Measuring Morbidity in Populations: Performance of the Johns Hopkins Adjusted Clinical Group (ACG) Case-Mix Adjustment System in Manitoba

June 1999

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ACKNOWLEDGEMENTS

The authors wish to acknowledge the contributions of many individuals whose efforts and expertise made it possible to produce this report. We appreciate the assistance of Dr. Barbara Starfield, Dr. Jonathan Weiner, and Dr. Chris Forrest of the Johns Hopkins School of Hygiene and Public Health in applying the software in Manitoba, helping to interpret the results, and providing insightful feedback on draft versions of the document. In addition, Dr. Morris Barer, Dr. Robert Evans, Dr. Clyde Hertzman of the Centre for Health Services and Policy Research and Dr. Charles Normand of the London School of Hygiene and Tropical Medicine provided many insights into understanding the system's performance in the Canadian setting. In addition, the authors would like to thank Dr. Lorne Verhulst, Dr. Alan Thompson and Mike Atkinson from the British Columbia Ministry of Health for assisting with the preparation of the British Columbia comparative data and making it available for our use. We also appreciate the many individuals who provided feedback on draft versions including Dr. Verena Menec, Dr. Patricia Martens, Dr. Norm Frohlich, Dr. K.C. Carriere, and Carolyn DeCoster. The authors also wish to thank Eileen Pyke for her assistance in preparing the final report.

The results and conclusions are those of the authors and no official endorsement by Manitoba Health was intended or implied.

This report is being simultaneously released by the Centre for Health Services and Policy Research at the University of British Columbia.

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EXECUTIVE SUMMARY

This study examined the performance of the Johns Hopkins Adjusted Clinical Group (ACG) system in measuring the morbidity of individuals and populations in the province of Manitoba. The ACG system, which was developed by researchers at the Johns Hopkins University, estimates the illness burden of individual patients and, when aggregated across individuals, of populations. ACGs represent a new class of case-mix tools which measure individuals' overall morbidity across their range of illness episodes experienced over the course of a year. This longitudinal perspective on morbidity has found a diverse array of research and management applications in the United States, including adjusting provider payment rates and profiling practices. Although the system has been extensively validated in the United States and more recently Europe, experience with the system in Canada has been limited. Given the potentially broad applicability of this tool in Canada for both research and administrative purposes, this study aimed to assess ACG performance using existing administrative data from the province of Manitoba. The specific aims of the study were to: (1) assess the performance of the ACG system in explaining variation in the health care provided to individual Manitobans; and (2) evaluate the extent to which the ACG system can provide a valid measure of population health 'need' through comparison with other generally accepted measures of population health. The study was based on demographic, diagnostic, and expenditure data from Manitoba Health's patient registration, physician claims, and hospital separation files for fiscal year 1995/96.

An Overview of the ACG System

For each individual, the ACG system assigns up to 32 different Ambulatory Diagnosis Groups (ADGs) by clustering diagnoses coded on hospital separation abstracts and physician claims over a defined interval. Diagnosis codes are grouped into clinically meaningful categories based on their expected clinical outcomes and resource use. In addition to describing morbidity patterns across the range of ADGs, individuals are also assigned a single Adjusted Clinical Group (ACG). ACGs represent common combinations of ADGs and patient demographic categories that influence the use of health services. As opposed to other grouping systems, ACGs do not rely on the most important or most common diagnoses experienced over time. Instead, ACGs describe the multiplicity of illnesses which, in combination, contribute to the overall level of health services that an individual would be expected to consume.

Acceptability of Diagnosis Codes in Manitoba

Since the ACG system uses data on routinely-collected administrative forms (namely diagnoses recorded on hospital and physician claims) to estimate morbidity, if the diagnoses contain many errors in code assignment, the ACG software won't accept them. After checking all the ICD-9 and ICD-9-CM codes from the physician claims database (3-digit codes) and hospital separation abstracts (3-, 4-, and 5-digit codes) for the total Manitoba population, fewer than 1% of all codes were found to be unacceptable. This low mismatch rate indicates that, in general, the administrative diagnoses represent valid ICD-9 codes with enough specificity to group them using this tool. Moreover, there was little difference between urban and rural diagnosis mismatch rates.

Validating the ACG Distribution in Manitoba

Approximately 82% of Manitobans were assigned at least one ADG during the one year study period and 18% had no contact with physicians or hospitals. These rates approximated those reported in prior research. About 65% of Manitobans had relatively small morbidity burdens (i.e., 1-3 ADGs) while about 1% had particularly high illness burdens (i.e., 10 or more ADGs). As one method to assess whether the software worked with Manitoba data, we examined the distribution of specific ADGs or ACGs where comparable prevalence data were available. For example, we estimated Manitoba's crude birth rate at 13.5 births / 1,000 population using the infant-specific ACGs. This rate was markedly similar to Statistics Canada reports of 13.8 births per 1,000 for Manitoba during 1995. For mental health disorders, we found a crude treatment prevalence of mental health disorders of 12.8 cases per 100 adults compared to the 10.6 cases per 100 (21% lower) treatment prevalence found in another study conducted several years earlier (Tataryn, Mustard, Derksen 1994). Thus, for infants and persons with mental health disorders, the distribution of ACGs is compatible with available research.

Evaluation of ACG-Specific Expenditures

The validity of the ACG system must also be assessed by examining what the system was intended to measure, that is, do those with higher measured morbidity incur higher costs of medical care? For these analyses, we examined how well the ACG system was able to explain the variation in expenditures for both 'physician' and 'total' (i.e., physician, inpatient hospital care, and ambulatory surgery) services. The expenditure estimates were calculated directly for physician services from their claims, while the hospital costs were imputed using the Refined Diagnosis Related Group (RDRG) and Day Procedure Group (DPG) estimates. Comparing the lowest to highest cost ACGs, we found about a 50-fold variation in physician costs and a 400-fold variation in total costs. In general, we found that the ACG relative costs had substantial face validity; the ACGs with the greatest morbidity burdens (i.e., ACGs with 10+ ADG combinations) were the most expensive, and those with the smallest morbidity burdens were the least costly. However, we found considerable variation in costs within each ACG, with a small number of high users in each category of ACGs. Some ACGs had more variability in their costs than others; 47 ACGs had coefficients of variation which were greater than 1.0 while 45 ACGs had coefficients of variation less than 1.0. We found that the costs of ACGs with acute major, chronic unstable medical, and psychosocial ADGs were the most variable. On the whole, the less resource-intensive ACGs showed more variability than the high intensity ones.

Comparison of the Costs of ACGs in Manitoba with Other Populations

To gauge the validity of the Manitoba ACG cost estimates, we compared the relative costs of Manitoba patients with similar cost estimates for three other populations: a random sample of the British Columbia population (n~170,000); non-disabled enrolees of Minnesota's Medicaid health insurance program (n~290,000); and enrolees of one large US Health Maintenance Organization (HMO) plan (n~71,000). For the majority of ACGs, there were few differences in the relative costs constructed for physician services between Manitoba and British Columbia. Notable exceptions included the psychosocial ACGs; these large differences can be partially explained by the methods that the provinces use to pay physicians for psychiatric services. We also found substantial similarity between the Manitoba and the US relative costs; the Manitoba costs were more closely aligned with the HMO costs than those of the Minnesota Medicaid program. Our findings of a similar cost structure across ACGs for a variety of Canadian and US populations suggested substantial validity of the ACG system as a method to measure morbidity.

Explanation of Variation in Physician and Hospital Expenditures

When only patient age and gender categories were used to explain differences in expenditures, they explained only 9% and 5% of the variation in the same-year physician and total costs; adding the ADG categories improved the overall explanatory ability to about 53% and 27% respectively. Moreover, when the ACG categories were entered as the only explanatory factors (that is, without age and gender categories), there were few differences in the explanatory power (50% for physician costs and 33% for total costs). These results were similar to comparable findings in the US in relation to the performance of the ACG system across a range of enrolled populations. However, as opposed to the general population, we found that the 'ACG only' models did not explain as much variation for child, adolescent, and senior sub-populations. We found no clear differences in the explanatory power of the ACG system across socioeconomic strata represented by Winnipeg's income quintiles.

Using ACGs to Measure Population Health Status

To validate the ACGs as a method to account for population health status, we constructed an ACG population health status measure for Manitoba's 60 Physician Service Areas (PSAs), which we termed the 'ACG Morbidity Index'. The areas' performance on this index was then compared to their performance on other population health status measures, including premature mortality. We constructed the ACG Morbidity Index by first determining each resident's ACG category (reflecting his/her morbidity level over the year). Then using the average provincial costs per ACG as a 'morbidity weight', we assigned these weights to every Manitoban to estimate their morbidity burden. We then calculated the average ACG cost for each area (simply the sum of residents' ACG morbidity weights divided by the number of residents), and divided the result by the overall provincial average. When comparisons were made between area scores on the ACG morbidity index and premature mortality rates, we found a strong association (r = 0.76). Premature mortality is generally considered to be the best single indicator of 'need' in populations (Carstairs, Morris 1991;

Eyles, Birch, Chambers et al. 1993; U.S. General Accounting Office 1996; Kindig 1997). This association remained statistically significant after adjusting for a variety of confounders. The high degree of tracking of the ACG morbidity index and premature mortality provided substantial evidence for the criterion validity of using the ACG system as a population 'needs' indicator for geographically defined populations and as a general case-mix measure for practice populations.

The ACG morbidity index offers significant advantages over premature mortality in the measurement of population health status as it can be specified over shorter time periods and for smaller populations. Moreover, the ACG index is more logically related to health service need than an index based on deaths. We found that the population's health status (as measured by premature mortality) was better reflected by the ACG morbidity index than by a similarly constructed demographic index. Furthermore, the ACG morbidity ratio was more closely related to premature mortality than was the ratio of actual expenditures to the provincial average. These latter findings suggested that the ACGs provide a significant opportunity to develop better methods to adjust for illness burden of clinical populations. The ACGs appeared to confer significant benefit over measures developed using demographic data alone.

The major limitation of the ACG morbidity index appeared to be that it is systematically related to physician visit rates (the higher the visit rate, the more likely conditions which increase the morbidity score are to be recorded). The Winnipeg regions had more physicians and higher physician visit rates than did rural areas. Relative to the premature mortality rates, the ACG morbidity index tended to systematically overestimate morbidity for the Winnipeg areas and underestimate morbidity for the rural areas.

Summary

This report reviewed many types of validity checks which should be performed in jurisdictions considering using the Johns Hopkins ACG system. This case-mix system holds much promise for researchers and administrators interested in using administrative data for describing case mix and morbidity levels across individuals, physicians' practices and populations.

1. INTRODUCTION

Valid methods to measure the burden of morbidity in populations have a variety of important applications in health services research and health care management. For research, population-based case-mix adjustment methods are critical to understanding the patterns of health service delivery to populations with differing health needs. For health care policy makers and managers, these methods are important so that resource allocation is matched with population health need, and health care organizations are adequately compensated for the burden of illness of their patient populations. Moreover, as governments, health care managers, and provider organizations begin to use sophisticated methods to profile utilization patterns, adequate methods to account for differences in morbidity are required.

In the U.S., several risk adjustment tools have recently been developed with the goal of measuring morbidity in populations, many of which are currently in use by health insurers (private and public) and private health plans (Rogal, Gauthier 1998). The development of these tools has been driven by the problem of 'risk segmentation' in the U.S. that occurred in employer-based, Medicaid (i.e., impoverished), and Medicare (i.e., senior) populations. In general, these risk adjustment instruments measure the health status of individual patients by combining diagnoses from pre-existing administrative data sets or by asking patients directly about their health. Payments to health insurance plans or providers are then adjusted by the aggregate illness profile of their practices. While some tools are intended for specific populations or programs, for example, the Disability Payment System (DPS) for Medicaid populations (Kronick, Dreyfus, Zhou 1996), several have been developed for general use, including the Diagnostic Cost Groups (DCGs) (Ash, Ellis, Yu 1997) and Adjusted Clinical Groups (ACGs: formerly Ambulatory Care Groups) (Starfield, Weiner, Mumford et al. 1991). In addition to adjusting provider payments, these case-mix tools are also used for research purposes, provider profiling, and in other quality assurance activities.

The purpose of this study was to investigate the validity and feasibility of applying a leading method of this type, the Johns Hopkins ACG case-mix adjustment system, to existing administrative data from the province of Manitoba. The ACG system was developed by a group of U.S. researchers to measure the illness burden of individual patients and enrolled populations (Starfield, Weiner, Mumford et al. 1991). The ACG system quantifies morbidity by grouping individuals based on their age, gender and the constellation of diagnoses assigned by their health care providers over a defined time period, typically one year. ICD-9/ICD-9-CM diagnosis codes are clustered for similar conditions based on expected consumption of health care resources and short-term clinical outcomes.

Although the ACG system has been extensively validated in the U.S. (Weiner, Starfield, Steinwachs et al. 1991; Weiner, Starfield, Lieberman 1992; Powe, Weiner, Starfield et al. 1998; Weiner, Dobson, Maxwell et al. 1996) and more recently in Europe (Juncosa, Bolibar 1997; Orueta, Lopez-De-Munain, Baez et al. 1999), experience with the system in Canada has been limited. In their current form, Canadian administrative data systems have the potential to support the application of ACGs since the required data are routinely collected in physician service claims, hospital separation abstracts, and patient registration data. While patient enrolment and hospital separation data are similar in Canada and the U.S., there are several important differences in the data collection and coding practices for physician service claims that may limit the generalizability of U.S. validity studies and the overall usefulness of the ACG system in Manitoba and, more generally, in Canada. These differences include: (1) the common use of three digit ICD-9 diagnosis codes on physician claims instead of the more specific four- and five-digit diagnoses required by many U.S. health insurance carriers; (2) the lack of secondary diagnoses fields on physician service claims compared to the three to fifteen additional diagnosis fields on many U.S. claims; (3) the limited importance that has historically been placed on the validity of physician claims-based diagnoses by provincial governments, health care managers, and providers in Canada; and (4) the lack of any quality monitoring and improvement programs for physician claims-based diagnosis coding. This study intended to address these issues and evaluate the validity of the ACG system for use with existing administrative data in Manitoba.

The first objective of this study was to assess the validity of the ACG assignment using existing Manitoba Health's patient enrolment, physician claims, and hospital separation files, housed for research purposes at the Manitoba Centre for Health Policy and Evaluation. More specifically, the analyses included the evaluation of: (1) the degree to which diagnoses coded on Manitoba records are supported by the ACG system; (2) the distributional properties of several ACG morbidity groups; (3) the variability in health care expenditures incurred by persons in the same ACGs; (4) the relative differences in expenditures for each ACG category and comparison of these relative differences with those from other populations; and (5) the explanatory power of ACGs for concurrent (i.e., same year) health care expenditures. The ability of the ACG system to explain prospective (i.e., next year) expenditures is an important consideration in prospective payment applications. Although not addressed here, analyses for prospective expenditures are the subject of future study. The second aim of this study was to examine the extent to which the ACG system can be considered to be a valid measurement of population health 'need' by comparing it to other generally accepted measures of population health status and health service need.

This study was a first step in the comprehensive assessment of the validity and usefulness of the ACG in Canada and, in particular, Manitoba. While we are presenting results here, they should be viewed as preliminary with further research planned to more explicitly examine the usefulness of the ACG system in health care administration and health services research.

2. AN OVERVIEW OF THE ACG CASE-MIX SYSTEM

The differences in health service use among individuals are in part predictable, based on differences in health status. The underlying assumption of the ACG case-mix adjustment system is that a measure of morbidity can help explain the need for and consumption of medical care resources (Starfield, Weiner, Mumford et al. 1991). As opposed to data collected from patient interviews, the ACG system measures an individuals' health status by grouping their diagnoses into clinically cogent groups. With the assistance of expert clinicians, over 14,000 ICD-9/ICD-9-CM diagnoses have been categorized into 32 groups, called Ambulatory Diagnostic Groups (ADGs), on the basis of the following eight clinical and expected utilization criteria (listed in order of importance):

a. Clinical similarity;
b. Likelihood of the persistence or recurrence of the condition over time;
c. Likelihood that the patient will return for a repeat visit/continued treatment;
d. Likelihood of a specialty consultation or referral;
e. Expected need and cost of diagnostic and therapeutic procedures for the condition;
f. Expected need for a required hospitalisation;
g. Likelihood of associated disability;
h. Likelihood of associated decreased life expectancy.

Individuals are assigned an ADG if they have one or more of the ADG's constituent diagnoses coded on at least one physician claim or hospital separation record over a defined time interval, usually one year. Patients can be assigned as few as none and as many as thirty-two ADGs in a given period depending on the types of diagnoses that they have.

Risk-adjustment systems must have a manageable number of mutually exclusive actuarial 'cells' to be useful as payment adjusters. ACGs are the mutually-exclusive terminal groups of the ACG system and represent combinations of ADG, age and gender categories. The process of combining ADGs and patient demographics into ACGs echoed that used to create Diagnostic Related Groups (DRGs) (Fetter, Youngsoo, Freeman 1980). The ACG system first clusters the ADGs into 12 'Collapsed ADG's (CADGs) and then combines CADGs into common patterns called 'Major Ambulatory Categories' (MACs). Then, with the goal of maximizing the reduction in ambulatory visit variation, MACs are further partitioned and combined with relevant age and gender categories to form 52 ACGs. In the ACG system version 4.0, the ACG categories have been further refined with the development of the concept of 'major ADGs' and with the addition of variables on the delivery status of pregnant women and infant birth weight, some of which are optional (The Johns Hopkins University ACG Case-Mix Adjustment System, computer program 1997). There are approximately 100 ACG categories and subcategories, depending on the options chosen.

Thus, through its grouping strategies, the ACG system provides two methods to quantify the burden of morbidity of individuals. The first approach is to use the ADGs and demographic categories to create a morbidity 'profile' for each individual. The ADGs and the demographic variables can then be added to multivariate models to control for case-mix. The second approach is to use the ACG which provides a simplified method of categorizing persons into single morbidity categories. This method is useful for payment purposes since each ACG can be assigned a single payment.

An important theme of the ACG system is that patients' overall 'clinical complexity' or 'burden of morbidity' determines their health-related risk for health service use. As opposed to other diagnosis grouping systems, the ACG system does not rely on only the most important or most common diagnoses, but instead identifies common combinations of morbidities (related and unrelated) that build upon each other, both additively and multiplicatively, to determine an individual's overall need for health services.

3. EVALUATING THE ACG ASSIGNMENT

3.1 Acceptability of Diagnosis Codes

Since the ACG system uses diagnoses taken from physician claims and hospital records to quantify illness burden, ACG performance is dependent on the degree to which a patient's diagnoses are captured by these administrative records and the accuracy of these diagnoses. The ACG system groups more than 14,000 ICD-9 (3-digit) and ICD-9-CM (4- and 5-digit) codes into 32 ADGs. While most codes found on administrative records are grouped by the ACG system, some may not be acceptable because they are invalid ICD-9/ICD-9-CM codes (i.e., errors in transcription), are too non-specific to be coded into a single ADG, or are uncommonly used. In Manitoba, physician claims submissions permit only 3-digit ICD-9 codes, whereas hospital separation abstracts allow more specific 4- and 5-digit ICD-9-CM codes. To assess the degree that Manitoba diagnoses are acceptable to the ACG software, we calculated a diagnosis 'mismatch' rate, defined as the number of unique diagnosis codes that are left unassigned by the ACG software divided by the total number of unique codes submitted. Furthermore, to differentiate the acceptability of codes from rural versus urban locales and of hospital versus physician claims codes, three mismatch rates were calculated (see Table 1): (1) the rate calculated when all physician claims diagnoses (excluding diagnoses on laboratory and radiology claims) are submitted for the population residing in the Winnipeg metropolitan area for 1995/96; (2) the rate obtained when all diagnoses (from hospital separation abstracts and the above physician claims) were submitted for Winnipeg residents; and (3) the rate calculated with all diagnoses for the total Manitoba population (urban and rural).

All three mismatch rates were well below the rate considered acceptable by the system developers (i.e., less than 5%) (Johns Hopkins University 1997). These low rates revealed that the Manitoba codes generally represent valid ICD-9/ICD-9-CM codes with enough specificity to permit ADG assignment. This analysis did not determine, however, how closely the diagnosis codes represented the patient's clinical presentation. The 'physician claims only' mismatch rate was particularly low, suggesting that physician's 3-digit office codes had a slightly lower likelihood of rejection than hospital 3-, 4-, and 5-digit ones. There was little difference between the mismatch rates for 'Winnipeg residents only' and for 'all

Table 1: ACG Mismatch Rates

Sources of Diagnosis Codes	***Population***	***Mismatch Rate***
Physician Claims Only	Winnipeg Residents Only	0.02%
Physician Claim & Hospital Abstracts	Winnipeg Residents Only	0.61%
Physician Claim & Hospital Abstracts	All Manitobans	0.68%

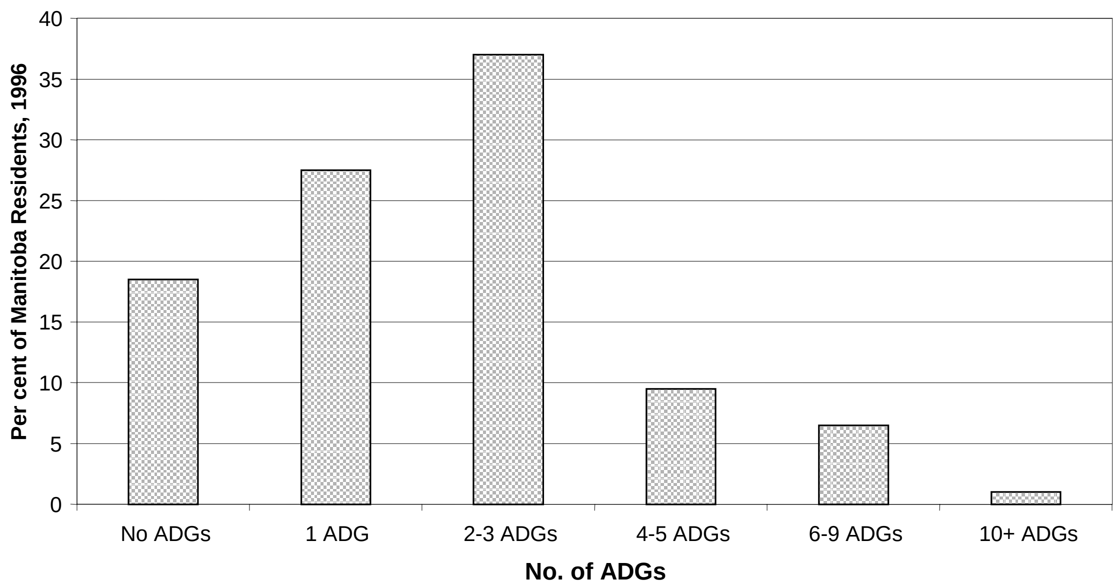
Manitobans, indicating that there were no major urban/rural differences in the use of unacceptable codes.

Approximately twenty diagnosis codes represented over 90% of the codes rejected by the ACG software. The rejected codes fell into two categories: 'E-codes' (representing external causes of injury and poisoning), and 'other' or 'unspecified' variants of certain diseases (e.g., other complications of pregnancy, rickettsiosis of unspecified site). E-codes are not used by the ACG system and they are left unassigned. It was decided not to recode the rejected codes to make them acceptable because of their overall infrequent occurrence (i.e., <1%).

3.2 ADGs and ACGs Distributions

Figure 1 presents the proportion of the Manitoba population, excluding infants and pregnant women, by the number of ADGs to which they were assigned in fiscal year (FY) 1995/96. Of the 1.2 million Manitoba residents enrolled in the provincial medical care plan, approximately 82% were assigned at least one ADG during the study year (i.e., they made at least one visit to a physician for which a claim was submitted and/or had one inpatient admission or ambulatory surgical procedure), and 18% had no ADGs (i.e., were non-users of the system). This non-user rate is similar to that reported previously for the Manitoba population (15-22%) (Tataryn, Roos, Black 1995). The proportion of persons who had an encounter with a physician but did not receive a classifiable diagnosis, was extremely low at less than 0.01%. Approximately 65% of the population were relatively healthy (i.e., assigned 1 to 3 ADGs), and about 16% were assigned four or more. Less than one percent of the total population had particularly high morbidity burdens (i.e., 10 or more different ADGs). Since

Figure 1: Per cent of Manitoba Residents With Different No. of ADG Assignments, 1995/96 (excluding infants and pregnant women)



the ACG system had been applied mainly to subsets of the general U.S. population (e.g., Medicaid, Medicare, and privately-insured HMO populations) which had very different mixes of morbidity from the Manitoba population, ACG distributions from comparable populations were not available.

One method to assess the performance of the ACG assignment process is to examine the distribution of specific ADGs (or ACGs). In particular, examination of the distributions for persons with mental health disorders, infants, and pregnant women can provide some important insights as to whether the system is assigning persons to the appropriate categories. These categories are chosen because prevalence data can be readily calculated from ACG frequencies. A recent study of the prevalence of mental health disorders in Manitoba during 1991/92 (Tataryn, Mustard, Derksen 1994) revealed a crude prevalence of 10.6 cases per 100 persons for psychotic and neurotic psychiatric conditions in adults aged $\geq$18 years. This study estimated prevalence based on diagnosis codes taken from physician claims and hospital separations, as well as encounter data from clinical, social service, and rehabilitative records from Manitoba Health's Mental Health Division. (These data were similar to those used in our study with the exception of the latter source.) In our study, we found a crude prevalence for the mental health ADGs (ADGs 23-25) of 12.8 cases per 100 adults aged ≥17 which is 21% higher than the prevalence found by Tataryn, Mustard, Derksen (1994). (Our rate represented the number of individuals who had at least one physician encounter for an ADG 23-25 diagnosis divided by the total adult population.) For children <17 years, we found a treatment prevalence of 35.8 cases per 1,000 in 1995/96 which is almost three times higher than the prevalence of 14.6 per 1,000 found by Tataryn, Mustard, Derksen (1994). One reason that may explain our higher prevalences is the wider variety of ICD-9 diagnoses that are included in ADGs 23-25 than in the categories used by Tataryn, Mustard, Derksen (1994) (such as ICD codes V40.x-V41.x and V60.x-V71.x). This higher rate was likely offset, to some extent, by not considering additional data from Manitoba Health's Mental Health Division.

Another potential error in the ACG assignment that we were able to assess was the assignment of infant-related ACGs (ACGs 5311 - 5342). (See Table 2) There were 15,495 enrolees assigned to an infant-related ACG for 1995/96, which corresponds to a rate of 13.5 infants per 1,000 residents. This rate can be considered as a proxy crude birth rate (CBR) for the province of Manitoba. From vital statistics records, Statistics Canada reported 15,738 births during 1995 which translates into a CBR of 13.7 live births per 1,000 residents. These rates were markedly similar suggesting that our assignment of infant-related ACGs was valid. We encountered two problems however when classifying infants into appropriate ACGs using the Manitoba data. First, many children in Manitoba did not receive any infant-related diagnosis on a physician claim or a hospital separation abstract during their first year and thus, were not appropriately assigned an infant ACG. To correct this problem, we assigned all infants aged <1 year who were without an infant-related ADG, a 'V30' diagnosis indicating a 'healthy new-born'. In imputing these data however, we assumed that these

Table 2: Distribution of Adjusted Clinical Groups (ACGs) For all Manitoba Residents, 1995/96

ACG	*Frequency*	*Percent*	*ACG Description*
100	2,211	0.19	Acute minor, age1
200	13,177	1.15	Acute minor, age2-5
300	127,790	11.10	Acute minor, age 6+
400	34,494	3.00	Acute major
500	44,167	3.84	Likely to recur, without allergies
600	2,622	0.23	Likely to recur, with allergies
700	3,492	0.30	Asthma
800	6,689	0.58	Chronic medical, unstable
900	24,017	2.09	Chronic medical, stable
1000	1,089	0.09	Chronic specialty
1100	8,386	0.73	Ophthalmological/dental
1200	3,158	0.27	Chronic specialty, unstable
1300	7,695	0.67	Psychosocial, without psychosocial unstable
1400	1,264	0.11	Psychosocial, with psychosocial unstable
1500	529	0.05	Psychosocial, with psychosocial unstable and psychosocial stable
1600	26,931	2.34	Preventive/administrative
1711	1,352	0.12	Pregnancy 0-1 ADGs, delivered
1712	427	0.04	Pregnancy 0-1 ADGs, not delivered
1721	4,967	0.43	Pregnancy 2-3 ADGs, no major ADGs, delivered
1722	2,037	0.18	Pregnancy 2-3 ADGs, no major ADGs, not delivered
1731	890	0.08	Pregnancy 2-3 ADGs, 1+ major ADGs, delivered
1732	190	0.02	Pregnancy 2-3 ADGs , 1+ major ADGs, not delivered
1741	3,154	0.27	Pregnancy 4-5 ADGs, no major ADGs, delivered
1742	1,918	0.17	Pregnancy 4-5 ADGs, no major ADGs, not delivered
1751	1,587	0.14	Pregnancy 4-5 ADGs, 1+ major ADGs, delivered
1752	607	0.05	Pregnancy 4-5 ADGs, 1+ major ADGs, not delivered
1761	1,461	0.13	Pregnancy 6+ ADGs, no major ADGs delivered
1762	1,294	0.11	Pregnancy 6+ ADGs, no major ADGs not delivered
1771	1,922	0.17	Pregnancy 6+ ADGs, 1+ major ADGs ,delivered
1772	1,339	0.12	Pregnancy 6+ ADGs, 1+ major ADGs, not delivered
1800	52,868	4.60	Acute minor and acute major
1900	5,338	0.46	Acute minor and likely to recur, age1
2000	15,576	1.35	Acute minor and likely to recur, age 2-5
2100	61,090	5.31	Acute minor and likely to recur, age>5, without allergy

ACG	***Frequency***	***Percent***	***ACG Description***
2200	5,240	0.46	Acute minor and likely to recur, age>5, with allergy
2300	22,172	1.93	Acute minor and chronic medical: stable
2400	6,976	0.61	Acute minor and eye/dental
2500	9,477	0.82	Acute minor and psychosocial without psychosocial unstable
2600	820	0.07	Acute minor and psychosocial with psychosocial unstable
2700	523	0.05	Acute minor and psychosocial with psychosocial unstable & stable
2800	16,778	1.46	Acute major and likely to recur
2900	3,146	0.27	Acute minor/acute major/likely to recur, age 1
3000	7,259	0.63	Acute minor/acute major/likely to recur, age 2-5
3100	5,887	0.51	Acute minor/acute major/likely to recur, age 6-11
3200	33,501	2.91	Acute minor/acute major/likely to recur, age >=12, no allergy
3300	2,664	0.23	Acute minor/acute major/likely to recur, age >=12, allergy
3400	4,635	0.40	Acute minor/likely to recur/eye & dental
3500	8,599	0.75	Acute minor/likely to recur/psychosocial
3600	16,522	1.44	Acute Minor/Acute Major/Likely to Recur/Eye & Dental
3700	9,968	0.87	Acute Minor/Acute Major/Likely to Recur/Psychosocial
3800	15,232	1.32	2-3 Other ADG Combinations, Age < 17
3900	9,936	0.86	2-3 Other ADG Combinations, Males Age 17-34
4000	10,395	0.90	2-3 Other ADG Combinations, Females Age 17-34
4100	86,265	7.50	2-3 Other ADG Combinations, Age > 34
4210	8,901	0.77	4-5 Other ADG Combinations, Age < 17, no major ADGs
4220	3,068	0.27	4-5 Other ADG Combinations, Age < 17, 1+ major ADGs
4310	16,261	1.41	4-5 Other ADG Combinations, Age 17-44, no major ADGs
4320	10,836	0.94	4-5 Other ADG Combinations, Age 17-44, 1 major ADG
4330	2,617	0.23	4-5 Other ADG Combinations, Age 17-44, 2+ major ADGs
4410	22,583	1.96	4-5 Other ADG Combinations, Age > 44, no major ADGs
4420	26,010	2.26	4-5 Other ADG Combinations, Age > 44, 1 m2kior ADG
4430	11,805	1.03	4-5 Other ADG Combinations, Age > 44, 2+ major ADGs
4510	1,509	0.13	6-9 Other ADG Combinations, Age < 6, no major ADGs
4520	773	0.07	6-9 Other ADG Combinations, Age < 6, 1 + major ADGs
4610	1,553	0.14	6-9 Other ADG Combinations, Age 6-16, no major ADGs
4620	989	0.09	6-9 Other ADG Combinations, Age 6-16, 1 + major ADGs
4710	701	0.06	6-9 Other ADG Combinations, Males Age 17-34, no major ADGs
4720	1,298	0.11	6-9 Other ADG Combinations, Males Age 17-34, 1 major ADG
4730	959	0.08	6-9 Other ADG Combinations, Males Age 17-34, 2 + major ADGs
4810	2,988	0.26	6-9 Other ADG Combinations, Females Age 17-34, no major ADGs

ACG	*Frequency*	*Percent*	*ACG Description*
4820	2,612	0.23	6-9 Other ADG Combinations, Females Age 17-34, 1 major ADG
4830	980	0.09	6-9 Other ADG Combinations, Females Age 17-34, 2 + maj ADGs
4910	32,967	2.87	6-9 Other ADG Combinations, Age > 34, 0-1 major ADGs
4920	14,659	1.27	6-9 Other ADG Combinations, Age > 34, 2 major ADGs
4930	6,368	0.55	6-9 Other ADG Combinations, Age > 34, 3 major ADGs
4940	2,174	0.19	6-9 Other ADG Combinations, Age > 34, 4+ major ADGs
5010	78	0.01	10+ Other ADG Combinations, Age 1-16, no major ADGs
5020	90	0.01	10+ Other ADG Combinations, Age 1-16, 1 major ADG
5030	82	0.01	10 + Other ADG Combinations, Age 1-16, 2 + major ADGs
5040	2,865	0.25	10+ Other ADG Combinations, Age > 16, 0-1 major ADGs
5050	3,038	0.26	10+ Other ADG Combinations, Age > 16, 2 major ADGs
5060	2,401	0.21	10+ Other ADG Combinations, Age > 16, 3 major ADGs
5070	2,332	0.20	10+ Other ADG Combinations, Age > 16, 4+ major ADGs
5110	87	0.01	No Diagnosis or Only Unclassified Diagnosis
5200	209,661	18.22	Non-Users
5311	261	0.02	Infants: 0-5 ADGs, no major ADGs, Low birth weight
5312	12,123	1.05	Infants: 0-5 ADGs, no major ADGs, Normal birth weight
5321	244	0.02	Infants: 0-5 ADGs, 1 + major ADGs, Low birth weight
5322	1,403	0.12	Infants: 0-5 ADGs, 1+ major ADGs, Normal birth weight
5331	21	0.00	Infants: 6+ ADGs, no major ADGs, Low birth weight
5332	717	0.06	Infants: 6+ ADGs, no major ADGs, Normal birth weight
5341	143	0.01	Infants: 6 + ADGs, 1 + major ADGs, Low birth weight
5342	583	0.05	Infants: 6+ ADGs, 1 + major ADGs, Normal birth weight
Total	1,150,463	100.00	All Manitoba Residents

infants were relatively healthy and did not have other uncoded morbidities. The second problem related to age 'rounding' by the ACG software to the nearest integer. This 'rounding' created the problem that infants less than 6 months old by the end of the year were labelled as age zero while infants between six and twelve months were classified as age one. To correct this misclassification, we reclassified all infants less than one year to age zero.

4. EVALUATION OF ACG-SPECIFIC HEALTH CARE EXPENDITURES

In addition to assessing the distributional properties of the ACGs, validity of the ACG system can be assessed by how well it measures what it is intended to measure, that is, morbidity as it relates to the use and expenditures for health care resources. The following section analyzes aspects of face and concurrent validity with regards to ACG-associated concurrent (i.e., same year) health care expenditures.

Table 3 presents the distribution of 1995/96 expenditures by ACG for 'physician services' (i.e., payments to physicians for patient interviews and examinations, procedures, non-hospital diagnostic imaging and laboratory services), and Table 4 presents the distribution by ACG for 'total expenditures' (i.e., physician expenditures and hospital expenditures combined). (The distribution of ACG-specific costs after removal of outliers is detailed in Appendix I.) Physician expenditures were based on billings to the medical services plan which represents approximately 90-98% of physician services (Tataryn, Roos, Black 1994). The methodology for estimating patient-specific hospital expenditures, representing expenditures for ambulatory surgical procedures and inpatient hospital stays, is presented in Appendix II.[1] Because of limitations in the datasets, outpatient pharmaceutical and emergency department expenditures were excluded. Cancer treatment expenditures incurred at the provincial cancer treatment centre were also excluded. The mean expenditure is presented as a measure of central tendency and the coefficient of variation as a measure of dispersion. In addition, the distribution is characterized by minimal and maximal values and by quartile. A total of 1,646 long-term residents of personal care homes (PCHs) were excluded from this and subsequent analyses, because their hospital expenditures were in part composed of long-term care expenses.

[1] Inpatient expenditures were estimated using Refined Diagnosis Related Groups (RDRGs), and expenditures for ambulatory surgical procedure were estimated using Day Procedure Groups (DPGs).

Variability in average physician expenditures between ACGs ranged from $53.01 (ACG 1600 – Preventive and Administrative) to $2,796 (10+ Other ADG Combinations, Age 1-16 years, 2+ major ADGs). There was considerable variation in health care expenditures within all ACGs. For both physician-specific and total expenditures, the means were higher than the medians, indicating that the distributions were right-skewed with a tail of relatively high users in all ACG categories. In relation to expenditures for physician services, some ACGs had more variability than others. Forty-seven ACGs had relatively low variation (i.e., coefficients of variation less than 1.0) while 45 categories had high variation (i.e., coefficients of variation greater than 1.0). ACGs 400 (Acute Major Conditions), 1100 (Ophthalmological and Dental Conditions), 1300 (Psychosocial Conditions without Psychosocial Unstable), and 2500 (Acute Minor Conditions with Psychosocial Stable without Psychosocial Unstable) had very high standard deviations (more than two times their means). In other words, there was considerable within-category variation in expenditures for these ACGs. On the whole, the less resource-intensive ACGs (i.e., those with one or two ADG combinations) showed greater variability in their expenditures than the high resource-intensive ones. In fact, the majority of the most resource-intensive ACGs (i.e., those with 10 or more ADGs) had coefficients of variation under 0.8. ACGs containing psychiatric/psychosocial conditions (ACGs 1300-1500, ACGs 2500-2700) had particularly high variability in physician expenditures as did those with acute and unstable diagnoses (ACGs 400, 800 and 1200). It is interesting to note that physician expenditures relating to pregnancy were all relatively stable, which probably relates to both the bundled nature of physician fees and the consistency in prenatal laboratory use. Two ACG categories, ACG 1100 (Ophthalmological and Dental) and ACG 1600 (Preventive and Administrative), had relatively high variability in expenditures, which was both unexpected and unexplained. For all ACGs, the variability was greater for total expenditures (i.e., inpatient, ambulatory surgery, and physician costs combined) than for physician expenditures alone (see Table 4). Nine ACGs (400, 800, 1200, 1300, 1600,1800, 3900, 4100 and 4710) had marked variability with coefficients of variation that exceeded the coefficient for the total population (5.64). As with physician expenditures, the ACGs with acute major, chronic unstable medical, and psychosocial conditions had total expenditures that were particularly variable. Again, we found the unexpected result that the total expenditures for the preventive and administrative

ACG (ACG 1600) were particularly variable, with some individuals having very high expenditures. The reason for this apparent discrepancy was unclear. It appears that some individuals in these categories may have been hospitalized but did not receive the appropriate acute or chronic diagnoses. As with physician expenditures, there was relatively low variability in total expenditures for ACGs related to pregnancy, suggesting consistent use of hospitalization in these categories. In addition, the expenditures of the infant-specific ACGs appeared stable, including ACG 5312 for healthy infants of normal birth weight. This finding confirmed the validity of our assignments of uncoded infants to this category (see discussion above).

In addition to the actual expenditures for each ACG, ACG-specific 'relative expenditures' (also called ACG 'resource intensity weights') were calculated by dividing the mean expenditures for each ACG by the grand mean for all ACGs. For these analyses, values for outliers, defined as individuals with expenditures greater than 3 standard deviations above the mean in each ACG, were trimmed (n = 14,542, 1.5%) for physician expenditures; 9,349 (1.0%) for total expenditures). The validity of these weights was assessed by comparing them with similar weights developed in other Canadian and U.S. jurisdictions. Table 5 presents ACG relative expenditure data for physician services provided to the Manitoba population and data from a parallel study in British Columbia (Reid, Weiner, Starfield et al. 1998). In the BC study, ACG resource intensity weights were developed for a 5% stratified random sample of BC residents (n=171,157) who were continuously enrolled in the province's health plan in 1995-96. In contrast to physician expenditure data in Manitoba, the expenditures in BC excluded payments for laboratory and radiology services.

The Manitoba resource intensity weights appeared to have substantial face validity. Those ACG categories with the greatest morbidity burdens (e.g., ACG 5070 with 10+ ADG combinations, age >16 and 4+ major ADGs) had the highest weights, and those with the lowest morbidity burdens (e.g., ACG 1600 - Preventive and Administrative) had the lowest weights. On the whole, ACGs with ten or more ADGs had the highest weights followed by ACGs with 6-9 ADGs, ACGs with 4-5 ADGs, and ACGs with 2-3 ADGs. Furthermore, within these broad groupings, the expenditures for physician services were associated with

Table 3: Distribution of Physician Expenditures* By ACG Category, Manitoba 1995/96

ACG	*Description*	*n*	*Mean ($)*	*cv ($)*	*Min ($)*	*25° ($)*	*Med ($)*	*75° ($)*	*Max ($)*
100	Acute Minor Age 1-2	2207	96.21	0.62	15.29	52.92	87.59	124.66	497
200	Acute Minor Age 2-5	13168	66.41	0.81	15.00	31.93	53.89	86.60	915
300	Acute Minor Age 6+	127646	56.95	1.23	3.65	16.64	35.77	70.40	6088
400	Acute Major	34325	88.43	2.24	5.00	17.44	49.00	93.87	23170
500	Likely to Recur, without Allergies	44064	66.20	1.46	6.97	16.64	36.97	75.12	2449
600	Likely to Recur, with Allergies	2620	76.75	1.36	10.00	17.44	48.24	89.51	2063
700	Asthma	3487	53.36	1.04	11.19	16.64	34.08	64.63	715
800	Chronic Medical, Unstable	6650	152.60	1.74	10.81	39.11	85.98	168.29	6659
900	Chronic Medical, Stable	23991	91.60	1.18	10.81	32.70	65.98	118.99	4510
1000	Chronic Specialty, Stable	1083	58.71	1.61	15.05	16.64	34.27	66.01	963
1100	Ophthalmological / Dental	8302	69.45	2.25	8.62	29.35	29.35	58.38	2491
1200	Chronic Specialty, Unstable	3157	75.33	1.59	11.76	23.30	45.20	76.90	2256
1300	Psychosl, without Psychosl Unstable	7679	155.28	3.15	10.81	16.64	48.05	107.19	11440
1400	Psychosl, c/ Psychosl Unstab, c/o Psychosl,Stab	1254	254.52	1.99	13.86	33.28	89.75	235.51	6054
1500	Psychosl, with Psychosl Unstab, c Psychosl Stab	527	589.98	1.53	21.20	125.37	259.29	629.45	7868
1600	Preventive / Administrative	26899	53.01	1.34	3.09	32.71	37.35	56.22	3520
1711	Pregnancy: 0-1 ADGs, delivered	1286	137.08	0.82	1.83	57.26	108.01	187.45	1582
1712	Pregnancy: 0-1 ADGs, not delivered	427	107.22	0.78	15.25	47.96	85.27	143.95	580
1721	Pregnancy: 2-3 ADGs, no maj ADG, delivered	4957	215.27	0.66	4.24	112.80	183.30	289.37	1953
1722	Pregnancy: 2-3 ADGs, no maj ADG, not delivered	2037	187.41	0.62	17.44	111.35	163.22	234.50	1943
1731	Pregnancy: 2-3 ADGs, 1+ maj ADG, delivered	876	222.96	0.84	1.83	103.55	183.13	296.71	2525
1732	Pregnancy: 2-3 ADGs, 1+ maj ADG, not delivered	190	233.03	0.73	33.79	129.76	193.66	286.43	1236
1741	Pregnancy: 4-5 ADGs, no maj ADG, delivered	3154	313.65	0.55	28.58	192.59	281.59	402.19	2018
1742	Pregnancy: 4-5 ADGs, no maj ADG, not delivered	1918	280.59	0.56	65.40	182.41	245.93	334.10	1867
1751	Pregnancy: 4-5 ADGs, 1+ maj ADG, delivered	1586	349.56	0.72	16.64	192.29	294.41	422.89	3474
1752	Pregnancy: 4-5 ADGs, 1+ maj ADG, not delivered	607	356.40	0.80	46.44	198.70	284.56	408.67	3028
1761	Pregnancy: 6+ ADGs, no maj ADG, delivered	1461	456.88	0.55	62.00	299.24	409.29	557.51	4420
1762	Pregnancy: 6+ ADGs, no maj ADG, not delivered	1294	425.57	0.56	100.43	276.06	372.72	505.76	3426
1771	Pregnancy: 6+ ADGs, 1+ maj ADG, delivered	1922	604.37	0.73	65.07	339.53	492.44	709.43	4221
1772	Pregnancy: 6+ ADGs, 1+ maj ADG, not delivered	1339	645.37	1.10	85.55	342.30	474.90	701.22	11973
1800	Acute Minor and Acute Major	52853	150.33	1.21	6.97	65.60	106.83	174.25	8992
1900	Acute Minor and Likely to Recur, Age 1-2	5338	195.12	0.72	16.64	112.06	162.97	238.10	2645
2000	Acute Minor and Likely to Recur, Age 2-5	15574	142.50	0.75	16.64	74.89	113.78	173.60	1484
2100	Acute Minor and Like to Recur, Age >5, c/o All.	61066	125.94	0.92	6.97	58.60	94.31	151.31	3188
2200	Acute Minor and Likely to Recur, Age >5, c All.	5239	149.85	0.90	24.60	65.99	113.04	182.29	2517
2300	Acute Minor and Chronic Medical: Stable	22167	145.65	0.86	15.85	69.12	116.31	185.57	3512
2400	Acute Minor and Eye / Dental	6975	120.13	1.33	15.85	51.71	79.95	128.00	3033
2500	Acute Min with Psychosl Stab c/o Psychosl Unst	9472	189.65	2.09	15.29	63.40	104.92	179.09	8740
2600	Acute Min c/o Psychosl Stab c Psychosl Unstab	819	270.60	1.93	15.85	78.69	133.05	259.12	8346
2700	Acute Min with Psychosl Stable and Unstable	523	651.93	1.57	47.55	162.37	300.40	686.42	11797
2800	Acute Major and Likely to Recur	16762	179.29	1.21	10.95	65.40	111.59	197.40	5511

ACG Description	n	Mean ($)	cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
2900 Acute Min /Acute Maj / Likely to Recur, Age 1-2	3146	300.95	0.69	17.44	174.80	247.87	362.61	2682
3000 Acute Minor /Acute Maj/Like to Recur, Age 2-5	7257	228.09	0.74	31.14	125.73	184.45	273.05	4454
3100 Acute Min /Acute Maj/Like to Recur, Age 6-11	5887	205.45	0.82	16.64	109.27	159.33	240.99	2564
3200 Acute Min /Acu Maj/Like to Recur, Age>11c/oAll	33494	267.53	0.98	15.85	123.66	193.37	316.90	12593
3300 Acute Min /Acute Maj/Like to Recur, Age>11 c Al	2663	276.85	0.84	45.89	140.52	217.67	336.13	4129
3400 Acute Min / Likely to Recur / Eye & Dental	4635	195.59	0.97	16.64	101.57	147.70	226.30	3297
3500 Acute Min / Likely to Recur / Psychosl	8598	312.06	1.69	34.88	117.55	183.66	306.05	8991
3600 Acute Min / Acute Maj /Like to Recur / Eye&Dent	16522	443.83	0.83	15.85	215.49	333.22	544.11	7156
3700 Acute Min / Acute Maj /Like to Recur / Eye&Dent	9968	478.77	1.23	23.61	205.38	313.94	523.52	10167
3800 2-3 Oth ADG Comb, Age < 17	15229	145.57	1.28	15.29	67.93	104.51	164.58	7374
3900 2-3 Oth ADG Comb, Males Age 17-34	9930	186.59	1.92	12.01	62.29	101.54	176.39	9951
4000 2-3 Oth ADG Comb, Females Age 17-34	10385	194.67	1.76	6.97	79.61	123.67	200.61	9817
4100 2-3 Oth ADG Comb, Age > 34	86169	244.55	1.30	4.57	93.40	159.47	268.62	8363
4210 4-5 Oth ADG Comb, Age < 17, no major ADGs	8901	248.00	0.83	16.83	140.30	200.89	292.92	4698
4220 4-5 Oth ADG Comb, Age < 17, 1+ major ADGs	3067	329.98	1.33	48.34	144.60	217.67	358.14	12124
4310 4-5 Oth ADG Comb, Age 17-44, no major ADGs	16259	289.78	1.24	14.64	142.32	209.16	320.72	9580
4320 4-5 Oth ADG Comb, Age 17-44, 1 major ADGs	10833	382.91	1.25	17.44	159.86	249.47	418.54	8281
4330 4-5 Oth ADG Comb, Age 17-44, 2+ major ADGs	2615	600.87	1.24	15.69	196.76	343.14	703.56	10868
4410 4-5 Oth ADG Comb, Age > 44, no major ADGs	22581	343.73	0.93	16.83	175.26	259.40	391.74	6902
4420 4-5 Oth ADG Comb, Age > 44, 1 major ADGs	25998	453.70	0.95	15.39	206.39	318.18	528.44	6584
4430 4-5 Oth ADG Comb, Age > 44, 2+ major ADGs	11784	704.00	1.06	7.48	267.87	456.03	866.46	8873
4510 6-9 Oth ADG Comb, Age < 6, no major ADGs	1509	431.77	0.58	83.40	273.14	376.35	512.63	3347
4520 6-9 Oth ADG Comb, Age < 6, 1+ major ADGs	773	667.21	1.07	115.11	309.12	447.93	779.78	10123
4610 6-9 Oth ADG Comb, Age 6-16, no major ADGs	1553	413.51	1.37	92.30	224.04	309.60	449.38	13790
4620 6-9 Oth ADG Comb, Age 6-16, 1+ major ADGs	989	657.96	1.26	69.15	269.20	409.20	709.09	9968
4710 6-9 Oth ADG Comb, Male Age 17-34,0 maj ADG	700	416.10	1.06	97.50	220.31	310.53	489.60	8404
4720 6-9 Oth ADG Comb, Male Age 17-34,1 maj ADG	1298	549.28	1.10	94.54	263.56	383.32	627.77	10191
4730 6-9 Oth ADG Comb, Male Age 17-34,2+majADG	959	931.00	1.35	113.17	324.05	563.18	1089.17	24006
4810 6-9 Oth ADG Comb, FemalAge17-34,0majADGs	2988	454.73	0.99	83.20	252.04	342.80	508.57	8854
4820 6-9 Oth ADG Comb, FemalAge17-34,1majADGs	2612	561.22	0.98	94.50	282.80	421.42	657.15	11651
4830 6-9 Oth ADG Comb,FemalAge17-34,2+majADG	980	912.76	1.13	73.53	359.42	601.45	1062.21	11532
4910 6-9 Oth ADG Comb, Age > 34, 0-1 major ADGs	32966	623.43	0.83	11.55	318.85	477.30	755.46	15234
4920 6-9 Oth ADG Comb, Age > 34, 2 major ADGs	14652	920.58	0.91	11.55	422.14	689.40	1159.07	42490
4930 6-9 Oth ADG Comb, Age > 34, 3 major ADGs	6364	1332.95	0.84	15.72	589.55	1021.64	1683.98	16002
4940 6-9 Oth ADG Comb, Age > 34, 4+ major ADGs	2169	1954.50	0.81	20.79	841.96	1482.57	2571.34	11795
5010 10+ Oth ADG Comb, Age 1-16, no major ADGs	78	1021.75	1.12	270.92	486.33	717.06	1131.01	9121
5020 10+ Oth ADG Comb, Age 1-16, 1 major ADGs	90	1137.66	0.67	250.69	546.10	888.29	1548.35	4227
5030 10+ Oth ADG Comb, Age 1-16, 2+ major ADGs	82	2796.90	0.78	378.31	1310.13	2225.68	3799.65	11356
5040 10+ Oth ADG Comb, Age > 16, 0-1 major ADGs	2865	1002.62	0.70	39.86	586.95	824.55	1210.55	9895
5050 10+ Oth ADG Comb, Age > 16, 2 major ADGs	3038	1314.06	0.68	197.94	733.05	1090.82	1620.73	9473
5060 10+ Oth ADG Comb, Age > 16, 3 major ADGs	2401	1741.55	0.72	190.62	926.23	1416.92	2167.86	15240
5070 10+ Oth ADG Comb, Age > 16, 4+ major ADGs	2332	2594.62	0.67	38.22	1384.35	2116.97	3254.09	12021
5110 No Diagnosis or Only Unclassified Diagnoses	78	129.38	1.13	15.80	28.00	101.92	174.72	1054

ACG	Description	n	Mean ($)	cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
5311	Infants: 0-5 ADGs, no maj ADG, low birth wgt	246	215.32	0.90	15.85	124.95	178.77	268.00	1916
5312	Infants: 0-5 ADGs, no maj ADG, norm brth wgt	11959	173.76	0.72	10.45	100.80	150.75	218.32	3756
5321	Infants: 0-5 ADGs, 1+ maj ADG, low birth wgt	234	365.64	0.78	34.27	192.38	304.86	443.15	2176
5322	Infants: 0-5 ADGs, 1+ maj ADG, norm brth wgt	1385	276.12	1.04	15.85	138.23	209.41	309.75	3386
5331	Infants: 6+ ADGs, no maj ADG, low birth wgt	21	460.10	0.63	159.69	304.60	400.90	491.62	1269
5332	Infants: 6+ ADGs, no maj ADG, norm brth wgt	717	446.53	0.65	109.80	300.25	387.06	506.06	3432
5341	Infants: 6+ ADGs, 1+ maj ADG, low birth wgt	143	986.87	1.04	105.25	409.52	695.85	1216.50	9323
5342	Infants: 6+ ADGs, 1+ maj ADG, norm brth wgt	583	703.22	1.11	59.71	320.97	454.65	735.68	6993
	All ACGs	939586	247.25	1.78	1.83	52.74	121.65	260.87	42490

Mean=mean physician cost per ACG; cv=coefficient of variation (standard deviation/mean); min=minimum value; 25°=25th percentile; 50°=median value;75°=75th percentile; max=maximum value.

* includes payments for physician interviews and examinations, procedures, non-hospital laboratory and diagnostic imaging services

the accumulation of more severe ADGs. For the majority of ACGs, there were relatively few differences between the Manitoba and BC weights. Forty-four ACG categories (54%) had absolute differences of less than 0.2 (range 0.1–6.0). In relative terms, the differences in the weights ranged from 0-65%. The ACGs with the largest relative differences were those for pregnancy-related care (ACG 1710, 1760 & 1770) and some with 10 or more ADG combinations (ACG 5030 & 5070). The overall variation among ACG-related expenditures were very similar in BC and Manitoba. In Manitoba, there was a 52-fold variation between the least and most costly ACGs compared to a 46-fold variation in the BC study, after excluding ACG 5200 (Non-users) and ACG 1600 (Preventive and Administrative). Figure 2 presents a plot of the Manitoba versus the BC relative expenditures.

Table 6 presents relative expenditure data for all services for Manitoba compared to similar data from non-disabled enrolees in Minnesota's Medicaid program in 1995 (n=290,888), and enrolees in a large U.S. staff-model Health Maintenance Organization (HMO) in 1994 (n=71,520). For total expenditures, there appeared to be a similar high degree of variability across ACGs in the U.S. and Manitoba populations. In the HMO population, there was a more than 500-fold variation from the most to the least resource-intensive ACG, and in the Minnesota Medicaid population there was a more than 200-fold variation. Among Manitoba

Table 4: Distribution of Total Expenditures* By ACG Category, Manitoba 1995/96

ACG	Description	n	Mean ($)	Cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
100	Acute Minor Age 1-2	2210	123.77	1.75	15.29	52.92	87.99	125.68	3689
200	Acute Minor Age 2-5	13173	78.02	2.34	15.00	31.94	53.89	87.20	10877
300	Acute Minor Age 6+	127733	68.12	2.92	6.97	16.64	36.04	71.02	33910
400	Acute Major	34468	212.78	9.98	6.97	17.44	49.35	98.10	292144
500	Likely to Recur, without Allergies	44151	99.68	3.76	6.97	16.64	37.35	77.49	42527
600	Likely to Recur, with Allergies	2621	102.10	2.41	10.00	17.44	48.34	90.27	3711
700	Asthma	3492	75.06	2.92	11.19	16.64	34.27	65.07	5685
800	Chronic Medical, Unstable	6687	1113.20	6.78	10.81	40.38	90.58	194.26	177207
900	Chronic Medical, Stable	24013	114.17	3.90	10.81	32.70	65.98	119.93	20862
1000	Chronic Specialty, Stable	1088	84.01	3.00	15.05	16.64	34.27	66.12	2820
1100	Ophthalmological / Dental	8385	115.97	2.89	8.62	29.35	29.35	61.20	7088
1200	Chronic Specialty, Unstable	3158	160.15	17.74	11.76	23.30	45.20	76.94	119119
1300	Psychosl, without Psychosl Unstable	7695	203.19	6.04	10.81	16.64	48.19	109.16	53967
1400	Psychosl, c/ Psychosl Unstab, c/o Psychosl,Stab	1264	1930.80	5.25	13.86	34.27	101.98	309.60	123405
1500	Psychosl, with Psychosl Unstab, c Psychosl Stab	529	2832.90	3.36	30.58	144.32	336.30	1107.70	118790
1600	Preventive / Administrative	26914	65.11	11.46	3.09	32.71	37.35	56.31	81523
1711	Pregnancy: 0-1 ADGs, delivered	1352	1808.10	0.72	531.56	1227.1	1513.40	2026.70	27955
1712	Pregnancy: 0-1 ADGs, not delivered	427	143.85	1.98	15.25	47.96	86.59	149.42	4088
1721	Pregnancy: 2-3 ADGs, no maj ADG, delivered	4967	2000.40	0.57	436.85	1328.80	1843.50	2419.60	30946
1722	Pregnancy: 2-3 ADGs, no maj ADG, not delivered	2037	281.72	1.51	31.70	117.49	173.82	277.12	7351
1731	Pregnancy: 2-3 ADGs, 1+ maj ADG, delivered	890	2440.60	0.68	454.29	1473.20	2044.50	2957.30	29618
1732	Pregnancy: 2-3 ADGs, 1+ maj ADG, not delivered	190	794.17	1.06	35.47	199.92	565.81	1106.40	4736
1741	Pregnancy: 4-5 ADGs, no maj ADG, delivered	3154	2328.00	0.62	439.17	1474.40	2013.30	2710.60	25330
1742	Pregnancy: 4-5 ADGs, no maj ADG, not delivered	1918	492.53	1.21	65.40	198.28	289.75	629.61	11182
1751	Pregnancy: 4-5 ADGs, 1+ maj ADG, delivered	1587	3031.00	0.91	657.09	1784.80	2469.90	3329.00	37616
1752	Pregnancy: 4-5 ADGs, 1+ maj ADG, not delivered	607	1216.60	1.37	70.85	295.86	848.65	1307.10	17767
1761	Pregnancy: 6+ ADGs, no maj ADG, delivered	1461	2741.00	0.60	730.47	1699.40	2366.50	3239.10	21744
1762	Pregnancy: 6+ ADGs, no maj ADG, not delivered	1294	771.51	1.03	112.40	327.55	554.71	899.04	8862
1771	Pregnancy: 6+ ADGs, 1+ maj ADG, delivered	1922	4098.10	1.02	698.21	2204.20	3134.70	4582.80	85929
1772	Pregnancy: 6+ ADGs, 1+ maj ADG, not delivered	1339	2006.50	2.13	149.70	649.33	1134.30	1937.40	83680
1800	Acute Minor and Acute Major	52865	313.59	5.88	6.97	65.98	109.04	186.85	201157
1900	Acute Minor and Likely to Recur, Age 1-2	5338	269.61	2.19	30.58	114.04	166.41	247.11	22353
2000	Acute Minor and Likely to Recur, Age 2-5	15574	178.22	1.58	16.64	75.05	114.57	176.13	8542
2100	Acute Minor and Like to Recur, Age >5, c/o All.	61079	178.03	2.07	6.97	59.20	96.29	160.70	43125
2200	Acute Minor and Likely to Recur, Age >5, c All.	5239	187.97	1.49	24.6	66.00	113.86	184.95	4820
2300	Acute Minor and Chronic Medical: Stable	22169	183.59	2.69	15.85	69.15	117.29	189.37	17813
2400	Acute Minor and Eye / Dental	6976	176.43	1.94	28.61	54.90	84.26	139.74	6150
2500	Acute Min with Psychosl Stab c/o Psychosl Unst	9477	236.82	3.75	15.85	63.40	107.43	191.05	62218
2600	Acute Min c/o Psychosl Stab c Psychosl Unstab	820	1267.10	4.73	30.58	83.39	160.51	370.40	92135
2700	Acute Min with Psychosl Stable and Unstable	523	2215.20	2.96	47.55	176.30	395.36	1140.00	68569
2800	Acute Major and Likely to Recur	16775	402.56	3.81	15.85	66.22	116.68	241.49	96250

ACG	Description	n	Mean ($)	Cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
2900	Acute Min /Acute Maj / Likely to Recur, Age 1-2	3146	723.46	2.17	47.55	181.67	273.77	534.44	40588
3000	Acute Minor /Acute Maj/Like to Recur, Age 2-5	7257	385.75	2.18	38.58	127.47	191.26	303.48	24395
3100	Acute Min /Acute Maj/Like to Recur, Age 6-11	5887	353.68	2.41	34.7	110.61	164.92	263.64	34089
3200	Acute Min /Acu Maj/Like to Recur, Age>11c/oAll	33499	548.25	2.62	15.85	127.23	210.13	466.81	73992
3300	Acute Min /Acute Maj/Like to Recur, Age>11 c A	2663	425.96	1.67	45.89	142.58	227.00	397.21	11409
3400	Acute Min / Likely to Recur / Eye & Dental	4635	287.19	1.48	16.64	104.42	158.00	262.15	8384
3500	Acute Min / Likely to Recur / Psychosl	8599	574.87	5.16	46.43	119.43	193.48	363.93	109635
3600	Acute Min / Acute Maj /Like to Recur / Eye&Dent	16522	1124.50	2.69	16.64	232.05	411.57	955.77	133877
3700	Acute Min / Acute Maj /Like to Recur / Eye&Dent	9968	1245.20	4.38	23.61	220.08	382.93	843.22	148302
3800	2-3 Oth ADG Comb, Age < 17	15232	303.57	5.69	27.93	69.40	107.91	178.66	111015
3900	2-3 Oth ADG Comb, Males Age 17-34	9936	467.95	6.15	15.85	62.85	105.12	199.37	143233
4000	2-3 Oth ADG Comb, Females Age 17-34	10395	353.48	4.89	6.97	81.15	127.93	220.96	95782
4100	2-3 Oth ADG Comb, Age > 34	86257	881.51	6.33	6.97	95.88	167.65	314.53	178633
4210	4-5 Oth ADG Comb, Age < 17, no major ADGs	8901	500.36	3.18	33.28	144.55	213.04	347.97	73836
4220	4-5 Oth ADG Comb, Age < 17, 1+ major ADGs	3068	979.22	3.52	48.34	148.03	230.40	610.65	73873
4310	4-5 Oth ADG Comb, Age 17-44, no major ADGs	16261	430.42	1.8	14.64	146.72	221.52	400.69	29158
4320	4-5 Oth ADG Comb, Age 17-44, 1 major ADGs	10835	928.72	4.12	32.70	167.05	282.50	680.98	171461
4330	4-5 Oth ADG Comb, Age 17-44, 2+ major ADGs	2617	2582.70	2.55	61.16	230.80	583.63	2372.70	113587
4410	4-5 Oth ADG Comb, Age > 44, no major ADGs	22582	573.74	2.56	40.85	181.71	278.07	484.62	131817
4420	4-5 Oth ADG Comb, Age > 44, 1 major ADGs	26010	1585.80	3.84	15.39	222.83	379.58	892.23	181238
4430	4-5 Oth ADG Comb, Age > 44, 2+ major ADGs	11805	6309.50	2.51	62.84	359.00	1315.40	5490.40	202524
4510	6-9 Oth ADG Comb, Age < 6, no major ADGs	1509	1258.60	2.36	102.84	294.16	450.29	1088.60	55885
4520	6-9 Oth ADG Comb, Age < 6, 1+ major ADGs	773	4035.80	3.61	115.11	331.68	754.56	2375.10	312089
4610	6-9 Oth ADG Comb, Age 6-16, no major ADGs	1553	868.65	4.17	92.30	231.63	334.73	574.30	83990
4620	6-9 Oth ADG Comb, Age 6-16, 1+ major ADGs	989	2817.40	2.86	97.35	297.42	582.52	1772.50	101525
4710	6-9 Oth ADG Comb, Male Age 17-34,0 Maj ADG	701	849.35	8.69	97.50	231.22	335.45	596.50	194910
4720	6-9 Oth ADG Comb, Male Age 17-34,1 Maj ADG	1298	1186.70	2.12	94.54	285.32	477.33	1069.40	32192
4730	6-9 Oth ADG Comb, Male Age 17-34,2+majADG	959	6366.90	3.45	113.17	408.17	1157.80	3852.60	317978
4810	6-9 Oth ADG Comb, FemalAge17-34,0majADGs	2988	702.22	1.40	93.98	264.68	398.80	751.70	20312
4820	6-9 Oth ADG Comb, FemalAge17-34,1majADGs	2612	1211.70	2.36	94.50	307.51	529.83	1188.30	82790
4830	6-9 Oth ADG Comb,FemalAge17-34,2+majADG	980	4168.60	2.60	73.53	513.22	1220.10	3317.90	173364
4910	6-9 Oth ADG Comb, Age > 34, 0-1 major ADGs	32967	1674.10	2.77	92.41	352.73	603.26	1311.70	165630
4920	6-9 Oth ADG Comb, Age > 34, 2 major ADGs	14659	5956.20	2.36	49.92	588.35	1578.40	5549.70	301024
4930	6-9 Oth ADG Comb, Age > 34, 3 major ADGs	6368	12483.00	1.59	68.18	1822.20	5907.20	4555.70	199070
4940	6-9 Oth ADG Comb, Age > 34, 4+ major ADGs	2174	22325.00	1.30	166.32	5950.80	13731.00	6142.80	335884
5010	10+ Oth ADG Comb, Age 1-16, no major ADGs	78	4556.00	2.20	270.92	606.40	1207.40	3452.40	65870
5020	10+ Oth ADG Comb, Age 1-16, 1 major ADGs	90	7771.10	2.21	250.69	649.61	1697.40	9836.80	140091
5030	10+ Oth ADG Comb, Age 1-16, 2+ major ADGs	82	35684.00	1.40	378.31	5914.60	19815.00	8116.40	337440
5040	10+ Oth ADG Comb, Age > 16, 0-1 major ADGs	2865	2396.50	2.29	218.45	702.66	1149.70	2302.40	159741
5050	10+ Oth ADG Comb, Age > 16, 2 major ADGs	3038	6006.10	1.92	197.94	1039.20	2240.60	6013.20	182018
5060	10+ Oth ADG Comb, Age > 16, 3 major ADGs	2401	13214.00	1.68	236.68	2088.20	6222.80	5132.20	404082
5070	10+ Oth ADG Comb, Age > 16, 4+ major ADGs	2332	25051.00	1.06	309.59	7536.10	16770.00	2700.30	277861
5110	No Diagnosis or Only Unclassified Diagnoses	87	292.43	2.16	15.80	42.57	120.41	215.20	4510

ACG Description		n	Mean ($)	Cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
5311	Infants: 0-5 ADGs, no maj ADG, low birth wgt	261	1786.20	1.00	307.25	762.01	1181.20	1904.20	12698
5312	Infants: 0-5 ADGs, no maj ADG, norm brth wgt	12123	743.52	0.87	15.85	476.65	592.80	820.30	14639
5321	Infants: 0-5 ADGs, 1+ maj ADG, low birth wgt	244	5316.80	0.90	371.80	1654.50	3892.50	7813.50	29983
5322	Infants: 0-5 ADGs, 1+ maj ADG, norm brth wgt	1403	1733.80	1.66	88.50	669.65	974.62	1785.40	60171
5331	Infants: 6+ ADGs, no maj ADG, low birth wgt	21	2746.60	0.93	534.15	1124.90	1618.50	4231.70	10977
5332	Infants: 6+ ADGs, no maj ADG, norm brth wgt	717	1833.00	1.37	376.99	779.50	1069.20	1908.70	41718
5341	Infants: 6+ ADGs, 1+ maj ADG, low birth wgt	143	12272.00	0.93	750.25	4048.90	8137.00	7618.70	81925
5342	Infants: 6+ ADGs, 1+ maj ADG, norm brth wgt	583	5664.50	1.55	260.99	1258.50	2315.30	5751.50	81484
	All ACGs	940634	940.02	5.64	3.09	53.72	128.71	346.30	404082

Mean=mean cost per ACG; cv=coefficient of variation (standard deviation/mean); min=minimum value; 25° =25th percentile; 50° =median value; 75° =75th percentile; max=maximum value.

* expenditures include physician expenditures (interview, procedure, non-hospital laboratory & diagnostic imaging payments) and hospital expenditures (see Appendix II).

residents, the variation was just over 100-fold. In general, the ranking of the resource intensity weights was similar across populations; those ACGs with the highest weights in Manitoba also had the highest weights in both U.S. enrolled populations. The weights for Manitoba appear to follow the HMO weights more closely than the Medicaid weights, with small differences between the weights for most ACGs. There were a few notable exceptions. Psychosocial ACGs (ACGs 1400, 1500, 2600) which appeared relatively less expensive in the HMO compared to Manitoba. This surprising finding was likely related to the fact that mental health services were ‘carved-out’ of the basic HMO benefit package.[2] Also, the weights for ACGs for relatively sick infants (i.e., those with major ADGs) were lower in Manitoba than in the HMO. This finding may have been related to the imprecise nature of the Manitoba infant physician and hospital expenditure data and/or less intensive care for very small infants. There appeared to be some large differences in the relative expenditures when Manitoba weights were compared to the Medicaid weights, especially in the most resource-intensive categories. The origins of these differences were unclear, but may have been related to the fact that Medicaid populations face access problems for primary care services and rely more heavily on emergency room services.

[2] A ‘carve-out’ refers to a set of medical services that are excluded from a health plan’s basic benefit package and contracted for separately (Kongstvedt 1996).

Table 5: Comparison of Relative Expenditures* for Physician Services By ACG, Manitoba versus B.C., 1995/96

		*Relative Costs**		*%*
ACG	***ACG Description***	***Manitoba***	***B.C.***	***Difference*** **
100	Acute Minor Age 1-2	0.40	0.41	-2.50
200	Acute Minor Age 2-5	0.27	0.34	-25.93
300	Acute Minor Age 6+	0.23	0.27	-17.39
400	Acute Major	0.35	0.27	22.86
500	Likely to Recur, without Allergies	0.26	0.21	19.23
600	Likely to Recur, with Allergies	0.30	0.25	16.67
700	Asthma	0.22	0.25	-13.64
800	Chronic Medical, Unstable	0.59	0.49	16.95
900	Chronic Medical, Stable	0.37	0.34	8.11
1000	Chronic Specialty, Stable	0.22	0.20	9.09
1100	Ophthalmological / Dental	0.25	0.19	24.00
1200	Chronic Specialty, Unstable	0.29	0.26	10.34
1300	Psychosocial, without Psychosocial Unstable	0.54	0.59	-9.26
1400	Psychosocial, with Psychosocial Unstable, c/o Psychos'l,Stable	0.97	0.67	30.93
1500	Psychosocial, with Psychosocial Unstable, c/ Psychos'l Stable	2.33	2.14	8.15
1600	Preventive / Administrative	0.22	0.14	36.36
1710	Pregnancy: 0-1 ADGs	0.54	0.18	66.67
1720	Pregnancy: 2-3 ADGs, no major ADGs	0.86	0.87	-1.16
1730	Pregnancy: 2-3 ADGs, 1+ major ADGs	0.92	0.89	3.26
1740	Pregnancy: 4-5 ADGs, no major ADGs	1.25	1.58	-26.40
1750	Pregnancy: 4-5 ADGs, 1+ major ADGs	1.44	1.72	-19.44
1760	Pregnancy: 6+ ADGs, no major ADGs	1.84	2.69	-46.20
1770	Pregnancy: 6+ ADGs, 1+ major ADGs	2.52	3.76	-49.21
1800	Acute Minor and Acute Major	0.60	0.72	-20.00
1900	Acute Minor and Likely to Recur, Age 1-2	0.80	0.83	-3.75
2000	Acute Minor and Likely to Recur, Age 2-5	0.59	0.68	-15.25
2100	Acute Minor and Likely to Recur, Age >5, without Allergy	0.51	0.56	-9.80
2200	Acute Minor and Likely to Recur, Age >5, with Allergy	0.61	0.68	-11.48
2300	Acute Minor and Chronic Medical: Stable	0.60	0.63	-5.00
2400	Acute Minor and Eye / Dental	0.47	0.48	-2.13
2500	Acute Minor with Psychosocial Stable c/o Psychos'l Unstable	0.71	0.94	-32.39
2600	Acute Minor without Psychosocial Stable c/ Psychos'l Unstable	1.02	1.25	-22.55
2700	Acute Minor with Psychosocial Stable and Unstable	2.58	3.04	-17.83
2800	Acute Major and Likely to Recur	0.72	0.54	25.00
2900	Acute Minor /Acute Major / Likely to Recur, Age 1-2	1.24	1.36	-9.68
3000	Acute Minor /Acute Major / Likely to Recur, Age 2-5	0.94	1.13	-20.21
3100	Acute Minor /Acute Major / Likely to Recur, Age 6-11	0.84	1.00	-19.05
3200	Acute Minor /Acute Major / Likely to Recur, Age>11 c/o All.	1.09	1.20	-10.09
3300	Acute Minor /Acute Major / Likely to Recur, Age>11 c/ All.	1.13	1.38	-22.12
3400	Acute Minor / Likely to Recur / Eye & Dental	0.79	0.78	1.27
3500	Acute Minor / Likely to Recur / Psychosocial	1.19	1.34	-12.61

		*Relative Costs**		%
ACG	***ACG Description***	***Manitoba***	***B.C.***	***Difference*****
3600	Acute Minor / Acute Major / Likely to Recur / Eye & Dental	1.83	1.78	2.73
3700	Acute Minor / Acute Major / Likely to Recur / Eye & Dental	1.90	2.33	-22.63
3800	2-3 Other ADG Combinations, Age < 17	0.58	0.63	-8.62
3900	2-3 Other ADG Combinations, Males Age 17-34	0.71	0.68	4.23
4000	2-3 Other ADG Combinations, Females Age 17-34	0.76	0.70	7.89
4100	2-3 Other ADG Combinations, Age > 34	0.97	0.79	18.56
4210	4-5 Other ADG Combinations, Age < 17, no major ADGs	1.01	1.14	-12.87
4220	4-5 Other ADG Combinations, Age < 17, 1+ major ADGs	1.31	1.22	6.87
4310	4-5 Other ADG Combinations, Age 17-44, no major ADGs	1.15	1.19	-3.48
4320	4-5 Other ADG Combinations, Age 17-44, 1 major ADGs	1.52	1.38	9.21
4330	4-5 Other ADG Combinations, Age 17-44, 2+ major ADGs	2.41	1.57	34.85
4410	4-5 Other ADG Combinations, Age > 44, no major ADGs	1.40	1.26	10.00
4420	4-5 Other ADG Combinations, Age > 44, 1 major ADGs	1.85	1.53	17.30
4430	4-5 Other ADG Combinations, Age > 44, 2+ major ADGs	2.84	2.14	24.65
4510	6-9 Other ADG Combinations, Age < 6, no major ADGs	1.79	2.14	-19.55
4520	6-9 Other ADG Combinations, Age < 6, 1+ major ADGs	2.69	2.42	10.04
4610	6-9 Other ADG Combinations, Age 6-16, no major ADGs	1.63	1.89	-15.95
4620	6-9 Other ADG Combinations, Age 6-16, 1+ major ADGs	2.62	2.35	10.31
4710	6-9 Other ADG Combinations, Males Age 17-34, no maj. ADGs	1.68	2.29	-36.31
4720	6-9 Other ADG Combinations, Males Age 17-34, 1 major ADGs	2.21	2.52	-14.03
4730	6-9 Other ADG Combinations, Males Age 17-34, 2+ maj. ADGs	3.73	2.71	27.35
4810	6-9 Other ADG Combinations, FemalesAge 17-34, 0 maj ADGs	1.83	2.16	-18.03
4820	6-9 Other ADG Combinations, FemalesAge 17-34, 1 maj ADGs	2.27	2.49	-9.69
4830	6-9 Other ADG Combinations, FemalesAge 17-34,2+maj ADGs	3.67	3.28	10.63
4910	6-9 Other ADG Combinations, Age > 34, 0-1 major ADGs	2.56	2.38	7.03
4920	6-9 Other ADG Combinations, Age > 34, 2 major ADGs	3.78	3.20	15.34
4930	6-9 Other ADG Combinations, Age > 34, 3 major ADGs	5.50	4.35	20.91
4940	6-9 Other ADG Combinations, Age > 34, 4+ major ADGs	8.21	6.09	25.82
5010	10+ Other ADG Combinations, Age 1-16, no major ADGs	4.04	3.91	3.22
5020	10+ Other ADG Combinations, Age 1-16, 1 major ADGs	4.74	4.26	10.13
5030	10+ Other ADG Combinations, Age 1-16, 2+ major ADGs	11.56	5.51	52.34
5040	10+ Other ADG Combinations, Age > 16, 0-1 major ADGs	4.11	4.33	-5.35
5050	10+ Other ADG Combinations, Age > 16, 2 major ADGs	5.43	5.11	5.89
5060	10+ Other ADG Combinations, Age > 16, 3 major ADGs	7.19	6.34	11.82
5070	10+ Other ADG Combinations, Age > 16, 4+ major ADGs	10.84	8.32	23.25
5110	No Diagnosis or Only Unclassified Diagnoses	0.51	0.19	62.75
5200	Non-Users	0.00	0.00	0.00
5310	Infants: 0-5 ADGs, no major ADGs	0.72	1.05	-45.83
5320	Infants: 0-5 ADGs, 1+ major ADGs	1.16	1.22	-5.17
5330	Infants: 6+ ADGs, no major ADGs	1.83	2.40	-31.15
5340	Infants: 6+ ADGs, 1+ major ADGs	3.04	3.82	-25.66

* relative costs for each ACG were calculated by dividing the ACG-specific mean expenditures by the mean expenditure for all ACGs. Outliers in excess of 3 standard deviations from the mean were trimmed.
** refers to the difference in relative health care costs between Manitoba residents and B.C. residents.

Figure 2: Manitoba and B.C Relative Weights 1995/96, Part 1

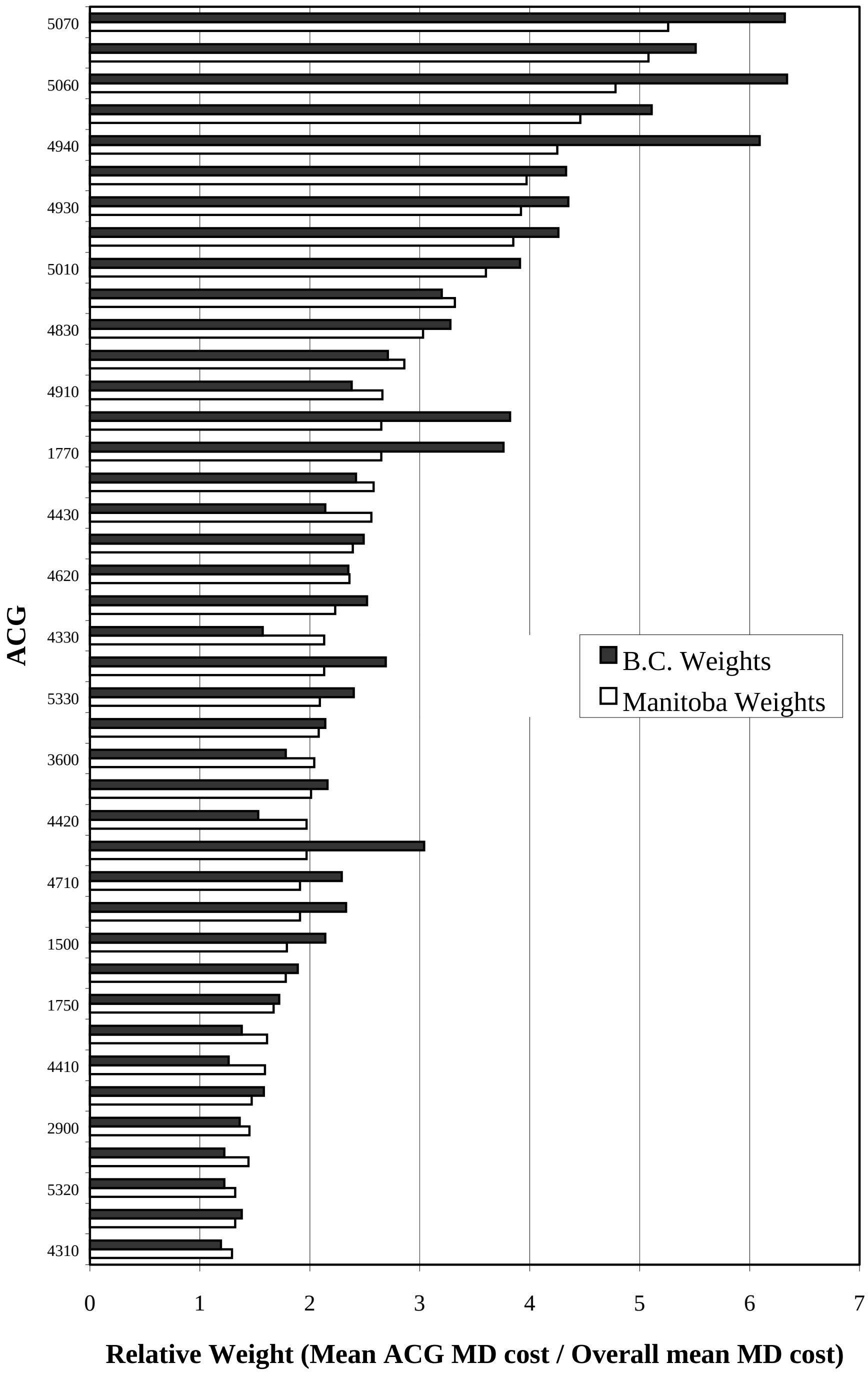


Figure 2: Manitoba and B.C Relative Weights 1995/96, Part 2

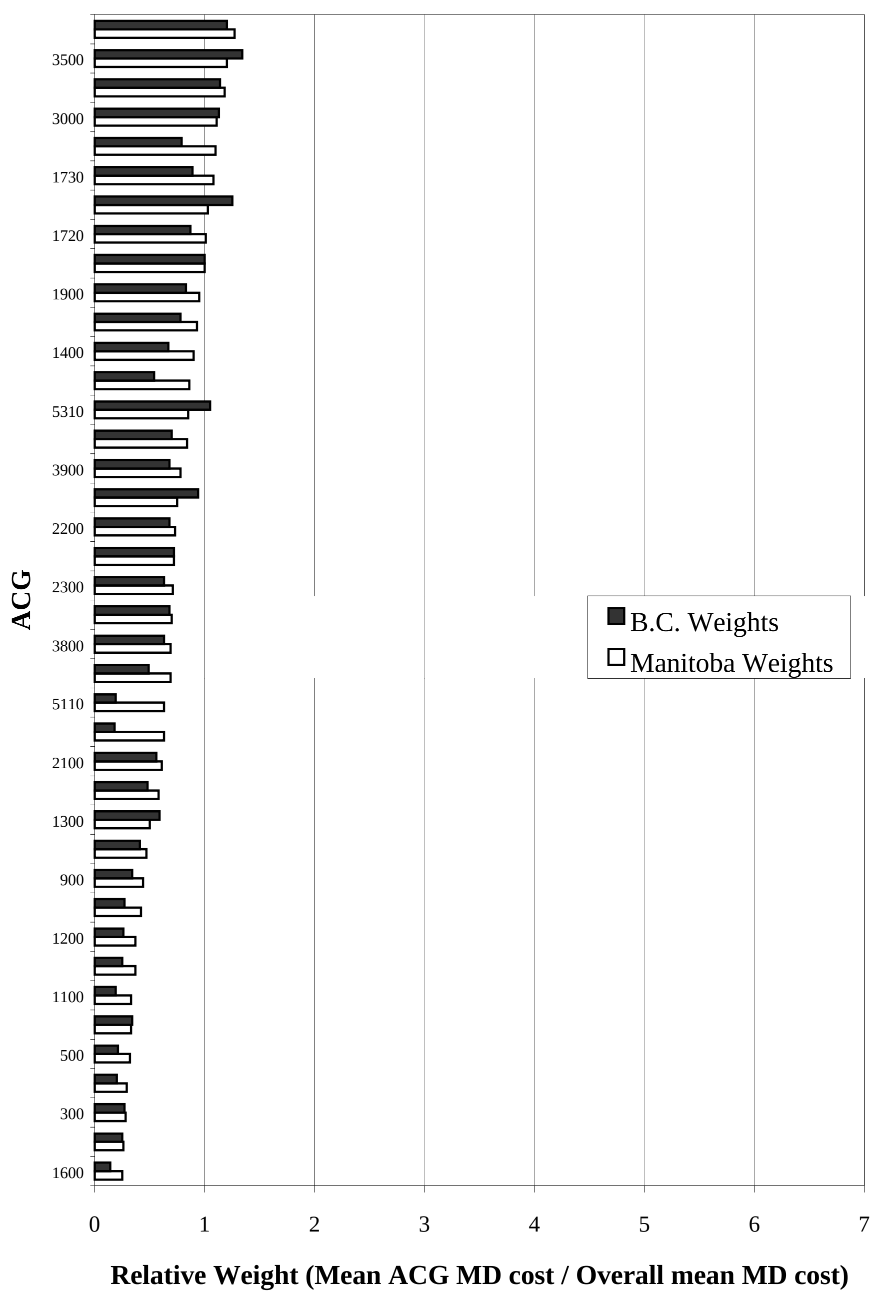


Table 6: Comparison of Relative Expenditures* for Inpatient & Physician Services By ACG - Manitoba, Minnesota Medicaid, and one Health Maintenance Organization (HMO)

ACG Description	*Manitoba Residents*	*Minnesota Medicaid*	*% Diff.***	*U.S. Staff-model HMO*	*% Diff.***
100 Acute minor, age1	0.14	0.36	-157.14	0.10	28.57
200 Acute minor, age2-5	0.09	0.29	-222.22	0.06	33.33
300 Acute minor, age 6+	0.08	0.29	-262.50	0.11	-37.50
400 Acute: major	0.21	0.58	-176.19	0.28	-33.33
500 Likely to recur, without allergies	0.11	0.31	-181.82	0.14	-27.27
600 Likely to recur, with allergies	0.11	0.24	-118.18	0.16	-45.45
700 Asthma	0.08	0.24	-200.00	0.11	-37.50
800 Chronic medical, unstable	0.91	0.93	-2.20	0.28	69.23
900 Chronic medical, stable	0.12	0.47	-291.67	0.10	16.67
1000 Chronic specialty	0.08	0.24	-200.00	0.09	-12.50
1100 Ophthalmological/ dental	0.11	0.24	-118.18	0.08	27.27
1200 Chronic specialty, unstable	0.12	0.33	-175.00	0.22	-83.33
1300 Psych, without psychosocial unstable	0.20	1.40	-600.00	0.13	35.00
1400 Psych, with psychosocial unstable	1.62	2.83	-74.69	0.17	89.51
1500 Psych, with psych unstable & psych stable	2.86	3.87	-35.31	0.12	95.80
1600 Preventive/administrative	0.07	0.22	-214.29	0.05	28.57
1710 Pregnancy 0-1 ADGs	1.67	0.56	66.47	2.53	-51.50
1720 Pregnancy 2-3 ADGs, no major ADGs	1.80	1.08	40.00	2.86	-58.89
1730 Pregnancy 2-3 ADGs, 1+ major ADGs	2.58	1.24	51.94	3.97	-53.88
1740 Pregnancy 4-5 ADGs, no major ADGs	1.95	1.61	17.44	3.62	-85.64
1750 Pregnancy 4-5 ADGs, 1+ major ADGs	2.96	1.92	35.14	4.42	-49.32
1760 Pregnancy 6+ ADGs, no major ADGs	2.17	2.75	-26.73	4.62	-112.90
1770 Pregnancy 6+ ADGs, 1+ major ADGs	3.75	4.69	-25.07	6.86	-82.93
1800 Acute min and acute major	0.33	0.84	-154.55	0.53	-60.61
1900 Acute min and LTR, age1	0.30	0.71	-136.67	0.23	23.33
2000 Acute min and LTR, age 2-5	0.20	0.53	-165.00	0.18	10.00
2100 Acute min and LTR, age>5, w/o allergy	0.20	0.52	-160.00	0.31	-55.00
2200 Acute min and LTR, age>5, w/ allergy	0.21	0.56	-166.67	0.39	-85.71
2300 Acute minor and chronic medical: stable	0.20	0.51	-155.00	0.21	-5.00
2400 Acute minor and eye/dental	0.19	0.47	-147.37	0.21	-10.53
2500 Acute minor & psych w/o psych unstable	0.26	1.48	-469.23	0.23	11.54
2600 Acute minor & psycho w/o psych unstab	1.16	3.05	-162.93	0.23	80.17
2700 Acute min & psych w/ psych unstab/stab	2.24	5.08	-126.79	2.30	-2.68
2800 Acute major and likely to recur	0.44	0.84	-90.91	0.70	-59.09
2900 Acute min/acute major/LTR, age 1	0.80	1.66	-107.50	0.86	-7.50
3000 Acute min/acute major/LTR, age 2-5	0.43	1.28	-197.67	0.57	-32.56
3100 Acute min/acute major/LTR, age 6-11	0.39	1.11	-184.62	0.81	-107.69
3200 Acute min/acute maj/LTR, age 12+, no all	0.60	1.37	-128.33	1.13	-88.33
3300 Acute min/acute maj/LTR, age 12+, all	0.48	1.25	-160.42	1.38	-187.50
3400 Acute minor/likely to recur/eye & dental	0.33	0.74	-124.24	0.40	-21.21
3500 Acute minor/likely to recur/psychosocial	0.56	1.79	-219.64	0.46	17.86

ACG Description	*Manitoba Residents*	*Minnesota Medicaid*	*% Diff.***	*U.S. Staff-model HMO*	*% Diff.***
3600 Acute Minor &Major/LTR/Eye & Dent	1.24	2.55	-105.65	2.01	-62.10
3700 Acute Minor & Major/LTR/Psych	1.23	3.04	-147.15	1.24	-0.81
3800 2-3 Other ADG Comb <17y	0.30	1.34	-346.67	0.33	-10.00
3900 2-3 Other ADG Comb Males 17-34y	0.46	2.17	-371.74	0.53	-15.22
4000 2-3 Other ADG Comb Females 17-34y	0.37	0.85	-129.73	0.46	-24.32
4100 2-3 Other ADG Comb Age >34y	0.77	1.03	-33.77	0.60	22.08
4210 4-5 Other ADG Comb <17y 0 maj ADGs	0.54	1.94	-259.26	0.68	-25.93
4220 4-5 Other ADG Comb <17y 1+ maj ADGs	1.00	2.75	-175.00	1.24	-24.00
4310 4-5 Other ADG Comb 17-44y 0 mj ADGs	0.49	1.15	-134.69	0.83	-69.39
4320 4-5 Other ADG Comb 17-44y 1 mj ADGs	0.97	1.83	-88.66	1.54	-58.76
4330 4-5 Other ADG Comb 17-44y 2+mj ADG	2.78	3.83	-37.77	2.99	-7.55
4410 4-5 Other ADG Comb >44y 0 maj ADGs	0.64	0.87	-35.94	0.81	-26.56
4420 4-5 Other ADG Comb >44y 1 maj ADG	1.58	2.13	-34.81	1.84	-16.46
4430 4-5 Other ADG Comb > 44 2+ maj ADGs	6.48	2.75	57.56	4.60	29.01
4510 6-9 Other ADG Comb <6y 0 maj ADGs	1.35	2.81	-108.15	1.53	-13.33
4520 6-9 Other ADG Comb < 61 + maj ADGs	4.22	5.47	-29.62	3.28	22.27
4610 6-9 Other ADG Comb 6-16y no mj ADGs	0.87	2.50	-187.36	1.34	-54.02
4620 6-9 Other ADG Comb 6-16y 1+maj ADGs	2.93	6.50	-121.84	4.01	-36.86
4710 6-9 Oth ADG Comb M 17-34y 0mj ADGs	0.74	3.56	-381.08	2.07	-179.73
4720 6-9 Oth ADG Comb M 17-34y 1 mj ADG	1.29	5.03	-289.92	2.06	-59.69
4730 6-9 Oth ADG Comb M 17-34y 2+mjADG	6.33	10.05	-58.77	6.18	2.37
4810 6-9 Oth ADG Comb F 17-34 0 maj ADGs	0.81	2.19	-170.37	1.61	-98.77
4820 6-9 Oth ADG Comb F 17-34y 1 maj ADG	1.35	2.95	-118.52	2.44	-80.74
4830 6-9 Oth ADG Comb F 17-34y 2+mj ADG	4.42	5.52	-24.89	5.45	-23.30
4910 6-9 Oth ADG Comb >34y 0-1 maj ADGs	1.79	2.69	-50.28	2.50	-39.66
4920 6-9 Oth ADG Comb >34y 2 maj ADGs	6.34	5.27	16.88	5.78	8.83
4930 6-9 Oth ADG Comb > 34 3 maj ADGs	13.83	9.83	28.92	12.17	12.00
4940 6-9 Oth ADG Comb >34y 4+maj ADGs	25.63	14.64	42.88	20.35	20.60
5010 10+ Oth ADG Comb 1-16 0 maj ADGs	4.87	5.24	-7.60	6.20	-27.31
5020 10+ Oth ADG Comb 1-16y 1 maj ADG	8.41	13.25	-57.55	5.27	37.34
5030 10+ Oth ADG Comb 1-16, 2+maj ADG	41.22	44.55	-8.08	22.87	44.52
5040 10+ Oth ADG Comb >16y 0-1maj ADGs	2.68	5.11	-90.67	3.97	-48.13
5050 10+ Oth ADG Comb >16y 2 maj ADGs	6.69	8.00	-19.58	6.46	3.44
5060 10+ Oth ADG Comb >16y 3 maj ADGs	14.92	16.66	-11.66	13.63	8.65
5070 10+ Oth ADG Comb >16y 4+maj ADGs	29.50	47.09	-59.63	27.83	5.66
5110 No Diagnosis or Only Unclass Diagnosis	0.31	0.18	41.94	0.14	54.84
5200 Non-Users	0.00	0.00	0.00	0.00	0.00
5310 Infants: 0-5 ADGs, no major ADGs	0.90	1.64	-82.22	2.78	-208.89
5320 Infants: 0-5 ADGs, 1 + major ADGs	2.63	2.33	11.41	12.35	-369.58
5330 Infants: 6+ ADGs, no major ADGs	2.15	3.52	-63.72	3.42	-59.07
5340 Infants: 6 + ADGs, 1 + major ADGs	8.14	8.93	-9.71	14.79	-81.70

*Refers to the difference in relative health care expenditures between Manitoba residents and enrolees in Minnesota's Medicaid plan and one U.S. staff-model HMO. For the Manitoba population, Outliers in excess of 3 standard deviations from the mean were trimmed.
** Differences between Manitoba and Minnesota Medicaid or Manitoba and HMO relative expenditures.

5. ABILITY TO EXPLAIN CONCURRENT HEALTH CARE EXPENDITURES

A series of multiple linear regression models were constructed in order to compare the ability of different case-mix variables to explain concurrent (i.e., same year) health care expenditures. For this set of analyses we used physician and total expenditures as the dependent variables in a parallel set of regressions. The predictive power of the following models were compared: age and gender alone; age, gender, and income level; age, gender and ADGs; ACGs alone; ACGs and income level. Income was operationalized for Winnipeg residents using an ecological variable based on the average income of the resident's neighbourhood. Winnipeg residents were assigned the income quintile of the neighbourhood in which they resided in 1995/96. The following is a description of how the independent variables were operationalized for entry into the models:

Variable	*Type*	*Levels*	*Data Source*
Age	Ordinal	0-1, 2-5, 6-11, 12-16, 17-34, 35-44, 45-64, 65+	Enrolee File
Gender	Nominal	Male; Female	Enrolee File
Neighbourhood Income	Nominal	Yes; No	Enrolee File
ADGs	Nominal	32 dummy variables	Claims/Abstracts
ACGs	Nominal	92 dummy variables	Claims/Abstracts

Given that the distributions of the expenditure variables were significantly right skewed, violating the normality assumption of general linear regression, ACG-specific outliers (defined as persons with expenditures three standard deviations above the ACG-specific mean) were trimmed from the analyses. Table 7 presents the adjusted R-squared values obtained using different case-mix models with concurrent physician and total expenditures used as the dependent variables for the Winnipeg only and the total Manitoba population. Because income quintile data is available only for Winnipeg residents, the models that used neighbourhood income level as a covariate were only specified for this population.

For Winnipeg residents and for all Manitobans, age and gender groupings alone explained only about 9% of physicians' expenditures and less than 5% of total expenditures. The explanatory power of the models appeared unchanged when the neighbourhood-level income variable (i.e., dummy variables for each neighbourhood income quintile) was added to the

Table 7: Explanatory Power of Various Case-Mix Models in Winnipeg and Manitoba, 1995/96, Physician Expenditures vs. Total Expenditures (Physician & Inpatient)

Model:	*Winnipeg Only (n=524,386)* MD Costs	Tot Costs	*All Manitoba (n=939,156)* MD Costs	Tot Costs
Age & Gender	0.089	0.039	0.083	0.045
Age, Gender, & Income	0.091	0.040	n/a	n/a
Age, Gender, & ADGs	0.524	0.274	0.506	0.277
ACGs Only	0.496	0.328	0.480	0.324
ACGs & Income	0.496	0.328	n/a	n/a

Note: Values represent adjusted R-squared values from general linear models. The income variable was specified for Winnipeg residents only.

model for Winnipeg residents. There was a substantial increase in the R-squared values, however, when the 32 binomial ADGs were added. In the Manitoba population as a whole, approximately 51% and 27% of the variations in physician and total expenditures respectively were explained by the age, gender and ADGs variables. Table 8 presents the parameter estimates for two models used to predict total expenditures: 1) age, gender, and ADG; and 2) ACGs only. When the regression models were limited to Winnipeg residents only, the predictive ability of the age / gender / ADG model improved somewhat for physician expenditures (52%) but slightly worsened for total expenditures (27%). For the ACG-only models, there was a marginal gain of some explanatory power for both physician expenditures (50%) and total expenditures (33%). It is interesting to note that the ADG / age / gender model performed better than the ACG-only model for physician expenditures but not for total expenditures. Little additional power was gained by adding neighbourhood-level income to the ACG-only model.

Table 9 presents the adjusted R-squared values for the regression analyses stratified by age group and by neighbourhood income. Again, while the age-related analyses used the total Manitoba population as the base, those using neighbourhood income were limited to Winnipeg residents. For the physician expenditure analyses, several differences in the

Table 8: Regression Coefficients of Age/Sex/ADG & ACG Models To Explain Total Expenditures

Model I: Age/Sex & ADGs				Model II: ACGs Only							
Variable	• coeff.	SE	P-val.	Variable	• coeff.	SE	P-val.	Variable	• coeff.	SE	P-val.
INCPT	-633.52	10.27	0.0001	INCPT	186.49	8.03	0.0001	ACG31	132.71	40.41	0.0010
FEMALE	-82.00	6.82	0.0001	ACG1	-75.39	65.12	0.2470	ACG32	307.85	18.45	0.0001
AGE0-1	-20.33	20.61	0.3240	ACG2	-115.53	27.66	0.0001	ACG33	207.59	59.42	0.0005
AGE2-5	29.75	15.92	0.0617	ACG4	-13.27	18.25	0.4673	ACG34	82.89	45.37	0.0677
AGE6-11	209.39	14.25	0.0001	ACG5	-97.91	16.55	0.0001	ACG35	270.39	33.74	0.0001
AGE12-16	204.96	15.37	0.0001	ACG6	-100.49	59.89	0.0934	ACG36	826.45	24.97	0.0001
AGE17-34	1.06	10.76	0.9216	ACG7	-123.65	52.06	0.0175	ACG37	821.89	31.48	0.0001
AGE45-64	-25.06	11.31	0.0267	ACG8	560.87	38.27	0.0001	ACG38	62.63	25.90	0.0156
AGE65+	597.36	13.22	0.0001	ACG9	-90.50	21.20	0.0001	ACG39	186.32	31.53	0.0001
ADG 1	-57.33	7.53	0.0001	ACG10	-119.49	92.51	0.1965	ACG40	113.63	30.87	0.0002
ADG 2	155.30	6.85	0.0001	ACG11	-93.23	34.29	0.0065	ACG41	440.37	13.11	0.0001
ADG 3	4018.51	19.10	0.0001	ACG12	-92.42	55.10	0.0935	ACG421	253.65	33.19	0.0001
ADG 4	1680.53	16.24	0.0001	ACG13	-25.30	35.58	0.4770	ACG422	627.52	55.44	0.0001
ADG 5	-159.61	18.66	0.0001	ACG14	1134.41	86.32	0.0001	ACG431	213.52	25.14	0.0001
ADG 6	107.67	15.55	0.0001	ACG15	2149.22	132.48	0.0001	ACG432	605.51	30.28	0.0001
ADG 7	107.43	9.48	0.0001	ACG16	-132.11	20.19	0.0001	ACG433	2084.31	59.95	0.0001
ADG 8	209.33	8.34	0.0001	ACG1711	1569.78	83.03	0.0001	ACG441	338.30	21.76	0.0001
ADG 9	5098.67	26.40	0.0001	ACG1712	-57.12	147.26	0.6981	ACG442	1103.28	20.51	0.0001
ADG 10	249.60	8.61	0.0001	ACG1721	1780.73	43.86	0.0001	ACG443	5113.12	29.30	0.0001
ADG 11	1685.14	11.79	0.0001	ACG1722	75.51	67.80	0.2654	ACG451	917.04	78.63	0.0001
ADG 12	994.52	26.97	0.0001	ACG1731	2204.79	102.17	0.0001	ACG452	3264.18	109.58	0.0001
ADG 13	-116.09	32.85	0.0004	ACG1732	588.40	221.16	0.0078	ACG461	524.88	77.52	0.0001
ADG 14	-33.90	12.84	0.0083	ACG1741	2096.87	54.71	0.0001	ACG462	2207.72	96.95	0.0001
ADG 16	849.33	35.82	0.0001	ACG1742	284.91	69.84	0.0001	ACG471	417.60	115.04	0.0003
ADG 17	-291.06	41.90	0.0001	ACG1751	2720.53	76.69	0.0001	ACG472	867.41	84.72	0.0001
ADG 18	-47.88	16.92	0.0047	ACG1752	951.19	123.59	0.0001	ACG473	4989.07	98.55	0.0001
ADG 20	-92.17	10.26	0.0001	ACG1761	2502.24	79.93	0.0001	ACG481	475.75	56.16	0.0001
ADG 21	-15.24	8.96	0.0890	ACG1762	552.67	84.85	0.0001	ACG482	915.35	59.99	0.0001
ADG 22	1020.26	10.07	0.0001	ACG1771	3744.13	69.77	0.0001	ACG483	3429.16	97.39	0.0001
ADG 23	840.59	20.73	0.0001	ACG1772	1630.89	83.42	0.0001	ACG491	1277.87	18.57	0.0001
ADG 24	92.61	11.17	0.0001	ACG18	83.54	15.47	0.0001	ACG492	4998.90	26.42	0.0001
ADG 25	3564.34	22.61	0.0001	ACG19	58.17	42.36	0.1696	ACG493	11121.0	39.15	0.0001
ADG 26	47.96	8.44	0.0001	ACG20	-20.29	25.64	0.4287	ACG494	20772.0	66.39	0.0001
ADG 27	327.01	8.54	0.0001	ACG21	-20.75	14.69	0.1576	ACG501	3792.04	344.14	0.0001
ADG 28	777.91	10.12	0.0001	ACG22	-12.70	42.74	0.7663	ACG502	6686.82	320.39	0.0001
ADG 29	302.46	12.06	0.0001	ACG23	-22.91	21.94	0.2963	ACG503	33516.0	335.64	0.0001
ADG 30	1501.37	43.24	0.0001	ACG24	-30.00	37.28	0.4209	ACG504	2006.77	57.34	0.0001
ADG 31	642.86	7.37	0.0001	ACG25	23.92	32.23	0.4581	ACG505	5281.74	55.75	0.0001
ADG 32	2481.67	21.16	0.0001	ACG26	762.16	106.80	0.0001	ACG506	12013.0	62.71	0.0001
ADG 33	368.24	21.85	0.0001	ACG27	1647.06	133.11	0.0001	ACG507	23936.0	63.70	0.0001
ADG 34	180.33	31.79	0.0001	ACG28	169.29	24.81	0.0001	ACG511	70.38	327.75	0.8300
Note: ADG 15 & 19 are not used				ACG29	467.03	54.76	0.0001				
by v. 4.0 of the ACG software				ACG30	162.60	36.56	0.0001				

The majority of individuals were in ACG 0300 (ACG3). It was used as the reference category for the regression analysis.

Table 9: Explanatory Power of ACG/ADG Case-mix Models by Age Group & Income Quintile in Manitoba, 1995/96, Physician Expenditures vs. Total Expenditures (Physician & Inpatient)

	Physician Costs Only			*Total (Physician & Inpatient) Costs*		
	Age & Sex	*Age, Sex & ADGs*	*ACGs Only*	*Age & Sex*	*Age, Sex & ADGs*	*ACGs Only*
All Ages & Incomes	0.083	0.506	0.480	0.045	0.272	0.324
Age Groups:						
Children (<17 yrs)	0.042	0.481	0.328	0.028	0.225	0.237
Adults (17-64 yrs)	0.026	0.482	0.447	0.005	0.245	0.305
Seniors (>64 yrs)	0.001	0.500	0.456	0.001	0.341	0.310
Income Quintile (Winnipeg residents only):						
Q1 (lowest)	0.089	0.531	0.499	0.042	0.285	0.334
Q2	0.090	0.528	0.508	0.039	0.280	0.341
Q3	0.093	0.527	0.499	0.040	0.287	0.334
Q4	0.086	0.520	0.491	0.037	0.259	0.315
Q5 (highest)	0.086	0.515	0.483	0.035	0.260	0.318

Note: Values represent adjusted R-squared values from general linear models. Since the income variable was specified for Winnipeg residents only, these analyses are based only on this subset of Manitobans.

performance of the ADG and ACG models across the age strata are apparent. The predictive ability of both models increased slightly as age increased. For children, the age / gender / ADG model achieved about the same predictive ability as for the general population, but the predictive ability of the ACG-only model was less that of the general population. The age / gender / ADG and ACG-only models performed approximately the same for the total expenditure analyses as they did for the physician expenditure analyses. Differences in the system performance for child and senior populations likely related to seniors having more different types of diagnoses within ADG categories. There were no clear differences in the performance of the ACG system across income strata among the Winnipeg urban population other than, as shown in other analyses, a higher predictive ability for physician expenditure than for total costs.

Comparisons of the R-squared values from our study with R-squared values from the U.S. are difficult because of significant differences in the construction of expenditure-related variables. These differences include: (1) expenditures for outpatient prescription pharmaceuticals are often included in U.S. expenditure estimates but were excluded from our analyses; (2) the expenditures for cancer treatment are included in the U.S. data but are excluded from the linked Manitoba data; (3) the expenditures for inpatient physician services are generally included as hospital expenditures in the U.S. but we grouped them as physician expenditures; (4) inpatient facility expenditure data in the U.S. is generally taken directly from hospital charges while we relied on RDRG-related imputations. Despite these differences, the percent of variation in expenditures explained by the ACG system in our study was very similar to the majority of U.S. studies. In the U.S., the age / gender / ADG and the ACG-only models explain about 40-59% and 32-50% of the variation in ambulatory charges respectively. These R-squared values compared to the 52% and 50% R-squared values when the same models were applied to physician expenditures in Manitoba. For total expenditures, the age / gender / ADG and ACG-only models explain about 19-23% and 18-25% of the variation in U.S. studies while, in our study, similar models performed slightly better at 28% and 33%. Some of the improved predictive power for total costs may relate to the fact that hospital expenditures in the Manitoba data are estimated based on case-mix groups and are not actual expenditures.

6. USING ACGS TO MEASURE POPULATION HEALTH STATUS

The ACG system was designed to measure the 'burden of morbidity' for individuals and populations in reference to their 'need' for health services in the short term. As discussed above, validation of the ACGs has centred on examining their ability to explain actual use and expenditures for care. The principal weakness of this approach to validating 'need' lies in the fact that a population's actual use of and expenditures for health care services may not reflect their morbidity-related need for these services. In addition to morbidity, other factors are also well known to influence use and cost of services, including patient factors (such as social support, location of residence etc.), provider factors (such as physician specialty), and system factors (such as the availability of resources). Thus, in order to validate the ACG system as a 'needs adjuster', additional validation approaches are required. This is particularly important for Canada given that equitable distribution of resources based on need is a major tenet of the health system.

There is no 'gold standard' to measure the need for health services in populations. Researchers and policy makers have relied on a variety of population health indicators as proxies, including mortality rates (e.g., all-cause, premature, infant and disease-specific mortality), incidence and prevalence rates of specific diseases (e.g., cancer and diabetes), socioeconomic indicators, and self-assessed health status aggregated from the individual to the population level. Little information was available however about how the case-mix measured by the ACG system compared with any of these measures. The final step in our validation of the ACG system in Manitoba, therefore, was to construct indicators of population health need using the ACG system, and to compare them to several other generally accepted needs indicators.

The following sections examine the methods and results of our comparisons between ACG-measured health need and selected population health indicators. More precisely, the discussion outlines: (a) the methods used to define the sub-populations on which the analyses were based; (b) the techniques used to create an ACG measure of population need; (c) the choice and construction of population health status indicators used for comparison purposes;

(d) the methods used to analyze the relationships among these indicators and the results of these analyses; and (e) further (i.e., multivariate) analyses of these indicators and explanatory factors.

a) Definition of Physician Service Areas

Using methods previously developed at the Manitoba Centre for Health Policy and Evaluation, we grouped Manitobans into 60 small geographic areas based on their residential postal codes. The goal underlying the formation of these 'physician service areas' (PSAs) was to cluster individuals that use the same group of physicians for the majority of their care. Outside the Winnipeg metropolitan area, 51 PSAs were created by grouping residents of a municipality containing a group (or groups) of primary care physicians with residents living in adjacent rural or urban areas who obtain most of their care from these providers. In Winnipeg (n=642,911) where individuals obtain their medical care throughout the city, populations were formed not by utilization patterns but by socioeconomic characteristics and neighbourhood of residence. From the 1991 Canada census, the average household income levels of Winnipeg's enumeration areas served to group neighborhoods into nine geographically contiguous areas such that all residents of an area had similar income profiles. For a complete description of the methodology used to construct the Winnipeg and non-Winnipeg PSAs, readers are referred to Roos, Fransoo, Bogdanovic et al. 1996.

b) Construction of an ACG-Based Measure of Population Health Need

Since ACGs are categorical variables measured at the individual level, three steps were used to convert the individual ACG assignments into a population-based measure of health need, which we term the 'ACG morbidity index' (see Table 10). First, individuals who used the health care system in the study year were assigned the expenditure of resources that they would be 'expected' to consume given their ACG morbidity burden. The ACG 'expected' expenditure was defined as the mean expenditure incurred by all individuals in the province who were assigned that ACG. This technique assumes that province-wide expenditures are responsive to differences in morbidity burdens. Because of the skewed distributions of expenditures within ACGs (see the above discussion), we used 'trimmed' means, calculated after trimming outliers in excess of three standard deviations from the mean (see previous section). Methods to account for outliers have been shown to be important in establishing stable ACG expenditure estimates (VanHouten, Naessens, Evans et al. 1998). Second, we summed the mean ACG-expected per person expenditures for each PSA. This total was divided by the number of users of medical services to yield an average ACG-expected per person expenditure for each PSA. Third, the 'ACG morbidity index' was calculated by dividing the PSA's mean ACG-expected expenditure by the provincial grand mean. The provincial grand mean was calculated as the total expenditures for the province divided by the total number of persons using the system. Because we divided the PSA mean by the provincial grand mean, the ACG morbidity index can be considered to be weighted by population size. We constructed two sets of ACG morbidity indices: one based on the ACG-related expenditures for physician services incurred during 1995/96 and one based on total (i.e., physician, inpatient, and ambulatory surgery) expenditures. Although weighted by population size, the indices were unadjusted for the age and gender characteristics of the PSAs. It was appropriate, therefore, to compare these indices to crude, rather than adjusted, population health indicators described in the next section.

To help judge the performance of the ACG morbidity index, we also created similar ratios based on age and gender 'expected' expenditures. By comparing the correlations between the ACG morbidity index and the population health indicators with the correlations between the age and gender ratios and the same health indicators, we could gauge the added benefit of measuring population need with ACGs over a similar measure based only on age and gender. The construction of the age and gender ratio followed the same process as the ACG index: (1) the trimmed average expenditure for each demographic stratum (i.e., ≤16 year, 17-64 year, and 65+ year age groups for males and females) was assigned to the individuals in that stratum (we termed these the age/gender 'expected' expenditures); (2) the age and gender expenditures were summed for each region and divided by the number of service users; and (3) the mean age/gender 'expected' expenditures for each PSA was divided by the overall mean expenditures. Again, age and gender ratios were created separately for physician and total expenditures.

Table 10: Development of the ACG Morbidity Index

Step 1: Calculation of ACG 'expected' expenditures for Manitoba

ACG	Actual Costs		Number		ACG 'Expected' Cost
ACG_1	$x_{1\cdot}$	÷	$n_{1\cdot}$	=	$\mu_{\cdot 1\cdot}$
ACG_2	$x_{2\cdot}$	÷	$n_{2\cdot}$	=	$\mu_{\cdot 2\cdot}$
!	!		!		!
ACGi	$x_{i\cdot}$	÷	$n_{i\cdot}$	=	$\mu_{i\cdot}$
Total	T..	÷	N..	=	μ..

Step 2: Calculation of Total ACG 'expected' costs for each PSA

ACG	Manitoba ACG 'Expected' Cost		Number in PSA_j		Total ACG 'Expected' Cost for PSA_j
ACG_1	$\mu_{1\cdot}$	×	n_{1j}	=	x_{1j}
ACG_2	$\mu_{\cdot 2\cdot}$	×	n_{2j}	=	x_{2j}
!	!		!		!
ACG_i	$\mu_{i\cdot}$	×	n_{ij}	=	x_{ij}
Total			$N_{\cdot j}$		$E_{\cdot j}$

Step 3: Calculation of 'ACG Morbidity Index for each PSA

ACG Morbidity Index for PSA_j = $(E_{\cdot j}/N_{\cdot j})$ ÷ μ..

Note: Population counts represent numbers of health service 'users'. Calculation of mean costs performed after exclusion of outliers greater than 3 standard deviations from the mean

Our final measure of population morbidity was the 'observed expenditure ratio', calculated by dividing the mean actual expenditures incurred by the PSA service users in 1995/96 by the overall provincial average. Again, trimmed averages were used. By comparing the correlations between the ACG morbidity index and the health status indicators with the correlations between the observed expenditure ratio and health status, we were able to highlight the differences between using actual expenditures and ACG-expected expenditures to reflect the health status of Manitobans. As discussed above, the actual expenditures of health services not only reflect morbidity-related determinants but also a variety of non-clinical factors.

c) Indicators of Population Health Status

We used several measures that have previously been developed at MCHPE to measure the health status of the PSA populations (Cohen, MacWilliam 1995; Cohen, MacWilliam 1994). Our principal measure was premature mortality (i.e., all-cause mortality for ages 0-74 years) because this indicator is generally considered to be the single best measure capturing a population's need for health care (Carstairs, Morris 1991; Eyles, Birch, Chambers et al. 1993; U.S. General Accounting Office 1996; Kindig 1997). The main assumption behind the use of premature mortality as an indicator of population need is that the delivery of appropriate primary, secondary, and tertiary care services can prevent or delay early death (i.e., death before average life expectancy). In other words, populations with higher premature mortality are considered to have lower health status and a greater need for and potential to benefit from ambulatory, inpatient, and community health services. A major attraction in using mortality indices as needs indicators lies in their standardized collection and ready availability. However, their major weaknesses include the lack of precise specifications of the types and amounts of services that are required by populations, and the long length of time necessary for their collection (i.e., they are rare events). Since several PSAs had small populations (i.e., less than 5,000 individuals) and premature deaths are infrequent, we used a five year interval (1992-96) to calculate premature mortality rates.

In addition to premature mortality, we also examined, as a measure of population health, chronic disease mortality rates defined as the number of deaths from ischemic heart disease, diabetes, asthma, hypertension, peripheral vascular disease and chronic obstructive pulmonary disease per 1,000 population per year. (Cohen, MacWilliam 1995) Again, because of the small PSAs, we calculated the mean rate over the five-year interval 1992-96. We also chose the period prevalence of diabetes mellitus as an indicator of the health of the residents of the PSAs, calculated as the average number of cases of diabetes per 1,000 population per year from 1994/95-1995/96. Diabetes prevalence was ascertained from diabetes-related ICD-9/ICD-9-CM diagnoses (250.xx) taken from inpatient separation abstracts and physician claims. Persons with diabetes were defined as those individuals with two physician and/or one hospital diagnosis coded during a two-year interval. The validity of this method of estimating diabetes prevalence has been previously demonstrated (Blanchard, Dean, Anderson et al. 1997; Blanchard, Ludwig, Wajda et al. 1996). It is important to note that the measurement of diabetes prevalence was based on the same data source as our ascertainment of ACG morbidity.

d) Univariate Analyses

The first stage of our analysis was to individually explore the three population health indicators (i.e., premature mortality, chronic disease mortality and diabetes prevalence) and the three morbidity indicators (i.e., the ACG morbidity index, the age/gender morbidity ratio, and the observed expenditure ratio) that were constructed from the residents' demographics, ACG profiles, and health service expenditures.

Table 11 summarizes the demographics and population health indicators for the 60 physician service areas. The population sizes of the PSAs ranged from 1,089 in Oxford House to 116,907 in the Winnipeg outer core. There was more than a 40% variation in the proportion of residents having a hospital separation, ambulatory surgical procedure, and/or physician claim, ranging from a low of 51% (Island Lake) to a high of 89% (Victoria/South Norfolk). In four PSAs (Gillam, Boissevain, Island Lake, Burntwood), less than 70% of the populations were found to be health system 'users'. Some of this low contact rate for some regions can be partially explained by the use of alternate funding mechanisms for physician services (e.g., salary). Although a 'shadow' claims system exists, physician services paid under these payment mechanisms are likely underreported in our data sources. Special attention was paid to these areas as variability of ACG case-mix estimates may be sensitive to the completeness of our data. To examine the effect of small population sizes on the estimation of morbidity with our derived indices, we also classified six PSAs (Gillam, Leaf Rapids, Lynn Lake, Oxford House, Boissevain, Churchill) as small areas because their 'user' populations numbered fewer than 2,000 residents.

The PSAs appeared to have important differences in their population age structures. While the mean age of the Manitoba population was 36.1 years, the mean ages of the PSAs ranged from 25.1 years in Island Lake to 45.0 years in Gilbert Plains. It is important to recall, however, that persons in personal care homes (PCHs) are excluded from our population counts and thus, the means may undercount senior populations and be biased downwards.

We operationalized socioeconomic status using the Socioeconomic Risk Index (SERI) which has been developed in prior research at the Manitoba Centre for Health Policy and Evaluation (Frohlich, Mustard 1994; Frohlich, Mustard 1996). This index combines 1991 and 1986 census data for Manitoba communities for the following indicators: the percentage of the labour force aged 15-24 who are employed; the percentage unemployed aged 45-54; the percentage of single parent female households; the proportion of the population aged 25-34 having graduated high school; the percentage females participating in the labour force and the average dwelling value. Readers are referred to Frohlich and Mustard 1996 for an in-depth discussion of this index. A higher index indicates areas with lower socioeconomic status. The SERI ranged from –1.05 in Winnipeg South East to 4.26 in Oxford House.

As reported in earlier studies (Cohen, MacWilliam 1995; Cohen, MacWilliam 1994), there was considerable variation in mortality and morbidity measured across the PSAs. While Manitoba's overall premature mortality rate was 3.5 deaths per 1,000 per year, based on 1992-96 data, this rate varied 4-fold from a high of 8.8 per 1,000 per year in the Winnipeg inner core to a low of 1.9 per 1,000 per year in Thompson. Similarly, the chronic disease mortality experience showed almost 10-fold variability from 0.5 deaths per 1,000 per year in Leaf Rapids to 4.8 per 1,000 per year in Swan River. For the two years 1994/95-1995/96,

Table 11: Demographic and Population Health Characteristics of Manitoba Physician Service Areas (PSAs)

	Population		Demographic Characteristics			Population Health Indicators (unadjusted)		
						Mortality‡		
Physician Service Area (PSA)	N* (1995-96)	Users of Services (%)†	Age (mean)	☐ (%)	SERI†† (%)	Premature (<75yr)	Chronic Disease	Diabetes Prevalence§
Manitoba (total)	1,137,844	81.7	36.1	53.7	1.00	3.5	2.9	45.6
Winnipeg Areas:								
Inner Core	30,837	81.4	36.1	50.6	0.97	8.8	4.5	57.7
Outer Core	116,907	82.1	35.3	53.8	0.69	4.3	3.2	53.7
Old St. Boniface	23,604	85.3	41.1	57.5	0.10	4.9	5.3	51.0
South Central	51,925	83.6	40.3	56.8	-0.64	3.4	3.4	36.2
West	62,838	83.8	39.2	55.0	-0.54	3.8	3.6	45.2
North West	73,029	84.0	35.0	53.9	-0.62	2.8	2.4	45.7
North East	108,778	83.4	36.0	54.4	-0.35	3.0	2.3	41.3
South East	81,545	84.3	34.8	53.6	-0.78	2.5	1.9	33.9
South West	93,448	83.0	35.5	54.4	-1.05	2.3	2.1	32.8
Small Areas:								
Gillam¶	1,110	55.0	26.4	51.1	0.53	2.0	0.8	70.0
Leaf Rapids	1,751	83.7	27.4	51.2	1.17	2.5	0.5	35.1
Lynn Lake	1,591	81.8	28.2	53.5	0.32	4.2	0.9	38.3
Oxford House	1,089	80.2	25.0	52.3	4.26	3.5	1.2	79.1
Boissevain¶	2,815	63.1	39.9	53.0	0.00	2.9	5.8	46.5
Churchill	2,394	81.4	28.5	50.6	0.63	4.3	1.2	61.2
Other Areas:								
Altona	7,211	76.1	35.4	52.5	0.34	3.0	2.9	24.8
Carman	9,887	79.9	37.9	53.2	0.07	3.5	3.5	31.1
Seven Regions	6,868	81.1	33.4	52.0	0.93	4.2	2.8	73.7
Lorne	9,092	83.6	38.5	52.1	0.16	4.0	3.0	46.3
Morris/Montcalm	7,424	80.5	36.3	53.1	0.23	3.3	3.0	41.2
Morden/Winkler	19,927	75.6	34.8	53.7	0.33	2.2	2.8	35.3
Portage	25,252	80.9	35.3	53.5	-0.02	3.7	2.9	44.5
C Wpg adj	11,052	80.4	31.8	51.2	-0.67	2.0	1.0	28.7
Springfield	26,959	81.9	36.9	52.0	-0.32	3.3	2.7	39.5
E Lake Winnipeg	10,840	76.1	32.1	52.1	1.69	4.1	2.0	88.3
Tache	13,648	81.3	32.0	52.0	-0.01	1.8	1.6	27.7
Piney District	5,506	81.2	42.8	50.9	0.96	4.8	4.0	59.8
De Salaberry	5,522	81.3	33.8	52.2	0.14	3.0	2.5	35.2
Steinbach	21,844	78.6	32.7	52.9	0.10	2.3	2.0	32.8
Richot	5,162	83.2	31.8	51.1	-0.50	2.2	1.5	27.3
Brandon	45,852	83.7	36.0	55.0	-0.27	3.1	2.9	38.2
East Interlake	10,040	77.9	34.6	52.4	1.21	3.6	2.5	71.8
Gimli	8,426	84.5	43.0	52.7	0.42	5.9	4.6	60.1
Grahamdale	5,496	76.9	33.7	53.2	1.00	4.3	2.7	86.8
Coldwell	4,046	82.2	36.8	51.3	1.14	4.8	3.5	76.5
Rockwood	16,459	80.6	35.6	52.7	-0.36	3.0	2.0	38.8
Selkirk	28,884	81.2	36.9	53.1	-0.34	3.8	2.7	42.1
Norman	9,189	71.8	29.2	52.1	1.63	3.9	1.8	84.4
The Pas Town	7,503	80.5	31.1	53.3	-0.12	3.9	2.5	53.7

	Population		Demographic Characteristics			Population Health Indicators (unadjusted)		
		Users of				Mortality‡		
Physician Service Area (PSA)	*N* (1995-96)*	*Services (%)†*	*Age (mean)*	*☐ (%)*	*SERI†† (%)*	*Premature (<75yr)*	*Chronic Disease*	*Diabetes Prevalence§*
Flin Flon	8,542	80.6	34.9	52.0	0.44	3.8	2.3	42.7
Gilbert Plains	4,430	77.9	45.0	52.3	0.77	4.8	4.5	52.8
Roblin	4,459	76.9	39.9	52.6	0.94	4.1	4.4	61.6
Alonsa	7,018	81.9	36.3	52.9	0.76	3.5	3.2	72.0
Dauphin	13,348	81.1	42.1	53.3	0.48	4.7	5.4	61.6
Pine Creek	3,684	83.9	27.0	50.6	2.71	4.2	2.0	128.9
Swan River	11,346	80.2	40.2	52.9	0.61	4.6	4.8	56.7
Burntwood¶	11,129	67.8	25.5	53.9	3.06	3.6	1.2	74.8
Thompson	14,897	82.7	27.7	51.6	-0.14	1.9	0.5	38.6
Norway/Cross	5,528	71.3	25.9	53.8	3.29	3.3	1.3	113.3
Island Lake¶	5,259	51.2	25.1	54.4	3.59	2.6	1.0	123.1
Killarney	10,562	80.5	39.9	52.5	-0.06	3.7	3.9	50.0
Melita/Deloraine	5,788	78.5	41.3	54.0	0.17	4.0	4.3	43.1
Souris	5,871	81.0	38.9	53.1	-0.15	4.3	5.2	51.6
Virden	8,675	74.4	40.0	53.5	0.50	4.0	3.8	47.2
Russell	9,272	83.4	38.4	52.0	0.33	4.7	3.9	55.0
Minnedosa	15,241	81.4	41.4	52.5	0.27	4.4	4.5	50.3
Sioux Valley	2,947	84.8	36.0	52.8	1.14	4.2	3.2	84.4
N Cypress	3,237	82.0	37.4	53.4	-0.09	3.7	4.2	45.9
Neepawa	7,508	82.0	41.3	52.9	0.38	4.2	4.5	60.4
Victoria/S Norfolk	2,842	88.9	39.9	50.4	-0.17	3.2	3.9	59.2

* Non-institutionalized resident population counts, FY 1995/96.
† Proportion of population. with at least one ambulatory or inpatient encounter with the health system, FY1995-96
‡ Average number of deaths per 1,000 per year (unadjusted), 1992-96
†† Socioeconomic Risk Index
§ Average number of individuals receiving at least one diabetes diagnosis per 1,000 (unadjusted), 1994/95-1995/96
☐ Proportion who were Female
¶ The low user rates (i.e., <70%) in these areas may reflect underreporting in our data sources of services provided through supplementary payment mechanisms (e.g., contract, salary)

diabetes prevalence also showed wide variation across PSAs, ranging from 27.7 to 128.9 cases per 1,000.

Table 12 presents the derived indices for FY 1995/96. As discussed above, we present two formats for each ratio: one based on the expected expenditures of physician services and the other based on total (i.e., inpatient, ambulatory surgical, and physician) expenditures. As

Table 12: ACG, Age & Gender, and Observed Expenditure Indices For Physician Service Areas (PSAs), 1995/96

	Population		Morbidity Indices (unadjusted)‡				Expenditure Index (unadjusted)	
			ACG (Expected/Avg Cost)§		Age / Gender (Expected/Avg Cost)‖		(Observed/Avg Cost)¶	
Physician Service Area (PSA)	N* (1995-96)	Users of Services (%)†	Total Costs	Physician Costs	Total Costs	Physician Costs	Total Costs	Physician Costs
Manitoba (total)	1,137,844	81.7	1.00	1.00	1.00	1.00	1.00	1.00
Winnipeg Areas:								
Inner Core	30,837	81.4	1.41	1.25	1.01	1.00	1.46	1.31
Outer Core	116,907	82.1	1.10	1.07	1.00	1.00	1.07	1.12
Old St. Boniface	23,604	85.3	1.32	1.19	1.23	1.11	1.34	1.32
South Central	51,925	83.6	1.11	1.08	1.15	1.08	1.08	1.24
West	62,838	83.8	1.12	1.09	1.09	1.05	1.09	1.18
North West	73,029	84.0	0.91	0.99	0.93	0.97	0.86	1.05
North East	108,778	83.4	0.95	0.98	0.98	0.99	0.89	1.03
South East	81,545	84.3	0.86	0.93	0.91	0.96	0.78	1.00
South West	93,448	83.0	0.88	0.94	0.93	0.97	0.79	1.02
Small Areas:								
Gillam	1,110	55.0	0.92	0.98	0.66	0.83	0.74	0.84
Leaf Rapids	1,751	83.7	0.81	0.91	0.65	0.83	0.77	0.73
Lynn Lake	1,591	81.8	1.05	1.01	0.73	0.86	0.97	0.78
Oxford House	1,089	80.2	1.07	0.94	0.72	0.85	1.35	0.83
Boissevain	2,815	63.1	1.25	1.16	1.16	1.07	1.25	0.98
Churchill	2,394	81.4	0.78	0.74	0.73	0.87	1.45	1.18
Other Areas:								
Altona	7,211	76.1	0.78	0.80	1.04	1.01	0.88	0.70
Carman	9,887	79.9	0.90	0.92	1.10	1.04	1.07	0.83
Seven Regions	6,868	81.1	1.16	1.02	0.98	0.97	1.36	0.86
Lorne	9,092	83.6	1.11	1.02	1.14	1.05	1.24	0.85
Morris/Montcalm	7,424	80.5	0.92	0.92	1.05	1.02	0.95	0.80
Morden/Winkler	19,927	75.6	0.80	0.82	1.03	1.00	0.93	0.73
Portage	25,252	80.9	1.02	0.97	1.00	0.99	1.02	0.79
C Wpg adj	11,052	80.4	0.75	0.85	0.81	0.91	0.66	0.85
Springfield	26,959	81.9	0.90	0.94	0.98	0.99	0.93	0.91
East Lake Winnipeg	10,840	76.1	1.18	1.07	0.90	0.94	1.20	0.99
Tache	13,648	81.3	0.73	0.83	0.84	0.92	0.71	0.81
Piney District	5,506	81.2	1.32	1.16	1.26	1.12	1.46	1.02
De Salaberry	5,522	81.3	0.86	0.90	0.95	0.97	0.87	0.83
Steinbach	21,844	78.6	0.79	0.85	0.92	0.96	0.87	0.77
Richot	5,162	83.2	0.70	0.81	0.83	0.91	0.70	0.86
Brandon	45,852	83.7	0.98	0.99	1.01	1.01	0.91	0.96
East Interlake	10,040	77.9	1.01	0.96	1.00	0.99	1.10	0.81
Gimli	8,426	84.5	1.30	1.18	1.24	1.11	1.17	1.01
Grahamdale	5,496	76.9	0.96	0.93	0.95	0.97	1.08	0.82
Coldwell	4,046	82.2	1.03	0.98	1.05	1.02	1.05	0.94
Rockwood	16,459	80.6	0.88	0.91	0.96	0.98	0.84	0.88
Selkirk	28,884	81.2	0.91	0.94	0.97	0.99	0.93	0.92
Norman	9,189	71.8	0.96	0.98	0.77	0.89	1.14	0.80

Physician Service Area (PSA)	*Population* N* (1995-96)	*Users of Services (%)†*	*Morbidity Indices (unadjusted)‡* ACG (Expected/Avg Cost)§ Total Costs	Physician Costs	Age / Gender (Expected/Avg Cost)|| Total Costs	Physician Costs	*Expenditure Index (unadjusted) (Observed/Avg Cost)¶* Total Costs	Physician Costs
The Pas Town	7,503	80.5	0.93	0.99	0.81	0.91	0.94	0.80
Flin Flon	8,542	80.6	0.92	0.97	0.94	0.97	0.93	0.77
Gilbert Plains	4,430	77.9	1.18	1.07	1.35	1.16	1.34	0.91
Roblin	4,459	76.9	1.11	1.02	1.18	1.08	1.41	0.78
Alonsa	7,018	81.9	1.12	1.06	1.05	1.01	1.43	0.97
Dauphin	13,348	81.1	1.14	1.04	1.25	1.12	1.33	0.95
Pine Creek	3,684	83.9	1.00	1.02	0.76	0.86	1.55	0.91
Swan River	11,346	80.2	1.17	1.09	1.19	1.08	1.36	0.83
Burntwood	11,129	67.8	0.96	0.91	0.71	0.85	1.18	0.70
Thompson	14,897	82.7	0.77	0.91	0.66	0.84	0.66	0.71
Norway/Cross	5,528	71.3	0.98	0.91	0.72	0.85	1.03	0.71
Island Lake	5,259	51.2	0.98	0.83	0.71	0.85	1.58	0.89
Killarney	10,562	80.5	1.15	1.05	1.16	1.07	1.16	0.93
Melita/Deloraine	5,788	78.5	1.06	0.98	1.23	1.10	1.23	0.84
Souris	5,871	81.0	1.11	1.01	1.13	1.05	1.24	0.91
Virden	8,675	74.4	1.00	0.95	1.22	1.09	1.17	0.81
Russell	9,272	83.4	1.30	1.15	1.14	1.05	1.39	0.88
Minnedosa	15,241	81.4	1.06	1.00	1.23	1.10	1.20	0.90
Sioux Valley	2,947	84.8	1.26	1.14	1.05	1.01	1.28	1.04
N Cypress	3,237	82.0	0.98	0.95	1.06	1.02	1.20	0.88
Neepawa	7,508	82.0	1.10	1.03	1.23	1.10	1.26	0.93
Victoria/S.Norfolk	2,842	88.9	1.02	0.99	1.19	1.08	1.19	0.87

* Non-institutionalized resident population counts, FY 1995-96.
† Proportion of population with at least one ambulatory or inpatient encounter with the health system FY 1995/96
‡ Ratios based on demographic, diagnostic, and costing data from Manitoba's health services plan, FY 1995/96. Costs calculated as 'physician only' costs and 'total' (i.e., inpatient, ambulatory surgical, and physician) costs
§ Average ACG 'expected' cost in PSA divided by mean provincial costs, excluding outliers +3SD
|| Average age and gender 'expected' cost in PSA divided by mean provincial costs, excluding outliers
¶Average actual costs for residents of PSA divided by provincial average, excluding outliers +3SD

expected, there was less variation in the ratios derived from physician costs than those derived from total expenditures. Among the indices based on total expenditures, the observed expenditure ratio had the most variability (range 0.66-1.58), the age and gender ratio had the least (range 0.65-1.26), and the ACG morbidity index was intermediate (range 0.70-1.41). This same pattern was evident for the subset of physician expenditures.

Table 13 presents the Spearman correlation coefficients between each pair of variables. There were statistically significant positive associations between crude premature mortality

Table 13: Correlation Matrix of Population Health Indicators & Morbidity Indices

		Health Status Indicators (unadjusted)			***Derived Morbidity Indices (unadjusted)‡***					
					Total Costs			***Physician Costs***		
		Premature Mortality Rate	***Chr.Dis. Mortality Rate***	***Diabetes Prevalence***	***ACG Morbidity Index***	***Age/Sex Morbidity Index***	***Observed Expend Index***	***ACG Morbidity Index***	***Age/Sex Morbidity Index***	***Observed Expend Index***
	Premature Mortality Rate	1.00	0.60***	0.55***	0.74***	0.53***	0.71***	0.68***	0.52***	0.32*
	Chronic Disease Mortality Rate	—	1.00	0.13 ns	0.69***	0.95***	0.53***	0.70***	0.94***	0.39**
	Diabetes Prevalence	—	—	1.00	0.56***	0.03 ns	0.70***	0.40**	-0.002 ns	0.14 ns
Total Costs	ACG Morbidity Index	—	—	—	1.00	0.63***	0.77***	0.92***	0.62***	0.45***
	Age / Sex Morbidity Index	—	—	—	—	1.00	0.46***	0.60***	0.99***	0.35**
	Observed Expenditure Index	—	—	—	—	—	1.00	0.58***	0.44***	0.31*
MD Costs	ACG Morbidity Index	—	—	—	—	—	—	1.00	0.60***	0.57***
	Age / Sex Morbidity Index	—	—	—	—	—	—	—	1.00	0.39**
	Observed Expenditure Index	—	—	—	—	—	—	—	—	1.00

† Values represent Spearman correlation coefficients. H_o: ρ=0 *****p<0.05 **p<0.01 ***p<0.001 'ns' not statistically significant
‡ Indices constructed for 'physician only' and 'total' (i.e., inpatient, ambulatory surgical, and physician) costs, FY 1995/96

and each of our derived measures, using both physician and total expenditures. For each measure, the associations derived from physician expenditures were weaker than those derived from total expenditures. When comparing the indices to each other, the associations were stronger for the ACG morbidity indices (r = 0.74 for total expenditures and r = 0.68 for physician expenditures) than for the age and gender ratios (r = 0.53 and r = 0.52) and the observed expenditure ratios (r = 0.71 and r = 0.32). These findings implied that population health ‘need’ as reflected by premature mortality was best approximated by the ACG morbidity index derived from total expenditures. The ACG morbidity index appeared to out-perform similar ratios constructed from demographic data and actual health service expenditures.

The correlations between the ACG morbidity index and the other health indicators revealed a different pattern. Chronic disease mortality, although significantly related to the ACG index (r = 0.70), had a much stronger relationship with the age and gender ratio (r = 0.94). It would appear, therefore, that this population health indicator was more closely related to age/gender-expected expenditures than ACG-expected ones. It is not surprising that the population’s demographic composition was highly related to these indicators given that senior persons are heavily represented among those that die from chronic illnesses. The weakest associations were found when the regions were profiled by their actual expenditures (r = 0.39).

In order to explore more fully the relationship between premature mortality and our ACG morbidity index, we also analysed the individual data points with a series of scatterplots. Figures 3-5 present scatterplots to compare the crude premature mortality rates with our indices derived from: (a) ACG-expected expenditures; (b) age/gender-expected expenditures; and (c) actual expenditures. The ratios were constructed with total expenditure estimates since this variety was more strongly related to the premature mortality rate (see above). Because our calculation of the derived ratios may be sensitive to small numbers, we paid special attention to PSAs with populations of fewer than 2,000 users. We also compared the Winnipeg PSAs to their rural counterparts in order to identify possible rural/urban differences in the performance of these ratios.

In general, the scatterplot of crude premature mortality and the crude ACG morbidity index (Figure 3) showed a linear relationship with the majority of PSAs falling in close proximity to the best-fit line. There were several outliers, however, that had either more or less mortality than would be expected based on the ACG morbidity index. The Winnipeg inner core was the principal outlier with 30% higher premature mortality than any other PSA. The remaining three outliers were all small PSAs (Boissevain, Gillam, Lynn Lake) where the ACG morbidity index was based on the ACG assignments of relatively few residents. Moreover, two of these regions also had high non-user rates (Boissevain, Gillam). As discussed above, these high non-user rates can be partially explained by incomplete data because of alternative physician funding mechanisms. Except for the Winnipeg inner core, all but one of the Winnipeg PSAs had lower premature mortality rates than would be expected based on their ACG morbidity index. Since these areas have higher than average physician visit rates (Tataryn, Roos, Black 1994), this finding may suggest that the ACG morbidity ratio may overestimate morbidity for populations with higher than average rates of physician utilization. The reasons that the Winnipeg inner core was a distant outlier are perplexing. Possible explanations include: (a) residents in this area face significant non-financial barriers in obtaining care resulting in systematically undercoded diagnoses; (b) the efficacy of 'usual care' in preventing early death is reduced for this disadvantaged population; (c) a larger portion of this population's premature mortality experience is unrelated to pre-existing morbidity (e.g., intentional and unintentional fatal injuries), and beyond the scope of traditional medical care. There was some evidence to support the latter possibility. In 1995/96, the age-adjusted mortality rate for injuries was approximately 0.78 per 1,000 for Winnipeg residents living in the lowest income areas compared to 0.20 per 1,000 for those in the highest income areas. This finding suggests that the excess risk of death in the Winnipeg inner core may be attributable in part to deaths that are unrelated to pre-existing morbidity. Further research is needed to elucidate the reasons that could explain the reasons for the high mortality rate for this population.

Figure 3: Crude Premature Mortality Rates (1992-96) vs. ACG Morbidity Index (1995-96), Manitoba Physician Service Areas (PSAs)

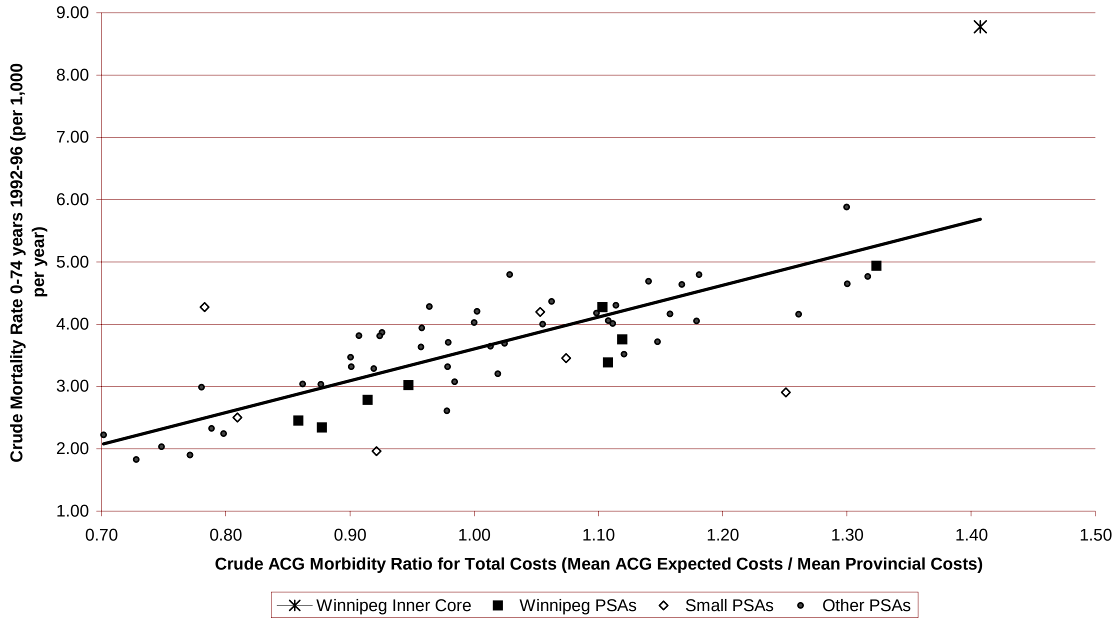


Figure 4 reveals much more dispersion of data points around the best fit line when premature mortality is plotted against the age/gender ratio derived from total expenditures. The linear trend that was apparent for the ACG morbidity index is less apparent for this ratio. Again, the Winnipeg inner core was the principal outlier with much higher mortality than would be expected based on its demographic-related expenditures. However, in contrast to the ACG morbidity ratio, the demographic index did not appear to perform markedly worse for small PSAs. In fact, there was no discernible pattern that delineated which PSAs fell furthest from the best fit line.

Figure 5 shows the plot of the observed expenditure ratio versus premature mortality rates. The dispersion around the best-fit line was greater than for the ACG plot and the linear trend was less apparent. The linear fit appeared to be better for PSAs with lower, as opposed to higher, expenditures. In fact, all the PSAs with relatively high expenditures (with the exception of the Winnipeg inner core) had lower mortality than would be expected based on their average expenditures. In other words, the regions with high unadjusted expenditures did not appear to have corresponding high unadjusted mortality. Possible explanations for this finding include: (a) the expenditures associated with the care of persons with similar morbidities may be higher in these PSAs than in others (e.g., because of differential geographic access); (b) these regions may have a profile of morbidity that is not necessarily associated with higher mortality (e.g., rehabilitative care); and (c) care is over-provided in these areas. Further research is needed to examine these and other possibilities.

Figure 4: Crude Premature Mortality Rates (1992-96) vs. Age/Gender Ratio (1995-96), Manitoba Physician Service Areas (PSAs)

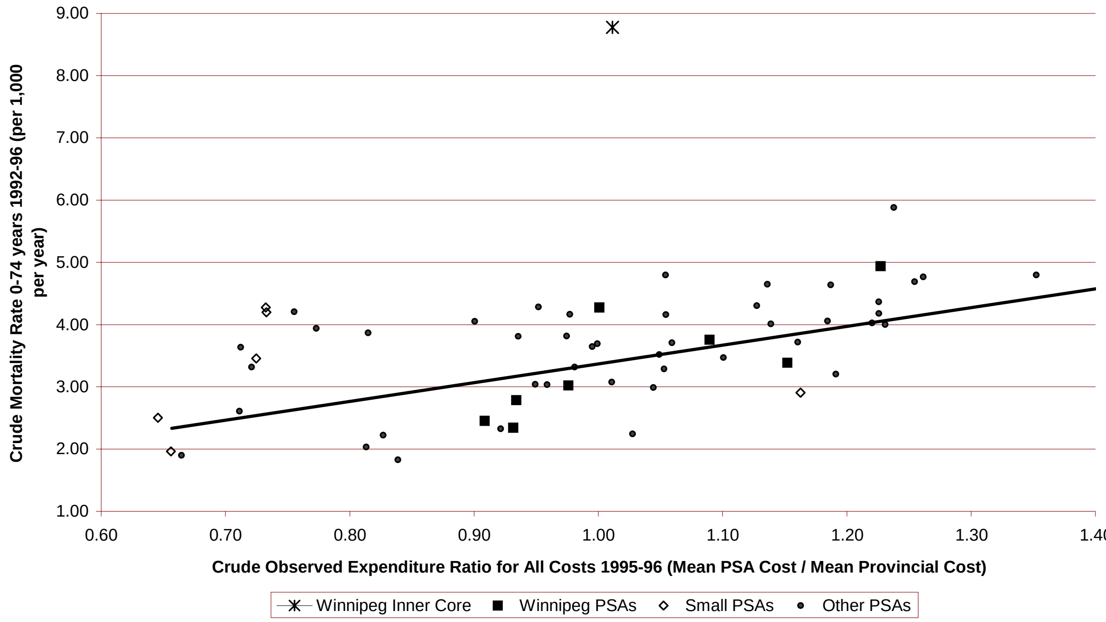
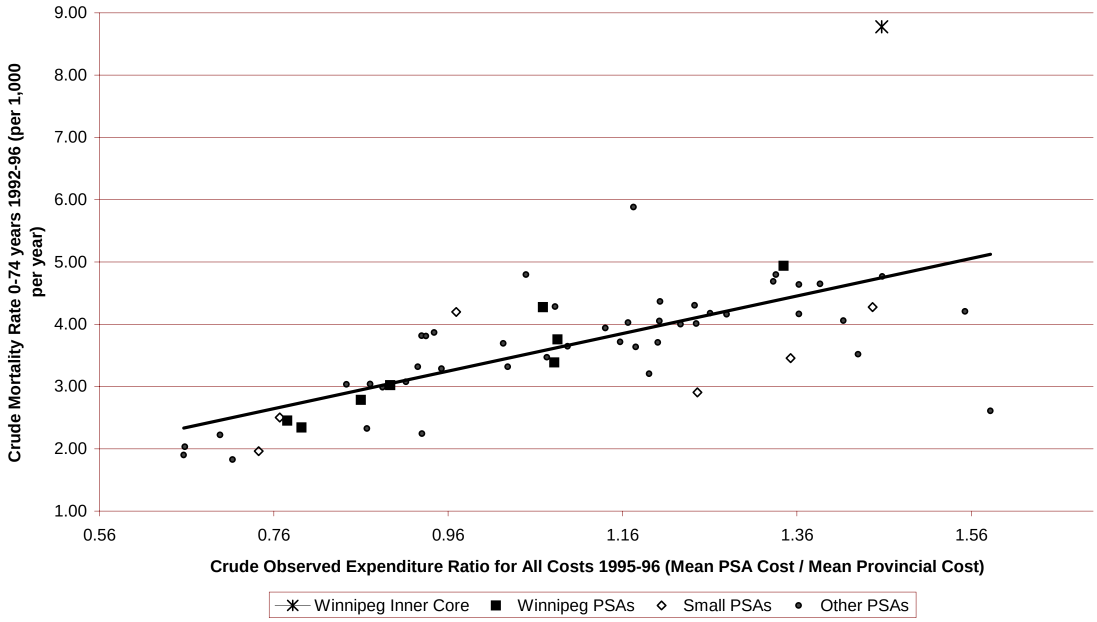


Figure 5: Crude Premature Mortality Rates (1992-96) vs. Observed Expenditure Ratio (1995-96), Manitoba Physician Service Areas (PSAs)



e) Multivariate Analyses

Multiple regression models were used to examine the relationship between premature mortality and the ACG morbidity index derived from total expenditures, after taking into account a variety of other possible explanatory factors. Specifically, we examined the ability of the ACG morbidity index to explain premature mortality rates when combined with variables relating to the PSA age and gender structure, an ecological measure of socioeconomic status, the proportion of the PSA residents who were system health 'users', and the PSA's actual health care expenditures. The reasons for adding these covariates included:

- Population age and gender are known to be highly related to mortality. We hypothesised, however, that most of the relationship between a population's age/gender structure and its premature mortality experience could be explained through the intervening effects of morbidity. Thus, when demographic characteristics are combined with the ACG morbidity index, we expected age and gender to add little explanatory power to the model. Independent effects relating to age and gender may be observed, however, if: (a) the ACG morbidity index does not fully capture the true morbidity-related effects of age and gender; (b) age and gender are related to the occurrence of premature deaths which are not due to pre-existing morbidity (e.g., intentional or unintentional injuries resulting in immediate death).

- The relationship between socioeconomic status (SES) and population health is well known. We hypothesized that a portion of this relationship can be explained by higher morbidity burdens. As discussed above, we operationalized socioeconomic status of the PSA resident populations using the Socioeconomic Risk Index (SERI) (Frohlich, Mustard 1994; Frohlich, Mustard 1996) (see above).
- The reason for adding the health service 'user' rate as a covariate relates to the inability of the ACGs to capture the health need of persons who are not represented in our data set.
- We hypothesized that the relationship between a population's actual expenditures and its mortality indicators is mediated through its overall burden of morbidity. In other words, populations with greater morbidity burdens have both higher health care expenditures and higher premature mortality rates. Thus, any independent effect of observed expenditures likely relates to morbidity-related residual confounding which is not captured by the ACG morbidity index.

Using the PSA as the unit of analysis, the five-year crude premature mortality rate was modelled as a linear function of the following covariates: (a) the ACG morbidity index derived from total expenditures; (b) the age and gender structure of the PSA operationalized as the mean age and the percent female; (c) the Socioeconomic Risk Index (SERI); (d) the proportion of the population that were 'users' of health services during the study year; and (e) the observed expenditure ratio. We assumed that the random component of variation followed a normal distribution (Y_i~Normal[μ,θ]). The multivariate model is represented as follows:

Crude Premature Mortality = $\beta_o + \beta_1$(*ACG Morbidity Index*) + β_2(*mean age of population*) + β_3(*% females*) + β_4(SERI)+ β_5(*% health service 'users'*) + β_6(*observed expenditure ratio*) + ε

where:

β_o	=	intercept term
β_1-β_6	=	parameters for the covariates x_1-x_6
ε	=	random error term

Table 14 provides the analysis of variance table for the above model. Overall, the model explained a little more than half (56%) of the variation in premature mortality. However, analysis of the residuals (i.e., the actual values minus the predicted values) revealed three data points that were poorly fit by the model and that exerted influence on the regression line (i.e., Studentized residuals >|2|). These data points included the Winnipeg inner core and two small areas (Boissevain and Churchill). We decided to re-fit the models after excluding these three observations. The analysis of variance table obtained after excluding these data points is presented in Table 15.

Table 14: Multivariate Linear Model of Premature Mortality

Sum of Squares	***SS***	***df***	***Mean Square***	***F-value***	***Prob>F***	***Adjusted R^2***
Model	43.4	6	7.24	13.7	0.0001	0.56
Error	27.9	53	0.53			
Total	71.3	59				
Parameter	***Type III SS***	***df***	***F-Value***	***Prob>F***		
Intercept	1.46	1	2.78	0.10 ns		
ACG Morbidity Index	9.76	1	18.50	<0.001		
Mean Age	3.78	1	7.20	0.010		
% Female	3.54	1	6.72	0.016		
SERI	0.02	1	0.04	0.95 ns		
% 'Users' of Services	0.94	1	1.79	0.19 ns		
Observed Expend Index	0.01	1	0.01	0.90 ns		

Two factor interaction terms between the ACG morbidity index and the other covariates were added to the model but none reached statistical significance. These interaction terms were not included in the final model to make it more parsimonious. After excluding the three influence data points, the re-fit model showed a better overall fit and explained about 74% of the variation in premature mortality across regions. The scatterplot of the residual versus the predicted values showed a general dispersion of the data points, suggesting that this model is unbiased for this subset of PSAs (see Figure 6).

In the final multivariate model, there appeared to be a direct, independent relationship between the ACG morbidity index and the rate of early death. In other words, after adjusting for potential confounders, the premature mortality rate increased in a linear fashion as the ACG morbidity index increased. Moreover, the model revealed that the PSA population's age structure and socioeconomic risk were also independent predictors of the premature mortality rate. Both regression coefficients were positive indicating that premature mortality increased in a linear fashion with an increase in population age and a decrease in socioeconomic risk. As discussed above, one explanation for the finding that mean age was an independent predictor is that the ACG morbidity index may have performed less well in quantifying the morbidity burden of older populations. There are several explanations for the

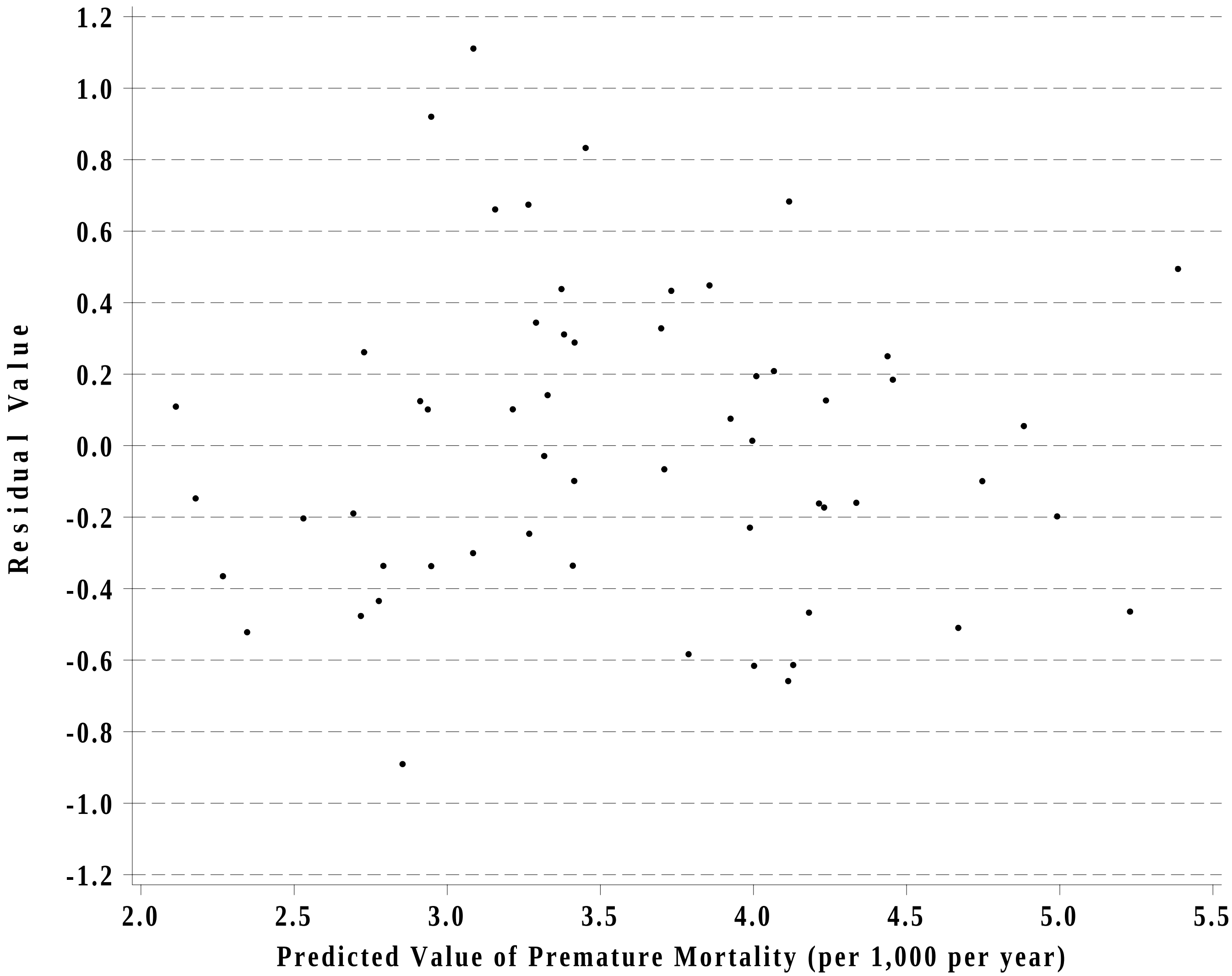
Table 15: Multivariate Linear Model of Premature Mortality (excluding Churchill, Boissevain, and the Winnipeg Inner Core)

Sum of Squares	*SS*	*df*	*Mean Square*	*F-value*	*Prob>F*	*Adjusted R^2*
Model	33.58	6	5.60	22.71	0.001	0.74
Error	10.32	50	0.23			
Total	33.91	56				
Parameter	*Type III SS*	*df*	*F-Value*	*Prob>F*		
Intercept	0.47	1	7.25	0.140 ns		
ACG Morbidity Index	6.48	1	31.38	<0.001		
Mean Age	2.58	1	12.49	<0.001		
% Female	0.02	1	0.09	0.770		
SERI	1.56	1	7.59	0.008		
% 'Users' of Services	0.032	1	1.58	0.214 ns		
Observed Expend Ratio	0.004	1	0.01	0.967 ns		

finding that socioeconomic status was a predictor of mortality, independent of the ACG morbidity index. These include: (1) the ACG morbidity index was less able to capture the burden of morbidity of more disadvantaged populations; (2) there was a relationship between premature mortality and socioeconomic risk that was independent of morbidity. There was considerable evidence from a variety of sources to support the latter. Further research is needed to examine the performance of the ACG morbidity ratio for more disadvantaged populations. Neither the proportion of users nor the observed expenditure ratio achieved statistical significance in the final models and did not contribute additional explanatory power to the re-fit model. The former finding suggests that non-users did not have large morbidity burdens that were related to premature mortality. Moreover, it was consistent with previous research showing that the health status of elderly non-users is not statistically different from low-users (Shapiro, Roos 1985). The latter finding suggests that actual expenditures provided no greater ability in describing the morbidity burdens for populations than did the ACG morbidity index.

In summary, the criterion validity of using the ACG morbidity index to measure population health status was supported by our finding of a significant positive relationship between premature mortality and the ACG morbidity index, after accounting for a variety of possible confounders. Its validity was further supported by the finding of a stronger relationship between premature mortality and the ACG morbidity index compared with the relationships between premature mortality and either the age/gender or observed expenditure ratios. Our findings suggested however that the measurement of ACG-related morbidity may have been unstable for small populations, and thus must be interpreted with caution for such populations. In addition, the ACG morbidity index appeared less able to quantify the morbidity patterns of older populations. The finding that socioeconomic status was an independent predictor suggested that, for a given burden of morbidity, populations with lower socioeconomic status have higher health service needs.

Figure 6: Plot of Residual versus Predicted Values for Premature Mortality



7. CONCLUSIONS

The following conclusions can be drawn with regard to the performance and validity of the ACG system in Manitoba.

- The diagnoses coded on Manitoba's physician claims and hospital separation abstracts were generally acceptable to the ACG software as valid and classifiable ICD-9/ICD-9-CM codes. There appeared to be no large differences in the use of unacceptable codes between rural and urban Manitoba and between physician claims and hospital abstracts.
- The distributions of selected ACG assignments had substantial face validity. For example, the ACG treatment prevalence of adult mental health disorders and the ACG-measured crude birth rates appeared similar to other reported rates. The proportion of non-users identified by the ACG system was similar to other reports.
- The majority of the ACG categories had relatively low within-category variation for physician expenditures. Several ACGs, however, included individuals with wide differences in expenditures. These included ACGs relating to psychosocial and acute medical conditions. Across the ACGs, there appeared to be greater variability for combined physician, inpatient, and ambulatory surgery expenditures compared to physician expenditures alone. However, the patterns of relative differences in expenditures across ACGs remained generally consistent for these two approaches.
- The relative expenditures across ACGs in Manitoba had substantial face validity, with the ACGs with the greatest morbidity burdens having both higher physician and total expenditures. Furthermore, the relative expenditures across ACGs were similar to those found in B.C., the Minnesota Medicaid program, and a large U.S. HMO population. These findings provided further evidence for the validity of the ACG assignments in Manitoba.
- The ACG system was able to explain about 53% of variation in concurrent (i.e., same year) expenditures by Manitobans who use medical care. This approximated the ability of the ACG system to explain variation in ambulatory expenditures in U.S. enrolled populations. For total expenditures, the ACG system explained about 35%

of the variation in expenditures which was also in the range of U.S. experience. The ACG system's explanatory ability represented a significant improvement over demographic adjusters which explained less than 10% of variation. Among statistical models, those that contain ADGs and demographics explained the greatest degree of variation. There appeared to be no added explanatory power by including an ecological indicator of income as an explanatory variable.

- In contrast to the general population, the ACG models (especially the 'ACG only' model) appeared to have less ability to explain concurrent expenditures for child populations.
- The population's burden of morbidity, as measured by the ACG morbidity index, appeared to be strongly related to the premature mortality rate which describes a population's need for medical care (Carstairs, Morris 1991; Eyles, Birch, Chambers et al. 1993; U.S. General Accounting Office 1996; Kindig 1997). This finding provided substantial evidence for the criterion validity of using the ACG system as a population 'needs' indicator for geographically defined populations and as a general case-mix measure for practice populations. The ACG morbidity index offers significant advantages in comparison to the premature mortality rate. It can be specified over shorter time periods and is more logically related to health service need than an index based on deaths.
- The population's health status (as measured by premature mortality) appeared to be better reflected by the ACG morbidity index than by a similarly constructed demographic index. Furthermore, the ACG morbidity ratio was more closely related to premature mortality than was the ratio of observed to average expenditures. These findings suggested that the ACGs provide a significant opportunity to develop better methods to adjust for illness burden of clinical populations. The ACGs appeared to confer significant benefit over measures developed using demographic data alone.

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APPENDIX I

Table A1:Distribution of Physician Expenditures (Trimmed Outliers)* By ACG Category, Manitoba 1995/96

ACG	Description	n	Mean ($)	cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
100	Acute Minor Age 1-2	2207	95.31	0.59	15.29	52.92	87.59	124.66	275
200	Acute Minor Age 2-5	13167	65.15	0.71	15.00	31.93	53.89	86.62	227
300	Acute Minor Age 6+	127525	55.15	0.91	3.65	16.64	35.70	70.37	268
400	Acute Major	34208	82.96	1.30	5.00	17.44	48.95	93.44	681
500	Likely to Recur, without Allergies	44014	61.72	1.08	6.97	16.64	36.89	75.00	356
600	Likely to Recur, with Allergies	2619	72.35	1.06	10.00	17.44	48.24	89.55	389
700	Asthma	3485	51.60	0.89	11.19	16.64	34.08	64.59	220
800	Chronic Medical, Unstable	6555	141.21	1.22	10.81	39.91	85.65	167.92	949
900	Chronic Medical, Stable	23961	88.04	0.87	10.81	32.70	65.98	118.85	415
1000	Chronic Specialty, Stable	1081	53.01	1.07	15.05	16.64	33.70	66.01	342
1100	Ophthalmological / Dental	8225	58.36	1.50	8.62	29.35	29.35	57.67	535
1200	Chronic Specialty, Unstable	3106	68.97	1.20	11.76	23.05	45.20	76.25	434
1300	Psychosl, without Psychosl Unstable	7670	129.04	2.06	10.81	16.64	48.05	106.95	1623
1400	Psychosl, c/ Psychosl Unstab, c/o Psychosl,Stab	1240	231.05	1.59	13.86	33.28	88.19	234.26	1769
1500	Psychosl, with Psychosl Unstab, c Psychosl Stab	526	554.83	1.31	21.20	126.55	260.64	629.45	3298
1600	Preventive / Administrative	26883	51.23	0.71	3.09	32.71	37.35	56.22	266
1711	Pregnancy: 0-1 ADGs, delivered	1286	135.42	0.76	1.83	57.26	108.01	187.45	471
1712	Pregnancy: 0-1 ADGs, not delivered	427	105.89	0.74	15.25	47.96	85.27	143.95	357
1721	Pregnancy: 2-3 ADGs, no maj ADG, delivered	4957	213.67	0.63	4.24	112.80	183.30	289.37	640
1722	Pregnancy: 2-3 ADGs, no maj ADG, not delivered	2037	185.15	0.56	17.44	111.35	163.22	234.50	538
1731	Pregnancy: 2-3 ADGs, 1+ maj ADG, delivered	876	217.56	0.71	1.83	103.55	183.13	296.71	781
1732	Pregnancy: 2-3 ADGs, 1+ maj ADG, not delivered	189	226.66	0.62	33.79	129.76	192.91	286.43	741
1741	Pregnancy: 4-5 ADGs, no maj ADG, delivered	3153	311.13	0.52	28.58	192.59	281.59	402.19	832
1742	Pregnancy: 4-5 ADGs, no maj ADG, not delivered	1918	276.60	0.49	65.40	182.41	245.93	334.10	752
1751	Pregnancy: 4-5 ADGs, 1+ maj ADG, delivered	1586	342.68	0.63	16.64	192.29	294.41	422.89	1110
1752	Pregnancy: 4-5 ADGs, 1+ maj ADG, not delivered	607	345.45	0.66	46.44	198.70	284.56	408.67	1217
1761	Pregnancy: 6+ ADGs, no maj ADG, delivered	1460	451.61	0.48	62.00	299.24	409.29	557.51	1212
1762	Pregnancy: 6+ ADGs, no maj ADG, not delivered	1294	420.01	0.48	100.43	276.06	372.72	505.76	1136
1771	Pregnancy: 6+ ADGs, 1+ maj ADG, delivered	1922	590.80	0.63	65.07	339.53	492.44	709.43	1931
1772	Pregnancy: 6+ ADGs, 1+ maj ADG, not delivered	1339	611.80	0.75	85.55	342.30	474.90	701.22	2779
1800	Acute Minor and Acute Major	52813	143.86	0.86	6.97	65.60	106.83	174.25	695
1900	Acute Minor and Likely to Recur, Age 1-2	5337	191.04	0.60	16.64	112.06	163.03	238.10	616
2000	Acute Minor and Likely to Recur, Age 2-5	15574	139.60	0.67	16.64	74.89	113.78	173.60	462
2100	Acute Minor and Like to Recur, Age >5, c/o All.	61046	122.04	0.77	6.97	58.60	94.31	151.31	474
2200	Acute Minor and Likely to Recur, Age >5, c All.	5238	146.06	0.78	24.60	65.99	113.04	182.29	554
2300	Acute Minor and Chronic Medical: Stable	22151	141.98	0.69	15.85	69.15	116.35	185.58	522
2400	Acute Minor and Eye / Dental	6967	111.10	0.90	15.85	51.71	79.87	127.82	599
2500	Acute Min with Psychosl Stab c/o Psychosl Unst	9471	168.16	1.29	15.29	63.40	104.90	179.18	1380

ACG Description	n	Mean ($)	cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
2600 Acute Min c/o Psychosl Stab c Psychosl Unstab	813	243.75	1.31	15.85	78.69	133.13	256.58	1840
2700 Acute Min with Psychosl Stable and Unstable	523	614.36	1.26	47.55	162.37	300.40	686.42	3717
2800 Acute Major and Likely to Recur	16745	171.57	1.02	10.95	65.40	111.59	196.96	831
2900 Acute Min /Acute Maj / Likely to Recur, Age 1-2	3146	294.28	0.59	17.44	174.80	247.87	362.61	928
3000 Acute Minor /Acute Maj/Like to Recur, Age 2-5	7257	223.63	0.64	31.14	125.73	184.45	273.05	731
3100 Acute Min /Acute Maj/Like to Recur, Age 6-11	5887	200.12	0.69	16.64	109.27	159.33	240.99	708
3200 Acute Min /Acu Maj/Like to Recur, Age>11c/oAll	33477	260.44	0.80	15.85	123.66	193.37	316.90	1055
3300 Acute Min /Acute Maj/Like to Recur, Age>11 c Al	2663	269.67	0.70	45.89	140.52	217.67	336.13	976
3400 Acute Min / Likely to Recur / Eye & Dental	4631	188.11	0.73	16.64	101.57	147.70	226.30	764
3500 Acute Min / Likely to Recur / Psychosl	8594	283.12	1.13	34.88	117.55	183.66	306.05	1894
3600 Acute Min / Acute Maj /Like to Recur / Eye&Dent	16513	434.74	0.73	15.85	215.49	333.22	544.11	1545
3700 Acute Min / Acute Maj /Like to Recur / Eye&Dent	9963	452.01	0.92	23.61	205.38	313.94	523.52	2249
3800 2-3 Oth ADG Comb, Age < 17	15228	138.36	0.84	15.29	67.93	104.51	164.58	706
3900 2-3 Oth ADG Comb, Males Age 17-34	9927	169.94	1.24	12.01	62.29	101.54	176.39	1260
4000 2-3 Oth ADG Comb, Females Age 17-34	10384	179.73	1.05	6.97	79.61	123.67	200.61	1224
4100 2-3 Oth ADG Comb, Age > 34	85861	231.10	0.99	4.57	93.40	159.47	268.62	1199
4210 4-5 Oth ADG Comb, Age < 17, no major ADGs	8901	240.94	0.62	16.83	140.30	200.89	292.92	865
4220 4-5 Oth ADG Comb, Age < 17, 1+ major ADGs	3067	312.86	0.91	48.34	144.60	217.67	358.14	1642
4310 4-5 Oth ADG Comb, Age 17-44, no major ADGs	16259	274.34	0.80	14.64	142.32	209.16	320.72	1365
4320 4-5 Oth ADG Comb, Age 17-44, 1 major ADGs	10829	362.04	0.92	17.44	159.86	249.47	418.54	1816
4330 4-5 Oth ADG Comb, Age 17-44, 2+ major ADGs	2614	573.92	1.05	15.69	196.76	342.82	703.56	2829
4410 4-5 Oth ADG Comb, Age > 44, no major ADGs	22563	332.73	0.74	16.83	175.26	259.40	391.74	1304
4420 4-5 Oth ADG Comb, Age > 44, 1 major ADGs	25910	440.00	0.82	15.39	206.39	317.93	527.24	1748
4430 4-5 Oth ADG Comb, Age > 44, 2+ major ADGs	11606	676.46	0.91	7.48	267.87	455.05	863.39	2936
4510 6-9 Oth ADG Comb, Age < 6, no major ADGs	1509	426.10	0.51	83.40	273.14	376.35	512.63	1176
4520 6-9 Oth ADG Comb, Age < 6, 1+ major ADGs	773	639.51	0.84	115.11	309.12	447.93	779.78	2809
4610 6-9 Oth ADG Comb, Age 6-16, no major ADGs	1553	388.10	0.74	92.30	224.04	309.60	449.38	2112
4620 6-9 Oth ADG Comb, Age 6-16, 1+ major ADGs	989	622.58	0.96	69.15	269.20	409.20	709.09	3143
4710 6-9 Oth ADG Comb, Male Age 17-34,0 maj ADG	700	400.97	0.69	97.50	220.31	310.53	489.60	1741
4720 6-9 Oth ADG Comb, Male Age 17-34,1 maj ADG	1298	525.01	0.82	94.54	263.56	383.32	627.77	2364
4730 6-9 Oth ADG Comb, Male Age 17-34,2+majADG	957	888.30	1.02	113.17	324.05	563.18	1087.09	4711
4810 6-9 Oth ADG Comb, FemalAge17-34,0majADGs	2988	435.86	0.70	83.20	252.04	342.80	508.57	1812
4820 6-9 Oth ADG Comb, FemalAge17-34,1majADGs	2612	541.33	0.73	94.50	282.80	421.42	657.15	2218
4830 6-9 Oth ADG Comb,FemalAge17-34,2+majADG	980	873.30	0.92	73.53	359.42	601.45	1062.21	3996
4910 6-9 Oth ADG Comb, Age > 34, 0-1 major ADGs	32919	608.78	0.70	11.55	318.85	477.30	755.46	2172
4920 6-9 Oth ADG Comb, Age > 34, 2 major ADGs	14564	899.68	0.75	11.55	422.14	689.40	1157.31	3439
4930 6-9 Oth ADG Comb, Age > 34, 3 major ADGs	6284	1309.42	0.77	15.72	589.55	1019.61	1685.39	4707
4940 6-9 Oth ADG Comb, Age > 34, 4+ major ADGs	2121	1954.63	0.78	20.79	851.90	1499.99	2590.50	6717
5010 10+ Oth ADG Comb, Age 1-16, no major ADGs	78	961.83	0.81	270.92	486.33	717.06	1131.01	4445
5020 10+ Oth ADG Comb, Age 1-16, 1 major ADGs	90	1128.58	0.64	250.69	546.10	888.29	1548.35	3410
5030 10+ Oth ADG Comb, Age 1-16, 2+ major ADGs	82	2749.79	0.73	378.31	1310.13	2225.68	3799.65	9319
5040 10+ Oth ADG Comb, Age > 16, 0-1 major ADGs	2864	977.97	0.54	39.86	586.95	824.55	1209.86	3107
5050 10+ Oth ADG Comb, Age > 16, 2 major ADGs	3034	1291.97	0.61	197.94	732.53	1090.82	1620.73	3979

ACG	*Description*	*n*	*Mean ($)*	*cv ($)*	*Min ($)*	*25° ($)*	*Med ($)*	*75° ($)*	*Max ($)*
5060	10+ Oth ADG Comb, Age > 16, 3 major ADGs	2387	1710.88	0.65	190.62	927.98	1418.67	2167.86	5514
5070	10+ Oth ADG Comb, Age > 16, 4+ major ADGs	2312	2579.88	0.64	38.22	1386.73	2121.22	3259.83	7792
5110	No Diagnosis or Only Unclassified Diagnoses	77	120.90	0.91	15.80	28.00	101.92	173.46	546
5311	Infants: 0-5 ADGs, no maj ADG, low birth wgt	246	205.76	0.66	15.85	124.95	178.77	268.00	790
5312	Infants: 0-5 ADGs, no maj ADG, norm brth wgt	11959	170.71	0.58	10.45	100.80	150.75	218.32	551
5321	Infants: 0-5 ADGs, 1+ maj ADG, low birth wgt	234	355.62	0.67	34.27	192.38	304.86	443.15	1215
5322	Infants: 0-5 ADGs, 1+ maj ADG, norm brth wgt	1385	262.91	0.80	15.85	138.23	209.41	309.75	1132
5331	Infants: 6+ ADGs, no maj ADG, low birth wgt	21	460.10	0.63	159.69	304.60	400.90	491.62	1269
5332	Infants: 6+ ADGs, no maj ADG, norm brth wgt	717	434.08	0.48	109.80	300.25	387.06	506.06	1321
5341	Infants: 6+ ADGs, 1+ maj ADG, low birth wgt	143	945.17	0.82	105.25	409.52	695.85	1216.50	4070
5342	Infants: 6+ ADGs, 1+ maj ADG, norm brth wgt	583	669.05	0.89	59.71	320.97	454.65	735.68	3051
	All ACGs	937940	237.98	1.61	1.83	52.64	121.48	260.31	9319

Mean=mean physician cost per ACG; cv=coefficient of variation (standard deviation/mean); min=minimum value; 25°=25th percentile; 50°=median value;75°=75th percentile; max=maximum value.

* includes payments for physician interviews and examinations, procedures, non-hospital laboratory and diagnostic imaging services. Individual costs greater than 3 standard deviations (SD) above the ACG specific mean were set equal to (Trimmed) the mean + 3 SD.

Table A2: Distribution of Total Expenditures (Outliers Trimmed)* By ACG Category, Manitoba 1995/96

ACG	Description	n	Mean ($)	Cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
100	Acute Minor Age 1-2	2210	111.15	1.04	15.29	52.92	87.99	125.68	774
200	Acute Minor Age 2-5	13172	70.98	1.04	15.00	31.94	53.89	87.22	627
300	Acute Minor Age 6+	127612	61.84	1.33	6.97	16.64	36.04	70.92	665
400	Acute Major	34351	173.36	3.38	6.97	17.44	49.35	97.69	6581
500	Likely to Recur, without Allergies	44101	88.62	2.01	6.97	16.64	37.35	77.41	1225
600	Likely to Recur, with Allergies	2620	86.04	1.59	10.00	17.44	48.37	90.27	841
700	Asthma	3490	62.84	1.59	11.19	16.64	34.27	65.04	732
800	Chronic Medical, Unstable	6592	747.60	3.89	10.81	40.10	90.03	193.95	23756
900	Chronic Medical, Stable	23983	96.01	1.33	10.81	32.70	65.98	119.85	1451
1000	Chronic Specialty, Stable	1086	67.07	1.90	15.05	16.64	34.27	66.14	840
1100	Ophthalmological / Dental	8308	93.28	2.19	8.62	29.35	29.35	60.80	1123
1200	Chronic Specialty, Unstable	3107	94.07	3.36	11.76	23.05	45.20	76.25	8685
1300	Psychosl, without Psychosl Unstable	7686	161.19	2.80	10.81	16.64	48.18	109.00	3887
1400	Psychosl, c/ Psychosl Unstab, c/o Psychosl,Stab	1250	1320.90	3.72	13.86	34.27	100.93	311.30	32319
1500	Psychosl, with Psychosl Unstab, c Psychosl Stab	528	2335.72	2.40	30.58	144.93	337.24	1111.71	31399
1600	Preventive / Administrative	26898	54.42	1.52	3.09	32.71	37.35	56.30	2303
1711	Pregnancy: 0-1 ADGs, delivered	1352	1756.27	0.49	531.56	1227.14	1513.43	2026.68	5715
1712	Pregnancy: 0-1 ADGs, not delivered	427	129.37	1.25	15.25	47.96	86.59	149.42	1000
1721	Pregnancy: 2-3 ADGs, no maj ADG, delivered	4967	1967.22	0.44	436.85	1328.82	1843.49	2419.63	5429
1722	Pregnancy: 2-3 ADGs, no maj ADG, not delivered	2037	262.01	1.05	31.70	117.49	173.82	277.12	1556
1731	Pregnancy: 2-3 ADGs, 1+ maj ADG, delivered	890	2391.29	0.52	454.29	1473.22	2044.52	2957.32	7434
1732	Pregnancy: 2-3 ADGs, 1+ maj ADG, not delivered	189	774.89	0.97	35.47	202.80	565.83	1106.41	3316
1741	Pregnancy: 4-5 ADGs, no maj ADG, delivered	3153	2283.37	0.48	439.17	1474.39	2013.44	2710.59	6649
1742	Pregnancy: 4-5 ADGs, no maj ADG, not delivered	1918	471.40	0.93	65.40	198.28	289.75	629.61	2275
1751	Pregnancy: 4-5 ADGs, 1+ maj ADG, delivered	1587	2907.03	0.64	657.09	1784.79	2469.88	3328.97	11293
1752	Pregnancy: 4-5 ADGs, 1+ maj ADG, not delivered	607	1137.68	1.06	70.85	295.86	848.65	1307.10	6203
1761	Pregnancy: 6+ ADGs, no maj ADG, delivered	1460	2688.74	0.51	730.47	1698.53	2364.57	3239.10	7701
1762	Pregnancy: 6+ ADGs, no maj ADG, not delivered	1294	739.16	0.83	112.40	327.55	554.71	899.04	3153
1771	Pregnancy: 6+ ADGs, 1+ maj ADG, delivered	1922	3930.63	0.72	698.21	2204.22	3134.74	4582.83	16579
1772	Pregnancy: 6+ ADGs, 1+ maj ADG, not delivered	1339	1817.38	1.24	149.70	649.33	1134.31	1937.38	14802
1800	Acute Minor and Acute Major	52825	270.05	2.37	6.97	65.98	108.99	186.68	5844
1900	Acute Minor and Likely to Recur, Age 1-2	5337	244.67	1.20	30.58	114.04	166.42	247.11	2037
2000	Acute Minor and Likely to Recur, Age 2-5	15574	166.23	1.09	16.64	75.05	114.57	176.13	1025
2100	Acute Minor and Like to Recur, Age >5, c/o All.	61059	165.77	1.35	6.97	59.20	96.29	160.64	1283
2200	Acute Minor and Likely to Recur, Age >5, c All.	5238	173.82	1.16	24.60	66.00	113.85	184.95	1029
2300	Acute Minor and Chronic Medical: Stable	22153	163.61	1.17	15.85	69.15	117.33	189.37	1668
2400	Acute Minor and Eye / Dental	6968	156.49	1.43	28.61	54.85	84.07	139.31	1201

ACG	Description	n	Mean ($)	Cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
2500	Acute Min with Psychosl Stab c/o Psychosl Unst	9476	210.41	1.76	15.85	63.40	107.43	191.07	2900
2600	Acute Min c/o Psychosl Stab c Psychosl Unstab	814	948.65	3.15	30.58	83.16	160.34	366.50	19257
2700	Acute Min with Psychosl Stable and Unstable	523	1833.56	2.23	47.55	176.30	395.36	1140.02	21882
2800	Acute Major and Likely to Recur	16758	355.85	2.06	15.85	66.20	116.54	240.95	4998
2900	Acute Min /Acute Maj / Likely to Recur, Age 1-2	3146	653.52	1.55	47.55	181.67	273.77	534.44	5436
3000	Acute Minor /Acute Maj/Like to Recur, Age 2-5	7257	349.19	1.38	38.58	127.47	191.26	303.48	2910
3100	Acute Min /Acute Maj/Like to Recur, Age 6-11	5887	319.20	1.48	34.70	110.61	164.92	263.64	2914
3200	Acute Min /Acu Maj/Like to Recur, Age>11c/oAll	33482	494.38	1.61	15.85	127.20	210.04	466.38	4854
3300	Acute Min /Acute Maj/Like to Recur, Age>11 c A	2663	394.23	1.21	45.89	142.58	227.00	397.21	2555
3400	Acute Min / Likely to Recur / Eye & Dental	4631	269.38	1.14	16.64	104.40	157.95	262.05	1559
3500	Acute Min / Likely to Recur / Psychosl	8595	456.89	2.22	46.43	119.43	193.48	363.93	9481
3600	Acute Min / Acute Maj /Like to Recur / Eye&Dent	16513	1012.95	1.62	16.64	232.07	411.59	955.59	10194
3700	Acute Min / Acute Maj /Like to Recur / Eye&Dent	9963	1008.38	2.09	23.61	220.03	382.85	843.03	17612
3800	2-3 Oth ADG Comb, Age < 17	15231	249.12	2.29	27.93	69.40	107.94	178.68	5482
3900	2-3 Oth ADG Comb, Males Age 17-34	9933	372.81	2.72	15.85	62.85	105.10	199.32	9100
4000	2-3 Oth ADG Comb, Females Age 17-34	10394	300.12	2.10	6.97	81.15	127.93	220.96	5537
4100	2-3 Oth ADG Comb, Age > 34	85949	626.92	3.15	6.97	95.74	167.26	312.63	17632
4210	4-5 Oth ADG Comb, Age < 17, no major ADGs	8901	440.14	1.64	33.28	144.55	213.04	347.97	5278
4220	4-5 Oth ADG Comb, Age < 17, 1+ major ADGs	3068	814.01	2.13	48.34	148.03	230.40	610.65	11328
4310	4-5 Oth ADG Comb, Age 17-44, no major ADGs	16261	400.02	1.23	14.64	146.72	221.52	400.69	2757
4320	4-5 Oth ADG Comb, Age 17-44, 1 major ADGs	10831	792.08	1.93	32.70	167.07	282.55	680.98	12410
4330	4-5 Oth ADG Comb, Age 17-44, 2+ major ADGs	2616	2270.81	1.78	61.16	230.63	583.39	2372.19	22326
4410	4-5 Oth ADG Comb, Age > 44, no major ADGs	22564	524.81	1.45	40.85	181.68	277.95	483.98	4974
4420	4-5 Oth ADG Comb, Age > 44, 1 major ADGs	25922	1289.77	2.20	15.39	222.62	378.59	885.96	19839
4430	4-5 Oth ADG Comb, Age > 44, 2+ major ADGs	11627	5299.61	1.89	62.84	354.03	1265.27	5383.36	53906
4510	6-9 Oth ADG Comb, Age < 6, no major ADGs	1509	1103.53	1.59	102.84	294.16	450.29	1088.57	10174
4520	6-9 Oth ADG Comb, Age < 6, 1+ major ADGs	773	3450.67	2.23	115.11	331.68	754.56	2375.10	47785
4610	6-9 Oth ADG Comb, Age 6-16, no major ADGs	1553	711.37	1.86	92.30	231.63	334.73	574.33	11748
4620	6-9 Oth ADG Comb, Age 6-16, 1+ major ADGs	989	2394.22	2.11	97.35	297.42	582.52	1772.45	26978
4710	6-9 Oth ADG Comb, Male Age 17-34,0 Maj ADG	701	604.09	1.88	97.50	231.22	335.45	596.53	22985
4720	6-9 Oth ADG Comb, Male Age 17-34,1 Maj ADG	1298	1053.90	1.51	94.54	285.32	477.33	1069.35	8747
4730	6-9 Oth ADG Comb, Male Age 17-34,2+majADG	957	5175.56	2.27	113.17	408.17	1157.78	3825.74	72264
4810	6-9 Oth ADG Comb, FemalAge17-34,0majADGs	2988	662.24	1.04	93.98	264.68	398.80	751.74	3655
4820	6-9 Oth ADG Comb, FemalAge17-34,1majADGs	2612	1101.85	1.43	94.50	307.51	529.83	1188.33	9808
4830	6-9 Oth ADG Comb,FemalAge17-34,2+majADG	980	3615.65	1.82	73.53	513.22	1220.07	3317.87	36665
4910	6-9 Oth ADG Comb, Age > 34, 0-1 major ADGs	32920	1464.37	1.70	92.41	352.65	602.80	1308.64	15592
4920	6-9 Oth ADG Comb, Age > 34, 2 major ADGs	14571	5185.40	1.72	49.92	587.07	1561.71	5504.86	48063
4930	6-9 Oth ADG Comb, Age > 34, 3 major ADGs	6288	11307.51	1.31	68.18	1790.94	5828.66	14341.07	71948
4940	6-9 Oth ADG Comb, Age > 34, 4+ major ADGs	2126	20958.96	1.09	166.32	5936.56	13726.48	25895.25	109533

ACG	Description	n	Mean ($)	Cv ($)	Min ($)	25° ($)	Med ($)	75° ($)	Max ($)
5010	10+ Oth ADG Comb, Age 1-16, no major ADGs	78	3978.53	1.77	270.92	606.40	1207.38	3452.40	34624
5020	10+ Oth ADG Comb, Age 1-16, 1 major ADGs	90	6873.31	1.64	250.69	649.61	1697.44	9836.77	59292
5030	10+ Oth ADG Comb, Age 1-16, 2+ major ADGs	82	33702.52	1.19	378.31	5914.61	19814.51	48116.35	185329
5040	10+ Oth ADG Comb, Age > 16, 0-1 major ADGs	2864	2193.26	1.38	218.45	702.60	1149.31	2301.66	18862
5050	10+ Oth ADG Comb, Age > 16, 2 major ADGs	3034	5468.23	1.46	197.94	1039.08	2234.70	5995.84	40670
5060	10+ Oth ADG Comb, Age > 16, 3 major ADGs	2387	12199.92	1.31	236.68	2078.53	6205.46	15019.77	79752
5070	10+ Oth ADG Comb, Age > 16, 4+ major ADGs	2312	24122.13	0.97	309.59	7515.80	16605.96	32213.36	104669
5110	No Diagnosis or Only Unclassified Diagnoses	86	256.87	1.72	15.80	42.57	114.70	207.15	2186
5311	Infants: 0-5 ADGs, no maj ADG, low birth wgt	261	1724.81	0.88	307.25	762.01	1181.16	1904.15	7141
5312	Infants: 0-5 ADGs, no maj ADG, norm brth wgt	12123	717.05	0.64	15.85	476.65	592.80	820.38	2689
5321	Infants: 0-5 ADGs, 1+ maj ADG, low birth wgt	244	5232.81	0.85	371.80	1654.52	3892.46	7813.52	19633
5322	Infants: 0-5 ADGs, 1+ maj ADG, norm brth wgt	1403	1612.02	1.07	88.50	669.65	974.62	1785.35	10379
5331	Infants: 6+ ADGs, no maj ADG, low birth wgt	21	2721.43	0.91	534.15	1124.85	1618.54	4231.72	10450
5332	Infants: 6+ ADGs, no maj ADG, norm brth wgt	717	1728.05	0.99	376.99	779.50	1069.15	1908.68	9373
5341	Infants: 6+ ADGs, 1+ maj ADG, low birth wgt	143	11994.90	0.84	750.25	4048.90	8137.00	17618.72	46437
5342	Infants: 6+ ADGs, 1+ maj ADG, norm brth wgt	583	5343.43	1.35	260.99	1258.46	2315.32	5751.53	31997
	All ACGs	938988	817.62	4.52	3.09	53.55	128.53	345.21	185329

Mean=mean cost per ACG; cv=coefficient of variation (standard deviation/mean); min=minimum value; 25° =25th percentile; 50° =median value;75° =75th percentile; max=maximum value.

* expenditures include physician expenditures (interview, procedure, non-hospital laboratory & diagnostic imaging payments) and hospital expenditures (see Appendix II).

Individual costs greater than 3 standard deviations (SD) from the ACG specific mean cost have been set equal to the mean + 3 SD.

APPENDIX II: HOSPITAL COSTING

Background

Hospitals in Manitoba are funded by a global budget rather than for individual services. Consequently, we employed a 'top-down' case-mix costing methodology to estimate patient-specific hospital costs. This method starts at the top with total expenditures and then divides these by a measure of total output. It has been used in various research projects by MCHPE (Shanahan, Jacobs, Roos et al. 1998; Shanahan, Loyd, Roos et al. 1994; Shanahan 1996; Shanahan, Steinbach, Burchill et al. 1997). This method goes further than a per diem costing methodology by dividing patients into groups that are clinically meaningful and homogeneous with respect to expected hospital expenditures. Patients are assigned higher weights if they are expected to consume more resources. Weights can be adjusted depending on whether the case is typical or atypical (see below). This method of case-mix hospital costing uses total hospital costs as the numerator (as is the case if one were to calculate unadjusted per diem rates), but rather than dividing by the number of patient days to find an "average" cost per day, it is divided by the sum of the case-mix weights to estimate the cost per weighted case (CWC).

It is important to note that:

1. The cost assigned to a case is for a complete course of treatment, and dividing the cost by the length of stay will not accurately reflect the costs of any particular day.
2. The cost for a case is an estimate of the average cost for that particular type of case, and may not accurately reflect the actual cost of a specific case.
3. The cost for a particular type of case is calculated as a value relative to all other types of cases.
4. Weights were not developed from Manitoba cost data. Maryland Health Services Cost Review Commission (HSCRC) 1991 and 1992 data were used to calibrate Manitoba (RDRG) weights and costs.

We used the Refined Diagnostic Related Group (RDRG) classification system to group inpatient cases into clinically meaningful resource use. (Canadian Institute for Health Information 1995) The RDRG system allows for differing levels of severity based on complications and co-morbidities within similar diagnostic groupings. Relative case weights (RCWs) were developed based on charge data from Maryland and Manitoba lengths of hospital stay (LOS). Average LOS (ALOS) and trim point (the point after which a length of stay is determined to be abnormally long) for typical patients were also developed for Manitoba patients for each RDRG.

For outpatient care, Day Procedure Groups (DPGs) and weights were available from the Canadian Institute for Health Information. (Canadian Institute for Health Information 1994)

Details of Costing Methods

Using 1995/96 patient hospital data, all inpatient hospital days were classified into RDRGs (version 9); each was weighted using Manitoba RCWs. Adjustments were made to the weights for atypical cases (cases involving non-acute days, outliers (LOS>Trim), transfers or deaths). For example, for cases with LOS>Trim, a marginal case weight was added to the RCW for every day that the LOS was past the average LOS (that is, case weight = RCW + Marginal case weight * (LOS - ALOS)). Marginal case weights were developed for each RDRG.

For each hospital these case weights were summed. Hospital-specific average case weights were calculated by summing all the case weights in each hospital and dividing by the total number of hospital cases. Hospital average costs per weighted case (CWC) were calculated by dividing the total inpatient dollars by the total hospital case weights. (See following for how the hospital inpatient dollars were identified.) The hospital average cost per weighted case (CWC) was the focus. The CWC for a hospital represents an average cost per case adjusted for the types of patients treated in that hospital.

CWC (per hospital) = Total $ per hospital / Sum of all RCW (per hospital)

To find the cost of a particular case:

*Cost of a case = CWC * RCW for that case*

Day care surgery costs were estimated using the DPG to classify cases and apply appropriate weights. The DPG weight was then multiplied by the CWC for the hospital providing the care to obtain an estimated cost per case.

*Estimated day surgery cost for a case = DPG weight * CWC for that hospital*

For each patient, the inpatient and day procedure costs, if any, were combined.

Source of Global Budgets

The primary source of financial data was the Statistics Canada HS-1 database. This information was supplemented with data from various other sources.

Hospital Statistics Part 1 (HS-1): Prior to 1995/96 all hospitals annually filed HS-1 data collection forms with Statistics Canada. The HS-1 consisted of hospital costs and statistics in an aggregate form.

Financial Information Systems (FIS): used to provide audited and inventory- adjusted cost data for drugs and medical and surgical supplies for the rural hospitals

Laboratory and Imaging Services (LIS): provides diagnostic services for many rural hospitals.

Community Therapy Services (CTS) and South Central Therapy Services (SCTS): cost data on occupational therapy and physiotherapy provided by outside agencies.

Some costs were excluded, such as medical reimbursements, medical housestaff salaries, capital costs and depreciation, and costs not directly related to patient care, such as education and research programs.

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