sampled consumed 70.8% of hospital days	5% of the elderly sampled consumed 89.5% of nursing home days
16 year period studied.	5% users only consumed 33.3% of all hospital days	5% users only consumed 46.3% of all nursing home days

In this article, "high users" were defined as people who had service usage at or above the 95th percentile for the study sample (Roos, Shapiro et al., 1989b). The authors determined that 20 - 24% of high users in one year repeated their usage patterns the following year. Impending mortality was a

greater predictor of the probability that an individual would be a high hospital user than were age or health status. High users of hospital services had an increased risk of entering nursing home. Over the sixteen years 43.5% of elderly spent 37 or more days in a hospital in some calendar year. Individuals for whom health care costs were higher died at a higher rate than others. In the group for whom expenditures were lower, 51.9% were alive 16 years later compared with 22% of higher expenditure groups.

Hertzman et al (Hertzman, Pulcins et al., 1990) reported on the health care needs of an elderly population in British Columbia. Long stay patients were found to spend 50% of all days in acute care hospitals. The primary reasons responsible for this included diagnoses of dementia, chronic diseases (heart disease and stroke), and status as people awaiting transfer to alternate institutional care. "Since the major sources of increase in patient days were not related to conditions for which new, effective hospital care modalities are available, they call into question the appropriateness of the system's response to the health care needs of the elderly population" (Hertzman et al, 1990, p. 819). From these articles (Rubenstein, Stuck et al., 1991; Hertzman, Pulcins et al., 1990; Roos, Shapiro et al., 1989b) it would seem that impending mortality or institutionalization, indicators of patient-related illness severity, also predicted service use.

Use of large data sets

The studies reviewed above used large secondary data sets to evaluate health care outcomes. This practice has increased substantially over the past 10-15 years. Several authors have raised concerns about the techniques and validity of this methodology.

Blumberg (1991) reported on the use of large databases to assess outcomes of the treatment of acute myocardial infarction. He used the Health Care Financing Administration 1986 and 1987 data files at "1400 hospitals in 14 systems and alliances". These data files included Medicare billing data. If the predictive models derived from the data were accurate, the observed results should closely match those predicted by the research models. However, differences were noted between observed and expected deaths. Blumberg suggested methodologic issues as the possible causes, e.g., imperfect data, the use of a biased model, the use of an incomplete model, chance variation, and/or actual differences in care.

McDonald and Hui (1991) presented an overview on issues in using large, routinely collected data sets for research purposes. They suggested that such data sets are potentially prone to bias. The authors suggested methods for dealing with bias in health services research based on large data sets. These methods included stratification, and adjusting or matching on relevant covariates. Measurement unreliability, selection biases, missing

data and the types of questions asked of the data sets were noted as additional sources of bias which were not easily dealt with.

Byar made a much stronger statement, "... that the comparison of treatments is rarely justified using information in databases except as frankly exploratory data analysis." (Byar, 1991, p. 666) He suggested that selection bias was implicit in clinical decision making as physicians routinely attempted to choose a treatment to benefit the individual patient. Analysis methodology, including the lack of an easy ability to include time in the analysis, and the frequent use of linear models in an inherently non-linear world were put forward as additional difficulties in the analysis of large data sets (Byar, 1991).

Roos, Sharp and Cohen compared clinical information with claims data on prostatectomy and cholecystectomy in 1991 (Roos, Jr., Sharp et al., 1991a). Data were cross-linked with prospective data from an anaesthesia follow-up study. The agreement for cardiovascular disease, respiratory disease, and metabolic disorders between the clinical and administrative data sets ranged between 65 and 90%. Clinical information from the anaesthesia file added information on comorbidity. Absence of this information did not change the ability to predict adverse outcomes in the study population.

In 1993, Roos and colleagues reported on the organization and accuracy of administrative databases (Roos, Jr., Mustard et al., 1993). Issues addressed included demographic organization, data management strategies,

and record linkage. Data quality was assessed, using provincial immunization data and chart review and found to be good. More comorbidity information was available from chart review than from hospital service abstracts. A hypothesized hierarchy of accuracy was outlined.

Jollis et al presented results of a concordance study between hospital discharge abstracts and a clinical cardiovascular diseases data set (Jollis, Ancukiewicz et al., 1993). Potential advantages were outlined for the use of insurance claims, including "1) large samples of geographically dispersed patients; 2) longitudinal records; 3) data already collected and available; and 4) defined sampling frames." (Jollis, Ancukiewicz et al, 1993, p. 844) Reliability of diagnoses was compared between the two data sets. Cohen's Kappa ranged between 0.83 for Diabetes Mellitus and 0.73 for acute myocardial infarction to 0.12 for angina and 0.09 for unstable angina. Overall agreement of ICD-9-CM codes with clinical data was 0.75. Claims records for older patients were more likely to identify clinical conditions than similar records for patients under age 65. Only 39% of clinical conditions for people aged 65 or less were identified by claims data. The authors presented a compelling case that claims data may under-estimate comorbidity in medical, as opposed to surgical, conditions for patients under age 65. These articles serve to outline some of the problems inherent in research using secondary data sources.

Epidemiological principles

Validity and Reliability

Questions may be raised about the quality of data obtained from secondary data sets. Determining the validity and reliability of data items is an integral step in assessing the quality of these data sources and any study results. Reliability is defined as the degree to which any measurement produces the same results on repetition (Carmines & Zeller, 1979a) The essence of reliability is consistency. Increasing amounts of random error or inconsistent results result in decreasing reliability. Repeated measures are one means of increasing reliability.

There are different methods to determine reliability. Inter- and intra-rater reliability are two such techniques. Inter-rater reliability refers to the measurement of the consistency of test results between different testers. Intra-rater reliability refers to the consistency of repeated measurements for the same tester at different times.

Having obtained information reliably a question then arises about the exactitude of data upon which reliability determinations are made. One means of expressing the accuracy of results uses the terms sensitivity and specificity. Sensitivity refers to the ratio denoting the chance of obtaining a truly positive result as compared to all positive results. Specificity refers to the ratio of the true negative results to all negative results. For optimal test performance sensitivity and specificity should be simultaneously maximized.

Sensitivity analysis is one method for expressing optimal sensitivity and specificity. A common means of performing a sensitivity analysis involves computing a receiver operating curve.

Once the data have been reliably obtained how convincing are they? The concept of validity deals with how credibly the data measures what we think it does. Validity is the term used to represent the extent to which a measurement corresponds to the "true" biologic value or some accepted "gold standard" (Kramer, 1994b). It depends on minimizing measurement error caused by bias and requires both an unbiased observer and an unbiased or controlled method. Validity depends on its consistency in measuring what it sets out to measure and not extraneous influences. At least five major types of validity are relevant to this study.

Face validity (Carmines & Zeller, 1979a) refers to the extent to which the measure appears appropriate to the entity measured. The face validity of the use of large secondary databases in assessing population health is well past its infancy (Roos, Shapiro et al., 1989b; Roos, Roos, Jr. et al., 1988). Feinstein, however, would define face validity as "... a statistically unmeasurable attribute that refers to the measurement's clinical 'sensibility' or 'common sense' in doing its job." (Feinstein, 1994, p. 805) Content validity (Carmines & Zeller, 1979a) refers to the appropriateness of the individual items or components of the measurement. From prior studies of the use of large data sets it has been determined that items such as age, sex, marital status, and income decile are indicators associated with health (Pappas,

Queen et al., 1993). Construct validity (Carmines & Zeller, 1979a) is defined as the extent to which the underlying entity itself, i.e. the theoretical construct, is valid. The discussion of this thesis deals with this element.

Concurrent criterion validity (Carmines & Zeller, 1979a) is the degree to which the measurement correlates with other accepted measures of the entity obtained at the same time. This is an intuitive meaning not shared by other types of validity (Carmines & Zeller, 1979b). Predictive criterion validity (Carmines & Zeller, 1979a) is the extent to which the measurement predicts some accepted criterion of the entity that occurs in the future. Repeated local comparisons of clinical measurement with large database measures have proven the equivalent ability to relate to and predict outcomes on a population rather than an individual basis (Roos, Jr., Sharp et al., 1991a).

An ecological fallacy is a false inference resulting from analysis of aggregate rather than individual data. This study attempts to avoid displaying ecological fallacies through the use of data about individuals.

Relative Risk and Odds Ratio

Valid data obtained with reasonable reliability can be used to determine population risk. Before commencing a discussion of the various means of differentiating risks and the means of adjusting for them it is important to define the terms to be discussed. Techniques for defining the clinical relevance of different risks of disease or death exist. They include

Relative Risk (RR), Attributable Risk (AR), Etiologic Fraction (EF), and Odds Ratio(OR). RR and OR will be briefly reviewed.

Relative Risk (Kramer, 1994c) is defined as the risk of an event or occurrence in the exposed subjects divided by the risk in the nonexposed population. RR is the best estimate of the strength or magnitude of the exposure-outcome association and is therefore useful for making causal inferences. Relative Risk refers to fixed cohorts without losses or additions during the period of follow-up.

Odds Ratio (OR) refers to the ratio of the probability that a given event will occur to the probability that it will not occur (Kramer, 1994a). For practical purposes OR can be considered equivalent to the Relative Risk, where the probability of the event is sufficiently rare, and the sample size sufficiently large. OR allows for losses during the follow-up period.

Standardization

When adjusting for risk some means must be found to adjust for different population demographics in order to foster comparisons between groups. Standardization refers to a uniform method of comparing different groups. Comparisons may be made between several groups in order to generate or test an etiologic hypothesis (Kramer, 1994d). The comparability of rates between two populations or groups is in doubt unless some means can be found to account for such differences as population size, and

population age and sex composition. Techniques for adjusting rates to reflect these differences are included under the rubric "standardization".

Direct standardization is the method used when two or more groups have a known structure by similar criteria. Such standardization is typically applied to a large population size. Indirect standardization is used when the rate for one of the groups is unknown, or when small numbers are in a study. A standardized mortality ratio (SMR), for example, is used to offer a single numerical comparison between populations, in comparison with the standard population, arbitrarily defined as SMR=100, or baseline. Numbers greater than the baseline indicate a higher mortality rate in the group of interest than in the baseline; numbers less than the baseline indicate a lower mortality rate, in comparison with the baseline.

As the central purpose of this project is the comparison of mortality rates between and among various users of Manitoba's hospital system standardization has been used. It is anticipated that such standardization has helped to ensure the comparability of the groups under study, by age and sex.

Efficacy versus effectiveness

Population standardized risks, reliably determined by valid means, are used in determining whether interventions have made a difference in the outcomes of care. Is this difference found only in a highly selected group or is it applicable to a wider population? Efficacy and effectiveness are the terms

used to differentiate these two conceptual ways of assessing outcomes of treatment.

Efficacy (Carmines & Zeller, 1979a) is defined as the degree to which an identified intervention, medication, or service effects a positive result under controlled situations. The efficacy of Geriatric inpatient units in affecting mortality appears to be well proven (Rubenstein, Stuck et al., 1991; Stuck, Siu et al., 1993). The primary goal of this study was to demonstrate the effectiveness of Geriatric inpatient units in influencing mortality. Effectiveness (Carmines & Zeller, 1979a) is defined as the degree to which an identified intervention, medication, or service effects a positive result under day-to-day conditions for a specific population. The primary purpose of this study is the demonstration of the effectiveness of Geriatric units in reducing mortality.

Risk Adjustment

Large numbers of reliable, valid results standardized to a reference population can be used to draw comparisons across geographic areas. However populations do not differ only in demographic distribution. Comorbid conditions may also affect health service utilization. Techniques exist for adjusting for these inherent differences. They fall into the category of risk adjustment.

Risk adjustment can be performed on well characterized groups using data obtained via randomized controlled trial (RCT) methodology or via large

secondary data sets. Using the former technique strict inclusion and exclusion criteria insure the relative homogeneity of the study groups. These criteria are defined based on an examination of an individual's specific condition. RCT authors set out to measure relevant comorbid conditions. Observational methods using large data sets, on the other hand, require other means for insuring comparability of the study cohorts. Various methods of risk adjustment for comorbid conditions exist. A selected review is presented.

Sickness Impact Profile

Gilson et al described the development of "a behaviorally based measure of the impact of sickness-related dysfunction" in 1975 , (Gilson, Gilson et al., 1975, p. 1306). The Sickness Impact Profile (SIP) was further described by Bergner et al in 1976 (Bergner, Bobbitt et al., 1976). A structured interview was performed and weighted scores obtained for the impact of illness on self-rated health status and on Activities of Daily Living (ADL). Comparisons were made with the results of clinical assessments. The subjects were 278 patients of a Seattle Washington Veterans' Administration hospital. Only 13% of the sample were aged 75 or more years. The authors found that ambulation, body movement and leisure pastime sub-items were most highly correlated with sickness and dysfunction assessments. The SIP correlated mildly with the Katz ADL score (Katz, Ford et al., 1963), a direct measure of functional status widely used then, with r=0.46.

In a follow-up validation study in 1981, Bergner et al reported on two 1976 samples (Bergner, Bobbitt et al., 1981). Test-retest reliability was 0.87-0.97. Cronbach's alpha was 0.94-0.97, suggesting a stable measure with good internal consistency. Mail delivered sampling was not as good at determining diminished function and sickness as direct observations. As the SIP requires direct measurement, it is not easily applied in analyzing secondary data sources.

Diagnostic Related Groups

Lee (1981) described the theoretical use of multiple logistic regression to adjust for covariates in analyzing epidemiologic data. Logistic regression modeling was chosen, as it provided partial odds ratios. He developed this thesis further in 1986 (Lee, 1986).

DesHarnais and colleagues followed on with Lee's suggestions. They reported on the use of risk-adjusted indices of mortality, readmissions and complications in assessing the quality of care received in United States hospitals (DesHarnais, McMahon, Jr. et al., 1990). Their study results were derived from annual reporting by the U.S. Health Care Financing Administration on individual hospitals' mortality rates. The study attempted to account for variability in comorbidity, social and functional condition of the patients served. "Although it would be preferable to rate the quality of hospital care directly, by measuring the changes in patients' health status following treatment, there is no practical way to obtain data on patient

health status before and after treatment for a large national sample of hospitals." (DesHarnais, McMahon, Jr. et al, 1990, p. 1128) The authors used surrogates of adverse events as proxies for positive outcomes. Diagnosis related groups (DRG) were used to adjust the individual indices of mortality, readmission, and complications. The indices generated were stable over time (Weiner, Maxwell et al., 1987).

Lubeck and Yelin designed "an alternate method to enumerate and value in common terms as many of the indirect costs of illness as can be done reliably." (Lubeck & Yelin, 1988, p. 448) The authors used a telephone survey to assess the importance of individual activities of daily living to individuals interviewed (Lubeck & Yelin, 1988). The patients were part of the cohort of 754 people attending the University of California, San Francisco's Multipurpose Arthritis Center, formed in 1982-1983. One hundred fifty people were selected at random from these patients. Evaluation of the data for stability of results was positive. A semi-quantitative technique can be used to evaluate the impact of arthritis in monetary terms.

Illness scale

Mossey and Roos discussed the use of insurance claims to measure health status (Mossey & Roos, Jr. 1987). Data from the Manitoba Longitudinal Study on Aging were linked to the Manitoba Health data base. The Illness Scale was derived from a summation of physician and hospital claims for the years 1970-1977. Reliability assessments were undertaken.

Cronbach's alpha was between 0.82 and 0.84, suggesting high internal consistency of the scale. Increasing age was associated with increasing illness. The score increased as the person approached death. The Illness Scale score was higher with patients known to have "serious chronic conditions" such as cancer or cerebrovascular disease, and for individuals who were hospitalized. The study demonstrated that insurance claims could be used in deriving a measure of comorbidity (Mossey & Roos, Jr. 1987).

Charlson Index

In 1987, Charlson et al reported on the development of a "prospectively applicable method for classifying comorbid conditions which might alter the risk of mortality for use in longitudinal studies." (Charlson, Pompei et al., 1987, p. 373) Six hundred four of 607 patients admitted to the Internal Medicine services at Cornell Medical Center during a month in 1984 were clinically evaluated (Charlson, Pompei et al., 1987; Charlson, Sax et al., 1986). Illness severity was assessed by the Internal Medicine resident admitting the individual patient. Ninety-three percent or 559 of these patients were followed for 1 year. The index of comorbid illness generated was tested on a separate group of 685 women with breast carcinoma treated at Yale New Haven Hospital between 1962 and 1969. Ten year follow-up data for these women were analyzed. Cox Proportional Hazards regression analysis was undertaken to determine the strength and prognostic relationship of specific variables. The total number of comorbid diseases was

counted and a weighted score developed. The effect on 1 year mortality was analyzed. "... the total number of comorbid diseases did predict 1-yr mortality ($p<0.05$), as did illness severity-reason groups...." (Charlson, Pompei et al., 1987, p. 376) "The weighted index of comorbidity was a significant predictor ($p<0.0001$) of 1-yr survival; as were illness severity and reason for admission." (Charlson, Pompei et al., 1987, p. 377)

Roos et al (Roos, Jr., Sharp et al., 1989a) critiqued risk adjustment and the Charlson index in health services research using large secondary data sources. The Winnipeg anesthesia follow-up study was used for clinical information. Data from the Manitoba Health databases were used for assessing claims-based indices of health status. "Claims-based measures of comorbidity, derived both from hospital discharge abstracts at the time of surgery and from hospitalizations in the 6 months before surgery, provided reasonably good predictions of postsurgical readmissions and mortality." (Roos, Jr., Sharp et al., 1989a, p. 1193)

Deyo and colleagues (Deyo, Cherkin et al., 1992) adapted Charlson's comorbidity index in order to study patients undergoing lumbar surgery using the Health Care Financing Administration listing of all 1985 Medicare claims. Linked data were obtained for hospitalizations in the year before the surgery. Mortality information was obtained. "The index was associated in the expected direction with postoperative complications, mortality, ..." (Deyo, Cherkin et al., 1992, p. 613)

Romano et al reported on a comparison of the clinical risk adjustment methods of Charlson, as described by Deyo, (Deyo, Cherkin et al., 1992) and the authors' modification as applied to two large administrative data sets (Romano, Roos, Jr. et al., 1993b). Abstracts of coronary bypass hospitalizations from Manitoba which were linked longitudinally to prior hospitalizations and to subsequent mortality, and abstracts of discectomy hospital stays were used in comparing Romano et al's methodology with that of Deyo et al. Modest differences were demonstrable between the Deyo et al and Romano et al's risk adjustment methods. In Romano's study, different weights would have been assigned to comorbid illness such as congestive heart failure and diabetes mellitus. Detailed chart review was undertaken in 1067 cases at a third site, Duke University Medical Center. The distribution of the comorbidity index shifted to higher scores. Questions were raised about the adequacy of the Deyo modification of the Charlson index. Romano et al concluded that "the Charlson comorbidity index should be applied with great caution to administrative data describing elective surgery patients" and state that "investigators should use their own data to re-estimate the weights assigned to various comorbidities". (Romano, Roos, Jr. et al., 1993a, p. 9) The overall consensus of these articles to date suggests that, given certain strictures in interpretation, use of the Charlson Index may be a reasonable technique to adjust large secondary data sets for the effect of comorbid

illness. Other factors such as socioeconomic status exist which also affect health and should be taken into account when assessing service use.

Demographic factors as determinants of health

Comorbid illness determined by reliable, valid measures can be used to adjust a population's risk for a specified outcome. Socioeconomic factors are also known to influence health and outcomes. Adler et al (1993) reviewed some of the available literature. The authors reported increased morbidity and mortality among individuals of lower socioeconomic status. Adler et al pointed out that these factors may account for up to 50% of the causes of mortality.

Wilkinson (1993) reviewed the literature on the impact of income on health. He pointed out that "the relationship between national mortality rates and the average standard of living in developed countries is very much weaker" (Wilkinson, 1993, p. 1082) than that between mortality and socioeconomic status. Wilkinson suggested a scheme of income redistribution, similar to that of Japan, Sweden, or Norway, in the belief that "it might add 2 years to average life expectancy." (Wilkinson, 1993, p. 1083)

Angell (1993) commented on socioeconomic status and its influence on mortality. She reaffirmed that lower socioeconomic status is associated with decreased health and increased mortality.

Prospective studies

Prospective studies have been undertaken to verify the influence of socioeconomic status on health outcomes. Hirdes and Forbes (1993) reported on a subsample of the Ontario Longitudinal Study of Aging (OLSA) evaluating the effect of socioeconomic status on health. Two thousand males aged 45 in 1959 were interviewed annually until 1978, when they reached age 65. Those reporting fair, poor, or very poor health numbering 298 or 14.8% of the initial sample were excluded from further analysis. Factors related to good health and remaining in the study included income, social network characteristics, and smoking. More individuals of lower income dropped out of the study over its 19 years. The study reported an association between relatively high income and education and remaining in good health.

Guralnik and colleagues (1993) studied life expectancy among 4,057 older blacks and whites. They used data from the Piedmont Health Survey of the Elderly, which is a component of the National Institute on Aging's Established Populations for Epidemiologic studies of the Elderly. Guralnik found that level of education had "a greater effect than race on total life expectancy and active life expectancy." (Guralnik, Land et al., 1993, p. 110)

Pappas et al (1993) used the National Mortality Followback Survey and the National Health Interview Survey for 1986 to study the mortality rates of the non institutionalized, civilian U.S. population aged 25 to 64. They then compared their results with the published results of Kitagawa and

Hauser from a similar study in 1960 (Kitagawa & Hauser, 1973). Measures of socioeconomic status included sex, race, family status, income and education groups. The authors found that lower education and income distinguished groups with higher death rates, despite declining death rates in the United States since 1960. These prospective longitudinal studies on service use suggest that socioeconomic variables contribute to health status.

Twin study

Are there other potential explanations for this contribution? It has been demonstrated that comorbid illness and socioeconomic status may account for health outcomes. Is this due to the primacy of environment or of genetic background? Twin studies help differentiate the relative effect sizes of environment and genetics.

Lichtenstein et al (1992) reported on a Swedish study of twins to assess the relationship of socioeconomic status and physical health while accounting for genetic variables. The sample included 90 pairs of monozygotic twins reared apart, 166 pairs of monozygotic twins reared together, 238 pairs of dizygotic twins reared apart, and 221 pairs of dizygotic twins reared together. Socioeconomic variables evaluated include material resources, (e.g. number of modern conveniences, ownership of cars, and savings) perceived standard of living (e.g. difficulty meeting general expenses, money for extra treats, or need for a rent subsidy), education (e.g. elementary or secondary school, junior college or university), and

occupational status. Physical health was measured using two self reporting tools, one for chronic illness, and one for overall health. The study demonstrated that social position in adulthood, socioeconomic environment during childhood, and health status during childhood contributed to the association of socioeconomic status and health. Thus, this study shows the persistence of an effect of socioeconomic status on health despite genetic influences.

Clinical Outcomes

Ventricular fibrillation

To evaluate further the relation between socioeconomic status and health outcomes Hallstrom et al reported on a study of ventricular fibrillation outside of hospital in Seattle Washington (Hallstrom, Boutin et al., 1993). They analyzed items specific to response time for cardiopulmonary resuscitation, as well as gender, age, location of collapse, assessed value of the home of the individual, and a chronic comorbidity index. Using multiple regression analysis to account for other effects the authors demonstrated that increased value of the home was associated with increased survival from out of hospital ventricular fibrillation. Socioeconomic status directly affected health outcomes in this study.

Functional status or disability

Rogers and colleagues (1993) attempted to address the question of other aspects of health status influenced by socioeconomic status. They

reported on the use of the 1986 Longitudinal Study of Aging (LSOA) data set from the U.S. Department of Health and Human Services. This was a follow-up study of a supplement on aging to the 1984 National Health Interview Survey involving noninstitutionalized elderly. Physical ability and disability information was sought for 5,151 people who had been aged 70 or more in the 1984 sample. Independent variables in a subsequent logistic regression analysis included age, sex, race, education, poverty status, and marital status. Increased disability was found with increasing age, lower level of education, black race, and poverty.

Kaplan et al (1993) reported on a 6 year follow-up study of members of the Alameda County Study who were 65 years of age or more in relating function to socioeconomic status. Functional assessments were undertaken in 1984 on 508 respondents aged 65 or more who had been interviewed in 1965, 1974 and 1983. The 508 participants were then followed for 6 years. There were 127 deaths, 20 interview refusals, and 5 people who could not be located, leaving 356 subjects for analysis. Increasing age, lower family income, and poorer self perceived health were associated with a decline in functional status. These two studies suggest that socioeconomic status can directly relate to ability to care for oneself.

Service utilization

Having demonstrated that socioeconomic status can relate to functional disability the question can be asked whether this diminished

capability can lead to increased health care expenditures. Billings et al reported on their study of hospital use in New York City (Billings, Zeitel et al., 1993). They used hospital data for 1988 from computerized discharge abstracts provided by the New York Statewide Planning and Research Cooperative System (SPARCS). Synthetically linked data on demography were obtained from a marketing company. The primary independent variable was income. Income was derived from U.S. Postal Code of residence and census data. Using utilization data Billings et al demonstrated that services which might alternately have been provided in an ambulatory care setting resulted in hospitalization more often in low-income areas.

McMahon and colleagues (1993) analyzed hospital use in Michigan's lower peninsula using small area analysis techniques. They used the Michigan Inpatient Data Base to study hospital discharge data from 1984 through 1986. Socioeconomic factors were added from the 1980 census, including, among other items, percent of the work force unemployed, percent of the population graduating from high school, percent of the population who were black, percent of the population disabled, per capita income, and the standardized mortality statistic. Data on diagnosis related groups were obtained. Multiple and simple regression techniques were used, in a log-linear model, to predict hospital discharge rates. Community characteristics of education, poverty, and unemployment were found to be significantly associated with the small area discharge rate for many DRGs. The socioeconomic and medical resource variables of education, number of

primary care physicians, poverty rate, unemployment rate, and percent of the population living in an urban setting accounted for 48% of the variance for medical admissions and 19% for surgical admissions. Calculations are not provided for the size of the variance in the absence of the medical resource variables. Higher educational levels were associated with lower hospitalization rates. From this selection of articles it would seem that, having accounted for genetic influences, socioeconomic variables can affect rates of mortality, functional disability, hospital service use, and expenditures.

Controversy about Geriatric services

Having discussed the use and validity of large data sets, approaches to adjustment for comorbidity, and determinants of health, we turn now to another element of this study, the Geriatric unit. Geriatric units are dedicated geographic areas in a hospital that deal exclusively with elderly patients. These units may be located in acute care hospitals, in long term care facilities, or be freestanding. Geriatric units are staffed by a variety of health professionals with additional training and expertise in care of the frail elderly. Multisystem illness is the rule. Geriatric services use a comprehensive, multidisciplinary team assessment and care plan directed toward the optimal management of a frail elder. Principal areas of assessment include function, cognition, medication use, and social situation, among others. The primary outcome of interest is improved function, with

discharge to an independent environment being an outcome of equal importance. A decrease in mortality would be an interesting byproduct but not of primary intention.

Geriatric Medicine may have begun as early as 1749 with the publication of the first book on Geriatric care (Allen, 1749). The unique characteristics and physiological qualities of elders were further enunciated by Day, in his text "A practical treatise on the domestic management and most important diseases of advanced life" (Day, 1849).

Dr. Marjory Warren is recognized as one of the earliest geriatricians (Matthews, 1984). She worked as the Deputy Medical Superintendent of the West Middlesex County Hospital in Isleworth in 1935 when the Poor Law Infirmary was annexed to her institution. In the process, Dr. Warren acquired the medical responsibility for 714 older patients. As a result, the first British geriatric multidisciplinary unit was created, based upon the principles of early assessment, and rehabilitation. In the process, Dr. Warren successfully discharged a majority of individuals home. Cape's survey (1972) of the functioning of the Geriatric services in a region of the West Midlands in England continued the work done by Warren, Sheldon (Sheldon, 1948) and others, and provided us with a model of descriptive research on outcomes of Geriatric Medicine services.

References abound regarding Geriatric services and their efficacy (Hendriksen, Lund et al., 1984; Tucker, Davidson et al., 1984; Reid & Kennie, 1989; Applegate, Miller et al., 1990; Cole, 1991). This efficacy is

assured by a direct transfer of the responsibility, in order to ensure implementation and modification of suggestions. Geriatric services provide a rehabilitative milieu with dedicated staff who have an unique experience base, and where control of prescribing is practiced.

Assessment of the efficacy of Geriatric services has been undertaken in community and hospital settings using randomized controlled trial methodology. Rubenstein and colleagues reported on a meta-analysis of this literature (Stuck, Siu et al., 1993). The following paragraphs briefly review the articles found in the Rubenstein analysis.

Community based services

Two articles report on the effects of a community service on outcomes for the frail elderly. Such services are only a small component of geriatric interventional services. Their inclusion in the meta-analysis is difficult to support. The first study, that by Hendriksen et al, (Hendriksen, Lund et al., 1984) described a 3 year randomized controlled study on a sample of 1,376 community-dwellers aged 75 or more from a total population of 37,847 in a suburb of Copenhagen. The study subjects underwent a home visit and needs assessment by 2 trained nurses or a physician with subsequent "appropriate" service implementation and case management. Only 174 or 13% were living in Personal Care Home at the time. Six hundred individuals were randomly selected for entry into the study, with 300 in the intervention and 300 in the control groups. The method of randomization was not specified. Controls

were interviewed at the same time as the final intervention group interview. There were 13 or 4% drop outs from the intervention group who refused to participate, and 2 who were omitted for unspecified reasons. Thirteen also refused to participate from the control group. The groups were similar in age, sex, and marital status distribution. The primary outcome was hospital admission, with secondary outcomes including admission to nursing home, mortality, contacts with general practitioners, and utilization of home nursing care or social services. The results for mortality demonstrated a reduction beginning in the third half-year, with an overall reduction in mortality from 4.2% to 3.6 %, for a risk reduction of 14%.

Vetter and colleagues reported on a 3 year randomized controlled cohort trial in 2 suburbs of Cardiff, Wales, 1 urban and 1 rural (Vetter, Jones et al., 1984). The study involved 1,148 people, 577 in the intervention group (281 in the rural and 296 in the urban suburb), and 571 in the control group (273 in 1 rural and 298 in the urban suburb). Randomization was by household, but the method of randomization was not specified. No appreciable differences were noted between the control and intervention group by age, sex, or disability rating. The intervention of interest was a home visit by 2 public health nurses. By the end of the trial, 3 from the intervention group had refused further follow-up, and 103 had died. In comparison, 10 from the control group had refused further follow-up and 104 had died. The primary outcome of interest was physical disability, with

secondary outcomes including mortality, and subjective quality of life. The mortality rate was reduced in the urban but not the rural area.

Community based consulting services

Having discussed community-based services Rubenstein et al reviewed the effects of a community-based multidisciplinary geriatric consultation team (Rubenstein, Stuck et al., 1991). In 1990, Epstein and colleagues published a study dealing with geriatric assessment and ambulatory care (Epstein, Hall et al., 1990). A randomized controlled cohort design was used to primarily evaluate mortality and health care use. Satisfaction, social activity, emotional health, cognitive function, physical function, and overall perceived health were secondary outcomes of interest. The site was an ambulatory care setting, in a health maintenance organization in Rhode Island. Patients aged 70 or more were stratified and entered. Those between 70 and 74 were entered if their health was self described as "fair or worse", or "experiencing very likely or probable deterioration". All patients older than 74 were entered. Further stratification was based on age, gender, a physician's rating of current health, and a primary physician being identified. Randomization occurred using a computer generated algorithm. Three comparison groups were formed - consultation by a geriatric assessment team and subsequent telephone follow-up; consultation by a "second opinion" internist; or usual services. The interventions occurred one month after randomization. Geriatric assessment included evaluation by a

geriatrician, geriatric nurse practitioner, and geriatric social worker. Follow-up occurred at 3 months and 1 year after randomization. Good inter-rater reliability was achieved on all measures. Note should be made that this was the only statistical study that used a correction for multiple tests, the Bonferroni method, and an adjusted P value of 0.005. A calculated sample size of 600 per group was needed. There were 1,156 potentially eligible patients. Twelve percent of all groups were excluded for similar reasons. "At both the 3 - and 12 - month follow-up examinations, there were no differences among groups in the number of patients hospitalized, admitted to a nursing home, or deceased." (Epstein, Hall et al., 1990, p. 543)

Williams and colleagues reported on a trial of a Geriatric community consulting service. Patients were randomly referred by an outside agency to either geriatric assessment or community physicians (Williams, Williams et al., 1987). No denominators are available in the article. The control group received "a geriatric evaluation by a well-qualified general internist". The intervention group was evaluated by an outpatient geriatric consultation service with multidisciplinary members participating. Follow-up was for 12 months. The mortality rate for the 58 treatment and 59 control patients did not differ. No post hoc power calculations were provided.

Inpatient consultation services

In a study of Geriatric consultation services, Hogan and colleagues reported on a 1 year randomized controlled cohort trial of all patients

admitted through the emergency department of a tertiary referral centre for the Maritime provinces in Halifax, Nova Scotia (Hogan, Fox et al., 1987). There were 160 eligible subjects, with 57 in the intervention group and 56 in the control group. Patients were excluded if they were in the Intensive Care Unit, had suffered an acute stroke, or if permission was refused. The excluded people numbered 47: - 42 not meeting inclusion criteria, 1 patient refusal, and 4 treatment crossovers. The groups were comparable by demographic characteristics. Randomization used a table of random numbers. The intervention involved screening by a trained observer who accumulated demographic data and performed specialized testing using a short mental status questionnaire and the Barthel Index, a tool for assessing functional status. Geriatric consultation by a multidisciplinary service was the intervention, with daily weekday follow-up and weekly full-team rounds. No drop outs were reported. The primary outcome of interest was mortality, with secondary outcomes including functional status, service utilization characteristics, number of medications, and number of referrals to community services per patient. Survival results were significantly different at 4 months of follow-up (control 70%, intervention 86%, $p<0.05$) but not at 8 or 12 months. No proportional hazards regression results were reported, which might have enabled the reader to better appreciate the factors relating to this apparent time-limited decline in mortality.

In 1988 Saltz and colleagues reported on a randomized controlled clinical trial of veterans aged 75 or older, admitted to a Veterans'

Administration Medical Center in Durham, North Carolina, between November 1983 and December 1984 (Salz, McVey et al., 1988). Patients were excluded if they had been admitted to intensive care units, previously been seen on a geriatric service, or were likely to stay less than 48 hours. There were 297 potentially eligible patients over the study interval. Exclusions numbered 112, of whom 42 refused consent, 5 died before consent, and 2 delayed consent, while the remainder met study exclusion criteria listed above. After randomization there were 93 patients in the intervention group and 92 in the control group, of whom 1 and 3, respectively, were subsequently excluded because of missing hospital records. Both groups underwent multidisciplinary assessment within 48 hours of admission involving physicians in geriatric medicine, a geriatric clinical nurse specialist, and a social worker. The team assessed participants using standard history and physical examinations, mental status using the SPMSQ (Pfeiffer, 1981), the Katz Index of ADL (Katz, Ford et al., 1963), the OARS instrumental activities of daily living scale (Pfeiffer, 1975), and the CES-D scale for measuring depression (Radloff, 1977). Patients were discussed at a multidisciplinary intake conference of the geriatric consultation team, where a priorized problem list and recommendations were generated. For the control group, only the problem list was returned to the chart. For the intervention group, the problem list and suggestions were returned to the chart, and direct discussions with the ward staff responsible for care

occurred. Intervention group patients were seen by individual members of the geriatric consultation team weekly, with follow-up recommendations made in the chart. Participant follow-up was by telephone at six months after discharge. The primary outcome measure was discharge site. Mortality at six months was a secondary outcome measure, as was length of stay. No statistically significant difference in mortality was detected.

Hogan and Fox (1990) presented the results of a second randomized controlled cohort trial of elderly patients admitted through the emergency department to a teaching hospital of Dalhousie University Medical School. This study replicated their earlier one. Patients were stratified by overall functional status before admission to hospital. There were 352 potential subjects recruited, mean age 81.4 years, with 54% women and 24% admitted from local nursing homes. The hospital fatality rate was 13% and mean length of stay of 16.4 days. This left 132 (or 37.5%) of the potential subjects who met the inclusion criteria. Randomization used a table of random numbers. Potential participants were screened by a trained observer who gathered demographic data, and performed specialized testing using a short mental status questionnaire and the Barthel Index. The primary intervention was the geriatric consultation using a multidisciplinary team with a control intervention of usual care. Follow-up took place daily during the week with full team rounds occurring weekly. Only one control person was lost, and was treated as if they had survived. Follow-up was for one year. The primary outcome of interest was mortality. Secondary outcomes were

functional status at 3, 6 and 12 months, as well as hospital admissions and readmissions within one year. For mortality, six month survival comparing intervention and control groups were 94% and 78% respectively. Twelve month survival was 75% and 64% respectively. Co-factors positively affecting mortality included assignment to the geriatric consultation service, and place of discharge.

Rubenstein and colleagues reported results of a randomized controlled cohort trial of a geriatric inpatient evaluation unit, used to treat Veterans still in hospital one week after admission to a Veterans' Administration Medical Center (Rubenstein, Josephson et al., 1984). Patients assigned to the geriatric unit were transferred there within 48 hours. The control group underwent usual care. Follow-up was for 2 years, with reassessments at 3, 6, 9, 12, 18 and 24 months. Inclusion criteria included age 65 or more, and the presence of a persistent medical/functional/psychosocial problem interfering with discharge home. Exclusion criteria included well-diagnosed severe dementia resistant to further management and with no social support system, terminal illness, length of stay less than 1 week, and/or those functioning well and able to be discharged. A total of 123 patients from a possible 1,442 was enrolled over 18 months, 63 to the treatment and 60 to the control group. Minor differences were noted between groups at randomization, including the prevalence of amputation, and the use of dentures. At one year follow-up, 48.3% of controls compared with 23.8% of the intervention group were dead, for a "P" value of less than 0.005. This

difference began after 2 months following admission and is unexplained by transfer to a nursing home. No difference was noted in death before discharge. In addition, treated patients were discharged to home or a board and care facility 73.0% of the time, compared with 53.3% for the controls.

Gayton and colleagues presented the results of a non-randomized controlled clinical trial of patients admitted to 2 of 4 possible general medical floors (Gayton, Wood-Dauphinee et al., 1987). Over a 22 month period, 222 intervention and 182 control group patients were seen out of an unknown total. Patients were aged 70 or more and eligible for health insurance benefits. Control group patients received regular care. Treatment patients were served by the geriatric consultation team. The trial and control groups appeared comparable at admission considering the variables provided. Drop outs included 6.8% of treatment and 9.3% of control group patients. Reasons and testing for this difference were not provided. The death rate at 6 months was 25.2% for treatment patients and 34.1% for control patients with no statistically significant difference demonstrable.

In a brief report in the British Medical Journal, a one year follow-up of patients with a fractured femur who had been submitted to a randomized control trial was reported by Reid and Kennie (1989). Patients were randomized at the time of operation. Two groups of 54 patients were generated. One year survival was 67% (95% CI 60% - 75%) for the control and 81% (95% CI 71% - 92%) for the treatment group. Only one person was

lost to follow-up. Of the 36 patients excluded 67% survived one year (95% CI 54% - 79%). Only descriptive statistics are available.

A randomized controlled cohort trial was performed by Applegate using a stratified block design and a computer generated table of random numbers (Applegate, Miller et al., 1990). Prerandomization stratification was for "perceived risk of nursing home admission". Patients were randomized to treatment in a geriatric assessment unit or to usual care. Follow-up occurred at 6 weeks, 6 months and one year after randomization. Measures included activities of daily living, cognitive status, and illness severity. Sample size calculations were made on an alpha level of 0.05 (2 tailed) and a power of 0.80. The calculations assumed a 50% institutionalization rate in nursing homes and a reduction to 30% in the intervention group. A total of 200 subjects was deemed necessary. "...time and fiscal constraints allowed the randomization of only 155 subjects." (Appelgate, Miller et al., 1990, p. 1574) The two groups were comparable by demographic, functional, and illness severity variables. Seventy-eight patients were randomized to the treatment group, and 77 to the control group. After six months, the difference in survival risk was not significant ($p = 0.08$). More patients in the treatment group lived in the community at 6 weeks and 6 months after randomization. More control group patients had nursing home stays of 6 months or longer in the year of follow-up. A non-significant absolute risk reduction of 14.7% was demonstrated for patients considered at lower risk for immediate nursing home placement ($p = 0.058$).

Mortality Rates and Geriatric inpatient units - Is there a relationship?
A. J. Kirshen, MD, FRCPC

Thomas et al described results of a Randomized Controlled Trial (RCT) on a cohort study of an inpatient geriatric consultation service at a community hospital in Mississippi (Thomas, Brahan et al., 1993). All admissions were potentially eligible for inclusion into the study. Exclusion criteria included age less than 70, refusal of consent, admission to an Intensive Care Unit (ICU)/Coronary Care Unit (CCU), presence of an obvious terminal illness, use of renal hemodialysis, or residence greater than 50 miles from the hospital. The 68 experimental group participants received multidisciplinary geriatric assessment and follow-up. The control group received usual care. Follow-up was for 6 months. Study groups were comparable at admission in demographic and in multidimensional functional assessment that included function, cognition, comorbid illness and economic status. At 6 months 6% of geriatric service users and 20% of control patients had died. No difference was demonstrated in discharge location. Function improved for 22% of geriatric service users compared with 7% of control patients. At 6 months geriatric service users had worse scores of cognition.

Winograd et al reported results of a RCT on a population of elderly veterans targeted for geriatric consultation (Winograd, Gerety et al., 1988; Winograd, Gerety et al., 1993). The study took place between Oct. 1985 and Jan. 1989 in a veterans' medical centre affiliated with Stanford University Medical School. Exclusion criteria included independence in ADL, residence in a nursing home prior to admission, or life expectancy of less than 6 months. In total, there were 2,728 admissions aged 65 or more in that

interval. Standard assessments of cognition, function, and mood were used. Inpatient geriatric consultation services were provided to the experimental group and usual care to the controls. No statistically significant difference in mortality was demonstrable, with 41% of geriatric service users dying compared to 36% of controls.

Harris et al reported the results of a RCT of admissions from the emergency department of a large Australian hospital in South Adelaide (Harris, Chalmers et al., 1991). Inclusion criteria included age 70 or more, non-elective admission, no prior admission within 7 years, residence in the region, and not being a resident of a nursing home. Participants were randomized using cards to either an inpatient stay on a Geriatric Assessment Unit (GAU) or one of 2 general medical units. No blinding was attempted. The 2 groups differed at randomization in that 7.7% of controls lived with family or friends compared with 15.5% of GAU users. Comorbid illness was evenly distributed. Mortality at 12 months was approximately 26% for GAU users and 38% for controls. This result was not statistically significant. Further, no differences were demonstrable in institutional admissions, function, cognition, or community service utilization.

AGS meta-analysis versus Manitoba study

The single most significant addition to the literature on outcomes of Geriatric service use was the structured literature review published by the

AGS (Rubenstein, Stuck et al., 1991) followed by a peer reviewed meta-analysis of these studies by Stuck et al (Stuck, Siu et al., 1993).

Basic descriptors

Rubenstein's meta-analyses included studies done in Britain, Canada, New Zealand, and the United States. Patients were cared for in both tertiary settings and primary settings in Rubenstein's studies. Our study combines results from tertiary acute care institutions with those of a primary acute care institution.

RCT versus secondary data source

The meta-analyses by Rubenstein et al (Rubenstein, Stuck et al., 1991; Stuck, Siu et al., 1993) were based on reviews of randomized controlled trials and requests for raw data from the authors. The patients in Rubenstein's meta-analyses were very highly selected for participation in the studies reviewed. In particular, patients were excluded if likely to die within the ensuing 6 months. While this exclusion is reasonable in a RCT design, it is not normally used in routine Geriatric unit admissions and was not used in the present study.

Follow-up in Rubenstein's studies varied from 6 months to 1 year. Sample sizes were small, varying from 108 in Reid's study (Reid & Kennie, 1989) to 1,376 in that of Hendriksen (Hendriksen, Lund et al., 1984). Pooling of results occurred in Rubenstein's articles, including study sites of hospital, community and outpatient department. The analysis of data, including those

from multiple sites, raises questions about the generalizability of the meta-analysis. The present study only included inpatient admissions.

Adjustment for comorbidity allows the reader to ascertain the prevalence of associated illness affecting the individuals in the study. The present study adjusts for comorbidity using the Charlson index. Rubenstein's studies do not control for comorbidity in the analysis across studies or institutions.

Education and socioeconomic status

None of the studies analyzed by Rubenstein accounted for educational or socioeconomic status of the patients. These are well know determinants of health. The present study is the first attempt to do so.

Meta-analysis methodology

A major concern arises about Rubenstein's meta-analysis regarding the aggregation of data for services provided both in and out of hospital, data that includes both consultation and specialized inpatient services (Stuck, Siu et al., 1993). The theoretical rationale for merging data from these 4 distinct, albeit not mutually exclusive settings, was thin. Homogeneity Chi-square results in the meta-analysis suggested the heterogeneity of the study sites. The clinical heterogeneity presented in the analysis raises questions about its validity and generalizability (Thompson & Pocock, 1991). Further, the meta-analysis clearly demonstrated the difference between dedicated services and consulting services, the former yielding improved results. Exclusion of

those potential participants too well or too ill to take part in the studies did not appear to affect the results of the meta-analysis.

The review of the studies in Rubenstein et al's structured literature review (Rubenstein, Stuck et al., 1991) and meta-analysis (Stuck, Siu et al., 1993) reveal mixed results, individually tending towards decreased mortality. The variety of sites and methodologies combined in the meta-analysis raises questions about generalizability. The studies included in the overall meta-analysis are summarized in Table 2.

Table 2: Review of RCTs dealing with geriatric services

Study	N	Study identifiers			Geriatric Mortality	Non-Geriatric Mortality
Hendriksen, Lund, & Stromgard, 1984	1,376	Community	Cohort - RCT		3.6%	4.2%
Vetter, Jones, & Victor, 1984	1,148	Community	Cohort - RCT		17.8%	18.2%
Epstein et al, 1990	1,017	Community service	RCT	Consult	5.4%	2.9%
Williams, Williams, Zimmer, Hall, & Podgorski, 1987	117	Community service	RCT	Consult	8%	9%
Gayton, Wood-Dauphinee, de Lorimer, Tousignant, & Hanley, 1987	404	Hospital service	cohort	Consult	25.2%	34.1%
Thomas, Brahan, & Haywood, 1993	120	Hospital service	cohort	Consult	10%	20%
Hogan, Fox, Bradley, & Mann, 1987	160	Hospital	RCT	Consult service	40%	45%
Hogan & Fox, 1990	132	Hospital	RCT	Consult service	25%	36%
Winograd, Gerety, & Lai, 1993	197	Hospital	RCT	Consult service	41%	36%

Continued page 52

Table 2: Review of RCTs dealing with geriatric services (continued)

Study	N	Study identifiers			Geriatric Mortality	Non-Geriatric Mortality
Salz, McVey, Becker, Feussner, & Cohen, 1988	181	Hospital service	RCT	Inpatient	20%	26%
Rubenstein et al, 1984	123	Hospital service	RCT	Inpatient	23.8%	48.3%
Reid & Kennie, 1989	108	Hospital service	RCT	Inpatient	19%	33%
Harris et al, 1991	267	Hospital service	RCT	Inpatient	26%	38%
Applegate et al, 1990	155	Hospital service	RCT	Inpatient	18%	25%

Study Setting

Manitoba Health Databases

Manitoba Health "administers the Manitoba Health Services Insurance Plan according to provisions of the Health Services Insurance Act and other relevant legislation. The plan finances an integrated system of hospital care, medical treatment, personal care, a prescription drug program and other health services for Manitoba residents." (Government of Manitoba, 1990, p.6)

One of the purposes of the plan is management of expenses. The administrative data of Manitoba Health include a registry file consisting of all persons in the province eligible for health care coverage, a physician claims file, a hospital file which includes admission and discharge dates and medical services used, among other elements, and a Personal Care Home file with data on persons admitted to or discharged from nursing homes. When combined, these elements constitute the core variables of the Manitoba Health Care Research databases (Nicol, 1993). Linkages with Vital Statistics allow mortality studies to be undertaken.

Analysis of data from these large secondary data sources has been well documented. The methodology (Roos, Jr., Mustard et al., 1993; Roos, Jr. & Brazauskas, 1990; Roos, Jr., Wajda et al., 1987; Roos, Jr., Roos et al., 1982; Wajda, Roos, Jr. et al., 1991) and software (Roos, Jr. & Wajda, 1991b; Roos, Jr. & Brazauskas, 1990; Roos, Jr., Sharp et al., 1989b; Roos, 1989a) for

analyses are established. The validity of this methodology of secondary data analysis has been validated for surgical outcomes analysis (Roos, Jr., Roos et al., 1982) and is now being tested for acute myocardial infarction (Roos, Jr., Mustard et al., 1993; Roos, Jr. & Brazauskas, 1990). As yet, however, the accuracy and reliability of the non-surgical diagnoses remain to be determined (Jollis, Ancukiewicz et al., 1993; Jollis, 1994; Malenka, McLerran et al., 1994). Additional methods have been used to provide for risk adjustment (Bergner, Bobbitt et al., 1981; Bergner, Bobbitt et al., 1976; Charlson, Pompei et al., 1987; Deyo, Cherkin et al., 1992; Mossey & Roos, Jr. 1987) and to allow for some prediction of outcomes (Roos, Roos, Jr. et al., 1988).

Winnipeg and Manitoba

Winnipeg is the capital of Manitoba. It is a city of approximately 600,000 people, in a province of 1,100,000 (Government of Manitoba, 1990). The nearest large centres of population, Regina in Saskatchewan, and Minneapolis in Minnesota, are about 600 and 800 road kilometers distant respectively. This has resulted in a regionally based health care service that derives its tertiary care from Winnipeg. Such tertiary care is provided at the province's two teaching hospitals, Health Sciences Centre and St. Boniface General Hospital.

According to the 1989/90 annual report of Manitoba Health 12.8% of the population of Manitoba and of Winnipeg, were aged 65 year or more (Government of Manitoba, 1990).

Winnipeg Hospitals

Table 3: Description of hospitals

Short Title	Full Title	Type of Hospital	1989 rated Bed Capacity	Geriatric Program
HSC	Health Sciences Centre	Teaching	1,113	36 beds
SBGH	St. Boniface General Hospital	Teaching	801	184 beds
SOGH	Seven Oaks General Hospital	Community	326	120 beds
MGH	Misericordia General Hospital	Community	409	No
Grace	Grace General Hospital	Community	301	No
VGH	Victoria General Hospital	Community	246	No
Concordia	Concordia Hospital	Community	136	No

In Winnipeg, 7 acute care hospitals (See Table 3) and 2 extended care centres, Winnipeg Municipal Hospital and Deer Lodge Centre, serve the adult population. HSC and SBGH are provincially designated University teaching hospitals. They have formal affiliations with the University of

teaching hospitals. They have formal affiliations with the University of Manitoba Faculty of Medicine and provide on-site training for undergraduate and postgraduate medical trainees. Deer Lodge Centre and Winnipeg Municipal Hospital are extended care centres and are not included in this report. They provide 24 hour on-site skilled nursing and medical care for individuals requiring an extended or indefinite stay, either for rehabilitation or because of illness severity

HSC, SBGH and SOGH have provincially recognized geriatric units to which Geriatric service codes 72 or 73 are attributed. During the study interval, HSC's Geriatric inpatient unit accepted admissions on consultation only and did not serve the Emergency Department. Medical services were provided by one Geriatrician, and by a physician providing full time primary care. SBGH's four Geriatric inpatient units accepted admissions from all sources, including the Emergency Department, consultation from within SBGH, other Manitoba hospitals, and people living in their own homes. Medical services were provided by University of Manitoba residents training in Family Medicine, Internal Medicine, or Geriatric Medicine, by one full time primary care physician, three family physicians, one general Internist, and four Geriatricians with tightly integrated Geropsychiatry liaison on-site. SOGH's Geriatric unit was subdivided into six 20 bed units, one of which was the only provincially recognized Geropsychiatry inpatient unit during the index study interval. Admissions were accepted from all sources. Medical services were provided by family physicians, and University of Manitoba

residents training in Family Medicine, with overall program supervision by a Geriatrician. In all three sites, admissions were accepted only after screening by the respective Geriatric service's medical personnel.

Geriatric units serve a frail elderly population in need of specialized diagnostic, rehabilitation and clinical management skills. According to Winograd (Winograd, Gerety et al., 1988), between 9 and 25% of people aged 65 or more admitted to an acute care hospital may benefit from geriatric consultation and/or care based on administrative data used to target a population deemed "at risk".

Admission & Discharge policies

HSC and SBGH provide a mixture of primary, secondary, and tertiary care to Winnipeg, and the province of Manitoba, as well as to parts of Saskatchewan, Ontario, and the Northwest Territories. Standard medical indications for admission and discharge decisions are based on recognized indicators. During the study interval, there were also 29 of 337 beds at Winnipeg Municipal Hospital and 44 of 120 beds at Deer Lodge Centre functioning as inpatient, specialty Geriatric units. Geriatric service codes were not attributed to people served by these units as they were not provincially recognized. These facilities did not provide emergency department services, and were not rated as acute care hospitals.

Geriatric inpatient units provide a multidisciplinary, team-based service to a defined elderly population. Admission is restricted to the frail

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Geriatric inpatient units provide a multidisciplinary, team-based service to a defined elderly population. Admission is restricted to the frail elderly, aged 65 or more, with a multitude of medical, functional, cognitive, and/or social issues of concern who, based on a clinical assessment by a specialist in Geriatric Medicine, or designate, is judged to have a reasonable clinical prognosis for recovery and discharge to an independent environment. Discharge is brought about when the elder has achieved maximum function and may then return home, move to a new home, or move to some form of institutional care.

A description of the age distribution of patients aged 65 or more years seen in Winnipeg's acute care hospitals during the study interval can be found below in Table 4.

Table 4: Percent of service users by age cohorts

	65-69	70-74	75-79	80-84	85-89	90-94	95+	TOTAL
Non-Geriatric	24.5%	23.8%	22.3%	15.7%	9.1%	3.5%	1.1%	21,835
Geriatric	9.2%	16.2%	21.8%	24.4%	18.2%	8.0%	2.2%	1,733

Chapter 3: Methods

The study used a cohort model to explore mortality among all Manitobans aged 65 or more, who used health care services in fiscal 1988 and 1989 (April 1, 1988 through March 31, 1990).

Hypothesis

The receipt of inpatient services in a Geriatric unit setting at Winnipeg hospitals is associated with no change in mortality in the ensuing 24 months.

Study Objectives

1. To determine whether the mortality rate of a study cohort of the elderly, hospitalized in Winnipeg hospitals, differs between ever and never users of Geriatric inpatient services
2. To determine whether Personal Care Home utilization of a study cohort of the elderly, hospitalized in Winnipeg hospitals, differs between ever and never users of Geriatric inpatient services

Data Source, Handling & Security

At the Manitoba Centre for Health Policy and Evaluation (MCHPE), data tapes exist for the Manitoba Health patient registry, hospitals abstract database, and the Vital Statistics registry. Linkages have already been developed between these databases allowing secondary analysis to be undertaken.

All hospital claims for the study population in the interval April 1, 1987 through and including March 31, 1992 were selected for further analysis. Date of index contact was determined as defined on page 63. Claims for those individuals were abstracted for a period 1 year prior to that admission and 2 years after the discharge from that admission.

The data analysis was undertaken on the MCHPE's networked minicomputer system running SunOS release 4.1.3 (SunOS, 1993), a UNIX operating system, and using Statistics for Applied Sciences (SAS) version 6.04 or higher to perform data handling and data analytic techniques (SAS, 1994). Some debugging of software programs on a scrambled, test database was undertaken using the microcomputer version of this software, SAS/PC (SAS/PC. 1993).

Sample size

As this is a whole population sample, a calculation of sample size is not necessary (Hassard, 1991b). Statistics Canada quotes a mortality rate for Manitoba, standardized by age and sex, of 46.5/1000 population aged 65 or greater (Government of Manitoba, 1990; Government of Manitoba, 1989a; Government of Manitoba, 1989b; Government of Manitoba, 1989c). Using a two-tailed α or Type I error level of 5%, a one-tailed β or Type II error level of 10%, and a clinically significant difference of 25%, a sample size of 80 per group would be required, were case control methodology used (Donner, 1984;

Fleiss, 1981; Hassard, 1991a). However, in a cohort study using regression methodology alternative sample size calculations must be undertaken.

Lemeshow, Hosmer and Klar (1988) derived sample size requirements, based on studies estimating Odds Ratios or Relative Risks. Their primary formula is listed below:

$$m = \frac{z^2_{1-\alpha/2}\left\{\frac{(1-P_1)}{P_1} + \frac{(1-P_2)}{P_2}\right\}}{\left[\ln(1-\varepsilon)\right]^2}$$

Lemeshow et al normalized their data using a natural logarithm transform. They defined "m" as the sample size, assuming the two groups were equal in size, P_1 and P_2 as the population proportions exposed and non-exposed, and ε as the size of the percentage range from the true value one would accept for the study. In addition, they set P_1 as equal to (Relative Risk) times P_2.

Using this formula, where P_2 is 0.0465, ε is 0.25, RR is 0.58 (from the AGS meta-analysis), and $z^2_{1-\alpha/2}$ is $(1.96)^2$ yields an estimated sample size of 2626 per group, a readily achievable number. Alternative values of m are presented for other values of ε below.

ε	0.15	0.2	0.25	0.3	0.35	0.4	0.5
m=	8,230	4,366	2,626	1,709	1,171	833	452

Data set Creation

Patient inclusion and exclusion

Following approval of the University of Manitoba Committee on Ethics, and Manitoba Health's Access and Confidentiality Committee, access was obtained to the Manitoba Health tapes available at the Manitoba Centre for Health Policy and Evaluation. Using SAS for data modification and analysis, the patient registry was accessed. All Manitobans reaching age 65 by March 31, 1990 who were covered by the provincial health insurance plan for 12 months before their index hospitalization were eligible for entry into the study. Manitobans who used no hospital services during the study interval were excluded from this analysis. Continuous coverage was not required as older Manitobans often go south for several months during the winter and maintain their coverage. Use of hospital day services, such as day surgery or dialysis, was excluded. If the individual was not covered by Manitoba Health for 1 year before the study interval s/he was excluded. Finally episodes of hospital inpatient service use were excluded from analysis if an individual resided outside of Winnipeg or was hospitalized outside of Winnipeg, as the provincially recognized Geriatric units were available only in Winnipeg during this interval. All contacts with the hospitals as recorded in that database from Manitoba Health were obtained for these individuals. The results of these exclusions are outlined in Table 5.

The 23,568 people included in the study had 41,855 hospitalizations from April 1, 1988 through March 31, 1990, and an additional 26,352 hospitalizations before and after the interval during which people could have had an index contact.

Table 5: Number of people excluded from study

	Number of people
Eligible	65,776
Exclusions	
Coverage	3,317
Age at admission	404
Residence outside of Winnipeg	37,963
Used Extended Care Centres	524
Sample size	23,568
with	68,207 hospital contacts

Selection and Identification of the Index Cases

New indicators were created for the geriatric service code, teaching hospital status, previous stay in Personal Care Home, and stay in an extended care centre. Personal Care Homes in Manitoba provided all levels of nursing home care.

Marital Status

For the purposes of this study, marital status was defined as married versus not married, an adverse health indicator. From the existing data set,

the recently widowed were difficult to distinguish from divorced or never married people. The realities of the data set dictated this either/or approach.

Income

Previous work by Mustard (Anderson, Grumbach et al., 1993; Mustard, 1991) validated a method of effectively assigning income status to individuals within the hospitals' data set, without using costly direct surveys. Using postal codes, Statistics Canada census tracts, and income averaging, a mean income and an income decile based on the postal code of residence could be assigned to an individual. Potential difficulties included the assignment of a single postal code to large long term care facilities, such as Personal Care Homes and extended care centres. These areas created significant difficulties, as the data set contained postal code of original residence as the home address, for a period of 2 years following admission to Personal Care Home. C. Mustard and S. Derksen have created a formatting statement in SAS allowing the income deciles to be assigned to individuals (Mustard, 1991). This SAS formatting statement was used in assigning income decile to the population under study.

Length of Stay

Length of stay was defined as the number of days between admission and discharge. Service codes are assigned for individual admissions and discharges. In addition, admission date to the service was also assigned. Therefore, service lengths of stay were obtainable by subtracting service date

of admission from date of service discharge. The inclusion of these dates was not undertaken due to the quantity of missing data in the data set.

Vital Status

Date of death was available on all hospitalizations through existing links with Vital Statistics and the registry files of Manitoba Health. For the purposes of calculating standardized mortality ratios for this study, patients were considered to have died if their date of death occurred between 1 April 1987 and 31 March 1992. Deaths during the index contact admission were specifically included. Death prior to April 1, 1988 would have automatically excluded the individual from further analysis. Subanalyses were also undertaken for deaths occurring within the study years.

Personal Care Home

An additional file existed of all Personal Care Home admissions in the province of Manitoba. From this file, the personal health identifying number, admission and discharge dates from Personal Care Home were obtained. These data items were then merged into the file created from the hospitals' database. Individuals admitted to a Personal Care Home prior to the index contact were considered to have lived in Personal Care Home previously. Individuals with admission to a Personal Care Home after the date of separation of the index contact were considered to have moved into a Personal Care Home subsequently. Analyses differentiating mortality outcomes by length of time to admission to Personal Care Home were not

undertaken for this thesis as it was impossible to separate out time spent in hospital awaiting Personal Care Home placement, a significant confounding factor in such an analysis.

Identifying numbers for all hospitals in the province existed. Only those files containing hospitalizations in centres serving adults in the city of Winnipeg were retained. Included were community and teaching hospitals. For reasons previously cited data from extended care centres were not included in this analysis. Also excluded were the two children's hospitals. In order to account for the systematic differences between and among the remaining institutions, groupings were made of the teaching hospitals, and the remainder. One community hospital has a recognized Geriatric inpatient service; this was a known confounding variable during the analysis.

In summary, all Winnipeg residents, hospitalized in a Winnipeg hospital, aged 65 by their index admission, were studied. Additional variables used in the analysis included marital status, income decile, lengths of stay, death, personal care home residence, and hospital type.

Charlson Index - Comorbidity

The Charlson Index was calculated for the combination of the index contact hospital stay and any admissions for the 1 year prior to the index contact using established software techniques. (Romano, Roos, Jr., & Jollis, 1993)

Index Contact

Using the service codes validated as described below, the first inpatient stay on a Geriatric unit was defined as the index contact. Where this did not exist, the first inpatient stay during the study interval was defined as the index contact.

Group separation

Validation of Service Codes 72 and 73

It was necessary to determine whether the individual had been an inpatient on one of the Geriatric inpatient units, in order to separate the records into two groups. In the Manitoba Health data set there are several service indicators. Provincial guidelines suggest the use of code 72 or 73 to indicate Geriatric or Extended Care service use, respectively.

In order to ascertain the validity of the use of this code, a record review was undertaken at Health Sciences Centre and St. Boniface General Hospital. Letters were written to the Medical Records Department of the Health Sciences Centre, and the Medical Information Department of the St. Boniface General Hospital requesting copies of their policy directives (Fondse, 1993; Medical Information Department, 1989). Using the Manitoba Health hospitals' data set for fiscal 1989 (April 1, 1989 through March 31, 1990), service codes were categorized into Code 72 (Geriatric Medicine), Code 73 (Extended Care), and all other. Only admissions of patients aged 65 or more at admission to Health Sciences Centre or to St. Boniface General

Hospital were used. Using a random number generator within SAS, randomizing on the date 020393, a random sample of 20 charts from Health Sciences Centre and 25 charts from St. Boniface General Hospital were obtained. The investigator coded the charts using the criteria listed in the policy directives above and compared the coding results obtained with those codes entered into the Manitoba Health data set by the individual hospital's health records abstractors. Application of codes 72 and 73 are as listed below:

a) Health Sciences Centre used Code 72 to mean Geriatric Medicine, throughout the study period.

b) St. Boniface General Hospital began using Code 72 to mean Geriatric Medicine on April 1, 1989. Before that, Code 73 was used, and included Palliative Care. Code 73 was used only for Palliative Care after April 1, 1989.

For the purposes of this study, Geriatric Medicine service use was then defined as any use of a Geriatric Medicine inpatient unit, consisting of the inpatient Geriatric unit (ward GD5) at the Health Sciences Centre, or wards E2, E4, E5, or E6 at St. Boniface General Hospital during the study interval.

Table 6: Validation of Geriatric Service Codes

	Observer			
SBGH	*Code 72*	*Code 73*	*Neither*	*Missing*
Code 72	9			2
Code 73		4		
Neither	1		9	
	10	4	9	2

Table 6 presents the results for St. Boniface General Hospital (SBGH). There was 100% agreement with usage of Code 72 at Health Sciences Centre. Initially, only 76% agreement is noted at St. Boniface General Hospital (the diagonal on the top chart). Excluding the missing charts, and assuming that all uses of code 72 or 73 are Geriatric Medicine, with later exclusion by physician billing number on Palliative Care at SBGH for the interval April 1, 1988 through March 31, 1989, then the actual rate of agreement becomes 96% at St. Boniface General Hospital. Kappa was calculated as greater than 0.99 for HSC and 0.64 for SBGH, suggesting reasonable congruity of results (Sackett, Haynes et al., 1991).

Therefore, at the two teaching hospitals, during the study interval, Code 72 and/or 73 can be used reliably to define Geriatric Medicine usage by excluding patients with these codes who were served by those physicians billing for patient services in the Palliative Care unit at SBGH. It would be inappropriate to exclude palliative care patients from the analysis entirely because of the widespread location of these patients in all Winnipeg

because of the widespread location of these patients in all Winnipeg hospitals, not only St. Boniface General Hospital. All Palliative Care patients were therefore included in the comparison group.

Without data to the contrary, it was assumed that any other usage of Code 72 within the data set, i.e. at Seven Oaks General Hospital, would have similar validity. Ethics approval was not given to contact any other facility for the purposes of similar studies there. This prevented testing this latter assumption.

Index contact status

Selection of standard cases and controls was not possible due to the use of secondary data sources. Therefore the groups were distinguished by their index contact status. All separations in the study interval were included in the analysis for patients living in Winnipeg and attending a Winnipeg hospital. The index contact was defined as the first contact with a Geriatric inpatient stay at St. Boniface General Hospital, Health Sciences Centre or Seven Oaks General Hospital Winnipeg, during the study interval from April 1, 1988 through March 31, 1990. If no such contact occurred, the index contact was defined as the first contact with any other inpatient stay during the study interval.

One primary comparison grouping was used, that of non-Geriatric and Geriatric service use. Data for use of all community hospitals and teaching hospitals were combined to provide an overall picture of system use.

Bias

This study used a whole population approach to describe the effectiveness of the intervention, exposure to a stay in a Geriatric inpatient unit on mortality. Bias (Last, 1988) was inherent in the selection of patients for admission to such units in that those most likely to respond to rehabilitation efforts were selected. The patients selected were frail and suffered from a multitude of chronic illnesses necessitating a multidisciplinary approach to their care. In effectiveness studies, bias is intrinsic as services are targeted at populations for whom a potential benefit is posited. In the present analysis patients who, in the clinical estimation of the physician, had a strong likelihood of dying within one month were not transferred into the geriatric unit.

Detection bias was dealt with by validating the hospitals' stated use of service codes 72 and 73. No observational bias was apparent, as both groups were handled similarly by the Manitoba Health data entry system. Because of the methodology used, recall, reporting and response biases were avoided.

Confounding is a potentially serious study design limitation (Last, 1988). It is common for patients in both teaching hospitals to be transferred from other services to Geriatric Medicine services. In day-to-day practice these transfers use the strengths of different services, one towards acute care and the other towards rehabilitation. For this study the data for patients who were identified as users of Geriatric services were analyzed as if the entire

stay were on the Geriatric service. Attempts to account for crossover through the use of service indicators, numbers of stay, and lengths of stay were unsuccessful, because of significant limitations in routinely coding changes in service dates. The two groups, those who did and did not previously use geriatric inpatient services, were therefore treated as one.

Analytic techniques

Description

A series of descriptive tables was prepared to allow the reader to determine the generalizability of the data. The number of subjects in categories of age cohort, marital status, income deciles, and use versus non-use of geriatric services was determined. Mean and standard deviations were calculated for age, marital status and length of stay. Median lengths of stay were also derived because of the skewed distribution of lengths of stay between users and non-users of geriatric services. Because the income deciles were measured categorically median income deciles were calculated.

Standardization

Direct standardization of mortality was used to compare all users of Geriatric inpatient services with the population of Winnipeg as a whole, aged 65 or more, using 5 year cohorts of age (i.e. 65-69, 70-74, to 90+).

Chi square testing

Chi square tests were performed to document known differences among the groups in age distribution, gender, marital status, living site (ever

PCH versus never PCH), and comorbidity as measured by the Charlson index. Because geriatric units serve the most frail and infirm, the Charlson index was expected to indicate a higher comorbidity among users of Geriatric inpatient services.

Survival analysis

Survival analysis originated with Mantel and Haenszel (Mantel, 1963; Mantel & Haenszel, 1959). It was designed as a means of accounting for differences in mortality between groups by using a combination of parametric and non-parametric methodologies. Survival analysis derives a survival function from data with both continuous and dichotomous covariates. No prior assumptions are made about the data or the error of the model. In 1958 Kaplan and Meier (Kaplan & Meier, 1958) described the methodology used for this analysis, as an extension of a preliminary version of the Maentel and Haenszel test, through the use of life tables to determine significance (Mantel & Haenszel, 1959).

Cox Proportional Hazards Regression

In 1972, Cox added to the prior work of Kaplan and Meier (Kaplan & Meier, 1958), with a paper "largely concerned with the extension of the results of Kaplan and Meier to the comparison of life tables and more generally to the incorporation of regression-like arguments into life-table analysis." (Cox, 1972, p. 187) Essentially, Cox added to the techniques of life-table or survival analysis the ability to include "censored" data items, ones

whose exact endpoints were unknown as, for example, through dropout, or the end of a study. Conditional likelihoods are obtained leading to inferences about regression coefficients. This analytic technique enables us to control for additional factors in the analysis while determining the relative size of the covariate effects.

Regression analysis makes nine essential assumptions, outlined by the following statements (Berry, 1993). All independent variables are quantitative or dichotomous. The dependent variable is quantitative, continuous, and unbounded in multiple regression. All variables are measured without error. All independent variables have nonzero variance. There is not perfect multicollinearity, i.e. there is no exact linear relationship between two or more of the independent variables. For each set of values for the independent variables the mean value of the error term is zero. Each independent variable is uncorrelated with the error term. The assumption of homoscedasticity states that the conditional variance of the error term is constant. The assumption of no autocorrelation emphasizes that error terms for different observations are uncorrelated. For each set of values for the independent variables the error term is normally distributed. In addition, the key assumption of Cox Proportional Hazards regression is that the potential risk or hazard of the outcome of interest is proportional across all groups.

The present study attempted to use Cox Proportional Hazards regression techniques to compare the primary outcome of differential mortality hazard among the groups at 6, 12, 18 and 24 months after the

index contact in 1988. Mortality hazard was compared across the groups, with the following elements added into the regression model: age, gender, marital status, prior or subsequent residence in a Personal Care Home, and the Charlson Index. A second set of Cox Proportional Hazards regressions used admission to Personal Care Home after discharge from the index contact as the dependent variable. Mortality hazard was again compared across the groups, with the following elements added into the regression model: age, gender, marital status, death within 2 years after the discharge from the index contact, and the Charlson Index. Regression assumptions were then verified. Where such assumptions were found wanting, life table analyses were undertaken.

Chapter 4: Results

Basic descriptors

To determine the generalizability of the study's results, basic demographics of the population studied and of their hospitalization episodes are presented. Inspection of these results provides information on potential inherent biases, aberrant hospital use, and factors possibly contributing to death rate.

Table 7 below presents a summary of the basic demographics of the people using hospital services during the index study period. The actual number of people in each category is presented in the total column, with cohort breakdowns in percentages by row in the remainder of the table. Mean age, with standard deviation in brackets, and median income deciles are presented. There were 12,866 women and 10,702 men service users in the index study period. The majority of women were not married, while the majority of men were married. The women were, on average, older than the men who used hospital services during this interval. Income for women was centered about the lower income deciles, and for men in the middle to higher income deciles.

Table 7 : Distribution of Demographic Characteristics of Index Study Period Service Users

	Male*	Female	Total
Marital Status			
Non-Geriatric			
Married	58%		12,566
Not Married		70%	9,269
Geriatric			
Married		51%	751
Not Married		73%	982
Age cohorts			
65-69	52%		5,517
70-74	50%		5,466
75-79		54%	5,239
80-84		60%	3,853
85-89		65%	2,299
90+		70%	1,194
Average Age	75.0(7.07)	77.0(7.76)	
Income Deciles			
<$18,700		64%	4,538
$18,800-$22,300		57%	2,081
$22,400-$25,000		58%	2,578
$25,100-$27,500		54%	2,154
$27,600-$30,300		53%	2,394
$30,400-$33,300		51%	2,148
$33,400-$36,400	52%		1,887
$36,500-$41,200	50%		1,842
$41,300-$46,800	53%		1,523
>$46,800	52%		2,238
Median Income Decile	$27,600 - $30,300	$25,100 - $27,500	

* Percentages are calculated by row. Only the larger result is presented for ease of viewing.

Table 8 presents simple descriptors by gender and Geriatric service use. Male and female geriatric service users were older than non-geriatric service users. Male and female geriatric service users were poorer than non-geriatric service users. Geriatric service users stayed in hospital longer than non-geriatric service users when comparing median lengths of stay. This difference is more prominent for women than for men. The Charlson Index of comorbidity indicated a greater prevalence of comorbid illness among male and female geriatric service users than among same gender non-users. Limiting the results to the teaching hospitals yields results which are nearly the same.

These results are expected. The target population for Geriatric services include those with limited supports and resources. Socioeconomic status of these individuals is circumscribed by the absence of spouses and of finances. Geriatric service users have a heterogeneity of demands. The Geriatric services meet these needs through a multidisciplinary assessment and treatment plan. More disability is identified through this process than is found in other areas caring for the elderly. The Charlson Index of comorbidity reflects the increased identification of comorbid illness. Patients referred for admission to Geriatric services are often those whose length of stay is already extended or for whom it is anticipated that discharge is likely to be delayed. This combination of limited support and funds, with a greater burden of illness and delayed discharge accounts for the descriptor differences found in Table 8.

Table 8: Mean Age and Median Income Decile, Length of Stay and Charlson Index

	Male		Female	
	Geriatric	Non-Geriatric	Geriatric	Non-Geriatric
Age (Mean ± SD)	78.7 ± 7.35	74.7 ± 6.96	80.7 ± 7.41	76.6 ± 7.68
Median Income Decile *	4	5	3	4
Median Length of Stay (days)	37.5	7.0	41.0	8.0
Charlson Index **	3	2	2	1

* Income deciles are:

1 - Less that $18,000
2 - $18,700-$22,300
3 - $22,400-$25,100
4 - $25,100-$27,500
5 - $27,600-$30,300
6 - $30,400-$33,300
7 - $33,400-$36,400
8 - $36,500-$41,200
9 - $41,300-$46,800
10 - Greater than $46,800

** A higher Charlson Index indicates a greater degree of comorbidity

Initial comparison of Covariates

Table 9 highlights potential covariates and their individual associations with mortality using the Chi-square statistic for statistical comparison. The percent dead column in Table 9 refers to the percent of the index study population who died within 2 years of the index contact. As expected, the percent of the population dead rose with increasing age. Men died at slightly higher rates than did women. Unmarried people died at a slightly greater rate than did married people. Increasing household mean income was associated with decreasing mortality rate, as expected (Adler, Boyce et al., 1993). People previously in Personal Care Home showed some minimal differences in mortality. People who left hospital and were subsequently admitted to Personal Care Home had a higher mortality rate. Admission to PCH subsequent to hospitalization is another indicator of burden of illness, as provincial home care guidelines promote maintenance of individuals in their home whenever possible. Individuals with higher burdens of illness as determined by the Charlson index died at a higher rate than those without this burden of illness. Users of geriatric service died at a more rapid rate than did users of non-geriatric services when uncorrected for age, gender, or marital status.

Table 9: comparisons of potential covariates

	% Dead within 2 years	Chi-squared	p
Charlson score		4186.458	<0.0001
0-1	13.6%		
2-5	37.5%		
5-9	65.8%		
>9	62.0%		
Age		1478.398	<0.0001
65-69	22.9%		
70-74	29.6%		
75-79	36.6%		
80-84	44.3%		
85-89	54.2%		
90+	67.9%		
Gender		116.226	<0.0001
Male	40.0%		
Female	33.3%		
Marital status		79.284	<0.0001
Married	33.9%		
Not married	39.5%		

Continued page 82

Table 9: comparisons of potential covariates (continued)

	% Dead within 2 years	Chi-squared	p
Income decile		277.26	<0.0001
<$18.7k	44.9%		
$18.7-22.3K	41.8%		
$22.4-25.0K	36.3%		
$25.1-27.5K	36.4%		
$27.6-30.3K	35.4%		
$30.4-33.3K	33.4%		
$33.4-36.4K	32.8%		
$36.5-41.2K	30.6%		
$41.3-46.8K	29.3%		
>$46.8K	30.9%		
Previously in PCH		12.074	0.001
No	36.0%		
Yes	40.1%		
Subsequently to PCH		525.732	<0.0001
No	34.4%		
Yes	63.7%		
Geriatric service use		295.756	<0.0001
Non-geriatric	34.8%		
Geriatric	55.5%		

Direct Adjusted Rates

Table 10 presents age and sex standardized mortality rates per 1,000. Standardization was to the population aged 65 or more living in Winnipeg in 1989. Death was defined as dying within 2 years of the index contact. Crude and standardized mortality rates were lower for women than for men. Age and sex specific crude and standardized mortality rates per 1,000 population at risk during the index study interval are dramatically higher in users of Geriatric services than among users of non-Geriatric services.

Table 10: Direct Adjusted Mortality Rates and the use of Geriatric service

	Age/Sex Adjusted Mortality/1000	Direct Standardized to 1989 Winnipeg Population/1000 *
Non-Geriatric	279.1	22.7
Geriatric	463.9	37.7

* The total population aged 65 or more in 1989 was 81,347.

Regression and life table analyses

The review of basic descriptors and simple statistical comparitors suggests a relationship between mortality and various demographic factors. Regression techniques can be used to account for multiple factors potentially affecting an identified outcome or dependent variable. But are regression assumptions valid for this data set? Page 74 in this thesis provides a more complete discussion of regression assumptions.

The outcome variables of death and of admission to Personal Care Home are quantitative or dichotomous. The independent variable of income deciles can be treated as continuous and quantitative, because of its method of creation. From prior studies, variables appear to have been measured with little error and have non-zero variance. Perfect multicollinearity is not present as the computer program will not run in the situation where perfect multicollinearity exists. Autocorrelation is not found.

Life table analyses and proportional hazards regression software modules were used to ascertain whether the data set items met further regression and proportional hazards assumptions. Martindale residuals were run under PROC PHREG (SAS Institute staff, 1993). This demonstrated that the error term was not normally distributed. In addition, the assumption of homoscedasticity failed. Finally, the assumption of proportional hazard was not satisfied. For these reasons, life table analyses were undertaken and are reported here.

PROC LIFETEST offers the option of additional plots to characterize the distribution of items in the data set (SAS Institute staff, 1990). Two such plots are presented in Figures 1 and 2. Figure 1 plots the time (in days) on

the x axis against the survival distribution function on the y-axis. Figure 2 plots time to death against the negative log of the survival distribution function. The appearance of an approximately straight line in Figure 1 suggests that an exponential model used in the survival function best fits the data in explaining causes of mortality for users of geriatric and non-geriatric services.

Table 11, on page 88 presents the results of a life table analysis of survival. Survival was worse among users of Geriatric services than among non-users, when controlling for comorbidity using the Charlson index, age, gender, prior or subsequent residence in a Personal Care Home, and income decile. Inspection of the rank statistics suggest that this is due to a difference in early mortality rates. Both log rank and Wilcoxon statistics yield the same results. Only the log rank results are presented. These results indicate that users of Geriatric services had a higher mortality rate than users of non-Geriatric services.

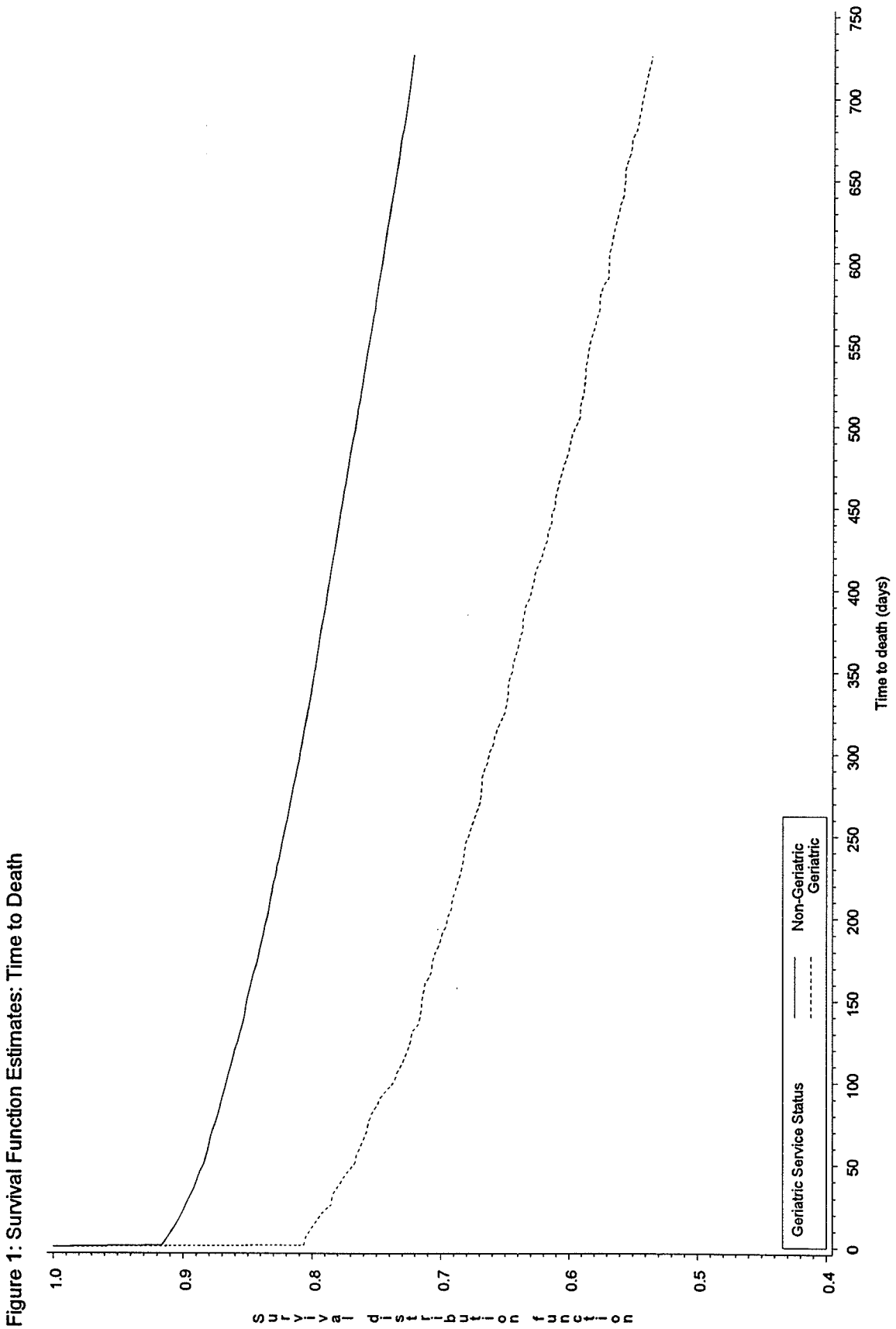

Figure 1: Survival Function Estimates: Time to Death

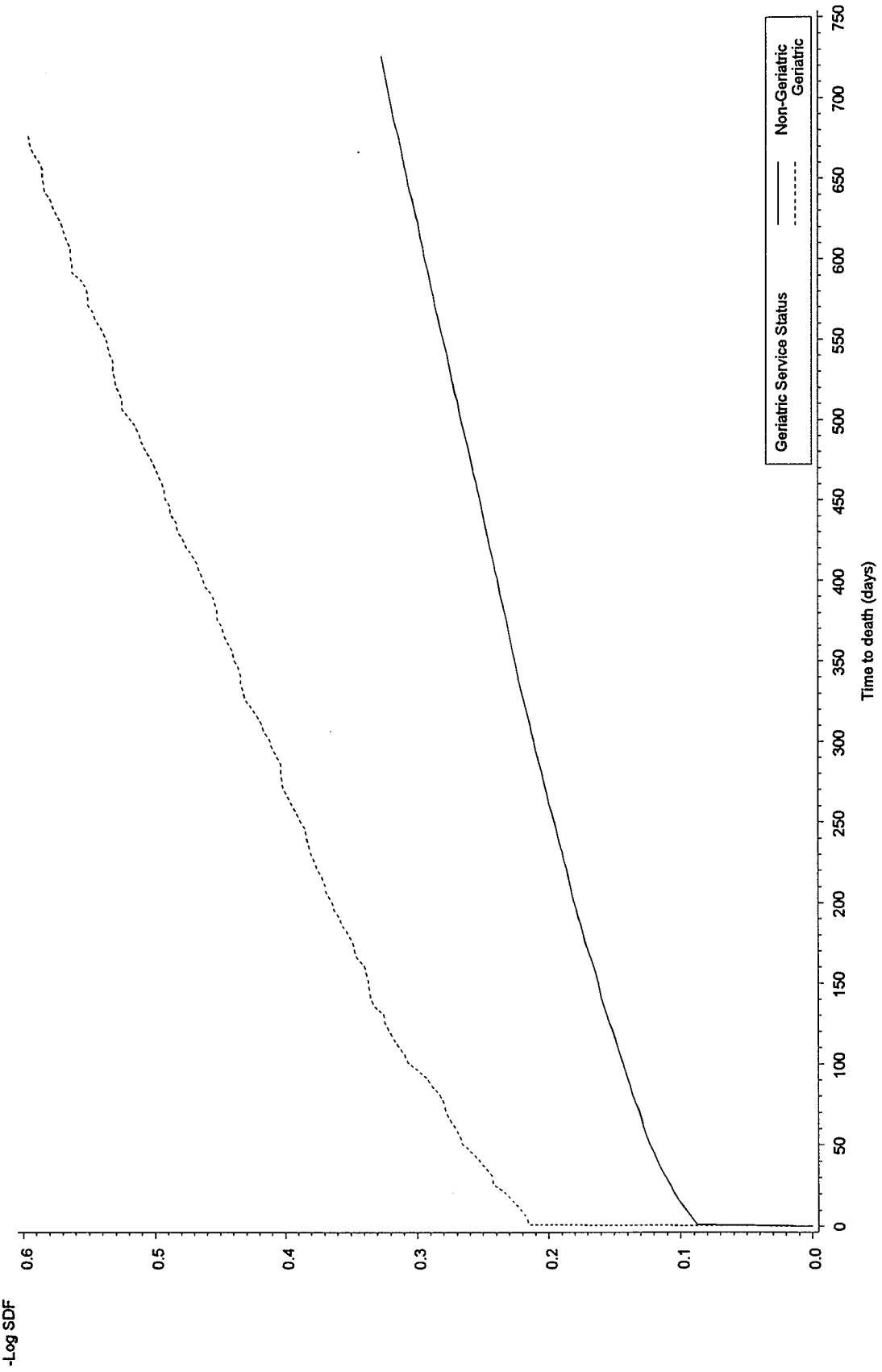

Figure 2: Log (Survival Function) Estimates: Time to Death

Table 11: Life table analysis of survival

A. Rank Statistics

	Log Rank	Wilcoxon
Geriatric	356.22	7549850
Non-Geriatric	-356.22	-7549850

B. Forward stepwise sequence of chi-squares for Log Rank

Variable	df	Chi-square increment	p>increment
Charlson index of comorbidity	1	3,888.0	0.0001
Age at admission (years)	2	943.8	0.0001
Subsequently in PCH (1=yes, 0=no)	3	203.3	0.0001
Previously in PCH (1=yes, 0=no)	4	139.3	0.0001
Gender (1=male, 2=female)	5	61.1	0.0001
Income decile (increases with increasing wealth)	6	17.8	0.0001
Marital Status (1=married, 0=not married)	7	0.2	0.6689

Similar plots for time to admission to Personal Care Home, not presented here, yielded a straight line fit to an exponential model. Table 12, found on page 90, presents the results of a life table analysis of time to admission to Personal Care Home. The chance of Personal Care Home admission was higher among Geriatric service users versus non-users, when controlling for comorbidity as measured by the Charlson Index, age, gender, income decile and marital status. The rank statistics suggest that this is due to a difference in rates of admission to Personal Care Home directly from hospital. The increased possibility of admission to Personal Care Home for Geriatric service users would appear to support the frailty and infirmity of these patients.

It should be noted that the chi-square increment for gender is large but not statistically significant. This is likely an artifact of calculation.

Table 12: Life table analysis of Personal Care Home admission

A. Rank Statistics

	Log Rank	Wilcoxon
Geriatric	266.58	5939402
Non-Geriatric	-266.58	-5939402

B. Forward stepwise sequence of chi-squares for Log Rank

Variable	df	Chi-square increment	p>increment
Age at admission (years)	1	887.8	0.0001
Income decile (increases with increasing wealth)	2	138.3	0.0001
Interaction of marital status and gender	3	16.9	0.0001
Charlson index of comorbidity	4	0.3	0.6053
Marital Status (1=married, 0=not married)	5	0.2	0.6376
Gender (1=male, 2=female)	6	3,261.1	0.0732

Chapter 5: Discussion

Analysis of a large secondary data set, the Manitoba Health data set, was used to describe the effect on mortality of using or not using Geriatric inpatient services in Winnipeg Manitoba. The results of this study raised questions about the generalizability of the AGS policy statement of prolongation of life after clinical usage of Geriatric inpatient services. The results are not applicable to other clinical settings and do not account for the roles of the effect of community or other institutional care in the outcomes evaluated.

How applicable are these results?

Study limitations

Methodology

The study method used suffers from certain limitations inherent to secondary analysis of large data sets as previously outlined. (See "Use of Large Data Sets" beginning on page 13) (Blumberg, 1991; McDonald & Hui, 1991; Byar, 1991; Roos, Jr., Mustard et al., 1993; Malenka, McLerran et al., 1994) A brief synopsis of potential methodologic deficiencies identified from this literature is presented below with summaries of how this study addressed them.

How complete was the data collection? It is unlikely that data collection was incomplete. Complete data collection is required by provincial

funding regulations. This would ensure that all hospitalizations were entered into the data set.

Was the study model appropriate? It is possible that the study may have used a biased or incomplete analytic model during the data handling. The model does not include clinical data about measurements of functional status and cognitive status, nor does it include direct measures of general health, burden of comorbid illness, or sociodemographic information. In addition, no measures of prior hospitalization and the effect on the present service users were used in this study. These flaws uniformly reduce the potential for the comorbidity data to explain the variability in the model for all services and are presently unavoidable. Some of these design flaws are currently being addressed by others using these data.

Other potential pitfalls of the data may have included chance variation, actual differences in care, and/or selection bias. This was a whole population study and was therefore subject to the same chance variation as the population studied. Chance variation was limited and minimized by the size of the data set. Differences in care were accounted for by combining data from a variety of hospitals. This combination of data would have been on a stronger footing were a homogeneity chi-square test calculated within groups of service users. This was attempted without success, at least in part due to the very large numbers in the study which rendered the homogeneity chi-square uninterpretable.

Elements of bias may have existed. Selection bias is inherent in service use decisions in the real world, as Geriatric services seek to appropriately care for the most frail and ill segment of the population (Rockwood, Fox et al., 1994). If this is the population served then mortality rates should be higher. This is a potential flaw in the study as well as a possible explanation of the results of decreased survival among users of Geriatric inpatient services.

Could bias have been introduced in the coding of diagnoses on the hospital separation abstracts? There was no reason to believe that differential coding of diseases would exist between users of Geriatric and non-Geriatric services. The same personnel did the coding for both service types at the individual hospital level. The study was not conceived of or executed before the coding had been completed making the possibility of purposeful miscoding unlikely.

Ascertainment bias was present. It is likely that claims data may have under-estimated comorbidity in medical, as opposed to surgical, conditions for patients under age 65 (Jollis, Ancukiewicz et al., 1993; Malenka, McLerran et al., 1994). Greater reporting among those aged 65 or more years may have been due to the financial incentive of ICD-9-CM diagnostic coding, as well as to the greater prevalence of illness (Jollis, Ancukiewicz et al., 1993). These recent articles have raised questions about the validity and reliability of medical diagnoses in secondary data sets. Geriatric services are known to add diagnoses beyond those found in other services (Cape, 1972).

This should have resulted in a higher Charlson comorbidity index for Geriatric service users, and did. This finding has face validity in that this group should include the most frail with the most problems. If Geriatric service users also had an a priori higher burden of illness than users of non-Geriatric services then the findings would have been identical. Thus, the question of under-estimation of comorbidity cannot be addressed by the present study and remains an additional design flaw. It is interesting to note the work of Malenka et al (1994) which would suggest that the analysis presented here is conservative in assessing comorbid illness and assigning weights to the analysis to account for comorbidity. This might have decreased the effect size of the comorbidity index and increased the size of the unexplained error terms in the statistical analysis.

Is it possible to address the question of causality of association between the use of a geriatric service and mortality? The AGS statement and Rubenstein's meta-analysis (Stuck, Siu et al., 1993; Rubenstein, Stuck et al., 1991) imply a direct causal relationship between Geriatric services and mortality. It is unfortunate that the present study could not satisfactorily address this question as it was not a Randomized Controlled Trial (RCT). In day-to-day practice, however, the study results are extremely relevant, as they call into question the patient selection in the RCTs to date and the generalizability of the results of the RCTs. Geriatric services used outside the RCT context do not appear to decrease mortality in the ensuing 2 years.

What would be the effect on the analysis if the assumption of validity of the Geriatric service code were itself invalid? Bias may have been introduced in the 2,772 non-Geriatric and 351 Geriatric service users included from the community hospital with a Geriatric unit. Repeat analyses excluding the community hospital's patients from all analyses didn't alter the results, suggesting that this was not the case. This case would have been more strongly made if a homogeneity Chi-square analysis had been undertaken which was capable of interpretation.

What is the best method of analyzing the data? If regression assumptions were satisfied multiple regression analysis would offer a more precise method for accounting for and defining the size of the effects of confounding variables. The direction of the effects would be known. In this study regression assumptions were not satisfied, mandating the use of survival analysis instead. Despite the lesser precision survival analysis still demonstrates the negative association of Geriatric services and mortality.

Was the study of sufficient power to answer the questions asked? Our study of 23,568 patients is much larger than the community-based study of 1,376 by Hendriksen (Hendriksen, Lund et al., 1984). Type I and II errors in our analysis are within accepted norms. They were accounted for using the techniques of Lemeshow (Lemeshow, Hosmer et al., 1988). Stuck's meta-analytic article (Stuck, Siu et al., 1993) did not present their results of power calculations nor did the original articles from which the meta-analysis was drawn, though 95% confidence intervals were provided for Type I error.

Because of the mixed results of Stuck's studies, the absence of power calculations, and the deficiency of full demographic data, the validity of Stuck's results is in question.

Was there an alternate method of statistical review which might have allowed some validation of the study analyses? The data set could have been divided randomly in half and the initial analyses performed on one half of the data set. The second half could then have been used to validate the results obtained from the first. Regrettably this was not done and precludes ready validation of these results on this data set. It might be possible to attempt to replicate these results on a subsequent two year sample from the Manitoba Health data base.

What was the quality of the analytic model which was used in explaining the data? Lemeshow and Le Gall (1994) suggest that the agreement between the estimated and true probabilities of the outcome of interest should be assessed by statistical tests of goodness of fit. Such tests are readily available for regression analyses. As regression analysis could not be undertaken in this instance due to the lack of validity of regression assumptions goodness of fit could not be calculated.

Confounding factors

A further question of methodology relates to the use of the Charlson Index. The Index has been widely used to control for comorbidity. Several difficulties potentially distort its use. To date the index has not been

extensively validated for use in the elderly, nor in the population studied. In addition, dementia is included as one of the comorbid illnesses but the prevalence is consistently underestimated in this secondary data set. (C. Mustard, personal communication)

Why is the prevalence of dementia underestimated in the data set? In order for the diagnosis of a dementia to be present in the data set it must first be recorded in the chart or on the discharge coding sheet. Studies have documented that Geriatric services are more consistent than non-Geriatric services in ascertaining that dementia is present and recording this fact (Silverman, Musa et al., 1995). It would appear that ascertainment bias and recording bias about dementia may be systematically present in secondary data sets of this type. This absence of dementia in the data set would lead to a systematic underestimation of the burden of illness, as measured by the Charlson Index, in the non-Geriatric service user. The size of this underestimation is presently unknown. Notwithstanding these issues the Charlson index has been reliably used to account for comorbidity in several prior studies from this data set (Romano, Roos, Jr. et al., 1994; Romano, Roos, Jr. et al., 1993a; Martin, Silverthorn et al., 1991; Young, Roos et al., 1991; Roos, Jr., Sharp et al., 1989a).

Unknown factors other than comorbidity may have contributed to the study results. Of the factors hypothesized to be of clinical relevance the study attempted to account for personal characteristics in analyzing the data. Age and income differences existed between men and women and between users

of Geriatric and non-Geriatric services. Women used more inpatient services in general and Geriatric services in particular. Several possible explanations exist. Population demographics were affected by aging so that there were more old women than old men resulting in gender imbalance. Women have less secure supports, a lower median income, and/or an inability to buy supports compared to men (Gee & Kimball, 1987b). Older men tended to have and be supported by spouses, reducing their service use (Gee & Kimball, 1987a). These factors result in longer hospital stays and increased service use by women.

Outcomes

The primary measure of outcome for the study was death. Mortality rates were found to be greater among women and Geriatric service users. The former may have been related to personal characteristics such as income, age distribution, and/or burden of illness. As previously mentioned increased death rates among Geriatric service users were expected as a natural consequence of serving the most frail and infirm elderly. After accounting for comorbid illness and personal characteristics those using Geriatric services suffered a higher death rate than the comparison group. This result stands isolated in its difference from RCT outcomes. RCTs likely offered a different outcome as they artificially selected against those in danger of death within six months while ordinary geriatric admission practices dealt with the infirm but excluded those in danger of death within one month.

How applicable are the results of RCTs to clinical situations in general? Randomized controlled trials select for specific groups of patients with highly characterized diseases or problems. Average results are obtained for the population studied. Differential risk for the outcome of interest is not uniformly factored into the analysis of the data. Generalizability to lower and higher risk populations is limited. Rothwell (1995) suggests that this limits the clinician's ability to apply results from RCTs to the individual patient for whom care is being provided.

Was it reasonable to use mortality as a primary outcome measure? It would appear that the emphasis on mortality as a primary endpoint began with Rubenstein's landmark study (Rubenstein, Josephson et al., 1984). In that study, Rubenstein et al reported an unexpected finding of decreased mortality. Multiple studies followed with generally similar results leading to a concentration on mortality as a major outcome. It is widely held, however, that the goal of Geriatric services is to attempt to add life to years rather than years to life. The specialty should be dealing with the most frail, and those most in danger of permanent institutionalization (Winograd, Gerety et al., 1988). Thus, as stated previously, the expectation should be that mortality would be higher among users of Geriatric services. Mortality may not be the most appropriate primary outcome to use (Hedrick, Barrand et al., 1991).

If not mortality then what other outcomes might reasonably be considered? Potential alternate outcomes to consider might include increased

service use, admission to Personal Care Home, and improvement in functional status. Studies of service use suggested that the greatest increase in service use among the elderly occurs in their last two years of life (Montgomery, Kirshen et al., 1988). The Admission to Geriatrics through Emergency study (Montgomery & Powell, 1991; Powell & Montgomery, 1991) suggested that the rate of admission to Personal Care Home was higher among users of Geriatric inpatient units. Improved functional ability is readily demonstrable in users of Geriatric inpatient units (Kirshen & Ringer, 1992). The present study replicated the outcome of higher Personal Care Home admission rates.

When all is said and done

When all is said and done a meta-analysis of randomized controlled trials clearly demonstrated the efficacy of various Geriatric services in reducing mortality among service users where the individual studies do not uniformly yield statistically significant differences. The present large study of effectiveness does not replicate that finding.

Chapter 6: Future directions of the research

The completion of a large study on Geriatric inpatient units and their lack of effectiveness in reducing or delaying mortality raises further questions.

If the analysis of secondary data were to be used again for the same purpose as that of this study then certain study design modifications would need to be considered. Clinical markers could be added to the data through direct measurement, such as functional status, cognitive status, burden of illness, and individual sociodemographic information. Additional explanatory variables could be included, e.g. length of time in a specific service, the effect of institutional status as a teaching versus non-teaching hospital, the quantity of services used on discharge, and/or some of the outcome measures mentioned on page 100. The homogeneity of the population studied could be more comprehensively evaluated and verified. The resulting data could then be separated a priori into equal portions to allow comparison and validation of the analytic model used. These changes would improve the quality of the data, reduce unexplained variation, and enhance the ability of the model to answer the questions posed.

Having modified the data accumulation one would ask if the results of the present study can then be replicated? The negative result presented in this study differs from the American Geriatrics Society's position which itself is based on RCTs. Replication of the study and results would serve to

demonstrate the consistency of the results. It would also suggest further directions in outcomes research relating to the use of Geriatric services. For instance, future RCT studies might substantially increase the sample size used, and consider including specific measures of comorbid illness and sociodemographic status in determining the efficacy and effectiveness of Geriatric units. Such studies might also consider using functional improvement and living arrangements one year after Geriatric service use, or health care service utilization as primary outcome measures.

With suitable study modifications to address issues of replication and study redesign the question arises about stability of the results. Outcomes of care are not static over time. The outcomes depend not only on the patient specific factors described above but also on alterations in the site and framework within which care is provided. Governments are discussing modifying health care systems to increase fiscal viability while maintaining core services. Sites for teaching health care personnel are changing with increased emphasis on rural opportunities for training - this would offer the opportunity of evaluating the model in a rural setting. The changes being proposed in health care provision and utilization and consequent reform of the health care system may modify the health care outcomes achieved. Provision of services may necessitate differing patterns of practice through the use of health care personnel with other skills and levels of expertise, through alterations in staffing levels, or through hospital downsizing. Methods could be developed and validated for quantifying the effects of

change on outcomes, and the study repeated with the modifications suggested here, in order to evaluate the stability of the results over time.

Issues of modification of study design and analysis, replication of study results, and stability of results over time have been raised for future study development. Reference has been made to times of change within the health care system. This methodology provides one means of evaluating the effects of such wide-spread systemic redirection in health care policy at a patient specific level. It also offers the clinician and the health outcomes researcher the opportunity to enhance effective patient care using what will surely be increasingly scarce resources.

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