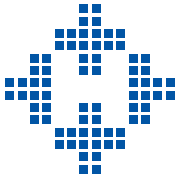
# Diagnostic Imaging Data in Manitoba: Assessment and Applications

June 2004



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ISBN 1-896489-17-6

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The Manitoba Centre for Health Policy (MCHP) is located within the Department of Community Health Sciences, Faculty of Medicine, University of Manitoba. The mission of MCHP is to provide accurate and timely information to health care decision-makers, analysts and providers, so they can offer services which are effective and efficient in maintaining and improving the health of Manitobans. Our researchers rely upon the unique Population Health Research Data Repository to describe and explain patterns of care and profiles of illness, and to explore other factors that influence health, including income, education, employment and social status. This Repository is unique in terms of its comprehensiveness, degree of integration, and orientation around an anonymized population registry.

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We thank the University of Manitoba, Faculty of Medicine, Health Research Ethics Board for their review of this project. The Manitoba Centre for Health Policy complies with all legislative acts and regulations governing the protection and use of sensitive information. We implement strict policies and procedures to protect the privacy and security of anonymized data used to produce this report and we keep the provincial Health Information Privacy Committee informed of all work undertaken for Manitoba Health.

# 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:

- The Project Working Group: Corinne Brennan, Lloyd McCabe, Shelley Mitchell, and Earl Slimmon.
- Colleagues who provided feedback on drafts of the report: Carolyn De Coster, Colleen Metge, Noralou Roos, and Evelyn Shapiro.
- Individuals in RHAs and hospitals throughout the province who provided useful summary data or information about diagnostic imaging data: Jean-Claude Drolet, Dave Fotheringham, Shirley Gagnon, Darlene Goertzen, Marion Harrison, Greg Prokopchuk, and Robin Smith.
- Individuals who contributed technical knowledge about diagnostic imaging data or data analysis: Marni Brownell, Randy Fransoo, Norman Frohlich, Blake McClarty, and Patrick Nicol.
- Individuals at Manitoba Health who provided information on diagnostic imaging data: Deborah Malazdrewicz, Cecile Simard, and Leonie Stranc.
- Brian Lentle provided valuable comments as an external reviewer.
- Paulette Collins managed the multiple data sharing agreements that were initiated through this project.
- Bogdan Bogdanovic and Marina Yogendran provided data and analytic support.
- Shannon Lussier provided administrative support and Janine Harasymchuk for proofreading/production support.

The results and conclusions are those of the authors and no official endorsement by Manitoba Health was intended or should be implied. This report was prepared at the request of Manitoba Health as part of the contract between the University of Manitoba and Manitoba Health.

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# EXECUTIVE SUMMARY

Each year, the Manitoba Centre for Health Policy (MCHP) undertakes a "database development" project at the request of Manitoba Health. Database development involves working with a particular component of the Manitoba Population Health Research Data Repository to enhance the capacity for using these data to answer population-based research questions. Typically, this involves a careful review of the data and its sources, validity and reliability testing, and establishing parameters under which the data may be used for research purposes. This year, our work has focussed on the broadly defined area of "diagnostic imaging," and has investigated various data sources within Manitoba.

When this project was initiated, MCHP maintained three sources of anonymized person-level diagnostic imaging data in the Repository: hospital discharge records, physician services claims and magnetic resonance imaging (MRI) clinical data. Hospital discharge records are those that are created when a person is discharged from an acute care hospital and include information on the person's diagnosis and treatment, physician services claims are records of real or evaluation claims that are submitted by physicians to Manitoba Health, and the MRI clinical data include information concerning MRI examinations. Management Information System (MIS) data were also available, and include aggregate statistical information for hospitals in the province. The initial task of this project was to assess how these data could be used to understand the use of diagnostic imaging (DI) services in Manitoba.

One of the concepts developed to assist in making comparisons between hospitals and RHAs, and to assess the validity of data, was that of "modality." Modality refers to a general classification of DI services into one of seven categories. These categories are: general x-ray, ultrasound, computed tomography (CT), mammography, MRI, angiography and nuclear medicine. The use of this classification system avoids recognized inconsistencies in coding, and provides a manageable number of categories for making comparisons. These modalities are used to describe the results of our assessment of the available data.

*Key Findings*

- ***On a province-wide basis, hospital discharge records may be used to look at angiography—for all other modalities data may or may not be included in the hospital discharge abstract.***
- ***On a province-wide basis, physician services claims may be used to look at angiography, adult MRI and screening mammography***
- ***Physician services claims for all modalities except nuclear medicine are available for Winnipeg and Brandon but are not necessarily reported in all other locations in the province.***
- ***ICD-9-CM codes on physician services claims may not accurately reflect the diagnosis.***
- ***Alternative payment arrangements with physicians (i.e., memoranda of understanding (MOU) or batch-billing) without a requirement to submit evaluation claims result in incomplete data, particularly outside of Winnipeg and Brandon.***
- ***MIS data are reported to Manitoba Health at a high level of aggregation. While the data may be useful for management purposes they have little value for research.***

Early in the project, regional health authorities and hospitals throughout the province were asked to provide information on diagnostic imaging data they collect. This information was used to develop an inventory of databases that are currently in use. These databases are independent of the hospital discharge abstract and physician services claims data held by Manitoba Health and MCHP. It is clear that data are collected and maintained for a variety of purposes and in various formats, and that, in some cases, these independent databases could enhance our understanding of DI if it was possible to link them with other existing databases.

*Key Finding*

- ***Inconsistencies between radiology information systems maintained in hospitals throughout the province, and in particular the lack of use of a province-wide unique patient identifier limits our ability to link with other databases.***

It was hoped that these other databases could be used to supplement the data held in the Research Data Repository, or to validate the data. Differences in classification systems made it impossible to use the data for validation. Two "Data Sharing Agreements" were initiated with the WRHA and Brandon General Hospital for Bone Mineral Density (BMD) testing data, and for the radiology information system data maintained by the Health Sciences Centre and at St. Boniface General Hospital. The BMD data were successfully linked with other data in the Repository. For technical and logistical reasons it was not possible to obtain the radiology information system data from the two Winnipeg hospitals.

A feature of this project that is unique among MCHP data development projects is the use of "demonstration projects." These independent research activities have three primary benefits: they provide examples of the type of research that can be done using data in the Population Health Research Data Repository, they answer clinically relevant research questions, and they "test" the data to identify issues that arise when conducting

this type of research. Three demonstration projects were initiated, developed and directed by clinicians—one investigated the impact of establishing a bone densitometry program in Brandon, the second asked the question "is there an association between socioeconomic factors and the per capita utilization of selected diagnostic imaging modalities?" and the third looked at repeat coronary angiography and revascularization procedures following initial percutaneous coronary intervention and coronary artery bypass surgery. Each of these research projects makes an important contribution to the body of knowledge in these areas, and the investigators intend to publish the findings in peer-reviewed journals.

*Key Finding*

- ***Within prescribed limitations, diagnostic imaging data within the Population Health Research Data Repository may be used to answer clinically and policy relevant research questions.***

To address the limitations that have been identified, we recommend the following actions:

- A complete picture of DI services in Manitoba could be developed if all services were reported through the existing Physician Services Claims system. If all services were reported, either as actual claims or evaluation claims, it would be possible to answer many important DI-related questions. Claims should be submitted whether physicians are paid on a fee-for-service basis, are salaried, or provide services through a Memorandum of Understanding.
- The current procedure of adding ICD-9-CM codes (where they have not been recorded by the radiologist) to claims during processing at Manitoba Health should be reconsidered, and potentially eliminated. Anecdotal evidence suggests that the codes that are assigned may not accurately reflect the diagnosis that would be associated with the DI procedure.
- ICD-9-CM codes are available for radiologists to use to describe situations where a DI procedure is being used to "rule-out" a diagnosis. The use of these codes should be encouraged when the diagnosis is uncertain.

Physician Services Claims data accurately represent DI activity for services provided in Winnipeg and Brandon for general x-ray, radiologist-provided ultrasound, CT, mammography, and adult MRI, but are inconsistently reported when these services are provided in other areas of the province (MRI were provided only in Winnipeg during the time of analysis).

Physician Services Claims do not accurately reflect the use of nuclear medicine, BMD testing and pediatric MRI services—these are services where there are gaps in the data. Complete BMD testing data are now available through the BMD Clinical Database. Coronary angiography was poorly

reported in Physician Services Claims prior to 1993, but has improved in recent years (1999-2002)—however, the use of these services are more accurately reflected in the hospital discharge abstracts.

Consideration is being given to implementation of Radiology Information Systems (RIS) across the province, and Picture Archiving and Communication Systems (PACS) in various locations in the province. A Radiology Information System is a computerized system for tracking patients and the DI procedures they receive, scheduling, reporting and billing; and a Picture Archiving and Communication System is a computerized system for storage and distribution of digital medical images over a networked environment. A key benefit to improving our understanding of the role DI plays in the health of the Manitoba population would be that these systems could produce data or reports that would allow important questions to be addressed. If such systems are to be implemented in the province it will be important to develop consistency that will allow data to be aggregated on a provincial basis, and that will permit comparisons between entities. It is important to recognize that data produced through any system are only as good as what goes into the system. A province-wide RIS, appropriately implemented and managed, would have the potential to benefit not only the administration of DI, but also the ability to deal with important population health issues. As new imaging systems become operational (specifically the MRI in Brandon and PET scanner in Winnipeg) it will be important to ensure information systems are put into place to collect the data needed to answer clinically- and policy-relevant research questions. An important step in this is the establishment of data share agreements such as has been developed between MCHP and the WRHA for PET scanner data.

## Conclusion

Diagnostic imaging is an important component of the health care system. Having the ability to describe its impact on the health of Manitobans is a desirable feature of a population-based data system. At present, we have the capacity to answer some important questions about the use of diagnostic imaging, but are limited by incomplete data, particularly in non-urban areas of the province. Given the province's initiatives through the Manitoba Wait List Reduction Plan to expand outpatient diagnostics, to invest in new diagnostic equipment for all regions of the province and to expand the use of rural diagnostic equipment, it becomes increasingly important to collect valid data. To fully understand the use of diagnostic imaging in the province it will be necessary to put additional data collection systems in place.

## Key Findings

On a province-wide basis, hospital discharge records may be used to look at angiography—for all other modalities data may or may not be included in the hospital discharge abstract.

On a province-wide basis, physician services claims may be used to look at angiography, adult MRI and screening mammography.

Physician services claims for all modalities except nuclear medicine are available for Winnipeg and Brandon but are not necessarily reported in all other locations in the province.

ICD-9-CM codes on physician services claims may not accurately reflect the diagnosis.

Alternative payment arrangements with physicians (i.e., memoranda of understanding (MOU) or batch-billing) without a requirement to submit evaluation claims result in incomplete data, particularly outside of Winnipeg and Brandon.

MIS data are reported to Manitoba Health at a high level of aggregation. While the data may be useful for management purposes they have little value for research.

Inconsistencies between radiology information systems maintained in hospitals throughout the province, and in particular the lack of use of a province-wide unique patient identifier limits our ability to link with other databases.

Within prescribed limitations, diagnostic imaging data within the Population Health Research Data Repository may be used to answer clinically and policy relevant research questions.

# 1.0 INTRODUCTION AND BACKGROUND

Most Manitobans have had an encounter with diagnostic imaging services at some point in their lives. Indeed, these services are such an integral part of the health care system that they form the foundation of the diagnosis of many conditions. Whether it be an x-ray to determine if a child has fractured their arm due to a fall in the playground, an expectant mother who has an ultrasound to evaluate the status of the fetus, or a person with suspected heart problems who has an angiogram to determine the condition of the arteries supplying the heart, all of these services are considered diagnostic imaging.

Hospitals incurred net expenditures of about $45 million for diagnostic imaging (DI) services in 2000/01 for personnel, supplies, and equipment leases and maintenance. In addition, the Physician Services Claims database includes 1,110,762 claims for radiology services with a total cost to Manitoba Health of $22,604,138. The province continues to provide substantial investment towards the capital costs of DI equipment, including recent expenditures of $2.3 million for three CT scanners in Winnipeg, $1.7 million for a CT scanner in Steinbach, $1.5 million for a CT scanner in Selkirk, $200,000 for imaging systems in Neepawa, and the expansion of the neuro-angiography program at the Health Sciences Centre. Most recently, the province has announced that MRI services will be available in Brandon, and a positron emission tomography (PET) scanner will be part of the new Institute for Advanced Medicine.

Given the importance of diagnostic imaging from both a health care and a cost perspective, the Manitoba Centre for Health Policy (MCHP) was asked by Manitoba Health to review the data that are available concerning DI to determine how they can be used to answer questions related to the use of these services by Manitobans, and in particular, the link between health and health care utilization.

Roos (1999) has described two key aspects of a population-based data system as:

1) A complete population-wide enumeration of encounters (of service delivery) is essential. A core set of data elements must be collected using the same definitions, province-wide.
2) Each encounter must identify the individual to whom service is provided and be linkable to the individual's area of residence. This ensures the service data can be tied to a specific population in order that counts of those receiving services as well as those not receiving services can be identified (typically by age and sex).

The data we have reviewed here are those that are currently in use for decision-making in Manitoba. While data may be reported in many formats and may be used for a variety of purposes, it is always important that the user fully understand what the data represent, and that there be a clear understanding of their limitations. In particular, when data are incomplete it is important to recognize this fact and incorporate this factor when data are used for decision-making. Missing data can have a major influence on how we look at all issues, including DI.

Having good data not only helps understand patterns of health care, but it also contributes to the effective management of health care systems. As stated in Manitoba's Health Indicators Report (2002): "Canadians want and need information about the health programs and services supported by governments across the country." The task that was assigned to us was to assess the quality of data concerning diagnostic imaging to determine whether the information can be used to make health care policy decisions. Specifically, we set out to:

- Assess the validity of provincial data for investigating questions involving DI services.
- Identify limitations of the data in the Repository for investigating questions involving DI services.
- Identify potential sources of additional data to address the limitations of the data in the Repository for investigating questions involving DI services.

Examples of potential uses of diagnostic imaging data include:

- Calculating population-based rates of use for different DI modalities.
  - Access to and use of DI according to where individuals live (i.e., Do residents of some areas have limited access to services?)
  - Different patterns of use by age-group (important for planning for demographic changes).
- Considering whether patterns of use vary according to where people receive their DI services (e.g., Do people need to travel to other locations to receive these services?)
- Considering how practice patterns vary for physicians and radiologists (e.g., are service patterns substantially higher or lower than expected when compared to practice guidelines?)

In the following pages, the approach that was taken in assessing the database components will be described, as well as the results of this assessment. The limitations of the data will be presented, along with additional sources of data that have been identified. Finally, an overall assessment of the state of DI data in Manitoba will be provided with recommendations for further action.

An additional component of this report is that selected data have been used to address real research questions. These "demonstration projects" are described in detail in the appendices, and are referred to throughout the text as examples of how province-wide data can (and sometimes cannot) be used. It is important to note that diagnostic imaging technology is constantly changing, and so are the information systems that can support these systems. Consideration is being given to implementation of Radiology Information Systems (RIS) across the province, and Picture Archiving and Communication Systems (PACS) in various locations in the province. A Radiology Information System is a computerized system for tracking patients and the DI procedures they receive, scheduling, reporting and billing; and a Picture Archiving and Communication System is a computerized system for storage and distribution of digital medical images over a networked environment. Both of these systems have the potential to contribute to the availability of valuable data.

# 2.0 METHODS

A primary goal of this study was to determine the extent to which the diagnostic imaging-related data available from various sources reflect the actual use of DI services in the province. When the project was initiated, the Manitoba Population Health Research Repository contained three sources of DI data: physician services claims, hospital discharges and MRI clinical data. It was our intention to validate these data by comparing them to information from external sources. The external sources that were identified as having potential for assessing the validity of the data in the Repository included: summary statistics reported by hospitals, selected clinical databases and Management Information System (MIS) data. In the following sections the various sources of data will be described, and the approach that was taken to assessing their quality will be discussed.

## 2.1 Data Sources held at MCHP—the Manitoba Population Health Research Repository

### 2.1.1 Physician Services Claims

In Manitoba, most physicians are compensated through a "fee-for-service" arrangement. This requires that the physician submit a record to Manitoba Health that indicates (among other things): the physician's unique identifier, the patient's unique identifier, a tariff code for the service that was provided, and the date of the service. For some types of claims, an ICD-9-CM code is required. These records are used to compensate physicians. Records may be submitted electronically to Manitoba Health, or manually using a billing card. These records are used to create the Physician Services Claims database that was used in this study. As is the case for all data held in the Manitoba Population Health Research Data Repository, information that would personally identify an individual is removed from the records by Manitoba Health before it is provided to the Manitoba Centre for Health Policy. The records held by MCHP include the data elements listed above as well as indicators of the physician's area of specialty and the hospital in which the service was provided (if it was provided in a hospital). There are 387 tariff codes associated with diagnostic imaging, and in 2001/02 there were 1,110,762 radiology claims representing a total cost of $22,604,138.

Unlike many other types of services provided by physicians, a diagnostic imaging claim may consist of two components, both using the same tariff code: a professional component, and a technical component. In addition, in some cases a third claim can be made when an interventional procedure is performed. The professional fee is what is charged by the radiologist for interpreting the radiograph, while the technical fee relates to the services required for obtaining the radiograph. If the service is provided in a hospital, in most cases only the professional fee is charged as the technical com-

ponent is provided by the hospital. The existence of two claims for some cases and only one for others means that it is important to be able to "match" professional and technical claims when attempting to count the number of services that are provided. Failure to do so causes duplication of many cases, resulting in a substantial overstatement of utilization.

Another feature of claims for DI services is that there may be multiple claims associated with a particular diagnostic process. For example, a person may have a diagnostic ultrasound plus a Doppler procedure to gain additional information. To recognize this fact, an "episode" identification approach was developed. First, different DI modalities were identified (general x-ray, ultrasound, CT, mammography, MRI, angiography, and nuclear medicine) and each tariff code was assigned to one of these modalities. The tariff codes that were included in each of these modalities are listed in Appendix B.

Episodes were then counted within each modality, with an episode being defined as a single person receiving one or more services in a given modality on a single day. If a person received multiple ultrasound procedures on a single day, for example, this would be counted as one episode. This approach has multiple benefits in that it recognizes that some services may entail multiple billable procedures, that there may be differences in coding between different radiologists, and it provides a manageable number of categories that can be used for looking at population-based rates. A limitation of this approach is that it does not reflect those situations in which truly independent DI imaging procedures occur within the same modality on the same day. While this does not occur frequently, the episode approach that has been used will slightly underestimate actual usage under these situations.

Each physician claim may also include a single (principal) ICD-9-CM code—however recording this code is not required for radiology claims. During the processing of the claim, if a diagnosis code is not reported on the claim, Manitoba Health computer systems assign a code by matching the date of the claim and the requesting physician's unique identification number with another medical claim on the same day. If the person saw the physician for multiple reasons, it is possible that the wrong ICD code would be assigned to the radiology claim; or if the radiological procedure was requested to "rule out" the diagnosis that was recorded on the claim, then the claim could incorrectly report a diagnosis that had not been made. The lack of any systematic approach to recording diagnoses for radiology claims led to the conclusion that these data elements could not be used as part of this study—indeed users should be cautioned about using these data elements for any purposes.

Although the vast majority of DI services are provided by imaging specialists (certified radiologists and nuclear medicine physicians), a small volume of DI is practiced by non-radiologists. Two forms of non-radiologist DI activity are distinguished. In the first, DI occurs without the involvement of an imaging specialist. In the second, a non-radiologist typically uses DI to perform an interventional procedure and the images generated are interpreted by a radiologist. An example of the former is when a urologist performs office ultrasound to supplement the clinical examination and to guide biopsy. The urologist is not allowed to bill for the ultrasound procedure and there is no way to estimate volumes of activity. Another ultrasound procedure that is performed by a non-radiologist is ultrasonography of the eye to determine axial length for cataract surgery. Obstetrical ultrasound as part of fetal assessment represents an exception since it is reimbursed by Manitoba Health when interpreted by a qualified obstetrician using designated tariff codes (#4819 "Dynamic ultrasound fetal risk assessment" or #4820 "Subsequent ultrasound fetal risk assessment"). Only the Health Sciences Centre (HSC) and St. Boniface General Hospital (SBGH) are approved facilities for performing fetal assessment ultrasound. Both sites submit fee-for-service claims, and should be captured in the Physician Services Claims file. Combined annual statistics provided by the clinical program based on a calendar year (January 1-December 31) are 12,685 patient visits in 2000, 12,045 visits in 2001 and 11,829 visits in 2002. There is also a smaller volume of fetal assessment performed as part of the Provincial Mobile Outreach Program. This program was established in 1983 and is jointly funded by the province and federal government (through the First Nations and Inuit Health Branch). The program is funded globally and activity is not reflected in the Physician Services Claims file or other Repository data sources. It provides on-site fetal assessment services to rural and northern areas, including several isolated First Nations communities. In the fiscal year April 1, 2001-March 31, 2002 the Outreach Program reported 1,105 patient visits of which 598 were in areas accessible by car and 507 were in only accessible by air.

Several situations exist in which a non-radiologist performs an interventional procedure that generates images subsequently reported by the radiologist. Procedures performed in the cardiac catheterization laboratories are typical of this shared responsibility. A qualified cardiologist performs the actual diagnostic and/or therapeutic procedure and bills for the procedural code(s) while the radiologist bills the interpretation code. In theory this could allow for cross-validation of the claims data, but in practice there are serious flaws with this approach due to a high level of discordance (see Appendix D.3). Fluoroscopy is also routinely used by gastroenterologists and surgeons during the performance of endoscopic retrograde cholangiopancreatography (ERCP), by cardiologists for pacemaker insertion, by urologists for cystoscopic retrograde urography, by orthopedic surgeons working in the operat-

ing room to repair fractures, and for a wide variety of other procedures. The non-radiologist bills for the non-radiologic procedure while the radiologist bills for interpreting images arising from the fluoroscopy. Even non-physicians rely on DI. For example, occupational or speech therapists supervise and review videofluoroscopy images in order to assess a patient's swallowing function.

The examples presented above are illustrative, not exhaustive. They serve as a reminder of the broad scope and importance of DI in modern medical practice. The diverse application of DI by non-radiologists makes it more difficult to capture and quantify all DI services. Clearly DI is not the sole purview of radiologists—an expanding role in other disciplines is likely to occur.

### 2.1.2 Hospital Discharges

When a person is discharged from a hospital following an inpatient stay or an outpatient procedure, their chart is abstracted into a computerized record. This record includes detailed information about the patient, their diagnosis or diagnoses, the care that they received, and the physicians who provided the care.

For inpatients, the following rules apply to diagnostic imaging reporting (D. French, personal communication, September 20, 2002):

- Manitoba Health requires reporting of the following diagnostic and therapeutic procedures for inpatient hospitalizations: a) MRI for out-of-province inpatients (codes 88.91-88.97); b) angiocardiography (codes 88.50-88.58); c) angiography (codes 88.40-88.49 & 95.12).
- Prior to April 1, 2000, Manitoba Health required reporting of CT scans and MRI services. Following that date, these services may or may not be reported in the discharge abstracts, depending upon the practice of the hospital, and the number and type of procedures a particular patient has during their inpatient stay.
- Additional diagnostic and therapeutic procedures may be reported, at the discretion of individual hospitals.
- The Manitoba Health abstract is limited to 12 fields for coding procedures/interventions. Provincial and national guidelines require coding from the most invasive to the least invasive. Therefore, if a patient had multiple surgical procedures, radiological procedures may not be coded.

For outpatients, the following rules apply (D. French, personal communication, September 20, 2002):

- Manitoba Health requires reporting of angiocardiography (codes 88.50-88.58) for outpatient visits.
- Effective April 1, 2001, Manitoba Health revised their guideline for outpatient coding to include angiography (codes 88.40-88.49).

### 2.1.3 MRI Clinical Data

The Winnipeg Regional Health Authority (WRHA) has developed a clinical database to be used in conjunction with the Magnetic Resonance Imaging (MRI) programs that are operating at SBGH and HSC. These databases include the following data: patient demographics, area of body examined, diagnoses and findings. The databases are designed to collect personal and clinical data regarding the exam, and are not part of the administrative data that are reported to Manitoba Health. Through a data sharing agreement with the WRHA, MCHP holds a copy of the MRI databases, although data from HSC have not been available since May 1999, and the database is not currently being maintained at HSC. Individuals who live outside of Manitoba or cases where the MRI exam is being paid for by a third party (e.g., Workers' Compensation Board, Manitoba Public Insurance Corporation) have been removed.

## 2.2 Assessing Data Validity

As was indicated earlier, it was our intention to assess the validity of the diagnostic imaging data contained in the administrative records routinely reported to Manitoba Health by comparing them to data obtained from other independent sources. In particular, it was expected that hospitals that have radiology information systems could produce summary reports of services, and that the Management Information System data on diagnostic services that are routinely reported by all facilities could be used as an additional source of comparison. Finally, in recognition of the presence of various hospital databases maintained for some DI programs, it was expected that these data could be compared with data reported to Manitoba Health to assess their validity.

### 2.2.1 Summary Statistics from Hospitals

Each hospital maintains an information system for internal tracking of radiological services. At a minimum, hospitals are required to report workload statistics through the Management Information System ("MIS") to the Canadian Institute for Health Information (see the description of MIS following this section). Some hospitals have flexible reporting systems that permit customized reports of radiology services, while others produce standardized reports. See Appendix A for an inventory of databases maintained in hospitals in Manitoba. Hospital-wide radiology information systems (RIS) are maintained in Winnipeg hospitals and at Bethesda, Boundary Trails, Brandon and Thompson General Hospitals.

Summary reports from their internal systems were received for hospitals in Brandon RHA, Burntwood RHA, Interlake RHA, Nor-Man RHA, South Eastman RHA and Winnipeg RHA, and Boundary Trails Health Centre.

### 2.2.2 Management Information System

The Management Information System (MIS) was developed by the Canadian Institute for Health Information (CIHI) and was implemented throughout Manitoba during the 1995/96 fiscal year. MIS is a financial and statistical classification system. For radiology services, MIS can be used to produce summary reports of numbers of procedures, earned hours for staff, and total workload units. Data are available for individual health care facilities, but do not report data that can be associated with an individual patient or provider. While MIS includes codes that permit a high level of detail (e.g., Inpatient x-ray, thoracic cage and contents), this level of precision is not reported to Manitoba Health by hospitals. Data are reported according to whether the person who received the service was an inpatient, an outpatient registered in the hospital who received the service in the hospital, or an outpatient registered in another hospital who was "referred-in" to the hospital for DI services. At best across most Manitoba hospitals, MIS can be used to determine the number of general x-ray procedures for inpatients, outpatients (not referred-in) and referred-in outpatients.

Hospitals are required by Manitoba Health to report diagnostic imaging workload units and procedures using MIS. Typically, MIS data are collected by the hospital's finance department and are then submitted to Manitoba Health. MIS data held at MCHP were compiled, and an attempt was made to "map" MIS codes to tariff codes to permit cross-validation.

### 2.2.3 Selected Hospital Databases

As reported in Appendix A.1, databases are maintained in several departments in hospitals in Winnipeg and Brandon. In particular, "stand-alone" information systems have been in place at the HSC for the cardiac catheterization lab (recently consolidated at the SBGH site), MRI and echocardiography, and at SBGH for the cardiac catheterization lab, MRI and bone density testing. As well, hospital-wide or multi-department radiology information systems are operational in Winnipeg hospitals and at Bethesda, Boundary Trails, Brandon and Thompson general hospitals.

Hospital databases can be classified as "clinical only," "administrative only," or "hybrid" (where the database includes both administrative and clinical data). Clinical databases are typically used for recording results of imaging procedures, and may be used to produce descriptive statistics. Administrative databases are most frequently used for billing purposes, or for reporting summary statistics to external sources (e.g., to report workload units to CIHI). Hybrid databases combine both clinical and administrative functions, and are either hospital-wide or involve multiple diagnostic imaging departments.

Considerable time was dedicated to obtaining annual summary utilization reports from hospitals against which claims data could be validated. Requests were made directly to each hospital, and to each RHA, for routinely produced reports, and meetings were held with representatives from the WRHA and Brandon RHA (BRHA). The reports that were obtained were compared to reports produced from the Physician Services Claims database.

# 3.0 RESULTS

As was indicated earlier, when this project was initiated, it was our intention to validate data within the Repository using summary reports from external sources. Routinely used utilization reports would be requested from hospitals throughout the province and these would be compared to equivalent reports produced using the administrative data held at MCHP. It was expected that hospital-produced reports would have a high level of accuracy as they are used as a management tool within the facilities—these reports would be considered the "gold standard."

Two barriers to adopting this approach became apparent: data describing DI services provided by many hospitals are not readily accessible (in particular for those services provided outside of the urban areas), and the classification systems used by hospitals for internal reporting are different from the tariff code classification system used by Manitoba Health, both in definition and application. As a result, it was not possible to fully assess the validity of the DI data for all locations in the province. In the following sections, the strengths and limitations of each data source will be described, and an assessment of the quality of the data will be provided.

## 3.1 Administrative Data

### 3.1.1 Physician Services Claims

As we were unable to obtain province-wide comparative reports from hospitals for DI services it was impossible to validate the Physician Services Claims using this approach. Instead we reviewed the procedures that are used to collect these data, and conclude that the Physician Services Claims data accurately represent DI activity for services provided in Winnipeg and Brandon for general x-ray, radiologist-provided ultrasound, CT, mammography, and adult MRI. Physician Services Claims do not accurately reflect the use of nuclear medicine, BMD testing, coronary angiography and pediatric MRI services. DI records included in the claims database are created as follows:

- For procedures that occur in a hospital:
  - When radiologists interpret an examination they complete a claim for their services and record the individual patient's identifier as well as a tariff code for the service. The radiologist fee is referred to as the "professional" fee.
  - If the radiologist performs an intervention, a separate claim is submitted for this service (this is referred to as a "Column C" procedure).
- For procedures that occur outside of a hospital:
  - When a radiological service is provided, a single claim for service is created by the interpreting radiologist. When processed by Manitoba

Health, the single claim is split into two claims. The single claim contains identifiers for payment for both the "technical" and "professional" portions. One claim is processed for the "technical" portion of the service. The second claim is processed for the "professional" portion.

- A single encounter can result in as few as one claim, or can have multiple claims (e.g., one or more technical claims and one or more professional claims). Possible combinations of claim types are:
  - Professional only.
  - Professional and intervention.
  - Professional and technical.
  - Professional, technical and intervention.
- Because the claims are used as the basis of payment for radiologists there is a strong incentive to submit claims completely and in a timely fashion. It is therefore unlikely that, where fee-for-service is used, claims would understate the actual services that are provided.
- Manitoba Health has formal audit procedures in place to ensure claims follow the established rules, to identify possible reporting errors and to discourage fraudulent activity.
- It is possible that the interpreting radiologist may not be the same individual as the one making the claim. The private radiology facilities submit all their billings under the Director's name. This was initiated to avoid issuing a billing number to each interpreting radiologist. A finite number of billing numbers are available for use. Therefore the billings are submitted under one billing number assigned to the Director for that one facility. If a radiologist is a Director at more than one facility, then he or she would have a separate billing number for each facility.
- As was noted earlier, DI claims are not required to report a diagnosis code (i.e., ICD-9-CM code), and there are concerns that the codes recorded in the claims database may be inaccurate. We have not investigated the validity and reliability of the diagnoses recorded with these claims.

### *Strengths*

Subject to the limitations noted below, the claims submitted to Manitoba Health by radiologists can be used to understand DI activity. The tariff code classification system provides sufficient level of detail to identify activities within the modalities that we have described earlier, and include specific information about the type of service provided.

### *Limitations*

While tariff codes and descriptions are included in the "Physicians' Manual," anecdotal evidence suggests that there are different interpretations in the application of these codes, and the codes may not be used consistently. For example, ultrasound may be claimed as a complete abdominal or

regional abdominal examination, and practice patterns of radiologists may differ in terms of the use of Doppler. Consequently, precise comparative results from different locations or radiologists may not be accurate. Any investigation that utilizes specific tariff codes should include a validation of the application of the codes in the settings being studied.

Most physicians in Manitoba provide services on a "fee-for-service" basis with an individual claim being made for each service that is provided—the exception to this is for radiologists working within many hospitals in northern and rural Manitoba. Rather than having an individual claim for each service, "batch billing" is used. On a monthly basis, a list of the tariff codes along with the frequency of each code is submitted to Manitoba Health for payment. As a result, claims cannot be associated with an individual patient.

Furthermore, the claims database maintained by Manitoba Health does not include records for these procedures. Not having the ability to look at the full use of DI services throughout the province makes it impossible to assess access to, or use of, these services by Manitobans, or to assess quality of care.

**Table 1: Hospitals utilizing batch-billing, 2001/02**

| | |
|---|---|
| **Parkland** | **Marquette** |
| Dauphin | Birtle |
| Gilbert Plains | Carberry |
| Grandview | Erickson |
| McCreary | Hamiota |
| Roblin | Minnedosa |
| Ste Rose du Lac | Neepawa |
| Swan River | Rivers |
| Winnipegosis | Rossburn |
| | Russell |
| | Shoal Lake |
| **Nor-Man** | **Interlake** |
| Flin Flon | Gimli |
| Snow Lake | Selkirk |
| The Pas | Stonewall |
| **Burntwood** | |
| Leaf Rapids | |
| Lynn Lake | |
| **South Westman** | **Central** |
| Baldur | Altona |
| Boissevain | Carman |
| Deloraine | Crystal City |
| Glenboro | Emerson |
| Killarney | Gladstone |
| Melita | Manitou |
| Reston | Morden |
| Souris | Morris |
| Treherne | Notre Dame |
| Virden | St. Claude |
| Wawanesa | Swan Lake |
| | Boundary Trails |
| | Winkler |
| **North Eastman** | |
| Beausejour | |
| Lac du Bonnet | |

The claims data do not accurately present the frequency of services that have been provided in these hospitals and RHAs. See Table 1 for a list of hospitals that batch-billed in 2001/02.

In some settings, the presence of salaried radiologists can further limit the comprehensiveness of the claims data. A salaried physician does not submit claims that result in compensation, and does not have the same reporting incentive as fee-for-service physicians. Many salaried physicians submit "evaluation claims" (also known as "shadow-billing") for services that they provide, but radiologists may provide services under a Memorandum of Understanding (MOU) that does not require the submission of evaluation claims. Two areas in particular, nuclear medicine and bone mineral densitometry (BMD), are incompletely reflected in the claims data. Only nuclear medicine and BMD services provided outside of the WRHA hospitals are reported in the claims data—physicians working in nuclear medicine at HSC are paid on a MOU basis while SBGH nuclear medicine and BMD are batch-billed and do not submit evaluation claims.

In the case of BMD there is an alternative source of data—a clinical database that is described below. See Appendix D.1 for a demonstration of how the clinical database can be used in place of the administrative data available from Manitoba Health (and can be linked to other Repository data) to consider questions regarding this service.

#### *Summary*

Physician Services Claims are the most consistently recorded and useful source of information regarding DI services provided in Winnipeg and Brandon for general x-ray, radiologist-provided ultrasound, CT, mammography, and adult MRI. However, in other areas of the province, and for other modalities, Physician Services Claims should be considered incomplete, and there is essentially no systematic method of tracking how and to whom DI services are delivered using these data.

### 3.1.2 Hospital Discharge Records

#### *Strengths*

A discharge record is created for every person who is treated as an inpatient in an acute care hospital in Manitoba. Therefore, hospital discharge records are a complete record of all individuals who have received inpatient care. Prior to 1993, only hospital discharge records could be used to determine who received coronary angiography, and from 1999 to 2002 there were 15% fewer radiologist claims than were reported in the hospital discharge abstracts. Therefore, hospital discharge records should be used rather than Physician Services Claims when looking at coronary angiography. See Appendix D.3 in which Physician Services Claims are compared with hospital discharge records.

### *Limitations*

Hospital discharge records should not generally be considered a reliable source of information regarding DI. The computerized record that is created provides summary information that may be used to classify cases using case-mix systems such as RDRG and CMG. However, the records do not contain details of all of the diagnostic services that were provided during the hospital stay. The exception to this would be for coronary angiography, as mentioned above.

### *Summary*

Hospital discharge records include very little information regarding DI, except for coronary angiography.

## 3.2 Clinical Databases

### 3.2.1 MRI

Four data sources provide information about MRI services. The WRHA reports the number of MRI exams for HSC (adult and pediatric) and SBGH in their "Diagnostic Imaging Program Workload" report. This report includes all exams, regardless of where a person lives or the source of payment for the exam, and is based on information contained in the hospital patient information system. The "MRI Clinical Dataset" developed by the WRHA and available to MCHP through a data sharing agreement reports each exam, but individuals who live outside of Manitoba or cases where the MRI exam is being paid for by a third party (e.g., Workers' Compensation Board, Manitoba Public Insurance Corporation) have been removed. The MRI Clinical Dataset can be linked with other MCHP databases because it includes individual identifiers that have been anonymized, whereas the Diagnostic Imaging Program Workload data cannot be linked to individuals as data are reported only at the aggregate level. The third source of data, physician claims, uses a different reporting method from the other two in that an individual exam may involve multiple claims. For example, if a person was having an MRI exam of their head, they could have 2 separate procedures (e.g., multislice T2, and repeats in another plane or a different pulse sequence)—2 claims would be submitted and reported in the claims database—whereas only 1 exam would be reported in the Workload report and

***Person-Level MRI Data Sources***

***Hospital Discharge Abstracts***

- *Exams were recorded for all discharges before April 1, 2000.*
- *Exams may or may not be recorded for discharges after April 1, 2000.*

***Physician Services Claims***

- *Exams are recorded for all adult exams after November 2000.*
- *No pediatric exams are recorded.*

***MRI Clinical Database***

- *Data collection started in 1990.*
- *Anonymized PHIN included in dataset starting in 1993.*
- *Data are current for SBGH.*
- *Data collection ceased at HSC in May 1999.*

in the Clinical Dataset. It should also be noted that pediatric MRI cases are not reported in the Physician Services Claims data as these services are provided through an MOU and not through the fee-for-service system. Finally, MRI exams may (or may not) be reported in the discharge abstracts for individuals who have been admitted to the hospital.

### 3.2.2 Bone Mineral Densitometry with Dual-Energy X-ray Absorptiometry (DXA)

In 1998, a relational database system was developed at St. Boniface General Hospital to perform test scheduling and reporting, and also for capturing basic demographics, the major criterion for testing, any osteoporosis treatment, and the clinical risk factor score (RFS). A bone density testing site was established in Brandon in 1999. This site used the identical testing criteria, requisition, scheduling and report template. This database was subsequently "backfilled" with the results from tests performed since 1990 (the year that DXA was first available in the province). A random chart audit of 265 scans indicates that the database is over 99% complete. Matching of personal identifier information with the Repository in over 34,000 DXA patients was achieved in over 99%. See Appendix D1 for further information about the BMD database.

## 3.3 Summary Data

### 3.3.1 Management Information System ("MIS")

MIS was introduced in hospitals throughout Manitoba in 1995/96. MIS is a financial and statistical classification and reporting system that is used to report data to Manitoba Health, and in many facilities, for internal reporting. For 2001/02, facilities are required to report limited DI statistical data to Manitoba Health, and DI workload units to CIHI. These minimum reporting requirements mean that data from this source are not sufficiently detailed to allow comparison with other data sources, and they do not permit person- or provider-level analysis.

### 3.3.2 Summary Statistics from Hospitals

Hospitals have a variety of systems that are used for reporting DI activity. For hospitals in the WRHA, radiology information systems (RIS) can produce standardized reports, and these are used to produce a WRHA-wide DI Program Report. Unfortunately, the systems do not produce reports that can be used to validate Physician Services Claims data because the classification systems that are used in these reports are different from those used within the Physician Services Claims database.

Brandon General Hospital has a RIS that has flexible reporting capabilities, and we had hoped to be able to use it as a basis for comparison with claims data. On a monthly basis, the data are electronically submitted to Manitoba

Health. The data are used by Manitoba Health to issue fee-for-service payments to radiologists who have provided the services. When we compared the reports produced by BRHA to those produced from the Manitoba Health Physician Services Claims database, there were different counts for 138 of the 166 tariff codes that were recorded in the two data sources in 2001/02. There was agreement within 10% (i.e., the number of claims was between 90% and 110% of the numbers reported by BRHA) for 92 (55%) of the tariff codes. Sometimes the counts were higher in the BRHA report, sometimes they were higher in the claims database report—although in total there were 4,233 fewer claims reported in the Manitoba Health data than were reported in the BRHA data. Timing may explain some of the differences, as may claims processing by Manitoba Health; but we were unable to reconcile the differences for this report. BRHA has accounting systems in place that would identify discrepancies in total payments to radiologists.

Other hospitals and RHAs produce management reports of DI activity and submit workload data to CIHI. Again, the classification systems that are used in these reports make direct comparison with other databases impossible.

## 3.4 Estimating the Missing Data

We attempted to develop a rough estimate of the number of services that were not included in the Physician Services Claims database in 2001/02. To do this, age- and sex-specific rates for each modality for residents of Winnipeg and Brandon RHAs were calculated (Winnipeg and Brandon residents' utilization was aggregated for this analysis). Winnipeg and Brandon residents were selected as the standard because, for most modalities, we believe that the claims data report most DI services received by these populations. These age-sex-specific rates were then applied to the populations of each of the other RHAs—this approach estimates the number of services that residents of other RHAs would have received if they resided in Winnipeg or Brandon. These estimated rates were then compared to the rates calculated using the Physician Services Claims for each RHA (see Figures C3 and C4, in Appendix C). In some cases, residents of non-urban RHAs received more services than their urban counterparts. When this occurs it is likely that there is a "real" difference between the services received; that is the differences are not due to under-reporting. When the projections indicate that residents of northern and rural RHAs are receiving fewer services than they would have received if they lived in Winnipeg or Brandon, it is unknown if the difference is due to unreported services or real differences in services received. Overall, when compared to residents of Winnipeg and Brandon, 38% fewer DI services were reported for the 453,000 residents of other RHAs. There are two modalities where we are confident that data are routinely recorded in the claims data (i.e., adult MRI

and screening mammography). Services within these modalities are either provided in limited numbers of settings (i.e., MRI) where fee-for-service payment systems are used (or evaluation claims are routinely completed), or are part of a provincial program (i.e., screening mammography) where evaluation claims are used. In these modalities, a difference of 8% between urban and non-urban residents is found. This indicates that while some differences exist between the populations, at least some of the 38% difference indicated above is most probably due to lack of reporting—but perhaps most importantly, the current data reporting systems do not allow us to know if there are real differences and if some areas are potentially being under-serviced, while others are being over-serviced, that is, they do not allow inter-regional comparisons.

## 3.5 Summary

Table 2 provides a summary of all data sources, an assessment of the quality of the data, and an indication of when they can be used with confidence and when they should be used with caution. Footnotes to the table provide details for each source and use category.

**Table 2: A Summary of data sources, quality and use, 2001/02. Refer to the following pages for notations**

| Data Source | Reporting Level | | Modalities Included | | | | | | | Data may be used for: | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Service Provider[1] | Service Recipient[2] | General X-ray[3] | Ultrasound[4] | CT[5] | Mammography[6] | MRI[7] | Angiography[8] | Nuclear Medicine[9] | Data include an identifier that allows linking with other individual level data[10] | Data includes all episodes of diagnostic imaging services[11] | Taxonomy is the same across all reporting entities[12] | Population based rates[13] | Provider rates and frequencies[14] | Data reported by location where service is provided[15] | Data reported by location where recipient lives[16] |
| Physician Services | Individual[17] | Individual[23] | 1 | 1 | 1 | 1[29] | 1[30] | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 1 |
| Claims | | | | | | | | | | | | | | | | |
| Hospital Discharges | Facility[18] | Individual[24] | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 1 | 2 | 1 | 1 | 2 | 2 |
| Clinical | | | | | | | | | | | | | | | | |
| - MRI | - [19] | Individual[25] | 0 | 0 | 0 | 0 | 1[31] | 0 | 0 | 2 | 2 | 2 | 1[32] | 1[32] | 2 | 2 |
| - BMD | Individual[20] | Individual[26] | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Summary data | | | | | | | | | | | | | | | | |
| - MIS | Facility[21] | Facility[27] | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 2 | 2 | 0 |
| - Hospital reports | Facility[22] | Facility[28] | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 1 | 0 | 1 | 2 | 0 |

0=Never - this information is not available from this data source, within the designated category
1=Sometimes - this information is available for some (but not all) entities from this data source
2=Always - this information is consistently available from this data source, and may be used to describe radiology activity

1 Reporting Level—Service Provider

This is the entity for which data on service providers are available. Individual level reporting indicates that the data source includes information on the physician who provided the service; facility level reporting indicates that the data source reports the hospital at which the service was provided, but does not report the radiologist who provided the service.

2 Reporting Level—Service Recipient

This is the entity for which data about service recipients are available. Individual level reporting indicates that the data source includes information on the individual person who received the service; facility level reporting indicates that the data source reports aggregate counts for the facility and does not indicate the individual person who received the service.

3 Modalities included—General X-ray

See Appendix B for details on the types of procedures that are within this classification.

4 Modalities included—Ultrasound

See Appendix B for details on the types of procedures that are within this classification. Ultrasound sessions often include multiple Physician Services Claims for a single case. Ultrasound services are also performed by obstetricians for obstetric cases, and by ophthalmologists prior to cataract surgery—these cases are reported in the Physician Services Claims but not in the summary data reported by hospitals.

5 Modalities included—CT

See Appendix B for details on the types of procedures that are within this classification.

6 Modalities included—Mammography

See Appendix B for details on the types of procedures that are within this classification.

7 Modalities included—MRI

See Appendix B for details on the types of procedures that are within this classification. Physician Services Claims for MRI were first submitted in 2000/01, but only for part of the year. Starting with the 2001/02 fiscal year they are complete for adults, but are not reported for pediatric cases. MRI sessions often include multiple Physician Services Claims for a single case.

Modalities included—Angiography

See Appendix B for details on the types of procedures that are within this classification. These services are only provided in Winnipeg and Brandon hospitals.

9 Modalities included—Nuclear Medicine

See Appendix B for details on the types of procedures that are within this classification. Only Brandon General Hospital reports Physician Services Claims for nuclear medicine. All of these services in Winnipeg hospitals are performed under a Memorandum of Understanding with Manitoba Health.

10 Individual Level Data Linkage

Indicates whether this data source includes a unique personal identifier that can be linked with other databases within the Manitoba Population Health Research Data Repository. These identifiers are anonymized by Manitoba Health to comply with privacy regulations.

11 Completeness of data

Indicates whether the data source includes records of all diagnostic imaging activity in the province. Physician Services Claims are not complete because some services are provided under a Memorandum of Understanding while others are reported through a batch-billing process. In these two cases, individual level data (either service provider or service recipient) are not available.

12 Taxonomy Consistent Across Entities

Indicates whether this data source uses a classification system that is consistent across all reporting entities, that is, it should be possible to make direct comparisons between entities. There may be, however, differences in the application or interpretation of the classification system that will affect comparability between entities. Hospital Summary Reports may be comparable within RHAs, but are not consistent between facilities in different RHAs.

13 Population-based Rates

Indicates whether population-based rates can be developed from this data source. The criteria for being able to prepare these rates is that complete data are available for the numerator regarding services received by a population, and that a reliable count of the population is available for the denominator. Summarized data sources (i.e., MIS and hospital reports) cannot be used for calculating population-based rates because the summarized data do not report demographic information about the individual recipient. This means that although we know the total number of services provided, we do not know the age, gender or location of residence of the people receiving the services. Physician Services Claims can be used for residents of Winnipeg and Brandon, but cannot be used for other areas due to incomplete reporting. Hospital discharge information can be used for angiography procedures but not for other modalities.

14 Provider Rates and Frequencies

Indicates whether provider rates can be developed from this data source. Provider rates could be used to look at differences between practice patterns of individual providers, and could be used as a basis for developing provider "profiles." The criteria for being able to prepare these rates is that complete data are available regarding services provided. The Physician Services Claims database includes all records for providers that submit claims (providers who do not submit claims are not included, and so rates and frequencies for these individuals could not be determined). It should be noted that a single billing number is used by all radiologists practicing in the commercial radiology labs.

15 Location of service

Indicates whether the dataset reports the location where the service is provided. Physician Services Claims do not necessarily include a facility code-even those associated with hospitals do not always report the hospital code. The physician number is also an unreliable source of information about the location where the service was provided as radiologists may work at multiple locations, or may interpret the examination in a location other than where the procedure was performed.

16 Residence of Recipient

Indicates whether the record can be used to determine the location of residence of the service recipient. Physician Services Claims, hospital discharge records and clinical databases can be linked with the Registry to determine the recipient's location of residence. In locations where individual Physician Services Claims are not submitted (due to batch billing or a Memorandum of Understanding), data are not available for the individual recipient.

17 Individual Service Provider—Physician Services Claims

Each medical claim includes a unique identifier for the provider, with the exception of private radiology groups where a single identifier is used for the entire group.

18 Facility Service Provider—Hospital Record

While the discharge record may include information on specialists that provided care, not all specialists are recorded so individual provider data are not available. However, the record does report the hospital in which the person received care.

19 Service provider—MRI clinical record

Neither unique identifiers for the radiologist providing the service or the location where the service was provided are currently available in this file.

20 Individual Service Provider—BMD Clinical Record

Unique identifiers indicate the physician who provided the service.

21 Facility Service Provider—MIS Record

Unique identifiers indicate the facility where the service was provided, but, because the data are aggregated, do not indicate the individual provider.

22 Facility Service Provider—Activity Report

Identifiers indicate the facility where the service was provided, but, because the data are aggregated, do not indicate the individual provider.

23 Individual Service Recipient—Physician Services Claim

All Physician Services Claims include a unique identifier for the individual who received the service.

24 Individual Service Recipient—Hospital Discharge Record

Inpatients

- Manitoba Health requires reporting of the following diagnostic and therapeutic procedures for all inpatient hospitalizations: a) MRI for out-of-province inpatients (codes 88.91-88.97); b) angiocardiography (codes 88.50-88.58); c) angiography (codes 88.40-88.49 & 95.12).
- Prior to April 1, 2000, Manitoba Health required reporting all CT scans and all MRI services.
- Additional diagnostic and therapeutic procedures may be reported, but each hospital may or may not do so.
- The Manitoba Health abstract is limited in the number of procedures that can be coded for a hospitalization. There are 12 fields for coding procedures/interventions-provincial and national guidelines require coding for the most invasive to the least invasive. Therefore, if a patient had multiple surgical procedures, radiological

Outpatients

- Health Records are required by Manitoba Health to code angiocardiography (codes 88.50-88.58) for outpatient visits.
- Effective April 1, 2001, Manitoba Health revised their guideline for Outpatient coding. Health Records incorporated the coding of angiography (codes 88.40-88.49) at that time.

[25] Individual Service Recipient—MRI Record

All MRI records include a unique identifier for the individual who received the service.

[26] Individual Service Recipient—BMD Record

All BMD records include a unique identifier for the individual who received the service.

[27] Facility Service Recipient—MIS record

Unique identifiers indicate the facility where the service was received, but, because the data are aggregated, do not indicate the individual recipient.

[28] Facility Service Recipient—Hospital Report

Identifiers indicate the facility where the service was received, but, because the data are aggregated, do not indicate the individual recipient.

[29] Physician Services Claims—Mammography

Screening mammography procedures are consistently reported, but diagnostic mammography are not.

[30] Physician Services Claims —MRI

Only adult MRI is recorded in the physician services claims database (i.e., pediatric MRI are not in the physician claims).

[31] MRI Clinical data

Data are not available for Health Sciences Centre after May 1999, but continue to be available for St. Boniface General Hospital.

[32] MRI Clinical data—Population and provider rates

Data are not available for Health Sciences Centre after May 1999, but continue to be available for St. Boniface General Hospital.

# 4.0 CONCLUSIONS AND RECOMMENDATIONS

This work has found that there are limitations in the data that are currently available to understand the use and impact of diagnostic imaging activities in Manitoba. Information systems use different classification systems making it difficult or impossible to validate the data, and inconsistent or incomplete data submission makes most province-wide measures of utilization inappropriate. We have estimated that up to 38% of data could be missing for residents receiving these services outside of Winnipeg and Brandon, using as a standard the utilization rates for residents of Winnipeg and Brandon.

To illustrate the importance of having complete province-wide data collected on each individual receiving the service, we show the types of important questions that can be answered using diagnostic imaging data where the records are essentially complete, through selected "demonstration projects." Research concerning the impact of the Brandon regional BMD program, the association between socioeconomic status and types of diagnostic imaging that is used, and trends in coronary angiography are all important issues for understanding what contributes to the health of Manitobans and their access to health care.

Data now available in the Manitoba Population Health Research Data Repository can be used to describe:

- Province-wide utilization rates for adult MRI, BMD, screening mammography and coronary angiography
- Utilization rates for all modalities except nuclear medicine and pediatric MRI for residents of Winnipeg and Brandon, although data may be missing for residents of Winnipeg and Brandon who receive DI services in other RHAs

The existing data cannot be used to describe:

- Inter-RHA, inter-hospital or inter-radiologist difference in practice patterns (for example, "Is hospital X providing fewer or more ultrasound procedures than average, after adjusting for the age-sex composition of the population it serves?")
- Geographical differences in access to services (for example, "Do women living in rural areas have similar access to fetal ultrasound as women in urban areas, and what are the effects of this differential access?")
- Province-wide rates for general x-ray, ultrasound, CT and nuclear medicine (for example, "how does the rate of CT use in Manitoba compare to that in other jurisdictions?")
- Quality of care issues (for example, "Are appropriate diagnostic proce dures being done prior to invasive interventions"?)

To address the limitations that have been identified, we recommend the following actions:

- A complete picture of DI services in Manitoba could be developed if all services were reported through the existing Physician Services Claims system. If all services were reported, either as actual claims or evaluation claims, it would be possible to answer many important DI-related questions. Claims should be submitted whether physicians are paid on a fee-for-service basis, are salaried, or provide services through a Memorandum of Understanding.
- The current procedure of adding ICD-9-CM codes (when they are not recorded by the radiologist) to claims during processing at Manitoba Health should be reconsidered, and potentially eliminated. Anecdotal evidence suggests that the codes that are assigned may not accurately reflect the diagnosis that would be associated with the DI procedure.
- ICD-9-CM codes are available for radiologists to describe situations where a DI procedure is being used to "rule-out" a diagnosis. The use of these codes should be encouraged when the diagnosis is uncertain.

It is also important to consider the rapid developments that have occurred in diagnostic imaging over the recent past, and that are likely to continue in the future. New technologies and techniques are constantly being developed. Given our recommendation of relying on the Physician Services Claims system for collecting comprehensive data on DI services, it is important to ensure that the classification system (i.e., the tariff codes) keep up-to-date with changing technologies, and that accurate descriptions be provided for the various codes to ensure consistency in application. Paralleling the advances in DI have been the advances that have been seen in data collection and storage. Recently, initiatives have been taken by the Radiological Society of North America and the Healthcare Information and Management Systems Society to develop international standards for information and imaging sharing. Such standards should be considered when assessing new imaging or information systems.

Radiology Information Systems (RIS) and Picture Archiving and Communication Systems (PACS) are being considered for implementation in various locations in the province. A key benefit to improving our understanding of the role DI plays in the health of the Manitoba population would be that these systems could produce data or reports that would allow important questions to be addressed. If such systems are to be implemented in the province it will be important to develop consistency that will allow data to be aggregated on a provincial basis, and that will permit comparisons between entities. It is important to recognize that data produced through any system are only as good as what goes into the system. A province-wide RIS, appropriately implemented and managed, would have the potential to benefit not only the administration of DI, but also the ability to deal with important population health issues.

Putting the information management and technology infrastructure in place means that essential information can be collected, compiled and used to make better decisions and improve quality and care within the system. Improving our ability to assess new technology means that only the most effective new treatments, prescription drugs or equipment would be purchased and used in Canada's health care. With better information management and technology in place, researchers can assess the impact and value of different treatments and approaches to delivering health care services in addition to developing and testing new discoveries and cures. Together, these three "pieces of the puzzle" can create a 21st century information and evidence infrastructure that will guide and inform the future of Canada's health care system, improve its efficiency, and most importantly, improve the health of Canadians. *(Building on Values: The Future of Health Care in Canada - Final Report, November 2002).*

# GLOSSARY

### Episode
As a single person receiving one or more services in a given modality on a single day.

### Hospital Discharge Abstract
A computerized record containing information taken from a person's medical chart that is created at the time the person is discharged from an acute care hospital.

### ICD-9-CM
International Classification of Diseases, Ninth Revision, Clinical Modification. The official system of assigning codes to diagnoses and procedures.

### MIS - Management Information System
The official system of assigning codes to financial transactions and statistics within the health care system.

### Modality
A classification system used to group physician services tariffs into one of 7 different types of diagnostic imaging: angiography, computed tomography (CT), general x-ray, mammography, magnetic resonance imaging (MRI), nuclear medicine and ultrasound. Mammography may be disaggregated into screening mammography and diagnostic mammography; MRI may be disaggregated into pediatric MRI and adult MRI; and ultrasound may be disaggregated into obstetric ultrasound and non-obstetric ultrasound.

### Physician Service Claim
A record created representing a service provided by a physician. The records may be created in an electronic format or on a billing card. They may represent an actual bill for the service(s), or are submitted as a record of the service (an "evaluation claim").

### Picture Archiving and Communication System (PACS)
A computerized system for storage and distribution of digital medical images over a networked environment.

### Radiology Information System (RIS)
A computerized system for tracking patients and the DI procedures they receive, scheduling, reporting and billing

# REFERENCES

*Building on Values: The Future of Health Care in Canada*. Final Report. Commissioner: Roy J. Romanow, November 2002.

*Manitoba's Health Indicators Report*. A Federal/Provincial/Territorial Agreement on Comparable Indicator Reporting reached by First Ministers and developed by the Conference of Deputy Ministers. September, 2002

Roos NP. Establishing a Population Data-Based Policy Unit. *Med Care* 1999; 37(6 suppl):JS15-JS26.

Roos NP, Mitchell L, Peterson S, Shapiro E, *Perspectives on Home Care Data Requirements*. Winnipeg, MB: Manitoba Centre for Health Policy, 2001.

*Manitoba Health Annual Statistics 2000-2001*. http://www.gov.mb.ca/health/annstats/73-74.pdf

# APPENDIX A: INVENTORIES OF DIAGNOSTIC IMAGING DATABASES

**Table A.1: Diagnostic Imaging Databases – Winnipeg, Brandon and Province-Wide Programs**

| Data Source | Modality | | | | | | | | | Database Status | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | General X-ray | Ultrasound | CT | MRI | Mammography | Non-coronary angiography | Coronary angiography | Nuclear Medicine | Bone Density | Electronic | Start Date | Format | Primary Index | Billing | Diagnostic Codes | |
| HSC-Adult | X | X | X | X | X | X | X | | | Y | 5/1993 | MAXIFILE | HSC# | Y | Y | MAXIFILE data base includes all modalities, inpatient/outpatient, adult/pediatric. Includes procedure information. Used for electronic billing (general X-ray, ultrasound, CT, MRI, angiography) and to generate CIHI workload units. ACR diagnostic codes used inconsistently (ultrasound, CT, nuclear medicine best). Some PHIN but complete for Name, MHREG, DOB, Sex. LIMITATIONS: Procedure codes have changed over time (eg. multiple chest X-ray codes recently simplified to 1-view or 2-view, angio codes updated in 2000 to include new procedures). Codes are not consistent between hospitals. No official support for MAXIFILE after 6/2002 (retired MUMPS-based system). |
| HSC-Nuclear Medicine | | | | | | | | X | | Y | 5/1993 | MAXIFILE | HSC# | N | Y | See HSC–Adult (uses same MAXIFILE system). Reimbursement through physician contract (MOU). LIMITATIONS: No billing information or tariff codes. |
| HSC-Pediatrics | X | X | X | X | | | | | | Y | 5/1993 | MAXIFILE | HSC# | Y | N | See HSC–Adult (uses same MAXIFILE system). Reimbursement through physician contract (MOU). Shadow billing to Manitoba Health. |
| HSC-Cardiac Cath Lab | | | | | | | X | | | Y | ~1995 | MUSE | HSC# | N | N | See HSC–Adult (uses same MAXIFILE system). Overlaps MAXIFILE database (procedure performed by cardiologist, MAXIFILE report by radiologist). MUSE database recently moved to SBGH. It contains "Referring MD", "FP/GP", "Procedures" (billable DP, IP; non-billable DD, ID). |

| Data Source | Modality | | | | | | | | | | Database Status | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | General X-ray | Ultrasound | CT | MRI | Mammography | Non-coronary angiography | Coronary angiography | Nuclear Medicine | Bone Density | | Electronic | Start Date | Format | Primary Index | Billing | Diagnostic Codes | |
| | | | | | | | | | | | | | | | | | "Urgency" (elective, urgent, emergent). Can be exported to Excel spreadsheet. Slated for retirement and replacement with the Approach system (U of Calgary). LIMITATIONS: No PHIN but includes Name, MHREG, DOB, Sex, Address. |
| HSC-Echocardiography | | X | | | | | | | | | Y | 1998 | MS-Access | PHIN | N | Y | Not in HSC MAXIFILE system. Procedure performed and reported by cardiologist. MS-Access database developed in-house for HSC Echocardiography. Includes patient identifiers (PHIN, name, HSC#), indications, diagnostic codes, and limited test results (such as LVEF). Reimbursement through physician contract. LIMITATIONS: No individual claims data submitted to Manitoba Health. Access database replaced an earlier FoxPro database (1989-1998) which "crashed" and all data irretrievably lost. |
| SBGH-General X-ray | X | X | X | X | X | X | X | | | | Y | 6/1994 | MAXIFILE | BHIS | Y | N | MAXIFILE data base includes all modalities except Nuclear Medicine and Bone Density. Includes inpatient/outpatient and procedure information. Individual claims data submitted to Manitoba Health from Clinicare system. No PHIN but identifiers include Name, MHREG, DOB, Sex. LIMITATIONS: See HSC–Adult. |
| SBGH- Echocardiography | | X | | | | | | | | | Y | 6/1994 | MAXIFILE | BHIS | ? | N | SBGH-General X-ray. Performed and reported by cardiologists. Information captured in MAXIFILE. |
| SBGH –Nuclear Medicine | | | | | | | | X | | | N | | | | | | Batch billing to WRHA at fee-for-service rate. Total numbers of tariff ("99" codes) and procedures are available. PRN2000 system can identify out-patients registering for a nuclear medicine procedure but not specific test. All outpatient reports archived since 1999 (Wordperfect, includes Name, MHREG, DOB, BHIS#) therefore theoretically possible to write |

| Data Source | Modality | | | | | | | | | | Database Status | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | General X-ray | Ultrasound | CT | MRI | Mammography | Non-coronary angiography | Coronary angiography | Nuclear Medicine | Bone Density | | Electronic | Start Date | Format | Primary Index | Billing | Diagnostic Codes | |
| | | | | | | | | | | | | | | | | | macro to extract identifier/procedure information. LIMITATIONS: No individual claims data submitted to Manitoba Health. Out-patient report identifiers manually entered, probably quite dirty. No in-patient reports archived. |
| SBGH-Bone Density | | | | | | | | | X | | Y | 1/1990 | Paradox/ Access | BMD MAST R# | | N | Batch billing to WRHA at fee-for-service rate. Includes PHIN (most cases) and other identifiers (MHREG, DOB, gender). "Back-filled" to include all DXA testing since 1/1990. Successfully linked through Manitoba Health (>99% complete and accuracy). LIMITATIONS: No individual claims data submitted to Manitoba Health. |
| MRI Clinical data | | | | X | | | | | | | Y | 1990 | SAS Datafile | n/a | N | Y | Includes patient demographics (including PHIN since 1993), area of body examined, referral codes, diagnoses and findings. Fee-for-service billings since 10/1999 (initially batch billing, individual billing since 11/2000). Overlaps MAXIFILE since 6/1994. LIMITATIONS: Initially included HSC MRI as well, but no recent HSC data entry. |
| SBGH- Cardiac Cath Lab | | | | | | | X | | | | Y | 1988 | Paradox (DOS) | BHIS | N | N | Individual claims data submitted to Manitoba Health for fee-for-service billing. SBGH Paradox database contains similar info to HSC MUSE database (slight differences in procedure coding). Also includes "Disposition" (choice of 45 codes indicating tentative management plan, eg., "medical management"). LIMITATIONS: System slated for "retirement". (though data will remain on-line). |
| Brandon-Radiology | X | X | X | | X | X | | X | | | Y | 6/2000 | NOVIUS | ? | Y | N | Siemens NOVIUS radiology system established 6/2000; previous BDM system established in 1991 was imported (examination name, patient identifiers including name, MHREG, DOB, gender but not report). Includes inpatient/outpatient and |

| Data Source | Modality | | | | | | | | | Database Status | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | General X-ray | Ultrasound | CT | MRI | Mammography | Non-coronary angiography | Coronary angiography | Nuclear Medicine | Bone Density | Electronic | Start Date | Format | Primary Index | Billing | Diagnostic Codes | |
| | | | | | | | | | | | | | | | | PHIN. Small volume angio services (most done HSC/SBGH). LIMITATIONS: Nuclear medicine only appears in database since 1/1995. |
| Brandon-Bone Density | | | | | | | | | X | Y | 4/1999 | Paradox/ Access | BMD MAST R# | N | N | Identical Paradox/Access system to that used at SBGH Bone Density. Includes PHIN (most cases) and other identifiers (MHREG, DOB, gender). "Back-filled" to beginning of Brandon program (4/1999). Successfully linked through Manitoba Health (>99% complete and accuracy). Individual claims data submitted to Manitoba Health for fee-for-service billing. |
| Misericordia Health Centre – Radiology | X | X | X | | | | | | | Y | ~1993 | RISEPLUS | ? | Y | N | RISEPLUS system used for individual claims data submission to Manitoba Health for fee-for-service billing. Includes total # exams and workload units. LIMITATIONS: No nuclear medicine. No ultrasound before 10/1999 |
| Victoria General Hospital – Radiology | X | X | X | | | | | | | Y | ~1993 | RISEPLUS | ? | Y | N | RISEPLUS system used for individual claims data submission to Manitoba Health for fee-for-service billing. Includes total # exams and workload units. LIMITATIONS: No nuclear medicine. No ultrasound before 10/1999 . |
| Grace General Hospital – Radiology | X | X | X | | | | | | | Y | ~1993 | RISEPLUS | ? | Y | N | RISEPLUS system used for individual claims data submission to Manitoba Health for fee-for-service billing. Includes total # exams and workload units. LIMITATIONS: No nuclear medicine. No ultrasound before 10/1999. |
| Concordia General Hospital – Radiology | X | X | X | | | | | | | Y | ~1993 | RISEPLUS | ? | Y | N | RISEPLUS system used for individual claims data submission to Manitoba Health for fee-for-service billing. Includes total # exams and workload units. LIMITATIONS: No nuclear medicine. No ultrasound before 10/1999. |

| Data Source | Modality | | | | | | | | | | Database Status | | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | General X-ray | Ultrasound | CT | MRI | Mammography | Non-coronary angiography | Coronary angiography | Nuclear Medicine | Bone Density | | Electronic | Start Date | Format | Primary Index | Billing | Diagnostic Codes | |
| Seven Oaks General Hospital – Radiology | X | X | X | | | | | X | | | Y | 1/1999 | RADPLUS | ? | Y | N | RADPLUS system used for individual claims data submission to Manitoba Health for fee-for-service billing. Includes PHIN, total # exams and workload units.<br>LIMITATIONS: Replaced earlier RISEPLUS system; uncertain if data converted to RADPLUS. |
| Community Hospital – Nuclear Medicine | | | | | | | | X | | | N | | | | | | Batch billing to WRHA at fee-for-service rate (professional only). Total numbers of tariff ("99" codes) and/or procedures are available.<br>LIMITATIONS: No individual claims data submitted to Manitoba Health. |
| Rural Hospitals – LAXUS | X | X | | | | | | | | | N | 1947 | | | | | Covered lab, X-ray and US services for 1947 until regionalization for all of rural Manitoba except Thompson and Westman (71 rural centres, 3 additional contract areas). Annual reports on workloads still available.<br>LIMITATIONS: Batch billing from paper records. No individual claims data submitted to Manitoba Health. |
| Private Clinic – Nuclear Medicine | | | | | | | | X | | | N | | | | | | Individual claims data submitted to Manitoba Health for fee-for-service billing (professional and technical). |
| Private Clinic – Radiology | X | | | | X | | | | | | | | | | | | Individual claims data submitted to Manitoba Health for fee-for-service billing. |
| Provincial Breast Screening Program | | | | | X | | | | | | Y | 7/1995 | ? | BSP# | Y | Y | Province-wide screening mammography registry (includes Winnipeg, mobile, Thompson, Brandon). Includes PHIN (based upon MHREG file for women aged 50-69). Successfully linked to DPIN and Cancer Registry. Data also sent to a National BSP Registry. Individual claims data submitted to Manitoba Health for fee-for-service billing. |
| Breast Health Centre | | | | | X | | | | | | Y | 9/1999 | OPTEX | PHIN | N | N | OPTEX system established/maintained by CancerCare MB.<br>LIMITATIONS: No individual claims data submitted to Manitoba Health. Reimbursement through physician contract. No shadow billing. |

**Table A.2: Diagnostic Imaging Databases outside of Winnipeg and Brandon**

| RHA | Physical location of the database (e.g., name of hospital or health centre) | What is the purpose of the database, or what is the database used for? | What kind of information is in the database? | Who uses the database? | Does the database include the PHIN of patients? (YES or NO) | What is the earliest date included in the database? | Has the database been kept up-to-date? (YES or NO) | Would the database be considered complete? (e.g., a database that is not always updated would not be considered complete) (YES or NO) |
|---|---|---|---|---|---|---|---|---|
| Burntwood | Thompson General Hospital | - Duplication of patient demographics as recorded from the hospital ADT system<br>-Schedules<br>-Billing<br>-Statistics | Patient demographics.<br>Schedules. | Diagnostic Services clerical Staff<br>Diagnostic Imaging staff | Yes | All data from the most current to all past history | Yes | Yes |
| Burntwood | Other facilities in our region include:<br>Lynn Lake<br>Leaf Rapids<br>Gillam<br>These sites do all patient entries manually | | | | | | | |
| Central | Altona<br>Carman<br>Crystal City<br>Emerson<br>Gladstone<br>Manitou<br>Morris<br>Notre Dame<br>Portage General<br>St Claude<br>Swan Lake | Used to store patient demographics and can be used to generate radiology reports.<br>Can provide list of after hour callbacks. | Patient demographics.<br>Requisition generator.<br>Callbacks.<br>Radiology reports. | Clerical and technical staff of the diagnostic unit | Yes | | Yes | Yes |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Central | Boundary Trails Health Centre | Medipatient Plus – Radiology Information System. Mintains record of patients presence and activity in radiology.<br>Mark Care PACs – PACs system – electronic storage of patient x-rays, including CT, general x-ray, ultrasound | | Health records.<br>Imaging reception staff<br>Radiologists<br>Physicians | Yes | Dec/99 | Yes | Yes |
| Churchill | | No electronic databases | | | | | | |
| Interlake | Selkirk and District General Hospital | Patient scheduling for radiology and ultrasound.<br>CT scan as of Jan 2003. | Patient demographic information.<br>Type of study. | Receptionists and technologists | Yes | Nov 1/00 | Yes | Yes |
| Marquette | | No radiology databases | | | | | | |
| Norman | None | ADT system used to type reports. May not be stored electronically | | | | | | |
| North Eastman (Information not available) | | | | | | | | |
| Parkland (Information not available) | | | | | | | | |
| South Eastman | Bethesda Hospital | Storage of x-ray and ultrasound reports.<br>Electronic billing for radiologists. | Patient demographics<br>Radiology report.<br>Billing information. | Health records and radiology staff | Yes | Oct/97 | Yes | Yes |
| South Westman | | No radiology databases | | | | | | |

# APPENDIX B: MODALITIES, 2001

| Tariff Code | Description |
|---|---|
| **ANGIOGRAPHY** | |
| 7105 | Splenoportography |
| 7107 | Selective Angiograms, Cerebral (Brachial Retrograde) |
| 7120 | Aortograms, Abdominal |
| 7121 | Aortograms, Arch |
| 7122 | Aortograms, Intravenous |
| 7123 | Aortograms, Thoracic |
| 7124 | Aortograms, Translumbar |
| 7125 | Aortograms, Other, Specify |
| 7126 | Aortograms, For Two Examinations Done On Same Patient On Same Day |
| 7129 | Selective Angiograms, Popliteal with Antegrade Catheterization |
| 7130 | Selective Angiograms, Adrenal Arteriogram |
| 7131 | Selective Angiograms, Angiographic Examination Dialysis Shunt |
| 7132 | Selective Angiograms, Axillary |
| 7133 | Selective Angiograms, Brachial |
| 7134 | Selective Angiograms, Bronchial |
| 7135 | Selective Angiograms, Carotid |
| 7136 | Selective Angiograms, Celiac |
| 7137 | Selective Angiograms, Common Iliac |
| 7138 | Selective Angiograms, External Carotid Arteriogram |
| 7139 | Selective Angiograms, Hepatic |
| 7140 | Selective Angiograms, Inferior Mesenteric |
| 7141 | Selective Angiograms, Innominate |
| 7142 | Selective Angiograms, Internal Iliac |
| 7143 | Selective Angiograms, Renal |
| 7144 | Selective Angiograms, Superior Mesenteric |
| 7145 | Selective Angiograms, Subclavian |
| 7146 | Selective Angiograms, Splenic |
| 7147 | Selective Angiograms, Vertebral |
| 7148 | Selective Angiograms, For Two Examinations Done On Same Patient On Same Day |
| 7149 | Selective Angiograms, For Three Examinations Done On Same Patient On Same Day |
| 7150 | Femoral Arteriograms, Unilateral |
| 7151 | Femoral Arteriograms, Bilateral |
| 7152 | Femoral Arteriograms, Bilateral Selective Angiogram Or Venogram |
| 7153 | Venograms, Azygogram |
| 7154 | Venograms, Femoral |
| 7155 | Venograms, Iliac |
| 7156 | Venograms, Inferior Vena Cavogram |
| 7157 | Venograms, Intraosseous |
| 7158 | Venograms, Jugular |
| 7159 | Venograms, Lower Limb |
| 7160 | Venograms, Subclavian |
| 7161 | Venograms, Superior Vena Cavogram |
| 7162 | Venograms, Umbilical Vein Catheterization |
| 7163 | Venograms, Upper Limb |
| 7164 | Venograms, For Two Examinations Done On Same Patient On Same Day |
| 7165 | Selective Venograms, Adrenal |
| 7166 | Selective Venograms, Hepatic |
| 7167 | Selective Venograms, Jugular |
| 7168 | Selective Venograms, Renal |
| 7169 | Selective Venograms, For Two Examinations Done On Same Patient On Same Day |
| 7170 | Angiography, By Exposure Of Major Vein, Abdominal or Thoracic |
| 7171 | Angiography, By Exposure Of Major Vein, Cerebral |
| 7172 | Angiocardiograms, Atrial, Left |
| 7173 | Angiocardiograms, Atrial, Right |
| 7174 | Angiocardiograms, Pulmonary Angiogram |
| 7175 | Angiocardiograms, Selective Coronary Angiogram |
| 7176 | Angiocardiograms, Selective Coronary Angiogram W Left/Right Heart Catheterization |
| 7177 | Angiocardiograms, Ventricular, Left |
| 7178 | Angiocardiograms, Ventricular, Right |
| 7179 | Venograms, Orbital Venogram |
| 7324 | Intraluminal Dilatation, Operating Room Arteriogram |
| 7326 | Vasogram |
| **CT** | |
| 7112 | Computerized Axial Tomography, Infused Exam Of The Brain, One Or More Cuts |

| | |
|---|---|
| 7113 | Computerized Axial Tomography, Non-Infused Exam Of The Brain, One Or More |
| 7114 | Computerized Axial Tomography, Infused & Non-Infused Exam Brain, 1 Or More |
| 7221 | Computerized Axial Tomography Skull Base Int Auditory Canals Sella Turcica |
| 7222 | Computerized Axial Tomography Facial Bone(Orbits)Exam |
| 7223 | Computerized Axial Tomography Neck Exam |
| 7224 | Computerized Axial Tomography Thorax Exam |
| 7225 | Computerized Axial Tomography Abdomen And/Or Pelvis Exam |
| 7226 | Computerized Axial Tomography Musculoskeletal Exam |
| 7227 | Computerized Axial Tomography Spine-Cervical Exam |
| 7228 | Computerized Axial Tomography Spine-Thoracic Exam |
| 7229 | Computerized Axial Tomography Spine-Lumbar Exam |
| 7230 | Computerized Axial Tomography Biopsy And/Or Drainage |
| **GENERAL X-RAY** | |
| 7000 | Head And Neck, Polytomography Of Temporal Bones |
| 7001 | Head And Neck, Panorex |
| 7002 | Central Nervous System, Pneumoencephalography |
| 7003 | Central Nervous System, Ventriculography |
| 7004 | Head And Neck, Eye, Foreign Body Determination |
| 7005 | Head And Neck, Eye, Foreign Body Localization, Sweet Method, Etc. |
| 7006 | Head And Neck, Mandible |
| 7007 | Head And Neck, Temporomandibular Joints |
| 7008 | Head And Neck, Mastoids Routine |
| 7009 | Head And Neck, Facial Bones |
| 7010 | Head And Neck, Nasal Bones |
| 7011 | Head And Neck, Optic Foramina |
| 7012 | Head And Neck, Paranasal Sinuses |
| 7013 | Head And Neck, Sella Turcica |
| 7014 | Head And Neck, Skull |
| 7015 | Head And Neck, Skull, Base |
| 7016 | Head And Neck, Teeth, One Area |
| 7017 | Head And Neck, Teeth, Additional Area |
| 7018 | Head And Neck, Teeth, Full Upper Or Lower |
| 7019 | Head And Neck, Teeth Complete |
| 7020 | Head And Neck, Salivary Gland |
| 7021 | Sialography |
| 7022 | Head And Neck, Larynx Or Nasopharynx Or Neck For Soft Tissue |
| 7024 | Chest, Single PA |
| 7025 | Chest, Pa And Lateral |
| 7026 | Chest, Portable Chest |
| 7027 | Chest Fluoroscopy |
| 7028 | Intraluminal Dilatation, Kymography |
| 7029 | Chest, Pleurogram |
| 7030 | Bronchography, Unilateral |
| 7031 | Chest, Ribs, One Side |
| 7032 | Chest, Heart, Fluoroscopy and Radiography |
| 7033 | Chest, Pacemaker (Fluoro & Films), With Cine 25% Extra |
| 7034 | Spine And Pelvis, Sacrum And/Or Coccyx |
| 7035 | Spine And Pelvis, Spine, Complete |
| 7036 | Spine And Pelvis, Cervical Spine, Routine Views |
| 7037 | Spine And Pelvis, Spine, 2 Full Areas |
| 7038 | Cervical Spine, Routine Views with Spec Added Views (Obliques and/or Flexion/Extension) |
| 7039 | Spine And Pelvis, Pelvis, A.P. View |
| 7041 | Spine And Pelvis, Sacroiliac Joints |
| 7042 | Central Nervous System, Myelography |
| 7043 | Central Nervous System, Discography |
| 7044 | Upper Extremity, Shoulder, A.P. And Lateral Routine |
| 7045 | Upper Extremity, Joints, Sterno Clavicular |
| 7046 | Upper Extremity, Scapula Or Clavicle |
| 7047 | Upper Extremity, Humerus |
| 7048 | Upper Extremity, Elbow |
| 7049 | Upper Extremity, Forearm |
| 7050 | Upper Extremity, Wrist |
| 7051 | Upper Extremity, Hand |
| 7052 | Upper Extremity, Fingers |
| 7053 | Lower Extremity, Hip |
| 7054 | Lumbo-Sacral, Routine Views with Special Added Views (Obliques and/or Flexion/Extension) |
| 7055 | Lower Extremity, Femur |
| 7056 | Lower Extremity, Knee or Patella |

| | |
|---|---|
| 7057 | Spine And Pelvis, Scoliosis Series (8 Films) |
| 7058 | Lower Extremity, Tibia and Fibula |
| 7059 | Lower Extremity, Ankle |
| 7060 | Lower Extremity, Foot |
| 7061 | Spine And Pelvis, Single Combining Region (Thoraco-Lumbar) |
| 7062 | Lower Extremity, Toes |
| 7063 | Arthrography |
| 7064 | Lower Extremity, Hip Pinning |
| 7065 | Upper Extremity, Bone Age Studies |
| 7066 | Lower Extremity, Bone Length Study with Precise Measurement |
| 7067 | Abdomen, Single View |
| 7068 | Abdomen, 2 Views |
| 7069 | Upper Extremity, Sternum |
| 7070 | Presacral Insufflation, etc. |
| 7071 | Fluoroscopy (Isolated) |
| 7072 | Abdomen, Management Of Long Intestinal Tube Manipulation Fluoroscopy |
| 7073 | Gastro Intestinal Tract, Oesophagus, Fluoroscopy And Radiography |
| 7074 | Stomach and Duodenum, Fluoroscopy and Radiography (Including Oesophagus) |
| 7075 | Stomach and Duodenum, with Small Bowel Series |
| 7076 | Gastro Intestinal Tract, Small Bowel Series, Radiography and Fluoroscopy |
| 7077 | Gastro Intestinal Tract, Colon, Fluoroscopy and Radiography |
| 7078 | Gastro Intestinal Tract, Colon, Contrast Enema |
| 7079 | Gastro Intestinal Tract, Oral Cholecystogram |
| 7080 | Gastro Intestinal Tract, Cholangiogram, Intravenous |
| 7081 | Gastro Intestinal Tract, Cholangiogram, Retrograde |
| 7082 | Gastro Intestinal Tract, Cholangiogram, In Operating Room |
| 7083 | Urinary Tract, K.U.B. |
| 7084 | Urinary Tract, Pyelogram, Intravenous, Routine Including Preliminary Film |
| 7085 | Urinary Tract, Pyelogram, Rapid Sequence, Extra Views |
| 7086 | Cystogram |
| 7087 | Cystogram, Delayed |
| 7088 | Cysto-Urethrogram |
| 7089 | Obstetrical Studies, Abdomen and Pelvis For Foetus |
| 7090 | Obstetrical Studies, Pelvimetry |
| 7091 | Obstetrical Studies, Placentography |
| 7092 | Hysterosalpingography |
| 7093 | Upper Extremity, Joints, Acromio-Clavicular with Weights |
| 7094 | Sinus, Infection, etc. |
| 7095 | Gastro Intestinal Tract, Colon, Ba. Enema and Contrast (Same Day) |
| 7096 | Portable Machine Examination, In Home, Extra |
| 7097 | Pericardiocentesis |
| 7101 | Intraluminal Dilatation, Laminography, Planography, Tomography |
| 7102 | Central Nervous System, Basal Ganglia, Steriotaxis For Coagulation |
| 7103 | Intraluminal Dilatation, Lymphangiography, Unilateral |
| 7106 | Tracheogram, etc. |
| 7119 | Amniogram |
| 7190 | Gastro Intestinal Tract, Stomach And Duodenum, Hypotonic Duodenography |
| 7191 | Urinary Tract, Cine For G.I. Tract And Genito-Urinary Tract, Extra |
| 7192 | Urinary Tract, Ileal Conduit Loopogram |
| 7193 | Spine And Pelvis, Lumbo-Sacral, Routine Views |
| 7194 | Spine and Pelvis, Thoracic Spine |
| 7301 | Intraluminal Dilatation, Laminography, Planography, Tomography, with Contrast |
| 7322 | Intraluminal Dilatation, Laryngogram |
| 7323 | Intraluminal Dilatation, Lung Biopsy (Needle) |
| 7325 | Intraluminal Dilatation, Percutaneous Antegrade Pyelogram |
| 7327 | Specimen Radiograph |
| 7330 | Bronchography, Bilateral |
| 7331 | Chest, Ribs, Both Sides |
| 7332 | Chest, Thoracic Inlet (2 Views) |
| 7333 | Chest, Tomogram (Full Chest-2 Large Films) |
| 7339 | Spine And Pelvis, Pelvis With Lateral Hip Joint |
| 7341 | Skeletal Survey(Thorax, Skull, Thoracic And Lumbar Spine, Pelvis, 2 Long Bones |
| 7364 | Lower Extremity, Hip Pinning (Supervision And Interpretation) |
| 7366 | Lower Extremity, Calcaneus |
| 7370 | Intraluminal Dilatation, Peritoneal Insufflation |
| 7371 | Surgical Fluoroscory (Other Physician) |
| 7372 | Misc, High Filtration-High K.V. (Larynx, etc) |

| | |
|---|---|
| 7376 | Esophagus Stomach,Duodenum (Include Survey Film) Dbl Contrast With Or Wtihout Relaxant |
| 7377 | Esophagus Stomach,Duodenum Dbl Contrast With or Without Relaxant With Sml Bowel Series |
| 7381 | Cineradiography-Extra |
| 7382 | Cholangiography, Percutaneous |
| 7383 | Urinary Tract, Pyelogram, Special For Hypertension-Urea Washout |
| 7384 | Renal Puncture; Percutaneous |
| 7385 | Urinary Tract, Pyelogram, Retrograde |
| 7386 | Dacrocystography |
| 7387 | Urinary Tract, Retrograde Urethrography |
| 7389 | Genitography |
| 7394 | Fistula, Injection With Fluoroscopy |
| 7396 | Portable Machine Examination, In Hospital, Extra |
| 7400 | Head and Neck, Added Views (Not Films) Additional |
| 7401 | Chest, Added Views (Not Films) Additional |
| 7402 | Spine and Pelvis, Special Views (Minimum 2 Views) |
| 7403 | Upper Extremity, Added Views (Not Films) Additional |
| 7404 | Lower Extremity, Added Views (Not Films) Additional |
| 7405 | Urinary Tract, Added Views (Not Films) Additional |
| 7406 | Obstetrical Studies, Added Views (Not Films) Additional |
| **MAMMOGRAPHY** | |
| 7098 | Intraluminal Dilatation, Mammography, Bilateral |
| 7099 | Intraluminal Dilatation, Mammography, Unilateral |
| 7104 | Screening Mammography Bilateral |
| 7110 | Intraluminal Dilatation, Xeromammography, Unilateral |
| 7111 | Intraluminal Dilatation, Xeromammography, Bilateral |
| **MRI** | |
| 7501 | MRI, Head Miltislice T2 (1 or 2 Echos) |
| 7502 | MRI, Head Miltislice I.R. or T1 |
| 7503 | MRI, Head Repeat (Another Plane, Different Pulse Sequence To A Maximum Of 2 Repeats) |
| 7504 | MRI, Neck Miltislice T2 (1 or 2 Echos) |
| 7505 | MRI, Neck Miltislice I.R. or T1 |
| 7506 | MRI, Neck Repeat (Another Plane, Different Pulse Sequence To A Maximum Of 3 Repeats) |
| 7507 | MRI, Thorax Miltislice T2 (1 or 2 Echos) |
| 7508 | MRI, Thorax Miltislice I.R. or T1 |
| 7509 | MRI, Thorax Repeat (Another Plane, Different Pulse Sequence To A Maximum Of 3 Repeats) |
| 7510 | MRI, Abdomen Miltislice T2 (1 or 2 Echos) |
| 7511 | MRI, Abdomen Miltislice I.R. or T1 |
| 7512 | MRI, Abdomen Repeat(Another Plane, Different Pulse Sequence To A Maximum of 3 Repeats) |
| 7513 | MRI, Pelvis Miltislice T2 (1 or 2 Echos) |
| 7514 | MRI, Pelvis Miltislice I.R. or T1 |
| 7515 | MRI, Pelvis Repeat (Another Plane, Different Pulse Sequence To A Maximum Of 3 Repeats) |
| 7516 | MRI, Extremities Miltislice T2 (1 or 2 Echos) |
| 7517 | MRI, Extremities Miltislice I.R. or T1 |
| 7518 | MRI, Extremities Repeat (Another Plane,Different Pulse Sequence To A Maximum of 2 repeats) |
| 7519 | MRI, Limited Spine 1 Segment Miltislice T2 (1 or 2 Echos) |
| 7520 | MRI, Limited Spine 1 Segment Miltislice I.R. or T1 |
| 7521 | MRI, Limited Spine 1 Segment Repeat (Another Plane, Diff Pulse Seq To A Max Of 2 repeats) |
| 7522 | MRI, Intermediate Spine 2 Adjoining Segments Miltislice T2 |
| 7523 | MRI, Intermediate Spine 2 Adjoining Segments Miltislice I.R. or T1 |
| 7524 | MRI, Intermediate Spine 2 Adjoining Segment Repeat(Add Plane,Diff Pulse Seq Max 2 repeats) |
| 7525 | MRI, Complex Spine 2 or More Non-Adjoining Segments Miltislice T2 |
| 7526 | MRI, Complex Spine 2 or More Non-Adjoining Segments Multislice I.R. Or T1 |
| 7527 | MRI, Complex Spine 2+ Non-Adjoining Segment Repeat(Add Plane,Diff Pulse Seq Max 2 repeats) |
| 7528 | MRI, 3D Workstation Review (Applies To Whole Schedule) |
| **NUCLEAR MEDICINE** | |
| 7100 | Bone Mineral Density Dexa |
| 9901 | Diagnostic Isotope Procedure, Hematopoietic Function, Schilling Test Co57 or Co60 B12 |
| 9902 | Hematopoietic Function, Schilling Test Co57 or Co60 B12 W Intrinsic Factor |
| 9903 | Diagnostic Isotope Procedure, Blood Volume Studies, Red Cell Volume Cr51 |
| 9904 | Diagnostic Isotope Procedure, Hematopoietic Function, Red Cell Survival |
| 9905 | Diagnostic Isotope Procedure, Red Cell Labelling |
| 9906 | Diagnostic Isotope Procedure, Thyroid Function, 1 131 Uptake |
| 9907 | Diagnostic Isotope Procedure, White Cell Labelling |
| 9908 | Diagnostic Isotope Procedure, Thyroid Function, 1 131 Uptake With T.S.H. Stimulation |
| 9910 | Diagnostic Isotope Procedure, Blood Volume Studies, Plasma Volume |
| 9912 | Diagnostic Isotope Procedure, Cardiac Function, Cardiac Output (I.S.H.A.) |
| 9913 | Diagnostic Isotope Procedure, Cardiac Function, Circulation Time (I.S.H.A.) |
| 9914 | Diagnostic Isotope Procedure, Gastro Absorp, Malabsorp |

| | |
|---|---|
| 9919 | Diagnostic Isotope Procedure, Hematopoietic Function, Plasma Iron Clearance |
| 9920 | Diagnostic Isotope Procedure, Hematopoietic Function, Plasma Iron Turnover |
| 9923 | Diagnostic Isotope Procedure, Hematopoietic Function, Red Cell Utilization Fe59 |
| 9924 | Spect Transmission Attenuation Correction |
| 9925 | Diagnostic Isotope Procedure, Liver Function, Rose Bengal Study With Scintisan |
| 9927 | Diagnostic Isotope Procedure, Renal Function, Renal Scan |
| 9928 | Diagnostic Isotope Procedure, Renal Function, Renogram 1 131 |
| 9929 | Diagnostic Isotope Procedure, Spect Single Photon Em Comp Tom Spec Organ |
| 9930 | Diagnostic Isotope Procedure, Scanning And Localization, Brain |
| 9931 | Diagnostic Isotope Procedure, Parathyroid Imaging |
| 9932 | Diagnostic Isotope Procedure, Scanning And Localization, Lung |
| 9933 | Diagnostic Isotope Procedure, Scanning And Localization, Ocular Tumor |
| 9935 | Diagnostic Isotope Procedure, Scanning And Localization, Placenta |
| 9936 | Diagnostic Isotope Procedure, Scanning And Localization, Spleen |
| 9937 | Diagnostic Isotope Procedure, Thyroid Function, 1 131 Uptake With Scintiscan |
| 9938 | Diagnostic Isotope Procedure, Thyroid Function, 1 131 Uptake With Suppression |
| 9939 | Diagnostic Isotope Procedure, Abdominal Shunt Patency |
| 9940 | Diagnostic Isotope Procedure, Gastrointestinal Mot, Inc Esophageal, Gast, And Bowel Stud |
| 9941 | Diagnostic Isotope Procedure, Blood-Red Blood Cell Utilization W Serial Organ Counts, Add |
| 9942 | Diagnostic Isotope Procedure, Red Blood Cell Survival with Serial Organ Counts, Add |
| 9943 | Diagnostic Isotope Procedure, Bone & Joint-Bone Scan, Regional |
| 9944 | Diagnostic Isotope Procedure, Bone & Joint-Bone Scan, Whole Body |
| 9945 | Diagnostic Isotope Procedure, Bone & Joint-Joint Scan Regional |
| 9946 | Diagnostic Isotope Procedure, Bone & Joint-Joint Scan Whole Body |
| 9947 | Diagnostic Isotope Procedure, Bone & Joint-Bone Marrow Scan |
| 9949 | Diagnostic Isotope Procedure, Brain-Brain Scan With Flow Study, Add |
| 9950 | Diagnostic Isotope Procedure, Gastrointestinal Bleeding |
| 9951 | Diagnostic Isotope Procedure, CSF Circulation |
| 9952 | Diagnostic Isotope Procedure, Brain-Myelogram |
| 9953 | Diagnostic Isotope Procedure, Cardiovascular-Myocardial Scan |
| 9954 | Diagnostic Isotope Procedure, Myocapdial Perfusion Scan, Imediate |
| 9955 | Diagnostic Isotope Procedure, Myocardial Perfusion Scan, Immediate And Delayed |
| 9957 | Diagnostic Isotope Procedure, Cardiovasc-Myocard Wall Motion, Rest (Does Not Inc Computerization |
| 9958 | Diagnostic Isotope Procedure, Card/Myocard Wall Motion, Combined Rest & Stress (Not Incl Comput) |
| 9959 | Diagnostic Isotope Procedure, Cardiovascular-Admin & Super Pharmacol Or Physical Stress, Add |
| 9960 | Diagnostic Isotope Procedure, Cardiovascular, Additional Measurements (Maximum Of 3) |
| 9961 | Diagnostic Isotope Procedure, Cardiovascular-Cardiomyography (First Pass Non-Gated) |
| 9962 | Diagnostic Isotope Procedure, Cardiovascular-Venogram |
| 9963 | Diagnostic Isotope Procedure, Cardiovascular-Arteriography |
| 9964 | Diagnostic Isotope Procedure, Cardiovascular-Thrombosis Localization |
| 9965 | Diagnostic Isotope Procedure, Eye-Lacrimal Duct Study |
| 9966 | Diagnostic Isotope Procedure, Gastrointestinal-Biliary Tract Scan |
| 9967 | Diagnostic Isotope Procedure, Gastrointestinal-Liver & Spleen When Both Requested |
| 9968 | Diagnostic Isotope Procedure, Gastrointestinal-Dynamic Liver Study |
| 9969 | Diagnostic Isotope Procedure, Gastrointestinal-Salivary Gland Scan |
| 9970 | Diagnostic Isotope Procedure, Gastrointestinal-Stool Blood Lost |
| 9971 | Diagnostic Isotope Procedure, Gastrointestinal-Liver/Lung Scan |
| 9972 | Diagnostic Isotope Procedure, Lung-Ventilation Scan |
| 9974 | Diagnostic Isotope Procedure, Kidney-Reflux Cystogram |
| 9975 | Diagnostic Isotope Procedure, Kidney-Sequential Scan: 1 Isotope |
| 9976 | Diagnostic Isotope Procedure, Kidney-Sequential Scan: 2 Isotopes |
| 9977 | Diagnostic Isotope Procedure, Thyroid-Scan |
| 9978 | Diagnostic Isotope Procedure, Thyroid-Uptake with Washout |
| 9979 | Diagnostic Isotope Procedure, Misc-Adrenal Scan |
| 9980 | Diagnostic Isotope Procedure, Gastrointestinal Mucosa Scan |
| 9981 | Diagnostic Isotope Procedure, Misc-Soft Tissue Scan: Total Body (Gallium) |
| 9982 | Diagnostic Isotope Procedure, Misc-Soft Tissue Scan: Regional (Gallium) |
| 9983 | Diagnostic Isotope Procedure, Misc-Lymph Nodes And Lymph Angiogram |
| 9984 | Diagnostic Isotope Procedure, Misc-Skin Flow |
| 9986 | Diagnostic Isotope Procedure, Misc-Blood Flow to an Organ, or an Add-on to Another Proc |
| 9987 | Diagnostic Isotope Procedure, Misc-Assessment of Fatty Liver |
| 9988 | Diagnostic Isotope Procedure, Misc-C02 Exhalation Studies |
| 9989 | Diagnostic Isotope Procedure, Data Manip-Curve Analysis Without Blood Samples |
| 9990 | Diagnostic Isotope Procedure, Data Manip-Curve Analysis with Blood Samples |
| 9991 | Diagnostic Isotope Procedure, Data Manip-Curve Analysis Ejec Frac And Cine Formatting One Anal |
| 9992 | Diagnostic Isotope Procedure, Data Manip-Curve Analysis Ejec Frac And Cine Formatting Each Add |
| 9993 | Diagnostic Isotope Procedure, Data Manip-Image Enhancement |

| | |
|---|---|
| 9994 | Diagnostic Isotope Procedure, Data Manip-Gating |
| 9995 | Diagnostic Isotope Procedure, Data Manip-Quantitation Of Static Studies |
| **ULTRASOUND** | |
| 7220 | Diagnostic Ultrasound |
| 7300 | Cranial Sonography |
| 7302 | Sonography, Soft Tissues(Eg Thyroid, Parathyroid, Salivary, Glands, Orbits) |
| 7303 | Intraluminal Dilatation, Lymphangiography, Bilateral |
| 7304 | Sonography, Chest (Eg Pleural, Chest Wall, Mediastinal Mass) Real Time Study |
| 7305 | Sonography, Breast Unilateral Real Time Study |
| 7306 | Sonography, Breast Bilateral Real Time Study |
| 7307 | Sonography, Breast Unilateral Real Time Study Performed By Sonologist |
| 7308 | Sonography, Breast Bilateral Real Time Study Performed By Sonologist |
| 7309 | Sonography, Abdominal Complete Real Time |
| 7310 | Sonography, Abdominal Limited (Single Organ,Quadrant,Follow Up) Real Time |
| 7311 | Sonography, Renal (Bilateral), or Aorta, or Retroperitoneum Real Time |
| 7312 | Sonography of Organ Transplant Real Time & Doppler Studies |
| 7313 | Complete Doppler Exam of Portal Venous System |
| 7314 | Complete Doppler Exam of Mesenteric Veins |
| 7315 | Sonography, Spinal Canal and Contents |
| 7316 | Sonography, Skin and Subcutaneous Tissues Real Time |
| 7317 | Sonography, Pregnancy Uterus Complete Fetal & Maternal Evaluation |
| 7318 | Sonography, Complete Fetal/Maternal Evaluation Multiple Gestation |
| 7319 | Sonography, Pregnancy Uterus Limited(Fetal Size, Heart Beat, Placental Local) |
| 7320 | Fetal Biopsy Profile Scoring |
| 7321 | Echocardiology, Fetal, Cardiovascular System, Real Time(M-Mode And/Or Doppler) |
| 7328 | Echocardiology, Fetal Follow Up or Repeat Study of 57321 |
| 7329 | Sonography, Pregnancy Uterus First Trimester |
| 7334 | Sonography, Pregnancy Uterus Late First Trimester/Early Second Trimester |
| 7335 | Sonography, Transvaginal |
| 7336 | Sonography, Pelvic(Non Obstetric) - Complete |
| 7337 | Hysterosonography |
| 7338 | Sonography, Translabial |
| 7342 | Sonography, Scrotum |
| 7343 | Sonography, Transrectal |
| 7344 | Sonography, Penis |
| 7345 | Sonography, Extremity, Non-Vascular - Real Time (Hips, Shoulder, Knee) |
| 7346 | Doppler Is Primary Diagnostic Modality on any Procedure |
| 7347 | Doppler Is Not Primary Diagnostic Modality But Provides Ancillary Info |
| 7348 | Duplex Scan of Extra Cranial Arteries - Complete Bilateral |
| 7349 | Duplex Scan of Extra Cranial Arteries - Limited/Follow Up Study |
| 7350 | Duplex Scan of Extremity Arteries - Complete Unilateral |
| 7351 | Duplex Scan of Extremity Arteries - Complete Bilateral |
| 7352 | Duplex Scan of Extremity Arteries - Limited/Follow Up Study |
| 7353 | Duplex Scan of Extremity Veins - Complete Unilateral |
| 7354 | Duplex Scan of Extremity Veins - Complete Bilateral |
| 7355 | Duplex Scan of Extremity Veins - Limited/Follow Up Study |
| 7356 | Duplex Scan of Arterial Flow - Venous Outflow Abdominal,Pelvic,Retroperiton |
| 7357 | Duplex Scan of Aorta, Ivc, Iliac Vasculature Or Bypass Grafts |
| 7358 | Duplex Scan of Vascular Access Graft |
| 7359 | Video Tape Review of Vascular Studies - Add |
| 7360 | Intravenous Contrast Enhancement - Add |
| 7361 | Ultrasound Guided Compression Repair of Arterial Pseudo-Aneurysm or A-V Fistula Per 1/4 Hr |
| 7362 | Portable Ultrasound Exam By Ultrasonologist For Each 30 Min and Each Additional 30 Min |
| 7363 | Sonologist Perform Part of Exam For 10 Min Where Sonologist Revises Technologists Findings |
| 7365 | Sonologist Performs All of Examination |
| 7367 | Hysterosonography |
| 7368 | Sonography Intraoperative Real Time By Radiologist 1st 30 Min and Additional 30 |
| 4819 | Obstetrical Service – Dynamic ultrasound fetal risk assessment |
| 4820 | Obstetrical Service – Subsequent ultrasound fetal risk assessment |

# APPENDIX C: CHARTS AND TABLES

The following charts present the data reported in the Physician Services Claims database. Note that for most modalities, data may be incomplete for all Regional Health Authorities (RHAs) except for Winnipeg and Brandon. The modalities for which complete data are recorded in the Physician Services Claims database are mammography and adult MRI. Nuclear medicine data are complete only for Brandon RHA.

These charts provide an example of the type of information that could be considered if complete data were available. Complete data would allow us to answer questions like:

- Are there RHAs where the population is being underserved, that is they do not have access to necessary diagnostic imaging facilities, and what is the impact of this on the health of the population?
- Are there RHAs where the population is being overserved, and where practice guidelines could assist in more appropriate use of DI services, resulting in cost savings and improved health care experiences for residents?

We first present the data by "modality" where multiple procedures are classified as a single episode. Winnipeg and Brandon data are presented, followed by data for non-urban RHAs. The non-urban RHA charts also include a horizontal line indicating the number of episodes that residents of the RHA would have received, had they been living in Winnipeg or Brandon. A table providing the observed and projected numbers is provided following these charts.

Then, we present the data for the "top 10" most frequently performed procedures within each modality, and the top 10 procedures according to total cost.

All data are adjusted to the age and sex of the Manitoba population to allow comparisons to be made, on the basis of standardized populations.

**Figure C1. Age- Sex-Adjusted Rates by Modality and Regional Health Authority, 2001/02 (Source: Physician Services Claims Database)**

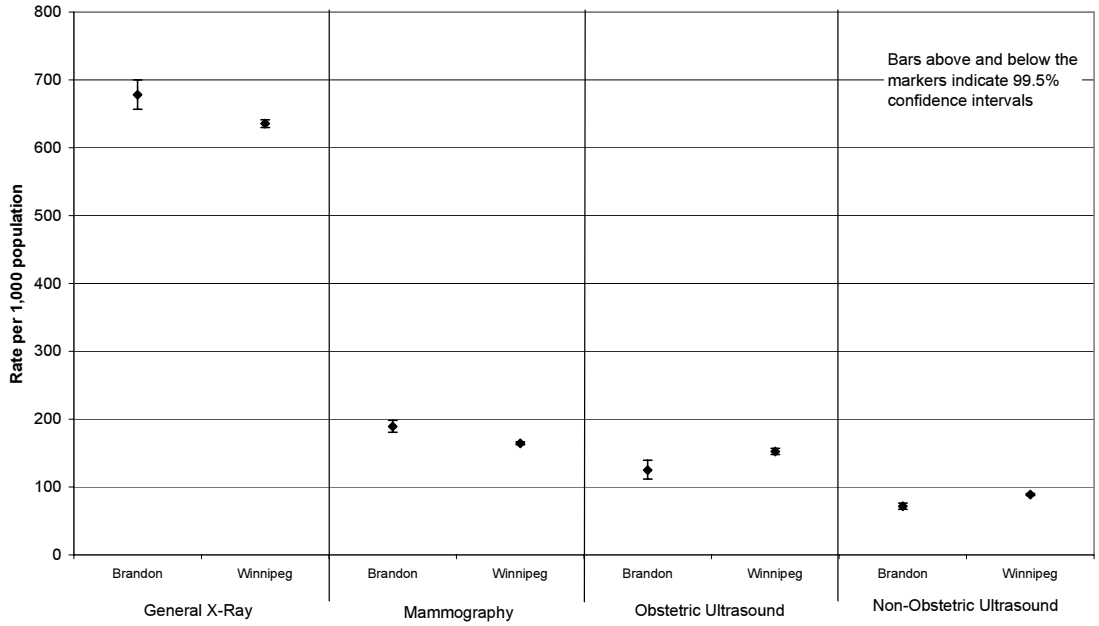



**Figure C2: Age- Sex-Adjusted Rates by Modality and Regional Health Authority, 2001/02 (Source: Physician Services Claims Database)**

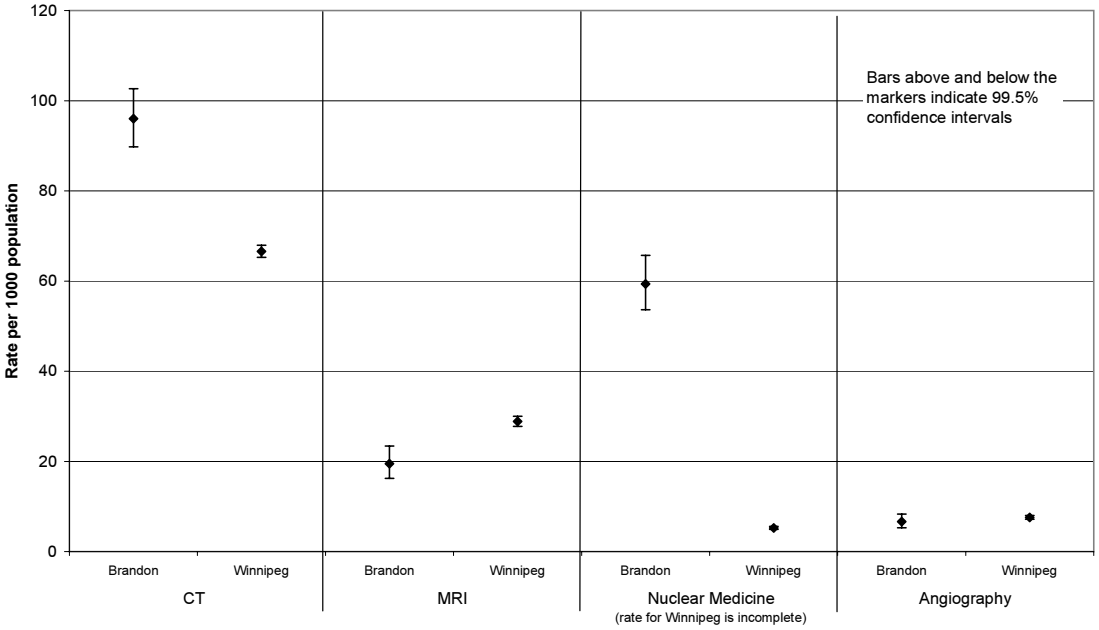
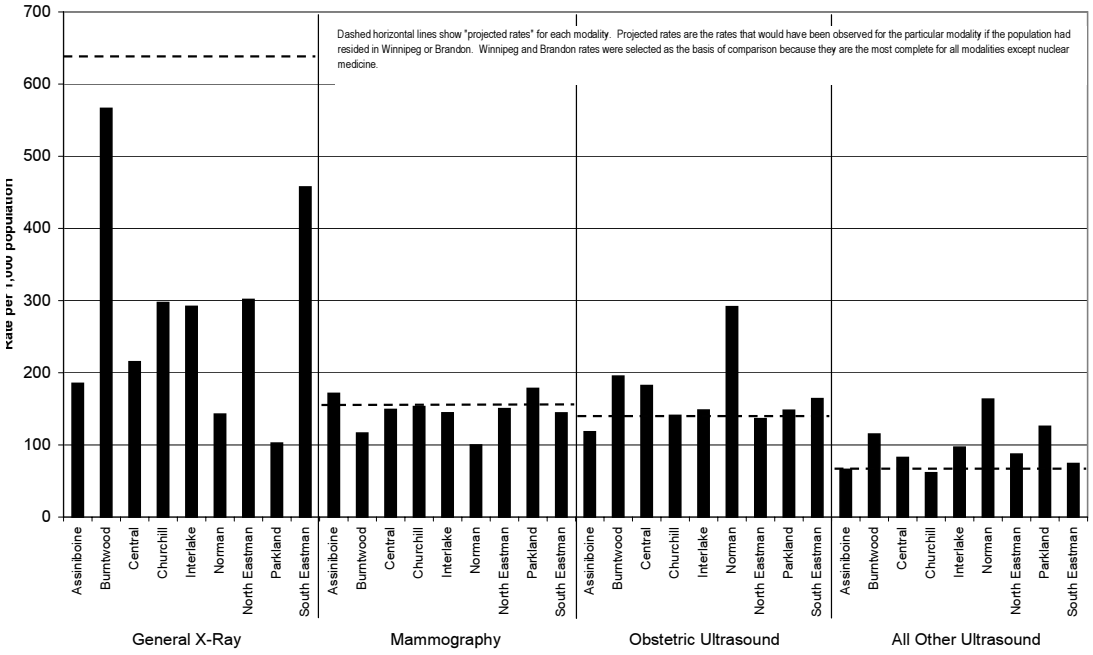
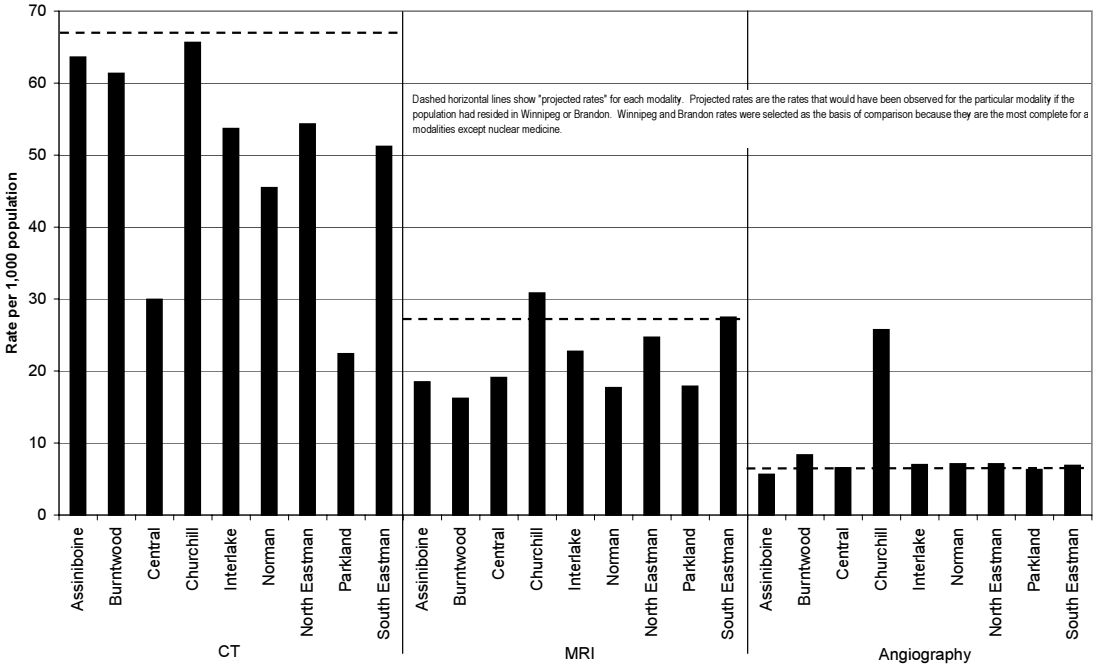


**Figure C3: Physician Services Claims, Age- Sex-Adjusted Rates, and "Projected Rates" for Rural and Northern RHAs, 2001/02 (Source: Physician Services Claims Database)** NOTE: These rates are considered incomplete and should be used only for demonstration purposes.




The rates shown here should not be considered an accurate representation of utilization, but rather a demonstration of the data that are included in the Physician Services Claims database.

**Figure C4: Physician Services Claims, Age- Sex-Adjusted Rates, and "Projected Rates" for Rural and Northern RHAs, 2001/02 (Source: Physician Services Claims Database)** NOTE: These rates are considered incomplete and should be used only for demonstration purposes.




The rates shown here should not be considered an accurate representation of utilization, but rather a demonstration of the data that are included in the Physician Services Claims database.

**Table C1: Comparison of reported diagnostic imaging episodes to projected episodes, by modality and RHA, 2001/02 (see notes following the table)**

| Modality | RHA | Projected | Reported | Reported as a % of Projected |
|---|---|---|---|---|
| **Angiography** | **Assiniboine** | **665** | **491** | **74%** |
| | **Burntwood** | **168** | **205** | **122%** |
| | **Central** | **711** | **621** | **87%** |
| | **Churchill** | **5** | **12** | **229%** |
| | **Interlake** | **609** | **567** | **93%** |
| | **Nor-Man** | **141** | **138** | **98%** |
| | **North Eastman** | **302** | **291** | **96%** |
| | **Parkland** | **402** | **324** | **81%** |
| | **South Eastman** | **364** | **336** | **92%** |
| CT Scans | Assiniboine | 5,696 | 5,110 | 90% |
| | Burntwood | 1,866 | 1,774 | 95% |
| | Central | 6,480 | 2,817 | 43% |
| | Churchill | 52 | 61 | 116% |
| | Interlake | 5,325 | 4,183 | 79% |
| | Nor-Man | 1,376 | 938 | 68% |
| | North Eastman | 2,645 | 2,111 | 80% |
| | Parkland | 3,442 | 1,039 | 30% |
| | South Eastman | 3,379 | 2,556 | 76% |
| General X-Ray | Assiniboine | 51,560 | 14,465 | 28% |
| | Burntwood | 20,392 | 17,438 | 86% |
| | Central | 61,279 | 20,601 | 34% |
| | Churchill | 518 | 270 | 52% |
| | Interlake | 48,933 | 22,617 | 46% |
| | Nor-Man | 13,583 | 3,109 | 23% |
| | North Eastman | 24,574 | 11,852 | 48% |
| | Parkland | 31,200 | 4,857 | 16% |
| | South Eastman | 32,394 | 23,393 | 72% |
| Diagnostic Mammography | Assiniboine | 2,526 | 2,353 | 93% |
| | Burntwood | 842 | 632 | 75% |
| | Central | 2,946 | 1,943 | 66% |
| | Churchill | 26 | 9 | 35% |
| | Interlake | 2,532 | 2,019 | 80% |
| | Nor-Man | 656 | 279 | 43% |
| | North Eastman | 1,255 | 984 | 78% |
| | Parkland | 1,508 | 915 | 61% |
| | South Eastman | 1,574 | 1,165 | 74% |
| **Screening Mammography** | **Assiniboine** | **1,798** | **2,083** | **116%** |
| | **Burntwood** | **572** | **485** | **85%** |
| | **Central** | **2,037** | **2,519** | **124%** |
| | **Churchill** | **18** | **34** | **187%** |
| | **Interlake** | **1,891** | **1,829** | **97%** |
| | **Nor-Man** | **463** | **408** | **88%** |
| | **North Eastman** | **959** | **1,038** | **108%** |
| | **Parkland** | **1,080** | **1,836** | **170%** |
| | **South Eastman** | **1,113** | **1,194** | **107%** |

| Modality | RHA | Projected | Reported | Reported as a % of Projected |
|---|---|---|---|---|
| **MRI (adult)** | **Assiniboine** | **2,047** | **1,295** | **63%** |
| | **Burntwood** | **994** | **588** | **59%** |
| | **Central** | **2,613** | **1,766** | **68%** |
| | **Churchill** | **27** | **34** | **126%** |
| | **Interlake** | **2,170** | **1,731** | **80%** |
| | **Nor-Man** | **644** | **407** | **63%** |
| | **North Eastman** | **1,115** | **958** | **86%** |
| | **Parkland** | **1,245** | **757** | **61%** |
| | **South Eastman** | **1,468** | **1,436** | **98%** |
| Nuclear Medicine | Assiniboine | 716 | 2,568 | 359% |
| | Burntwood | 246 | 62 | 25% |
| | Central | 828 | 498 | 60% |
| | Churchill | 7 | - | 0% |
| | Interlake | 693 | 360 | 52% |
| | Nor-Man | 180 | 41 | 23% |
| | North Eastman | 346 | 161 | 46% |
| | Parkland | 432 | 572 | 132% |
| | South Eastman | 439 | 157 | 36% |
| Obstetric Ultrasound | Assiniboine | 1,948 | 1,500 | 77% |
| | Burntwood | 1,669 | 2,203 | 132% |
| | Central | 3,103 | 3,734 | 120% |
| | Churchill | 38 | 36 | 95% |
| | Interlake | 2,238 | 2,192 | 98% |
| | Nor-Man | 870 | 1,696 | 195% |
| | North Eastman | 1,169 | 1,054 | 90% |
| | Parkland | 1,232 | 1,223 | 99% |
| | South Eastman | 1,831 | 1,986 | 108% |
| Non-Obstetric Ultrasound | Assiniboine | 6,658 | 4,962 | 75% |
| | Burntwood | 2,788 | 3,657 | 131% |
| | Central | 8,136 | 7,665 | 94% |
| | Churchill | 76 | 57 | 75% |
| | Interlake | 6,667 | 7,354 | 110% |
| | Nor-Man | 1,886 | 3,586 | 190% |
| | North Eastman | 3,361 | 3,349 | 100% |
| | Parkland | 4,043 | 5,653 | 140% |
| | South Eastman | 4,419 | 3,726 | 84% |

NOTES:

1. "Projected" values are calculated by applying the actual utilization rates for residents of Winnipeg and Brandon to the age-sex population of each RHA. These values present what the rate would be for residents of the RHA if they lived in Winnipeg or Brandon.
2. The "reported" values for the modalities in **bold** are considered accurate as they are provided in limited numbers of settings, and are consistently reported through the fee-for-service system.
3. For modalities where it is known that data are incomplete (i.e., those where the modality is not **bold**), when the "reported" value is less than the "projected" value, it is unknown if the difference is due to incomplete data or real differences in utilization by the population of that region.
4. For modalities where it is known that data are incomplete (i.e., those where the modality is not **bold**), when the "reported" value is greater than the "projected" value, it is likely that the population of that region is really receiving more of these types of services than residents of Winnipeg or Brandon, even after adjusting for age and sex differences between regions.
5. Due to the small population of Churchill, the numbers of services provided to residents may vary greatly from year-to-year. As a result, caution should be used when interpreting the data reported here for this RHA.

**Figure C5: Age- Sex-Adjusted Rates, Ten Most Frequently Provided General X-ray Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

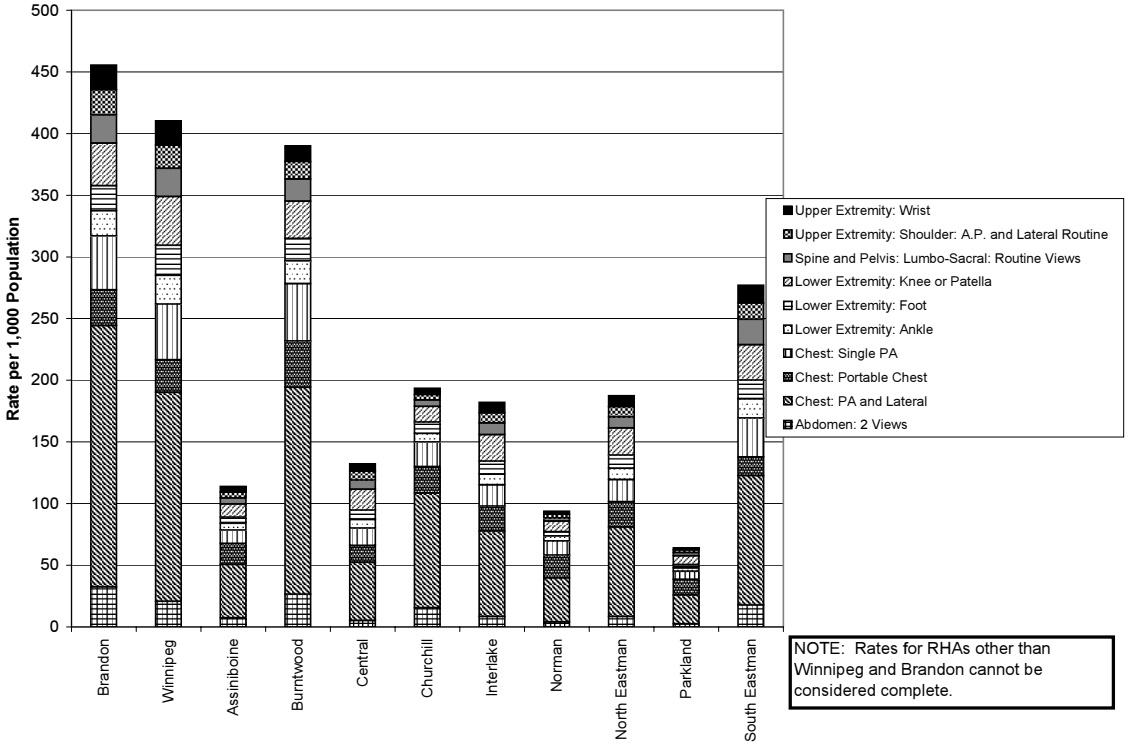



**Figure C6: Age- Sex-Adjusted Rates, Ten Services with the Highest Total Cost, General X-ray Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

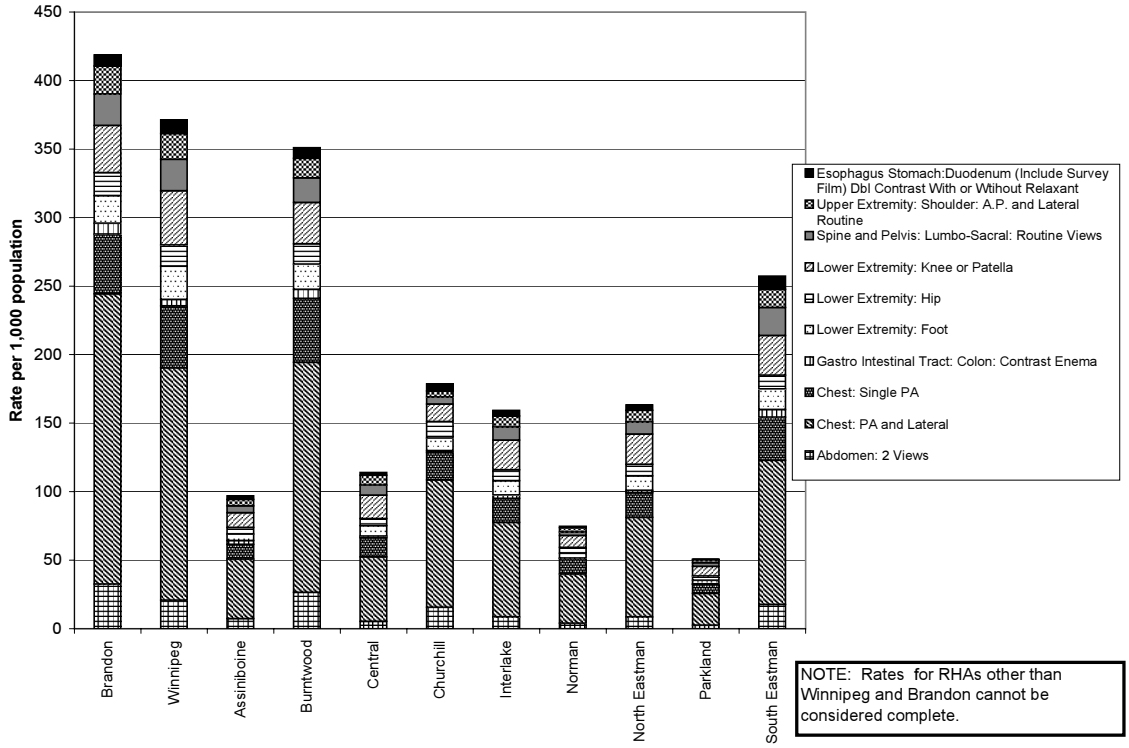


**Figure C7: Age- Sex-Adjusted Rates, Mammography, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: Only screening mammography rates are complete. Rates for diagnostic mammography provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

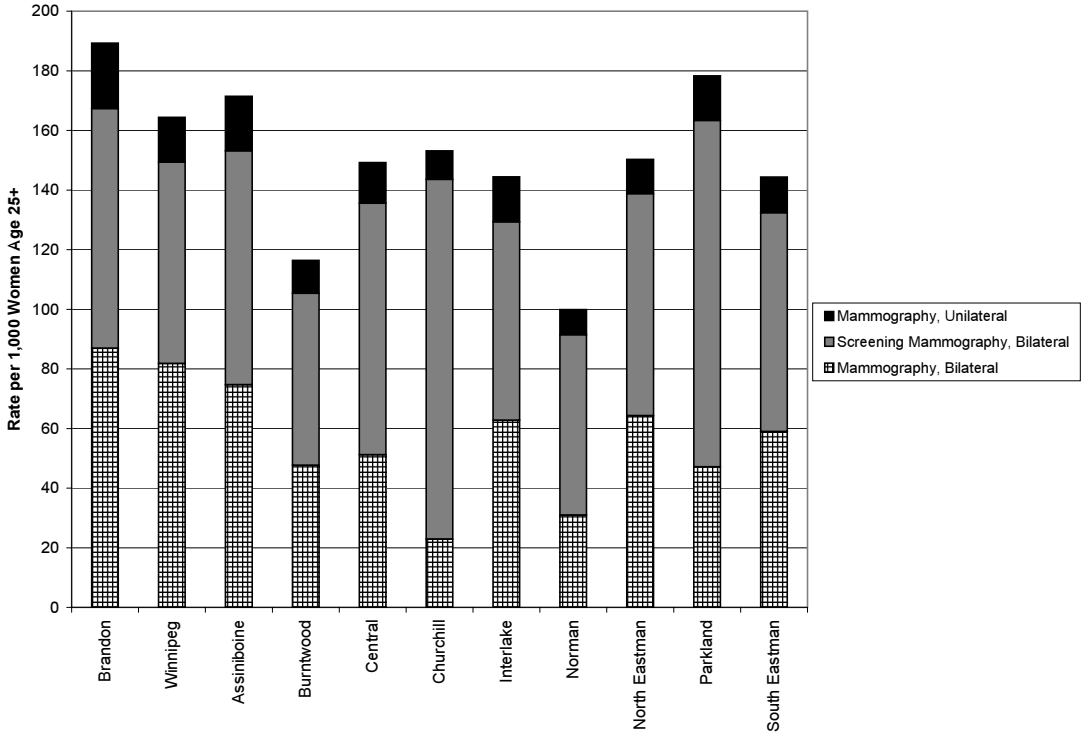



**Figure C8: Age- Sex-Adjusted Rates, Ten Most Frequently Provided Obstetric Ultrasound Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

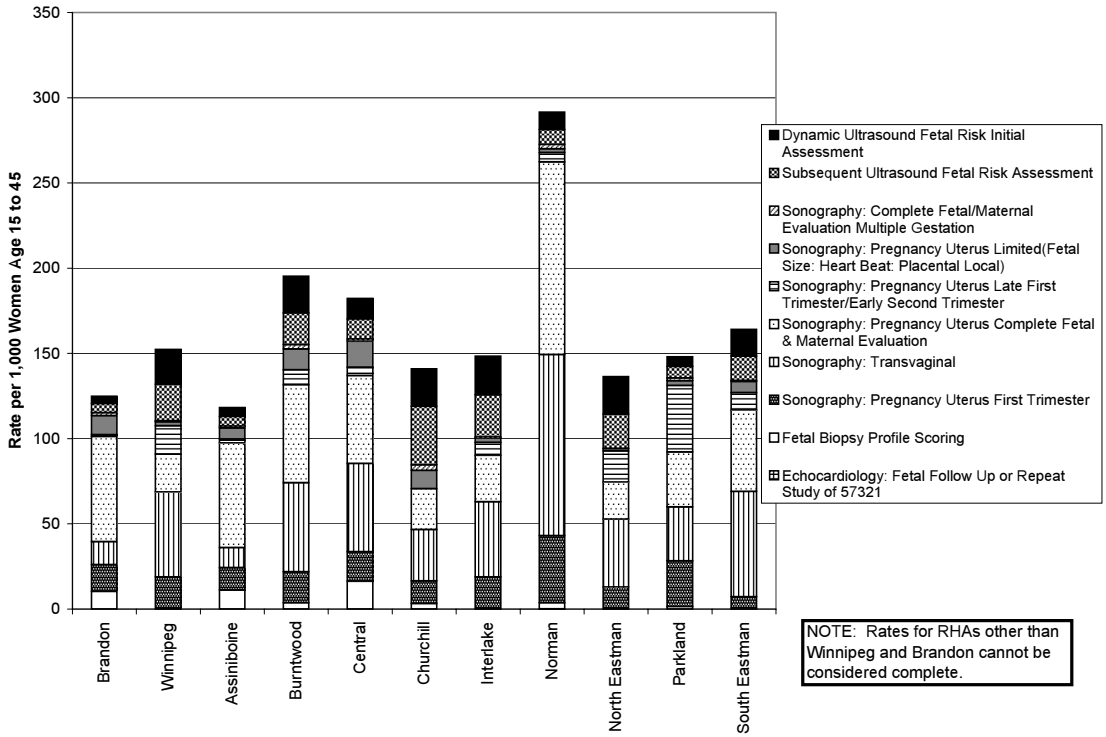


**Figure C9: Age- Sex-Adjusted Rates, Ten Services with the Highest Total Cost, Obstetric Ultrasound Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

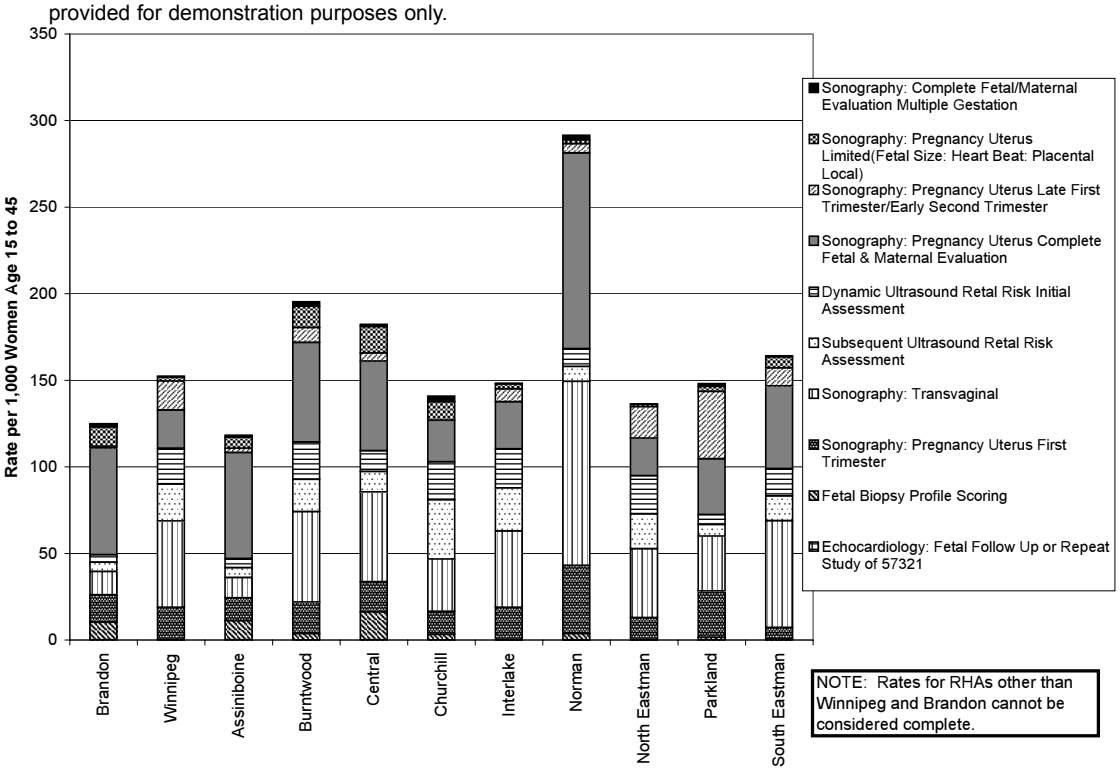



**Figure C10: Age- Sex-Adjusted Rates, Ten Most Frequently Provided Non-Obstetric Ultrasound Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

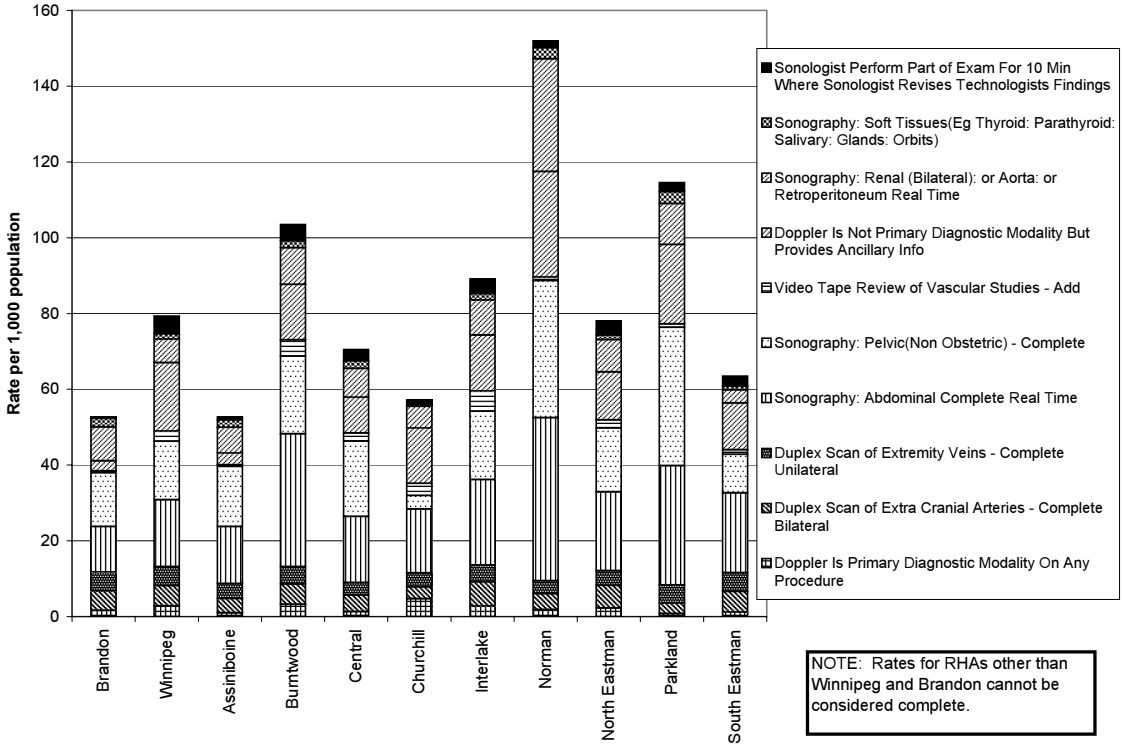


**Figure C11: Age- Sex-Adjusted Rates, Ten Services with the Highest Cost, Non-Obstetric Ultrasound Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

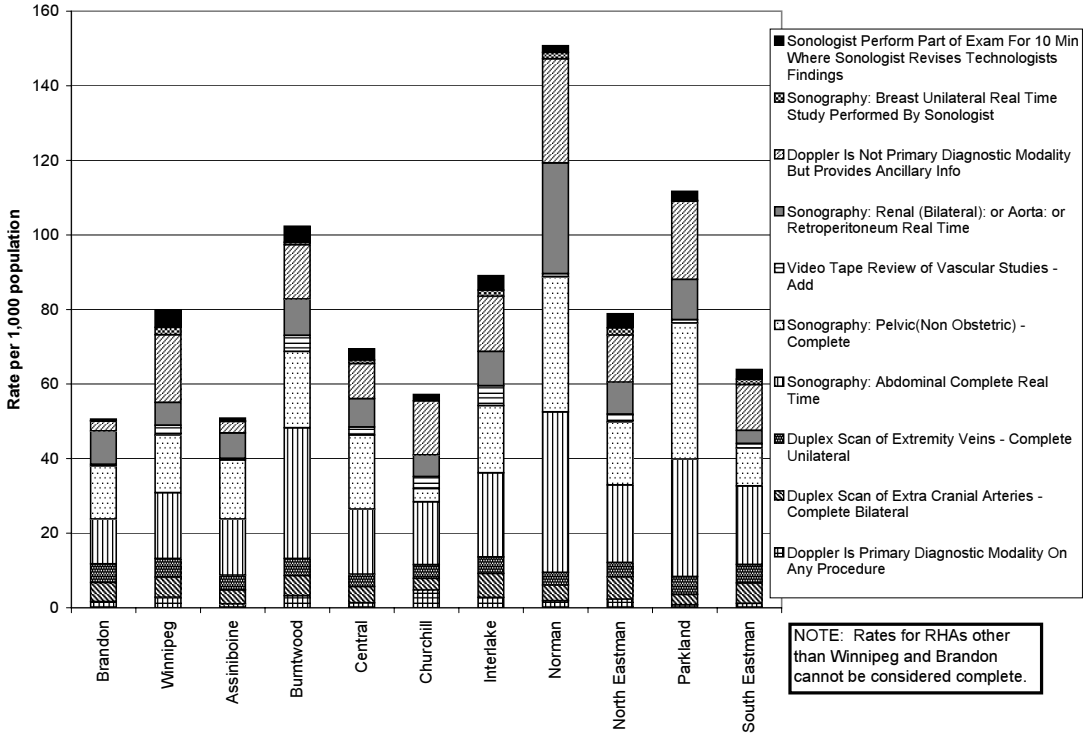



**Figure C12: Age- Sex-Adjusted Rates, Top Ten Most Frequently Performed CT Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

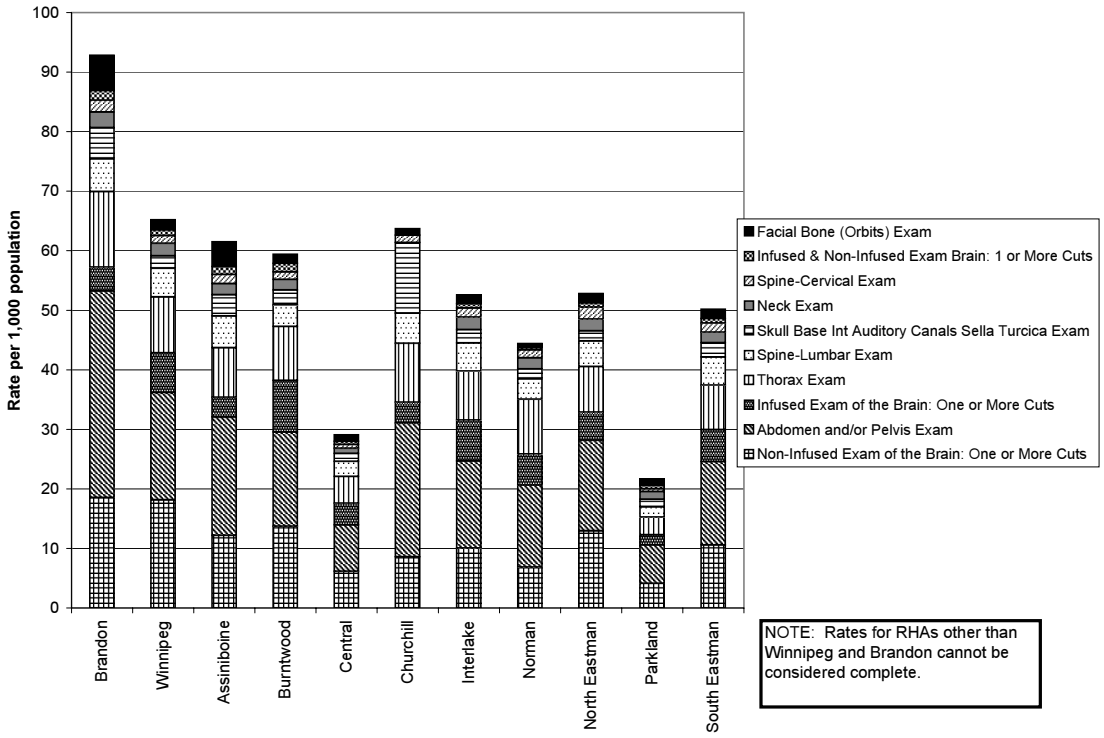


**Figure C13: Age- Sex-Adjusted Rates, Ten Services with the Highest Total Cost, CT Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Winnipeg and Brandon should be considered incomplete—this information is provided for demonstration purposes only.

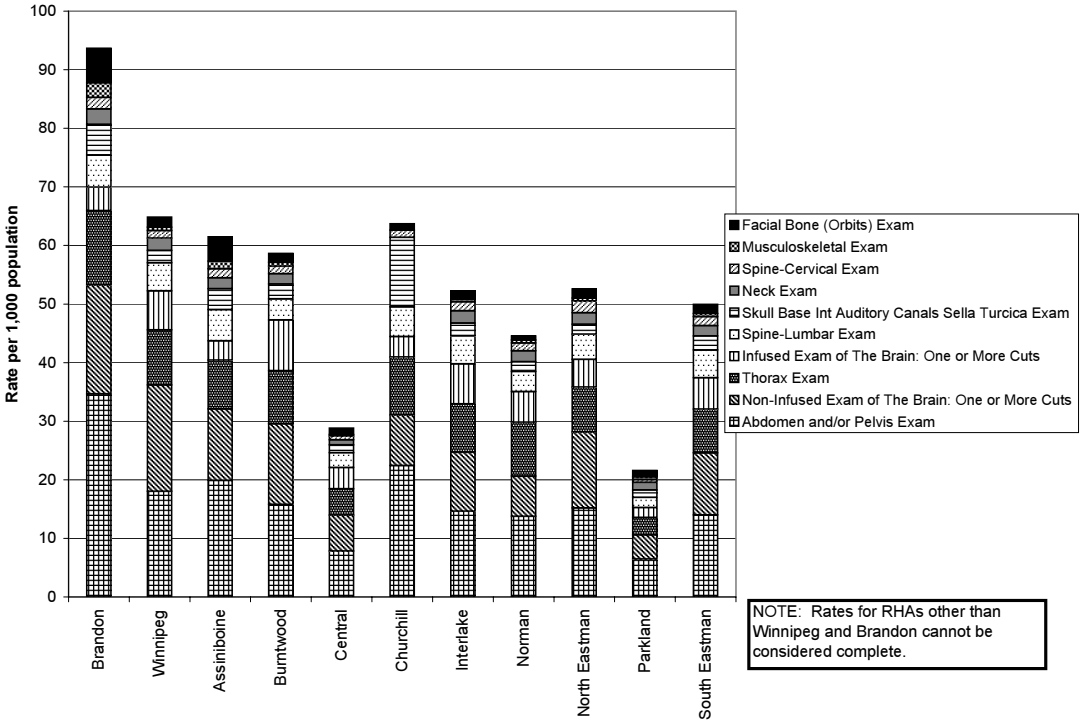



**Figure C14: Age- Sex-Adjusted Rates, Top Ten Most Frequently Provided Adult MRI Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: Pediatric MRI use is not included in these rates—they only reflect adult MRI.

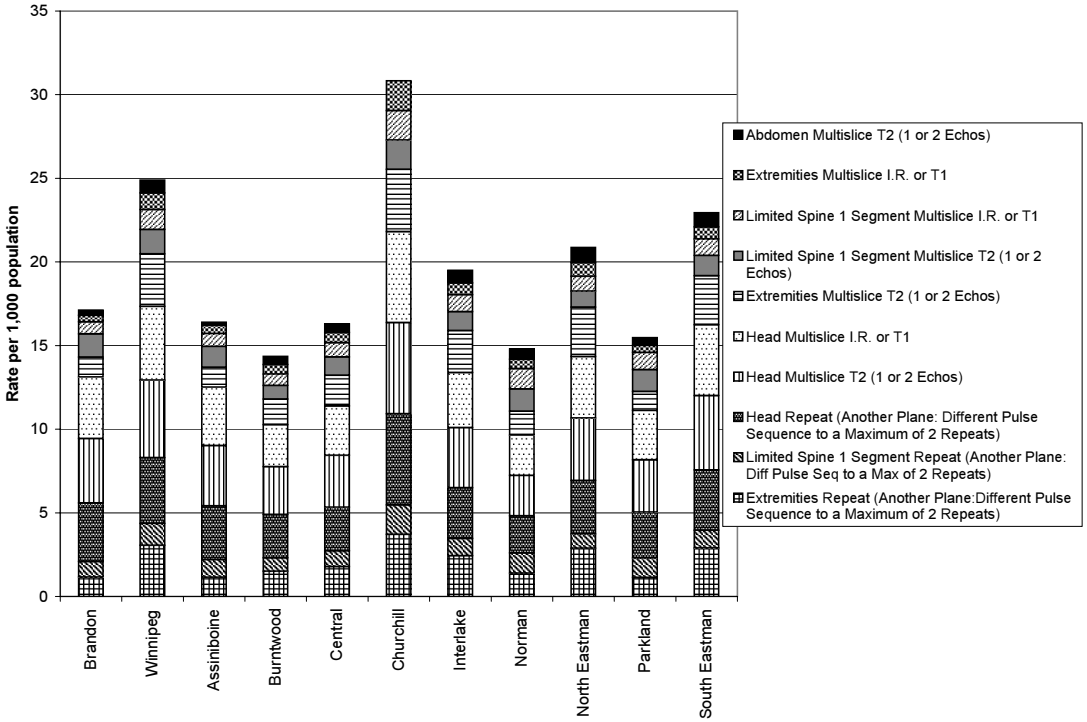


**Figure C15: Age- Sex-Adjusted Rates, Ten Services with the Highest Total Cost, Adult MRI Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: Pediatric MRI use is not included in these rates—they only reflect adult MRI.

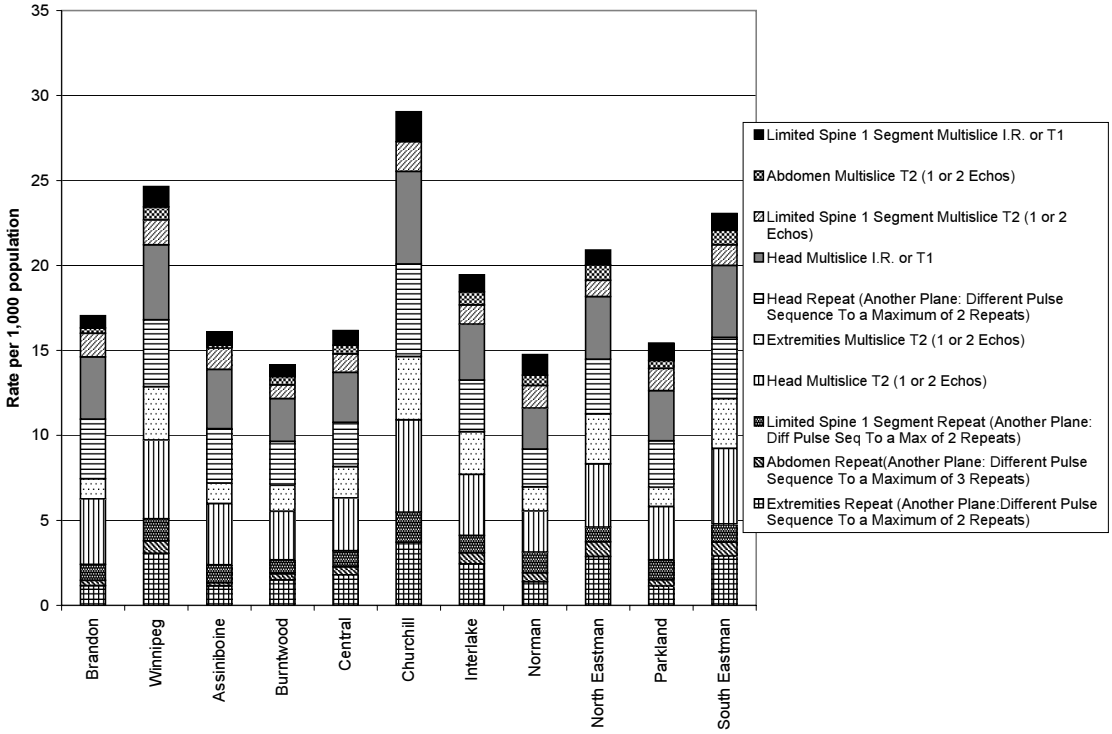



**Figure C16: Age- Sex-Adjusted Rates, Top Ten Most Frequently Provided Nuclear Medicine Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Brandon should be considered incomplete—this information is provided for demonstration purposes only.

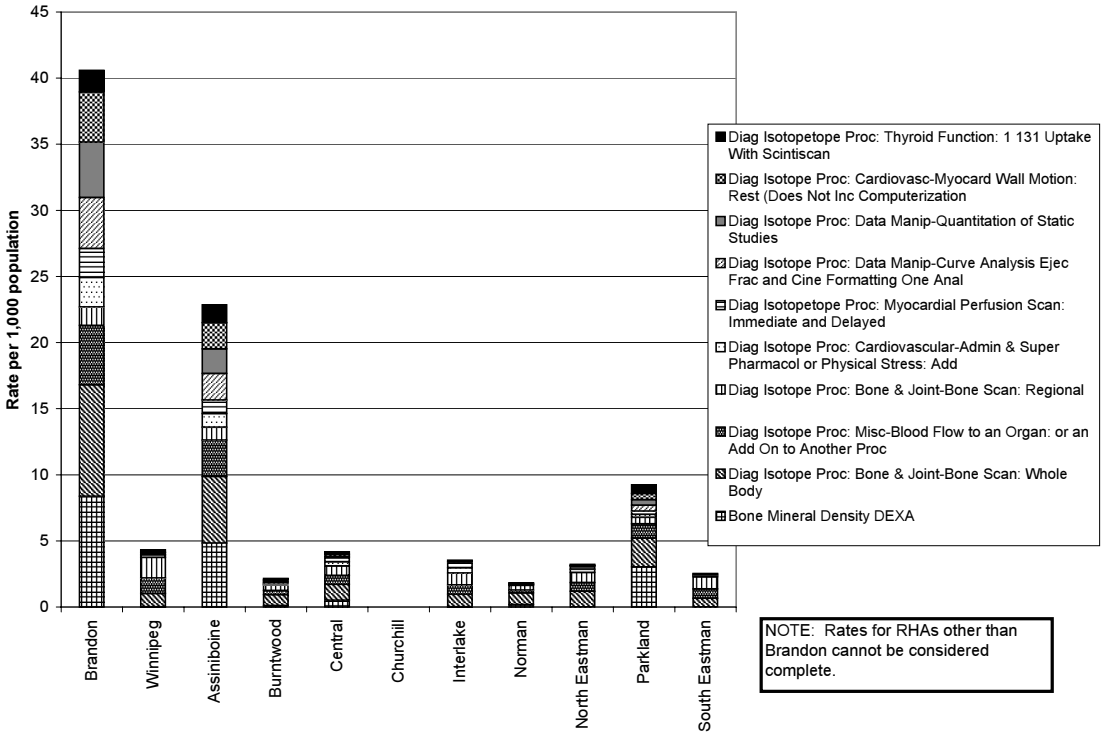


**Figure C17: Age- Sex-Adjusted Rates, Ten Services with the Highest Total Cost, Nuclear Medicine, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).** NOTE: rates for services provided outside of Brandon should be considered incomplete—this information is provided for demonstration purposes only.

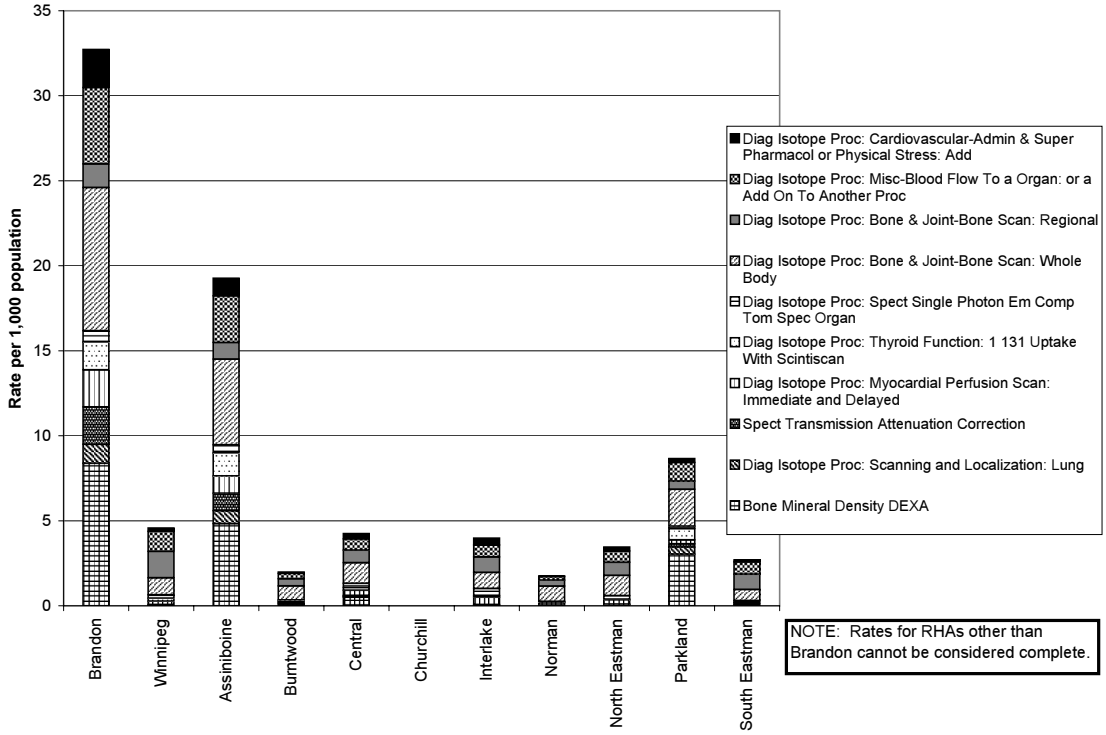



**Figure C18: Age- Sex-Adjusted Rates, Top Ten Services Most Frequently Provided Angiography Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).**

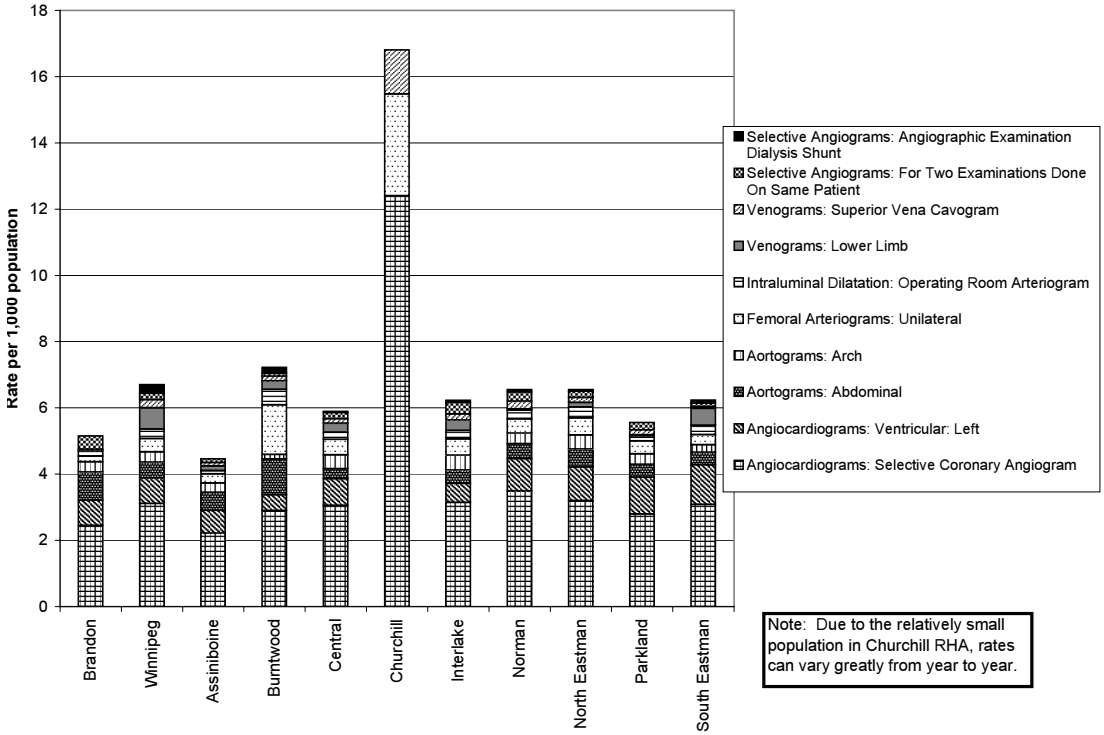
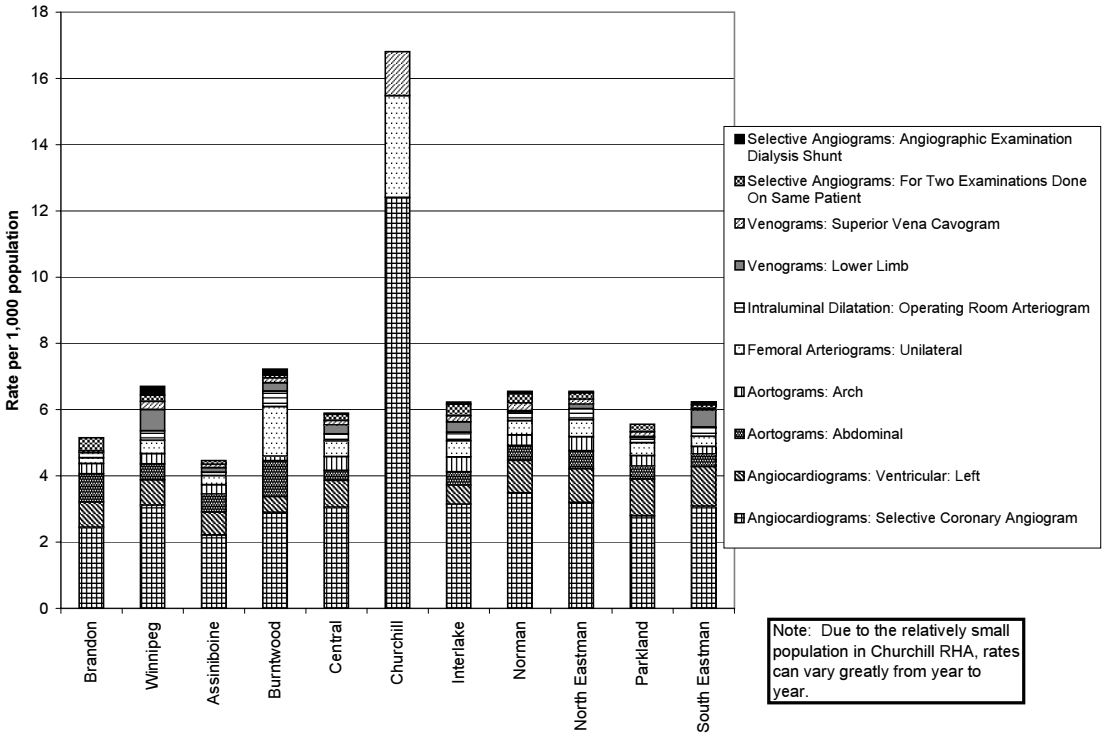


**Figure C19: Age- Sex-Adjusted Rates, Ten Services with the Highest Total Cost, Nuclear Medicine Services, by Regional Health Authority, 2001/02 (Source: Physician Services Claims Database).**



# APPENDIX D1: DENSITOMETRY IN MANITOBA: AN ASSESSMENT OF REGIONAL SERVICE DELIVERY AND IMPACT ON PATIENT MANAGEMENT

William D. Leslie, Leonard MacWilliam, Lisa Lix

## Background

Bone mineral density (BMD) measurement is accepted as integral to the diagnosis and management of osteoporosis. The currently preferred technology for BMD measurement is dual x-ray absorptiometry (DXA) which evolved out of earlier nuclear medicine techniques (SPA and DPA). Many models exist for the provision of health services like bone densitometry. However, the traditional doctor-patient relationship in which an individual patient seeks out and pays for the services of an independent practitioner is now a rarity in many countries. A variety of health insurance and health benefit plans have been designed to assist the patient gain access to and payment for physician services. Physicians are now often organized into larger organizations such as private health maintenance organizations (HMOs) or government-operated institutions which provide services while at the same time monitor costs. These new models of the doctor-patient relationship have their advocates and detractors, strengths and weaknesses.

Although few would disagree that bone densitometry is an important component in the diagnosis and treatment of osteoporosis, the diversity of health care models suggests a range of ways in which this service can be delivered. In many areas, access to bone densitometry has evolved along traditional lines where the individual patient interacts with a single facility or practitioner to have the test provided. In some situations the physician is even excluded from the process through "point of care" testing that takes advantage of more portable peripheral devices. Since 1997, the province of Manitoba, Canada, has pursued a regionalized approach to bone density testing, a model that is unique in North America.

## The Manitoba Bone Density Program

Bone density testing was first performed in Manitoba in 1985 with a dual-photon absorptiometry (DPA) device situated at one of the Winnipeg university-affiliated teaching hospitals (St. Boniface General Hospital). Not surprisingly, the majority of tests were performed on individuals referred by endocrinologists and other subspecialists with an interest in metabolic bone diseases and there were few requests from primary care practitioners. In 1990 the device was replaced with a dual x-ray absorptiometer (DXA). The 1990s ushered in a rapid increase in requests for testing as the general medical community and population became increasingly sensitized to the importance of osteoporosis and the availability of clinically proven methods for its

diagnosis and treatment. Unfortunately, the limited testing capacity was soon overwhelmed and a waiting list started to develop.

By 1997, the demand for testing reached crisis proportions with a waiting time in excess of one year (probably a gross under-estimate since most patients simply did not get referred for testing). Staffing of the DXA instrument was limited to 1,000 tests per year, well below its maximal capacity and the clinical demand. Government was wary about unlimited expansion in testing since other Canadian provinces had reported massive investments in DXA equipment and testing and, consequently, costs.

In 1997, Manitoba Health mandated the creation of a Bone Density Program Committee to develop, implement and oversee a strategic plan for bone densitometry for the province of Manitoba. A multidisciplinary team of individuals with a range of expertise was assembled that included representation from diagnostic imaging, endocrinology, rheumatology, obstetrics and gynecology, family practice, pharmacy, the Manitoba Centre for Health Policy, and the provincial government. Subsequently a lay member of the Osteoporosis Society of Canada, a medical physicist, as well as Associate Dean from the Faculty of Medicine Continuing Medical Education were added. This group provided expertise in bone densitometry, clinical care of osteoporosis, pharmacoepidemiology, radiation protection, quality assurance of x-ray imaging devices, and health policy assessment.

The initial priority was to develop criteria for testing that would be responsive to the needs of patients and physicians, but provide some assurance to government that testing would not be conducted indiscriminately. These criteria were drawn from published guidelines at the time and have undergone minimal modification. The Manitoba Bone Density Program developed clear guidelines for testing and a provincial standard in terms of the requisition, reporting and database. Screening of healthy individuals, including postmenopausal women without other clinical risk factors for fracture, with bone density testing was considered screening and not an approved indication for bone density testing. The website at Manitoba Health provides these testing criteria as well as administrative and educational materials related to the program which are freely accessible and include items of interest to both the general public and medical professionals (http://www.gov.mb.ca/health/programs/mbd/).

In 1997-98, after one-time funding was made available, the waiting list was reduced to 20 weeks. Additional permanent funding was provided in 1998 so that St. Boniface General Hospital could perform up to 3,000 bone density exams per year. In the spring of 2000 the Winnipeg Regional Health Authority transferred the Bone Density Clinic to a new location at 400 Tache Avenue. This clinic now has two bone density scanners and is funded

to perform 8,000 exams each year. Since then the waiting time for a BMD examination has remained within the target of 6 weeks established by the WRHA. This testing site "batch-bills" for services and has never submitted individual physician claims data to Manitoba Health.

A separate testing site was opened in Brandon (to serve the Brandon RHA and south western Manitoba RHAs of Parkland and Assiniboine) and became operational in April 1999. The BMD Program has used a single provincial requisition, report format and database for capturing results in both Winnipeg and Brandon. Unlike the WRHA site, the Brandon site has billed "true" fee-for-service and submitted individual physician claims directly to Manitoba Health.

The opening of the BMD testing service in Brandon offers an opportunity to evaluate the completeness of the Manitoba Population Health Research Data Repository (physician claims file) related to BMD testing and compare this with the primary clinical database (which is regarded as the gold standard). At the same time, it is possible to evaluate the impact of the Brandon densitometer on BMD testing in the Brandon and western Manitoba RHAs, and compare this with Winnipeg and other Manitoba RHAs. It is hypothesized that the lack of access to BMD testing in Brandon and western Manitoba may have led to a high rate of empiric osteoporosis drug treatment and that the introduction of the BMD scanner resulted in a shift from preventive/empiric (i.e., no prior BMD) to non-preventive/empiric (i.e., BMD-guided) treatment.

## Objectives

A. To evaluate the completeness of BMD claims data in Manitoba.
B. To characterize changes in the rate of BMD testing for Brandon and the Western Manitoba RHAs, and compare this with Winnipeg and the other Manitoba RHAs.
C. To characterize changes in the rate of empiric osteoporosis treatment in Brandon and the Western Manitoba RHAs before and after establish ment of the Brandon DXA scanner, and compare this with similar measures for Winnipeg and other the Manitoba RHAs.

## Data Souces and Definitions

Physician Services Claims file: A specific radiology tariff exists for BMD measurement ("7100 Bone Mineral Densitometry with DXA, one or more sites"). Prior to 2000 this tariff was listed under nuclear medicine ("9948"). It is worth noting that osteoporosis cannot be reliably diagnosed from medical claims. The ICD-9-CM code for osteoporosis is 733.0x. The 3-digit code 733.xx is not specific to osteoporosis and includes 733.1 Pathological Fracture, 733.2 Cyst of Bone, 733.3 Hyperostosis of skull, 733.4 Aseptic

Necrosis of Bone, 733.5 Osteitis condensans, 733.6 Tietze's Disease, 733.7, Algoneurodystrophy, 733.8 Malunion and nonunion of fracture, 733.9 Other and unspecified disorders of bone and cartilage.

BMD Database (1990-2002): The BMD Database is a clinical database used for scheduling and reporting all BMD tests performed within the Manitoba Bone Density Program (effectively all non-research testing). All BMD results from January 1990 (the date that DXA testing first became available in Manitoba) to the end of March 2002 (2001/02 fiscal year end) were used for the analyses discussed in this report. Non-Manitoba residents were excluded based upon Province<>"Mb" or a non-Manitoba postal code. In accordance with policies and procedures for the use of personal health information, all personal information from the database was initially sent to Manitoba Health for anonymization (i.e., personal information was replaced with scrambled PHIN). MCHP received BMD results without any identifying personal information and relied on the scrambled PHIN for merging with other datasets from the Manitoba Population Health Research Data Repository (e.g., Drug Programs Information Network for Objective C). The high level of completeness and accuracy of the information in the BMD Database is discussed later (see A.2 and A.3).

Some limitations in working with the Database are worth noting, however. Although the program has used a common provincial requisition and report format, technical problems were encountered in using the Paradox system which only went "live" in Brandon in December 2000. Between April 1999 and July 1999 only paper records have been retained, whereas from July 1999 to December 2000 electronic text documents (WordPerfect) have been retained. Fortunately, it has proven possible to extract bone density data performed prior to May 1998 at St. Boniface General Hospital from DBase tables of results (stored on the BMD scanner's computer) and link this with patient identifier information through the hospital patient registration system (PRN2000). Similarly, the missing DXA data from Brandon was extracted from the WordPerfect documents and a limited amount of manual data entry. Together these two initiatives complement the existing Paradox BMD Database and provide a near-complete picture of all DXA testing that has ever occurred in Manitoba. Excluded from the database is any research testing as performed at the Manitoba Clinic, though a small number of "clinical" BMD tests performed since 1997 are captured. A pediatric research DXA scanner at the John Buhler Research Centre is not included. The Winnipeg Clinic briefly operated a DXA scanner that was not reimbursed by Manitoba Health and the service was paid directly by patients; these cases are not included in the provincial database but are small in number. Finally, non-DXA BMD technologies, such as DPA which was used prior to 1990 and quantitative ultrasound which is offered as a screening procedure by some pharmacies, is not captured.

# Objective A. Completeness of BMD Claims Data in Manitoba

## A.1 Assessment of Medical Claims

The annual number of DXA bone density procedures was counted from the medical claims file (tariffs "9948" or "7100") and from the BMD Database (excluding non-Manitoba residents based upon Province<>"MB" or non-Manitoba postal code). The results summarized in Table A.1 confirm that the medical claims file grossly underestimates the actual rate of testing. This was predicted from the "batch billing" arrangement that exists at the largest testing site in Winnipeg. Somewhat surprisingly, even when analysis is limited to Brandon region alone there were significant discrepancies. This appears to be largely confined to the first year of operations in Brandon (3.72% concordance with the BMD Database for 1999/00) with much closer agreement thereafter (99% agreement in the final year 2001/02). The reason for the early discordance is unclear, but may have been related to a reimbursement issue that existed at the time but was resolved in 2000.

**Table A.1: Completeness of BMD physician services claims data versus BMD Database**

| Year | Number of BMD Tests physician claims | Number of BMD Tests BMD Database | | Completeness of physician services claims* | |
|---|---|---|---|---|---|
| | | All sites | Brandon only | All sites | Brandon only |
| | N | N | N | % | % |
| 1990/01 | 0 | 409 | - | 0.00 | - |
| 1991/92 | 0 | 431 | - | 0.00 | - |
| 1992/93 | 0 | 542 | - | 0.00 | - |
| 1993/94 | 0 | 706 | - | 0.00 | - |
| 1994/95 | 0 | 790 | - | 0.00 | - |
| 1995/96 | 0 | 900 | - | 0.00 | - |
| 1996/97 | 0 | 964 | - | 0.00 | - |
| 1997/98 | 0 | 2253 | - | 0.00 | - |
| 1998/99 | 0 | 4939 | - | 0.00 | - |
| 1999/00 | 45 | 4334 | 1210 | 1.04 | 3.72 |
| 2000/01 | 1055 | 6347 | 1174 | 16.62 | 89.86 |
| 2001/02 | 1014 | 6745 | 1026 | 15.03 | 98.83 |

* Completeness calculated as percent of corresponding figure from the BMD Database.

## A.2 BMD Database—Random Chart Audit

Clinical bone density results from the Winnipeg Regional Health Authority (WRHA) and Brandon Regional Health Authority (BRHA) have been combined into one common Access database. This involved merging multiple data sources from the two facilities:

- Paradox database used for scheduling and reporting of scans (WRHA 1997-2002 and BRHA 2000-2002).
- WordPerfect document reports (BRHA 1999-2000).
- Prodigy machine results tables (BRHA 1999-2000).

- Early DPX machine results tables (version 3.4 1990-1994 and 3.6 1994-1997) with patient identifier information from the PRN2000 hospital registration system (SBGH 1990-1997).

The use of the machine results tables involved extracting and manipulating raw scan parameters (e.g., bone area, bone mineral content, percent young adult) to generate the corresponding absolute BMD (in units g/cm2), T-score (the number of standard deviations that BMD is above/below average for a young adult reference population), Z-score (the number of standard deviations that BMD is above/below average for an age-matched reference population), fracture risk designation and WHO diagnostic classification (based upon T-score). The WHO diagnostic category is determined for each site as follows: normal if T-score greater than -1, ostepenia (low bone mass) if T-score less than or equal to -1 but not below -2.5, osteoporosis if T-score -2.5 or lower. The combined database contains patient identifier information and results for all clinical DXA scans performed between January 1990 and October 2002, inclusive.

To verify the completeness and accuracy of the database we reviewed 72 randomly selected patient charts (49 from WRHA and 23 from BRHA) covering 265 DXA examinations (234 from WRHA and 31 from BRHA). Most of the charts reviewed were from patients who had multiple visits to the bone density department spanning a large number of years (WRHA scans from January 1991 to October 2002, BRHA scans from July 1998 to October 2002).

A record were considered to be completely accurate if it was present in the Access table, identifier fields were correct and sufficient for patient identification, and all scan data fields matched the printouts in the patient chart. (For this analysis missing postal code, missing province or missing requisition date were not considered to be errors.) Any discrepancy in fracture risk designation or WHO diagnostic classification, or an absolute difference in BMD exceeding 0.05 g/cm2, T-score exceeding 0.5, or Z-score exceeding 0.5 was considered to represent an error in the database. The findings are summarized in the Table A.2.

**Table A.2: Random chart audit of BMD Database records for completeness and accuracy**

| | Total WRHA | % WRHA | Total BRHA | % BRHA | Total All | % All |
|---|---|---|---|---|---|---|
| Total number of scans reviewed | 234 | 100.0% | 31 | 100.0% | 265 | 100.0% |
| Completeness | | | | | | |
| scans missing from database | 2 | 0.9% | 0 | 0.0% | 2 | 0.8% |
| scans in database but clinical file lost | 1 | 0.4% | 0 | 0.0% | 1 | 0.4% |
| scans with missing BMD data | 0 | 0.0% | 1 | 3.2% | 1 | 0.4% |
| Review of patient identifier fields | | | | | | |
| missing PHIN | 0 | 0.0% | 11 | 35.5% | 11 | 4.7% |
| missing identifiers (excluding PHIN and Prov) | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| incorrect DOB | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| incorrect name spelling | 0 | 0.0% | 1 | 3.2% | 1 | 0.4% |
| incorrect scan dates | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Review of results fields | | | | | | |
| missing "SpineFractureRisk" | 1 | 0.4% | 2 | 6.5% | 3 | 1.1% |
| incorrect "SpineFractureRisk" | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| missing "WHO" | 16 | 6.8% | 2 | 6.5% | 18 | 6.8% |
| incorrect "WHO" | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| missing "BMD" | 2 | 0.9% | 2 | 6.5% | 4 | 1.5% |
| incorrect "BMD" | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| missing "T-score" | 2 | 0.9% | 2 | 6.5% | 4 | 1.5% |
| incorrect "T-score" | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| missing "Z-score" | 2 | 0.9% | 2 | 6.5% | 4 | 1.5% |
| incorrect "Z-score" | 0 | 0.0% | 2 | 6.5% | 2 | 0.8% |
| "ScanHipSite" switched to "left" side | 52 | 22.2% | 0 | 0.0% | 52 | 19.6% |

Overall, the database showed an extremely high level of completeness. Of the 265 DXA examinations selected for chart audit, 263 (99.6%) were present in the database. The database also contained one result for which the chart had been lost. Patient identifier fields were generally well coded as well, aside from the PHIN number. The PHIN field at the BRHA site was missing in 11 (35.5%) of the cases, though the remaining fields were judged to be sufficient for unambiguous identification in the Manitoba Health Registry File through probability matching (see below).

BMD results fields were generally accurate, including those that were generated from the machine databases. The most common problem was "ScanHipSite" at the WRHA site. This was found when hip scans were acquired with an older software version (version 3.4) and re-analyzed with a newer version of software (version 3.6). The original hip scan analyzed the right femoral neck. Later software also measured BMD for the total proximal femur, and this site is now preferred for measurement due to much better precision (reproducibility) then the smaller femoral neck subregion.

When the earlier scans acquired were re-analyzed under the newer software to generate the total proximal femur BMD, the machine result file update the site code to "total proximal femur" and incorrectly changed the side code from "right" to "left". The actual BMD data (absolute BMD measurement, T-score and Z-score) was correct but the side of the site scanned was changed and often reversed (a previously unreported software "bug"). Therefore, the site of hip scanning reflected in the Access database ("left total proximal femur") for DPX version 3.4 scans may differ from the original clinical report in the patient chart ("right femoral neck").

## A.3 Accuracy of Identifier Information

In 2001 a process was established to improve the completeness and accuracy of PHIN information in the BMD Database. The first time that the Database was submitted to Manitoba Health for encryption of personal identifier information it was found that approximately 20% of the records had an erroneous PHIN. Based on the other fields it was possible to obtain reliable probability match for the PHIN but this took considerable time on the part of the individual concerned. The corrected PHIN information was then re-inserted into the clinical version of the BMD Database and this same practice was followed with each successive submission to Manitoba Health. At the same time, Manitoba Health supplied the PHIN validity check algorithm which has been implemented in the Database. Currently, the PHIN is directly entered from the patient's Manitoba Health card and this information is no longer accepted from physicians' offices. As a final measure, the DXA technologist independently enters the PHIN into one of the DXA machine patient identifier fields (which then appears on the machine printout) and is cross-checked by the secretary-typist against the value in the BMD Database. This has dramatically reduced errors rates in the PHIN field.

The BMD Database containing all test results (January 1, 1990 to October 31, 2003) was sent to Manitoba Health for identifier matching after removing any tests performed in non-Manitoba residents. Matching of personal identifier information with the administrative data repository was achieved in 99.4% of the 34,132 BMD Database records. A chart review of the unmatched cases indicated that most of these were actually not true residents of Manitoba (e.g., Department of National Defense).

Some of the patient and testing characteristics are summarized in Table A.3. The Database also includes a primary clinical indication for testing, clinical risk factors that are used to screen validity of testing requests in healthy menopausal women, medication use, the requesting and reporting physicians as well as more detailed test results (absolute BMD, T-score, Z-score, qualitative fracture risk estimate, absolute fracture risk estimate, specific comments).

**Table A.3: Breakdown of demographics and selected test information on Manitoba residents recorded in the BMD Database (January 1, 1990 to October 31, 2003).**

| | Frequency | Percent |
|---|---|---|
| Site of testing | | |
| BRHA | 4278 | 12.61 |
| WRHA | 29651 | 87.39 |
| DXA machine | | |
| WRHA Lunar DPX (1/1990-2/2000) | 13795 | 40.66 |
| WRHA Lunar Prodigy 1 (3/2000-present) | 11064 | 32.61 |
| WRHA Lunar Prodigy 2 (9/2000-present) | 3972 | 11.71 |
| BRHA Lunar Prodigy 1 (5/1999-present) | 4278 | 12.61 |
| Manitoba Clinic Hologic (11/1997-present) | 771 | 2.27 |
| Not recorded | 49 | 0.14 |
| Gender | | |
| Female | 31096 | 91.65 |
| Male | 2833 | 8.35 |
| Age on test date | | |
| <20 | 61 | 0.18 |
| 20-29 | 400 | 1.18 |
| 30-39 | 963 | 2.84 |
| 40-49 | 2603 | 7.67 |
| 50-59 | 7817 | 23.04 |
| 60-69 | 9456 | 27.87 |
| 70-79 | 8142 | 24.00 |
| >80 | 4487 | 13.22 |
| Spine result (WHO classification) * | | |
| normal (T-score above -1) | 11905 | 37.07 |
| osteopenic (low bone mass) (T-score -1 to -2.5) | 12130 | 37.77 |
| osteoporotic (T-score -2.5 or lower) | 8084 | 25.17 |
| Spine comparison (if applicable) | | |
| significant decrease | 300 | 7.09 |
| borderline decrease | 252 | 5.96 |
| no change | 2633 | 62.25 |
| borderline increase | 438 | 10.35 |
| significant increase | 607 | 14.35 |
| Hip result (WHO classification) * | | |
| normal (T-score above -1) | 14513 | 44.26 |
| osteopenic (low bone mass) (T-score -1 to -2.5) | 13769 | 41.99 |
| osteoporotic (T-score -2.5 or lower) | 4509 | 13.75 |
| Hip comparison (if applicable) | | |
| significant decrease | 324 | 7.67 |
| borderline decrease | 206 | 4.88 |
| no change | 2594 | 61.41 |
| borderline increase | 361 | 8.55 |
| significant increase | 739 | 17.50 |

* Not all individuals had clinically usable spine and hip scans.

## A.4 Conclusions

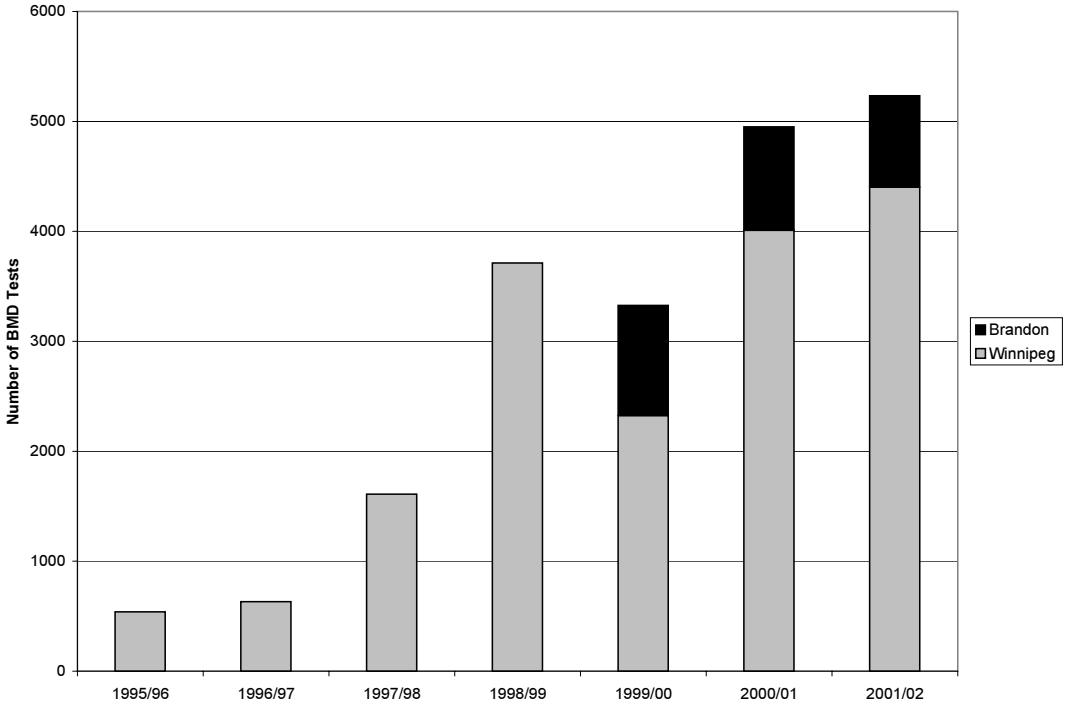
- The medical claims file is grossly incomplete in terms of BMD testing, though since 2000/01 data from the Brandon region is reasonably complete.
- The Manitoba BMD Database is felt to be extremely complete based upon a random chart audit. The BMD Database also has a high degree of accuracy, though some data fields may be incomplete (e.g., WHO category) and there was a previously unreported software error relating to the side of hip measurement in re-analyzed DPX scans.
- The Manitoba BMD Database also includes a rich set of clinical and test-related information.

# Objective B: Regional Rates of BMD Testing in Manitoba

## B.1 Numbers of BMD Tests

The Manitoba BMD Database provided numbers of BMD tests (Figure B.1). This shows the overall increase in the numbers of tests performed between 1995 and 2002. The majority of these are from the Winnipeg site with a smaller fraction coming from the Brandon site starting in 1999.

**Figure B.1: Annual Number of BMD Tests According to Testing Site**

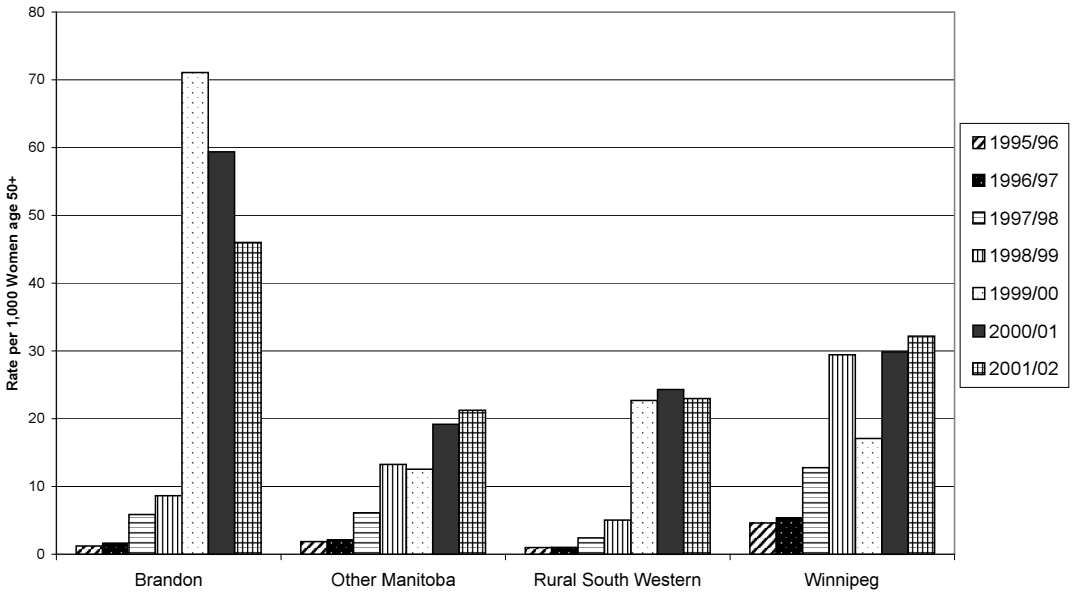



## B.2 BMD Testing Rates

Crude and direct age-adjusted rates (1995/96 to 2001/02) were calculated and stratified according to testing site (Brandon or Winnipeg) and patient residence (Brandon, Westman RHAs, other rural/northern RHAs and Winnipeg). Testing rates (per thousand) used the Registry File to determine the number of women registered to Manitoba Health who were age 50 or greater at any time during the reporting year. As expected, there was a consistent pattern of increasing testing rates over time in every region. The effect of access on testing is clearly evident in Figure B.2. In 1995/96 the only DXA testing service was in Winnipeg where testing rates were significantly higher than in areas without close access to DXA (Winnipeg (4.6 per thousand [95% CI 4.2-5.1), Brandon 1.2 [0.6-2.6], rural south western 1.0 [0.6-1.6], Rural/northern Other 1.9 [1.5-2.4]). With the establishment of the Brandon DXA service in 1999 there was an immediate dramatic increase

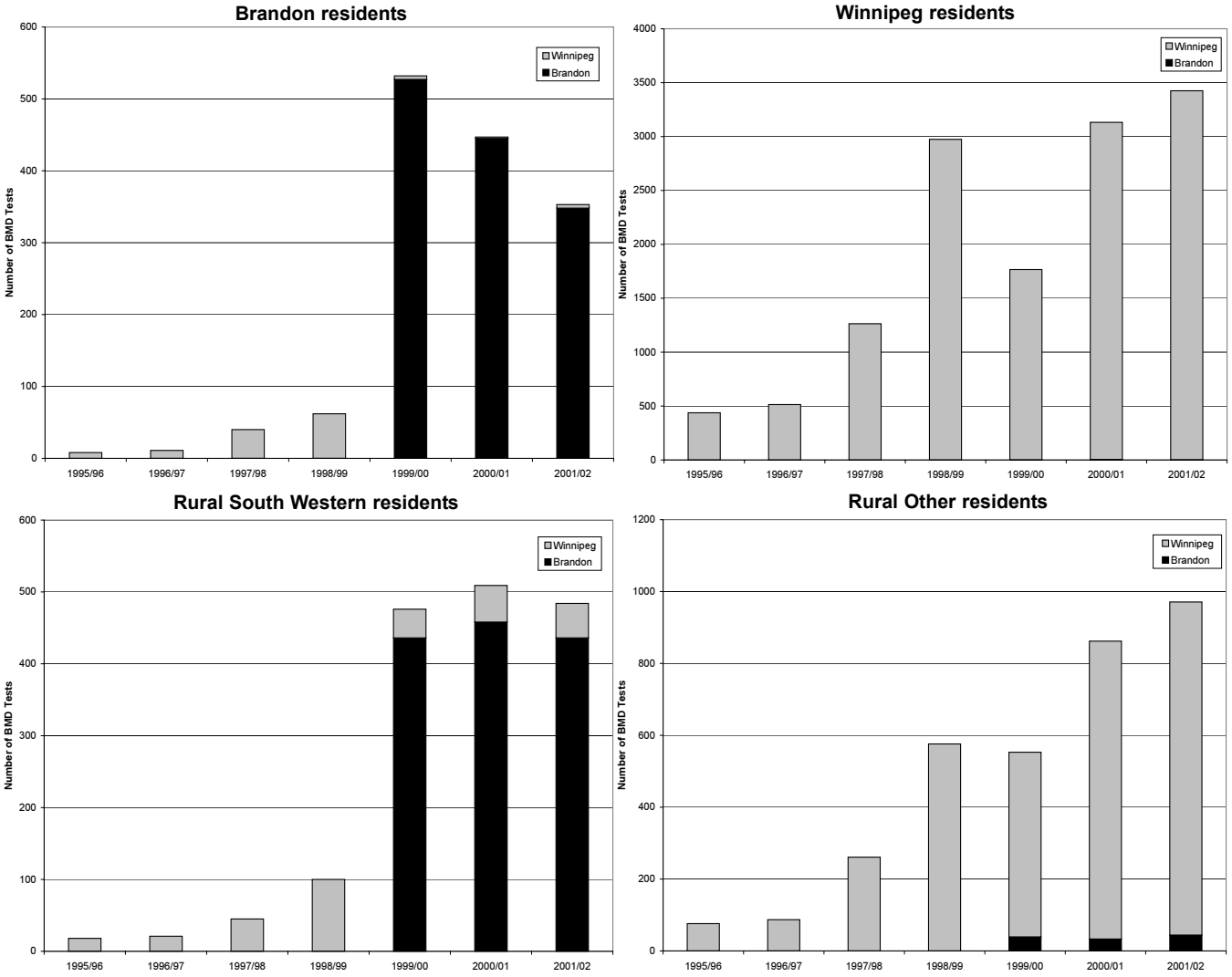
in testing rates from 8.6 per thousand (95% CI 6.7-11.1) in 1998/99 to 71.1 per thousand (65.5-77.1) in 1999/00. This rate has subsequently declined after the initial burst in activity which probably related to catch-up testing as a backlog of tests had been accumulated. A smaller catch-up effect probably accounts for the small spike in Winnipeg testing in 1998/99 when extended hours of operation were used to address the long waiting time. The change in rural testing tends to parallel the proximate urban region but does not exhibit the catch-up spike. The most rapid rural south western increase occurred in 1999/00 while Rural/northern Other showed an increase starting in 1997/98. As of 2001/02, Brandon still had the highest testing rate (46.0 per thousand [41.6-50.9]) but regional differences across the rest of Manitoba (Winnipeg 32.2 [31.2-33.3], rural south western 23.0 [21.0-25.1], Rural/northern Other 21.2 [20.0-22.6]) are less striking than in 1995/96. It is speculated that this may in part reflect dissemination and adoption of uniform testing criteria from the Manitoba Bone Density Program.

**Figure B.2: Age-Adjusted Rate (per 1,000) of BMD Testing in Women Age 50 and Above According to Region**




The referral site for DXA testing is depicted in Figure B.3. There is a strong impact of local accessibility on testing site with virtually all of the Brandon and rural south western residents being referred to the Brandon site after 1999, while Winnipeg and other rural/northern residents are referred to the Winnipeg site. This probably reflects a combination of physician and patient preference.

**Figure B.3: Site of BMD Testing According to Patient Residence**




## B.3 Statistical Analysis

Linear regression analyses was used to model the log-transformed testing rates. All statistical analyses were performed with the GENMOD procedure of SAS Release 8.02 (SAS Institute Inc., Cary, NC) with statistical significance established at a level of $\alpha = 0.05$. All models converged on a final solution and fit of the models, as assessed using the scaled deviance, was acceptable. The base regression model included the following predictors: region ("Brandon", "Westman RHAs", "other rural/northern RHAs" and "Winnipeg"), period ("before" or "after" the opening of the Brandon BMD testing service), and a region-by-period interaction term. The regression model parameters, which are used to estimate the relative rate ratios of treatment for individual regions and time periods, are summarized in Table B.1. The results reveal an important interaction between region and period, with significantly higher testing rates in the "after" period for Brandon (rate ratio 7.0, 95% CI 2.0-24.7) and rural south western RHAs (4.8, 1.4-16.9).

**Table B.1: Regression results: Relative rates of BMD testing according to region, period, and test year**

| Factor | Rate Ratio (95% CI) | P |
|---|---|---|
| I. Base Model (without test year or its interactions) | | |
| **Period*Region** | | |
| After-Brandon | 7.0 (2.0, 24.7) | 0.0023 |
| After-Rural/Northern Other | 1.6 (0.4, 5.5) | 0.4813 |
| After-Rural south western | 4.8 (1.4, 16.9) | 0.014 |
| After-Winnipeg | reference | |
| **Region** | | |
| Brandon | 0.3 (0.1, 0.7) | <.0001 |
| Rural/Northern Other | 0.4 (0.2, 1.0) | 0.0451 |
| Rural south western | 0.2 (0.1, 0.4) | 0.0071 |
| Winnipeg | reference | |
| **Period** | | |
| After | 2.6 (1.1, 6.3) | 0.0356 |
| Before | reference | |
| II. Model with test year and its interactions | | |
| **Test Year*Period*Region** | | |
| Test Year-After-Brandon | 1.3 (1.1, 1.5) | 0.0002 |
| Test Year-After-Rural/Northern Other | 1.1 (0.9, 1.3) | 0.262 |
| Test Year-After-Rural south western | 1.2 (1.0, 1.4) | 0.0118 |
| Test Year-After-Winnipeg | reference | |
| Test Year-Before-Brandon | 0.9 (0.7, 1.3) | 0.667 |
| Test Year-Before-Rural/Northern Other | 1.0 (0.8, 1.4) | 0.8555 |
| Test Year-Before-Rural south western | 0.9 (0.6, 1.1) | 0.3089 |
| Test Year-Before-Winnipeg | reference | |
| **Test Year*Period** | | |
| Test Year-After | 0.5 (0.4, 0.6) | <.0001 |
| Test Year-Before | reference | |
| **Region** | | |
| Brandon | 0.4 (0.2, 0.9) | 0.0239 |
| Rural south western | 0.3 (0.1, 0.6) | 0.0018 |
| Rural/Northern Other | 0.4 (0.2, 0.9) | 0.0251 |
| Winnipeg | reference | |
| **Period** | | |
| After | 20.8 (7.3, 59.3) | <.0001 |
| Before | reference | |
| **Test Year** | 2.0 (1.6, 2.5) | <.0001 |

Due to the secular increase in testing rates over time, a second model was evaluated that included all terms from the base model in addition to the main effect of test year (continuous variable) and relevant interaction terms (test year-by-period and test year-by-period-by-region). The inclusion of the two-way and three-way interactions with test year allowed for the modeling of the rate of change in the relative rate ratios for the "before" and "after" time periods. This is referred to as a change point or "broken stick" analysis, which allows for an assessment of change in the rate of increase or decrease over time. (Conceptually, the "stick" is the estimated regression line for the annual rates. If the stick is "broken" then this indicates a change in slope [i.e., inflection] at the point where the population intervention occurred

[e.g., Brandon BMD testing].) A significant test year-period-region interaction was observed; compared to Winnipeg, there was significantly greater growth in testing for Brandon (rate ratio 1.3, 95% CI 1.1-1.5) and rural south western RHAs (1.2, 1.0-1.4) after the introduction of the Brandon testing program. However, there was no significant difference in the rate of change in testing for Winnipeg and non-Winnipeg regions related to the introduction of Brandon BMD testing.

### B.4 Conclusions

- The volume of BMD testing has shown a progressive increase.
- The rate of testing among older women shows regional differences, in part thought to reflect catch-up testing. Regional differences are less striking in the most recent years.
- Testing site strongly relates to the site of the patient's residence.

## Objective C: Regional Patterns of Osteoporosis Treatment

### C.1 Pharmacological Agents for Osteoporosis Prevention and Treatment

The same pharmacological agents are used in the prevention and treatment of osteoporosis, whether the latter is defined on the basis of low-trauma ('fragility') fractures or low bone mass. The list of currently approved agents includes systemic estrogen-containing products, bisphosphonates, selective estrogen receptor modulator (raloxifene is the only available member), and calcitonin. These were used to develop a definition of osteoporosis treatment applicable to the Drug Programs Information Network (DPIN). It should be noted that DPIN does not permit identification of non-prescription products such as calcium or vitamin D. Non-systemic estrogen (e.g., estrogen-containing vaginal suppositories or pessaries) were excluded from the osteoporosis treatment definition since they are not believed to have sufficient systemic bioavailability to be effective treatments for osteoporosis. Although most of these drugs are highly specific for osteoporosis, estrogen is also used for perimenopausal symptoms. Therefore, analysis was stratified by age since estrogen prescribed after age 65 is almost always for osteoporosis.

### C.2 Calculation of Osteoporosis Treatment Rates

Crude osteoporosis treatment rates (1995/96 to 2001/02) were calculated and stratified according to age (age 50-65 inclusive or above age 65) and patient residence (Brandon, Westman RHAs, other rural/northern RHAs and Winnipeg). Treatment rates (per thousand) used the Registry File to determine the number of women registered to Manitoba Health who were age 50 or greater at any time during the reporting year. Prevalent osteoporosis treatment for the reporting year was defined as two or more dispensations of an osteoporosis medication listed above. Each individual receiving preva-

lent osteoporosis treatment was classified into one of the following three non-overlapping groups:

1) Preventive osteoporosis treatment: Osteoporosis treatment without a preceding BMD test (from April 1990 to the date of osteoporosis treatment) or incident fracture (Definition of incident fracture: a medical claim or hospital separation ICD-9-CM diagnosis code 805.xx, 807--829.xx between April 1990 and the date of osteoporosis treatment. This definition excludes craniofacial fractures 800-804.xx and vertebral fractures with cord damage 806.xx since these are usually caused by major trauma such as MVA.);
2) Empiric post-fracture osteoporosis treatment: Osteoporosis treatment after incident fracture (from April 1990 to the date of osteoporosis treatment) but without a preceding BMD test as recorded in the BMD Database; or
3) BMD-guided osteoporosis treatment: Osteoporosis treatment with a previous BMD test at any time after April 1990.

Similar crude osteoporosis treatment rates (1996/97 to 2001/02) were calculated for new osteoporosis treatment defined as an osteoporosis treatment where DPIN does not disclose coverage with any prescription for an osteoporosis treatment class medication during the preceding 12 months. Once again, individuals were classified according to the following three non-overlapping groups:

1) New preventive osteoporosis treatment: Osteoporosis treatment without a preceding BMD test or incident fracture, no coverage with any prescription for an osteoporosis treatment class medication during the preceding 12 months.
2) New empiric post-fracture osteoporosis treatment: Osteoporosis treatment after incident fracture but without a preceding BMD test, no coverage with any prescription for an osteoporosis treatment class medication during the preceding 12 months.
3) New BMD-guided osteoporosis treatment: Osteoporosis treatment with a BMD test in the preceding 12 months, no coverage with any prescription for an osteoporosis treatment class medication during the preceding 12 months.

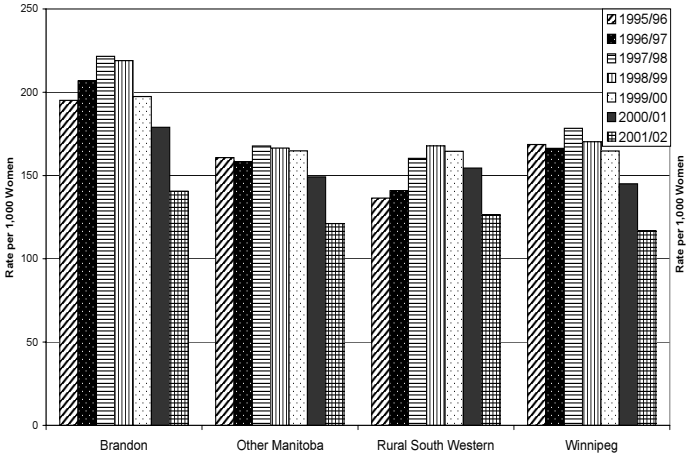
### C.3 Prevalent and New Osteoporosis Treatment Rates

Figure C.1 shows the strong impact of age on osteoporosis treatment. The highest rate of treatment occurs in early menopausal women (those aged 50-65) and is predominantly preventive (i.e., without preceding fracture or BMD test). This is consistent with the wide use of estrogen for symptom control in this group. Preventive treatment is much less common among older menopausal women (those over 65 years of age) but appears to be

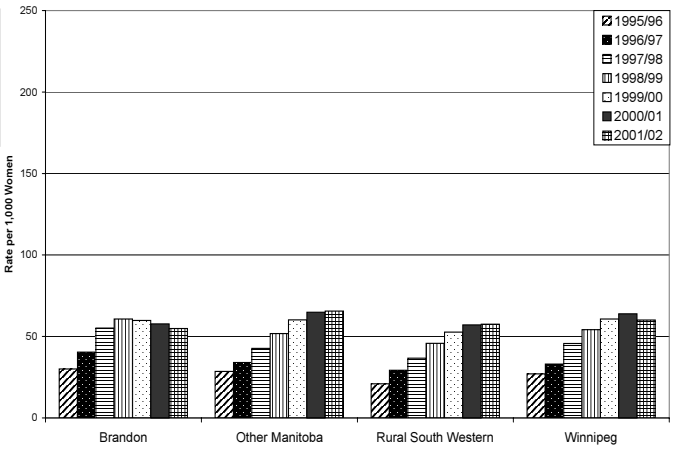
increasing in time for all regions while there is a decreasing trend among women age 50-65 years. This may reflect the recent de-emphasis of the menopause in terms of osteoporosis prevention in favour of targeting older women who are closer to the age at which fractures are likely to occur. The rate of empiric post-fracture osteoporosis treatment (i.e., without preceding BMD) has been constant among early menopausal women but shows a definite increase among women after age 65. The increase in BMD-guided osteoporosis treatment is clearly evident in both younger (age 50 to 65) and older (age 65+) menopausal women. The abrupt increase in the Brandon region in 1999/00 reflects the effect of access and contrasts with the more gradual increase in Winnipeg. The relative distribution of the treatment categories can be seen in Figure C.2. Overall treatment rates have been relatively constant over time in women age 50-65, with the decrease in preventive treatment roughly balancing the increase in BMD-guided treatment. In contrast, overall treatment rates have increased dramatically among women over age 65-this is seen for all treatment categories and regions. BMD-guided treatment makes a larger contribution to the total and now represents the majority treatment category in the Brandon region.

**Figure C.1: Prevalent Osteoporosis Treatment Rate According to Region (crude rate per 1,000)**

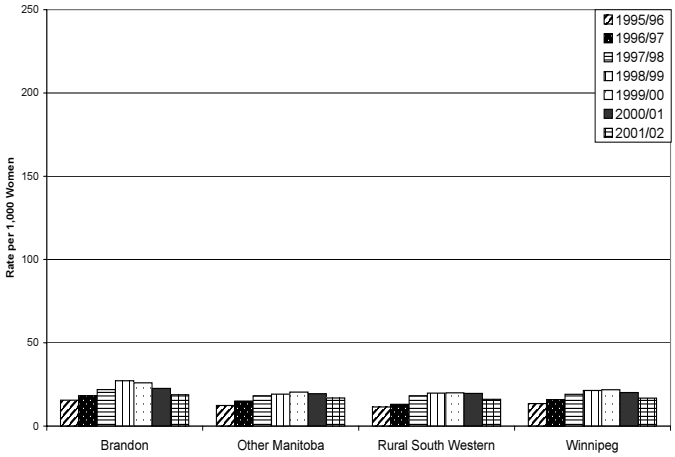
**Prevalent preventive osteoporosis treatment (women age 50-65)**



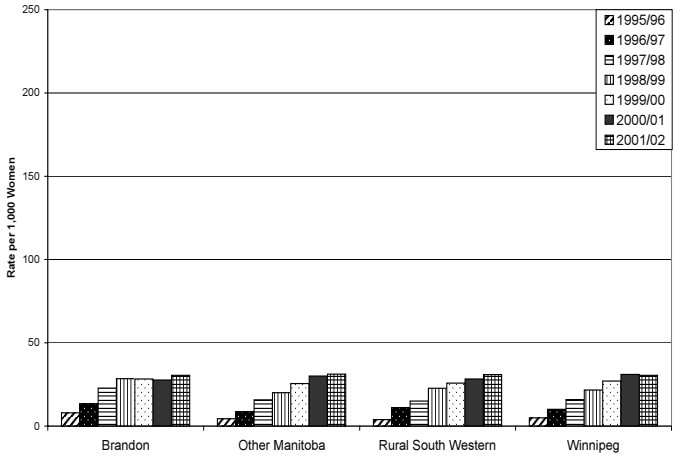

**Prevalent preventive osteoporosis treatment (women over age 65)**



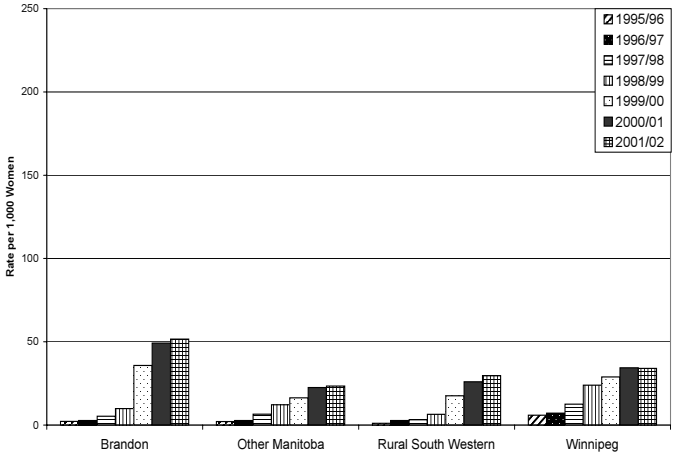

**Prevalent empiric post-fracture osteoporosis treatment (women age 50-65)**




**Prevalent empiric post-fracture osteoporosis treatment (women over age 65)**




**Prevalent BMD-guided osteoporosis treatment (women age 50-65)**




**Prevalent BMD-guided osteoporosis treatment (women over age 65)**

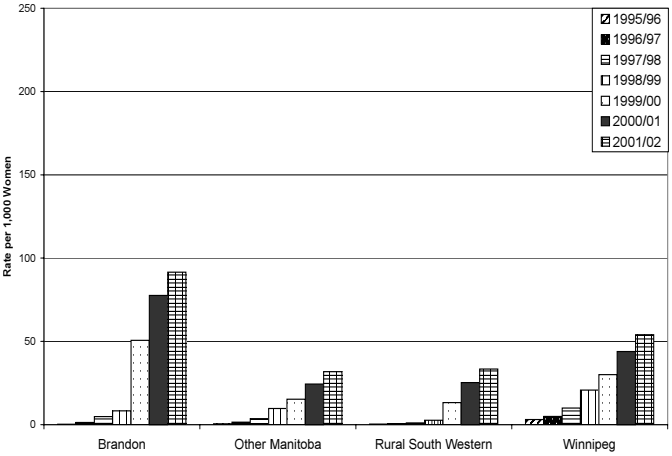
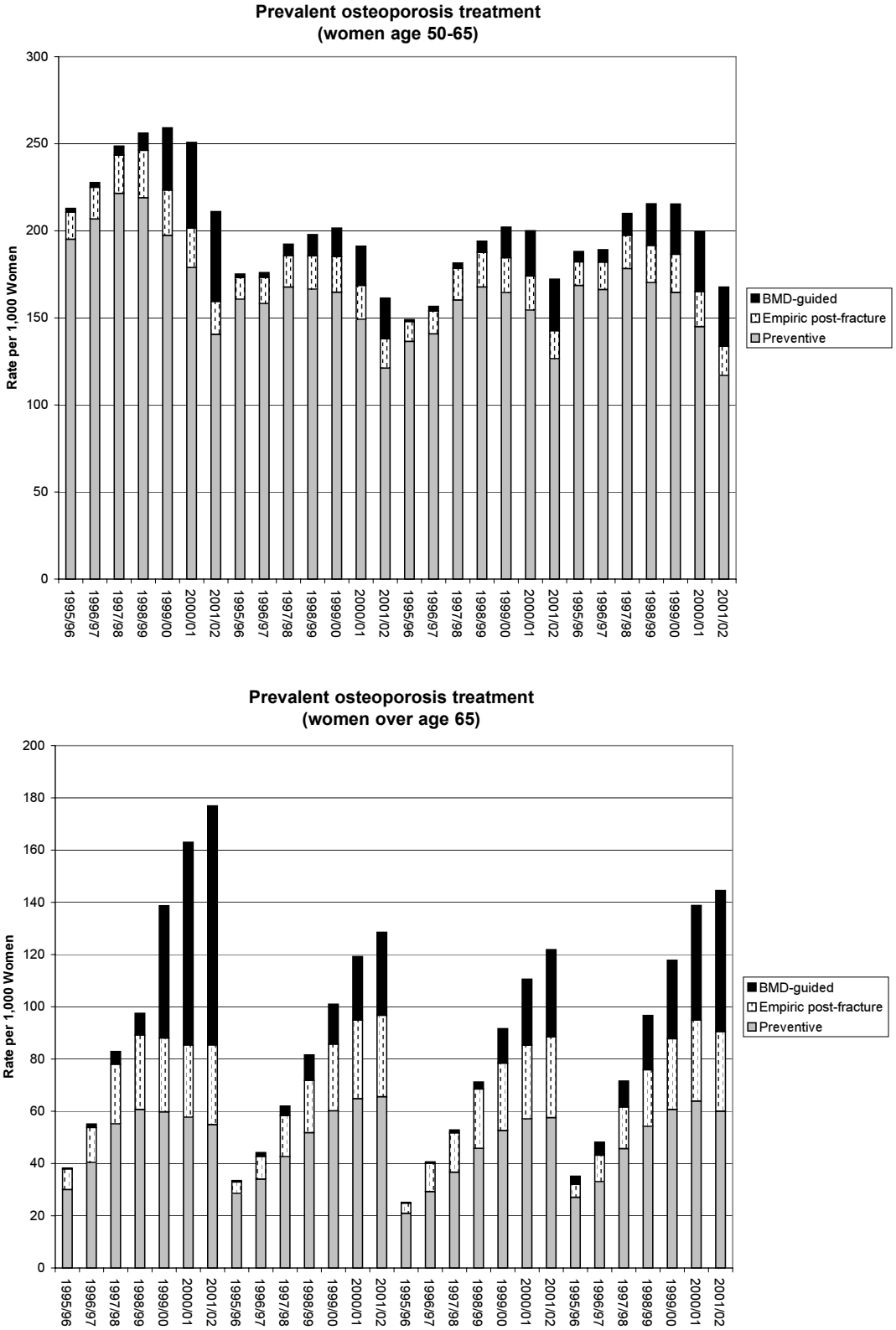


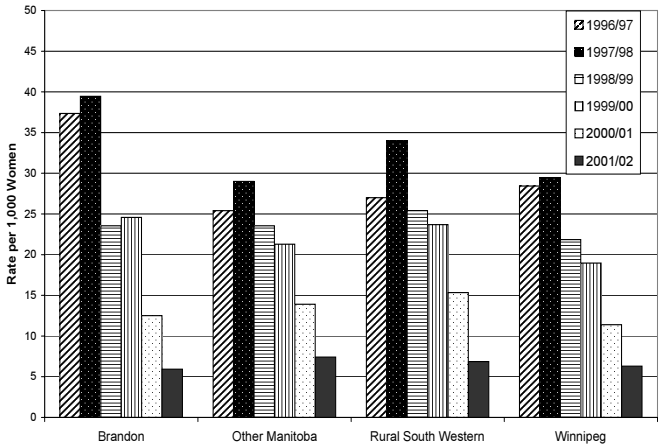
**Figure C.2: Distribution in Category of Prevalent Osteoporosis Treatment**



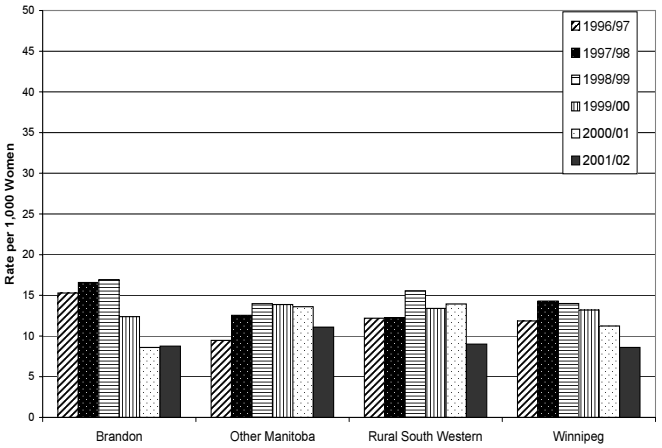
Analysis based on patients initiating osteoporosis treatment (i.e., no osteoporosis treatment class medication during the preceding 12 months) tends to parallel prevalent medication use. Once again, early menopausal women usually start osteoporosis treatment without a recent fracture or BMD test (Figure C.3). These women are much less likely to initiate osteoporosis treatment in recent years, a pattern seen in all regions and beginning in 2000/01. Among older menopausal women, overall osteoporosis treatment initiation rates are relatively stable in most regions except for Brandon where there was an abrupt increase starting in 1999/00 corresponding to the establishment of the local BMD service (Figure C.4). The increase in osteoporosis treatment initiation rates seen in Brandon since 1999/00 is completely explained by more BMD-guided treatment, and since 1999/00 the majority of new osteoporosis dispensations follow a recent BMD measurement (Figure C.4). In the two years since 1999/00 there has been a slight decline in BMD-guided and overall Brandon treatment rates, consistent with the previously noted catch-up phenomenon.

**Figure C.3: New Osteoporosis Treatment Rate According to Region (crude rate per 1,000)**

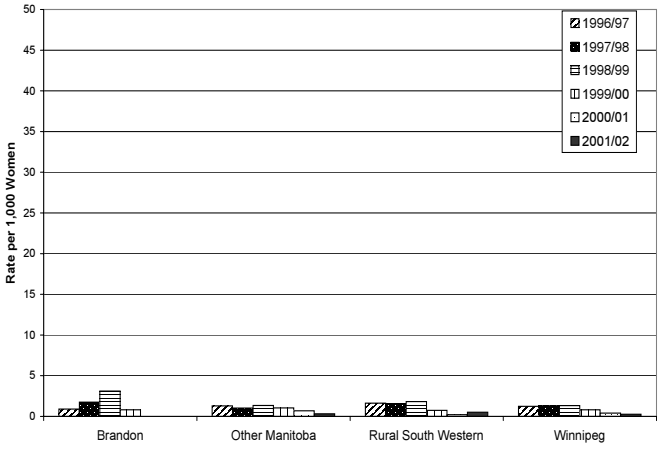
**New preventive osteoporosis treatment (women age 50-65)**



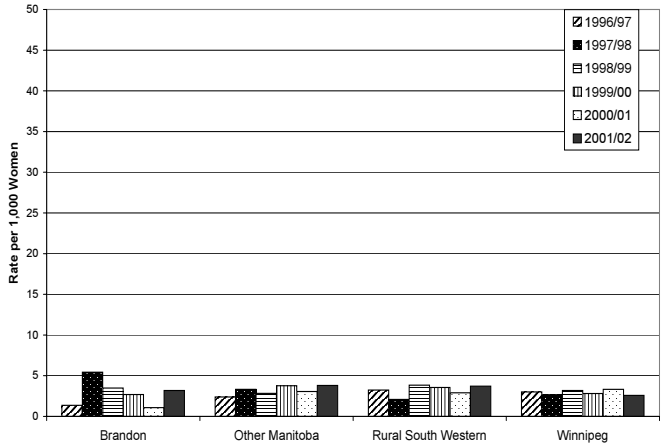

**New preventive osteoporosis treatment (women over age 65)**



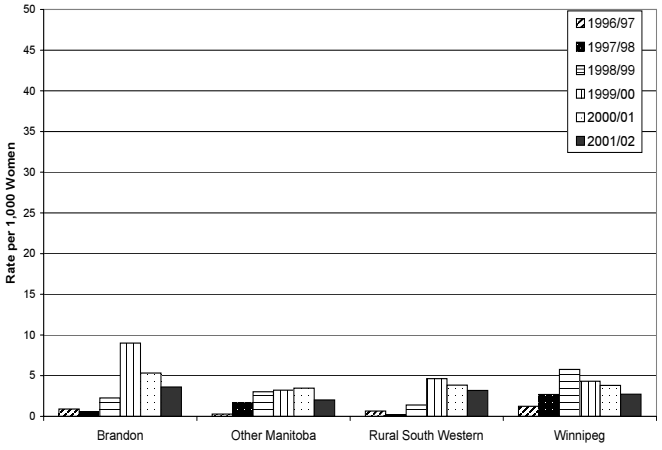

**New empiric post-fracture osteoporosis treatment (women age 50-65)**




**New empiric post-fracture osteoporosis treatment (women over age 65)**




**New BMD-guided osteoporosis treatment (women age 50-65)**




**New BMD-guided osteoporosis treatment (women over age 65)**

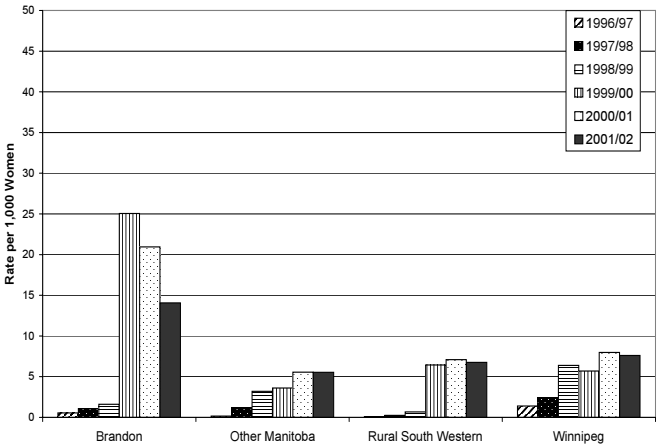
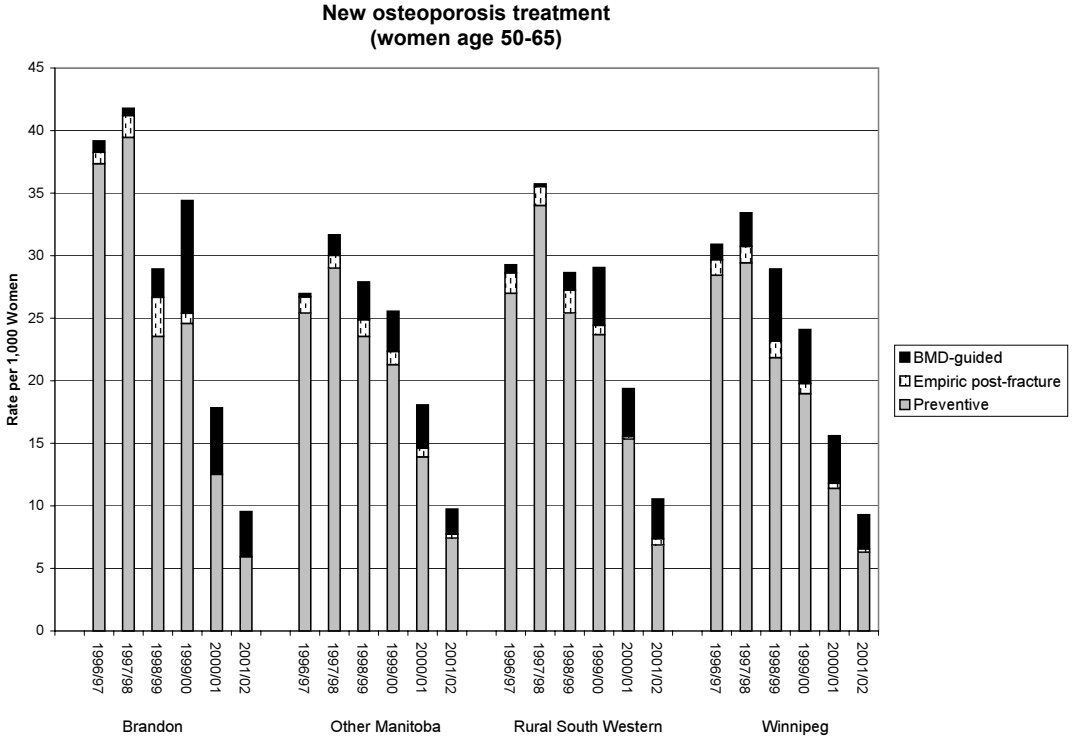


**Figure C.4: Distribution in Category of New Osteoporosis Treatment**



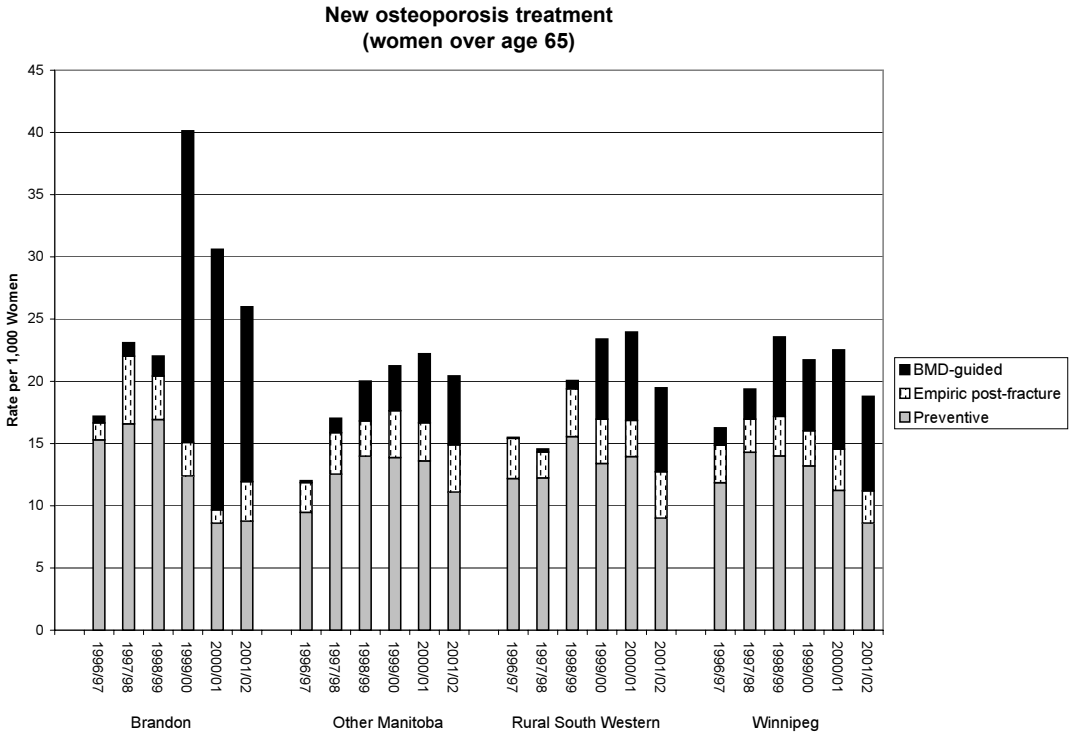



Table C.1 categorizes patients in the BMD-guided treatment group based upon the BMD measurement (minimum of spine or hip) using the conventional WHO diagnostic ranges. Only a minority of women in the early menopausal age range 50-65 years receiving treatment are osteoporotic according to a BMD definition (range 25.1-38.2% for prevalent treatment, 38.7-48.7% for new treatment). This is not surprising since many of these women are likely to be receiving an estrogen-containing product for menopausal symptom relief. In contrast, the majority of women over age 65 years receiving treatment have osteoporotic BMD measurements (range 54.7-74.3% for prevalent treatment, 59.4-84.2% for new treatment). Once again, it is not expected that all treated individuals would have BMD in the osteoporotic range since treatment may also be indicated for individuals with skeletal fragility fractures (independent of BMD), if BMD is reduced but still above the osteoporotic range (when accompanied by additional clinical risk factors or when there is evidence of rapid BMD loss on serial measurements), and in women receiving glucocorticosteroid therapy. Therefore, this analysis should not be used to determine which treatment as inappropriate or unnecessary.

**Table C.1: BMD results in women receiving prevalent or new BMD-guided osteoporosis treatment according to BMD category.** Percent of total is given in parentheses. (WHO diagnostic criteria: normal is T-score above -1, osteopenic range is T-score -1 to -2.5, osteoporotic range is T-score -2.5 or lower.)

| Prevalent Osteoporosis Treatment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Women age 50-65 year | | | | Women over age 65 | | | |
| | Normal | Osteopenic | Osteoporotic | Total | Normal | Osteopenic | Osteoporotic | Total |
| 1995/96 | 52 (15.4) | 157 (46.5) | 129 (38.2) | 338 (100.0) | 10 (5.9) | 38 (22.5) | 121 (71.6) | 169 (100.0) |
| 1996/97 | 77 (17.8) | 203 (46.9) | 153 (35.3) | 433 (100.0) | 13 (4.5) | 61 (21.2) | 214 (74.3) | 288 (100.0) |
| 1997/98 | 150 (18.5) | 402 (49.6) | 258 (31.9) | 810 (100.0) | 40 (6.7) | 182 (30.4) | 377 (62.9) | 599 (100.0) |
| 1998/99 | 355 (22.4) | 771 (48.6) | 459 (29.0) | 1585 (100.0) | 100 (7.7) | 403 (31.1) | 792 (61.2) | 1295 (100.0) |
| 1999/00 | 531 (24.3) | 1038 (47.6) | 613 (28.1) | 2182 (100.0) | 186 (8.7) | 734 (34.2) | 1224 (57.1) | 2144 (100.0) |
| 2000/01 | 736 (26) | 1369 (48.4) | 725 (25.6) | 2830 (100.0) | 296 (9.1) | 1158 (35.5) | 1812 (55.5) | 3266 (100.0) |
| 2001/02 | 826 (27.9) | 1396 (47.1) | 744 (25.1) | 2966 (100.0) | 389 (9.5) | 1460 (35.7) | 2236 (54.7) | 4085 (100.0) |

| New Osteoporosis Treatment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Women age 50-65 year | | | | Women over age 65 | | | |
| | Normal | Osteopenic | Osteoporotic | Total | Normal | Osteopenic | Osteoporotic | Total |
| 1996/97 | 6 (8.1) | 32 (43.2) | 36 (48.7) | 74 (100.0) | 2 (2.6) | 10 (13.2) | 64 (84.2) | 76 (100.0) |
| 1997/98 | 24 (13.9) | 82 (47.4) | 67 (38.7) | 173 (100.0) | 8 (5.3) | 44 (29.1) | 99 (65.6) | 151 (100.0) |
| 1998/99 | 42 (11.0) | 183 (47.9) | 157 (41.1) | 382 (100.0) | 10 (2.5) | 119 (30.0) | 268 (67.5) | 397 (100.0) |
| 1999/00 | 52 (13.9) | 172 (45.9) | 151 (40.3) | 375 (100.0) | 34 (6.5) | 178 (34.1) | 310 (59.4) | 522 (100.0) |
| 2000/01 | 40 (11.5) | 155 (44.7) | 152 (43.8) | 347 (100.0) | 27 (4.0) | 219 (32.6) | 425 (63.3) | 671 (100.0) |
| 2001/02 | 26 (10.5) | 105 (42.5) | 116 (47.0) | 247 (100.0) | 29 (4.6) | 215 (34.4) | 382 (61.0) | 626 (100.0) |

## C.4 Statistical Analysis

Regression analysis of the treatment rates was performed as described in B.2 for BMD testing rates. Again, the predictor variables included: region ("Brandon", "Westman RHAs", "other rural/northern RHAs" and "Winnipeg"), period ("before" or "after" the opening of the Brandon BMD testing service), and a region-by-period interaction term. The estimates of the rate ratios for prevalent osteoporosis treatment are summarized in Table C.2 and for new osteoporosis treatment in Table C.3.

**Table C.2: Regression results: Relative rates of prevalent osteoporosis treatment according to region and period**

| Factor | Age 50-65 | | Age over 65 | |
|---|---|---|---|---|
| | Rate Ratio (95% CI) | P | Rate Ratio (95% CI) | P |
| **Preventive** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 1.0 (0.8, 1.2) | 0.8784 | 0.8 (0.5, 1.2) | 0.3146 |
| After-Rural/Northern Other | 1.1 (0.9, 1.3) | 0.5452 | 1.0 (0.7, 1.6) | 0.8581 |
| After-Rural south western | 1.2 (1.0, 1.5) | 0.1231 | 1.1 (0.7, 1.7) | 0.6738 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 1.2 (1.1, 1.4) | 0.0037 | 1.2 (0.9, 1.5) | 0.2907 |
| Rural/Northern Other | 1.0 (0.8, 1.1) | 0.5329 | 1.0 (0.7, 1.3) | 0.9558 |
| Rural south western | 0.9 (0.8, 1.0) | 0.0893 | 0.8 (0.6, 1.1) | 0.1821 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 0.8 (0.7, 1.0) | 0.0234 | 1.6 (1.2, 2.2) | 0.0026 |
| Before | reference | | reference | |
| **Empiric post-fracture** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 1.0 (0.7, 1.4) | 0.8559 | 0.7 (0.3, 1.7) | 0.4368 |
| After-Rural/Northern Other | 1.0 (0.7, 1.5) | 0.8134 | 1.1 (0.4, 2.7) | 0.8841 |
| After-Rural south western | 1.1 (0.8, 1.5) | 0.7038 | 1.0 (0.4, 2.5) | 0.9939 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 1.2 (0.9, 1.5) | 0.1521 | 1.4 (0.8, 2.6) | 0.2659 |
| Rural/Northern Other | 0.9 (0.7, 1.2) | 0.5182 | 0.9 (0.5, 1.7) | 0.7681 |
| Rural south western | 0.9 (0.7, 1.1) | 0.299 | 1.0 (0.5, 1.8) | 0.8805 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 1.1 (0.9, 1.5) | 0.3147 | 2.6 (1.3, 4.9) | 0.0048 |
| Before | reference | | reference | |
| **BMD-guided** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 3.5 (1.3, 9.7) | 0.0152 | 6.5 (1.2, 34.4) | 0.0267 |
| After-Rural/Northern Other | 1.5 (0.5, 4) | 0.4666 | 1.8 (0.3, 9.5) | 0.4877 |
| After-Rural south western | 2.8 (1.0, 7.8) | 0.0466 | 4.9 (0.9, 25.7) | 0.0611 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 0.4 (0.2, 0.8) | 0.0062 | 0.3 (0.1, 0.8) | 0.0158 |
| Rural/Northern Other | 0.4 (0.2, 0.8) | 0.0142 | 0.3 (0.1, 0.9) | 0.0325 |
| Rural south western | 0.3 (0.1, 0.5) | <.0001 | 0.1 (0, 0.3) | <.0001 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 3.0 (1.5, 6.2) | 0.0024 | 5.5 (1.7, 17.8) | 0.0044 |
| Before | reference | | reference | |

**Table C.3: Regression results: Relative rates of new osteoporosis treatment rates according to region and period**

| Factor | Age 50-65 | | Age over 65 | |
|---|---|---|---|---|
| | Rate Ratio (95% CI) | P | Rate Ratio (95% CI) | P |
| **Preventive** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 1.2 (0.7, 2.2) | 0.4776 | 0.7 (0.5, 1) | 0.0621 |
| After-Rural/Northern Other | 1.0 (0.5, 1.8) | 0.9535 | 1.3 (1.0, 1.8) | 0.0797 |
| After-Rural south western | 1.1 (0.6, 2) | 0.787 | 1.1 (0.8, 1.5) | 0.5377 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 0.9 (0.4, 2.1) | 0.7858 | 1.2 (1, 1.5) | 0.0847 |
| Rural/Northern Other | 1.2 (0.5, 2.7) | 0.6767 | 0.9 (0.7, 1.1) | 0.2986 |
| Rural south western | 1.1 (0.5, 2.6) | 0.7764 | 1.0 (0.8, 1.2) | 0.9464 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 0.4 (0.2, 0.8) | 0.004 | 0.8 (0.6, 1.0) | 0.0713 |
| Before | reference | | reference | |
| **Empiric post-fracture** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 1.4 (0.5, 3.9) | 0.534 | 0.7 (0.4, 1.4) | 0.3315 |
| After-Rural/Northern Other | 1.5 (0.6, 3.4) | 0.3747 | 1.3 (0.7, 2.5) | 0.481 |
| After-Rural south western | 0.7 (0.3, 1.7) | 0.4958 | 1.2 (0.6, 2.3) | 0.6555 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 1.3 (0.7, 2.4) | 0.3539 | 1.0 (0.6, 1.6) | 0.9827 |
| Rural/Northern Other | 0.9 (0.5, 1.7) | 0.8312 | 1.0 (0.6, 1.5) | 0.8669 |
| Rural south western | 1.3 (0.7, 2.3) | 0.4109 | 1.0 (0.6, 1.6) | 0.9851 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 0.3 (0.2, 0.6) | 0.0005 | 1.0 (0.6, 1.6) | 0.9423 |
| Before | reference | | reference | |
| **BMD-guided** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 3.9 (1.1, 14.3) | 0.0368 | 7.8 (2.0, 31.3) | 0.0036 |
| After-Rural/Northern Other | 1.9 (0.5, 6.9) | 0.3239 | 2.3 (0.6, 9.1) | 0.2465 |
| After-Rural south western | 5.0 (1.4, 18.0) | 0.0149 | 11.2 (2.8, 44.7) | 0.0006 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 0.4 (0.2, 1.0) | 0.0472 | 0.4 (0.1, 0.9) | 0.0376 |
| Rural/Northern Other | 0.4 (0.2, 1.0) | 0.0586 | 0.3 (0.1, 0.8) | 0.0166 |
| Rural south western | 0.2 (0.1, 0.5) | 0.001 | 0.1 (0.0, 0.2) | <.0001 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 1.3 (0.5, 3.3) | 0.542 | 2.5 (0.9, 6.7) | 0.0644 |
| Before | reference | | reference | |

After the opening of the Brandon BMD testing service, there were significantly lower rates of prevalent (rate ratio 0.8, 95% CI 0.7-1.0) and new preventive treatment (0.4, 0.2-0.8) in early menopausal women (age range 50-65 years) but higher prevalent treatment rates after age 65 years (1.6, 1.2-2.2). Prevalent empiric post-fracture treatment rates are stable in the younger group but there is a significant decrease in new empiric treatment (0.3, 0.2-0.6); older women show a significant increase in prevalent treat-

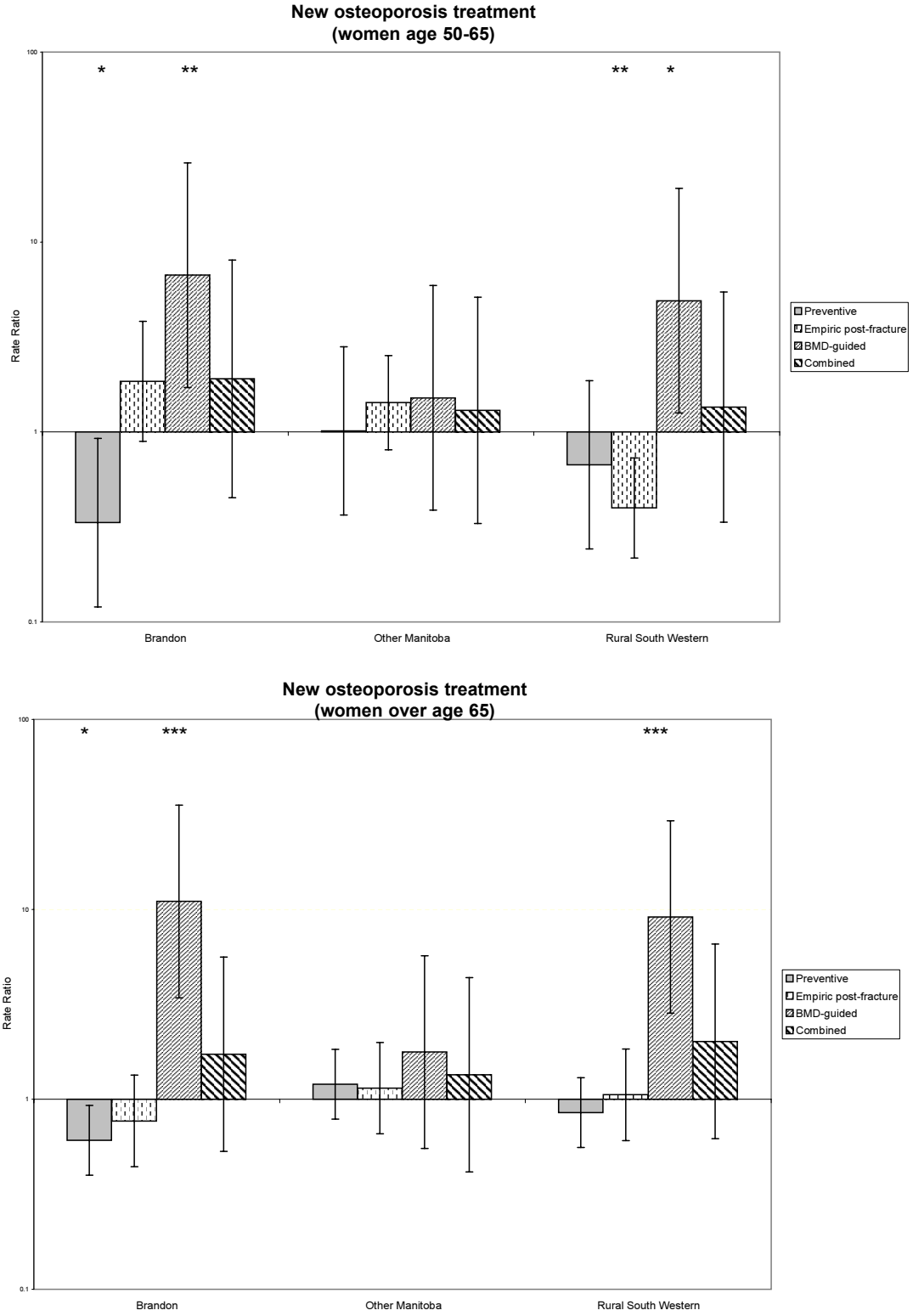
ment (2.6, 1.3-4.9) but stable rates of new empiric treatment. Importantly, no region-period interaction is seen with respect to either preventive or empirical post-fracture treatment. This contrasts with BMD-guided therapy which clearly shows a region-period interaction for both prevalent osteoporosis treatment; rates are higher in the "after" period for Brandon (rate ratios 3.5 [95% CI 1.3-9.7] for age 50-65 years and 6.5 [1.2-34.4] over age 65) and rural south western RHAs (2.8 [1.0-7.8] for age 50-65 years and 4.9 [0.9-25.7] over age 65). A similar interaction is seen for new BMD-guided osteoporosis treatment for Brandon (3.9 [1.1-14.3] for age 50-65 years and 7.8 [2.0-31.3] over age 65) and rural south western RHAs (5.0 [1.4-18.0] for age 50-65 years and 11.2 [2.8-44.7] over age 65). In comparison, the other rural/northern RHAs do not show any evidence of a significant change in BMD-guided treatment that can be related to the Brandon BMD testing service. Finally, overall osteoporosis treatment rates (e.g., combined preventive, empiric post-fracture, and BMD-guided) were modeled. There was no evidence of a region-period interaction with respect to prevalent or new osteoporosis treatment for either age range.

A supplementary regression analysis was performed to look at the rate of new osteoporosis therapy after excluding all estrogen hormonal preparations. The remaining agents (bisphosphonates, raloxifene, and calcitonin) are highly specific for osteoporosis prevention or treatment. None of these agents are effective for treatment of perimenopausal symptoms. The rate ratios given in Table C.4 again show a strong region-period interaction for BMD-guided therapy (higher in the "after" period for Brandon with rate ratios 6.7 [95% CI 1.8-26.1] for age 50-65 years and 11.0 [3.4-35.4] over age 65, rural south western RHAs 4.9 [1.3-19.1] for age 50-65 years and 9.1 [2.8-29.3] over age 65). A significant reduction in preventive treatment was seen in Brandon for both age groups (rate ratios 0.3 [0.1-0.9] for age 50-65 years and 0.6 [0.4-0.9] over age 65), and there was a significant reduction in empiric post-fracture treatment rates in the Westman RHAs for age 50-65 years (0.4 [0.2-0.7]) (Figure C.5). Once again, overall osteoporosis treatment rates (e.g., combined preventive, empiric post-fracture, and BMD-guided) showed no evidence of a region-period interaction for prevalent or new osteoporosis treatment in either age range. This suggests that improved access to BMD does not significantly increase overall osteoporosis drug utilization or related costs. If anything, a shift in prescribing habits from preventive/empiric to BMD-guided would be expected to translate into better targeting of women capable of benefiting from treatment and, ultimately, improved cost-effectiveness.

**Table C.4: Regression results: Relative rates of new non-hormonal osteoporosis treatment rates according to region and period**

| Factor | Age 50-65 | | Age over 65 | |
|---|---|---|---|---|
| | Rate Ratio (95% CI) | P | Rate Ratio (95% CI) | P |
| **Preventive** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 0.3 (0.1, 0.9) | 0.0347 | 0.6 (0.4, 0.9) | 0.0213 |
| After-Rural/Northern Other | 1.0 (0.4, 2.8) | 0.9775 | 1.2 (0.8, 1.8) | 0.3952 |
| After-Rural south western | 0.7 (0.2, 1.9) | 0.4445 | 0.9 (0.6, 1.3) | 0.4593 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 1.5 (0.7, 3.0) | 0.3055 | 1.4 (1, 1.9) | 0.023 |
| Rural/Northern Other | 0.8 (0.4, 1.6) | 0.4884 | 0.9 (0.6, 1.2) | 0.3432 |
| Rural south western | 1.4 (0.7, 2.8) | 0.3771 | 1.1 (0.8, 1.5) | 0.4539 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 1.8 (0.9, 3.6) | 0.1242 | 1.2 (0.9, 1.6) | 0.2415 |
| Before | reference | | reference | |
| **Empiric post-fracture** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 1.8 (0.9, 3.8) | 0.0987 | 0.8 (0.4, 1.3) | 0.3529 |
| After-Rural/Northern Other | 1.4 (0.8, 2.5) | 0.2222 | 1.1 (0.7, 2) | 0.6326 |
| After-Rural south western | 0.4 (0.2, 0.7) | 0.0028 | 1.1 (0.6, 1.8) | 0.8432 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 1.3 (0.9, 2.1) | 0.1965 | 1.0 (0.7, 1.5) | 0.8196 |
| Rural/Northern Other | 0.6 (0.4, 0.9) | 0.0072 | 1.0 (0.7, 1.5) | 0.903 |
| Rural south western | 1.9 (1.3, 2.9) | 0.0013 | 1.1 (0.7, 1.6) | 0.6028 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 1.1 (0.7, 1.6) | 0.7424 | 1.2 (0.8, 1.7) | 0.4821 |
| Before | reference | | reference | |
| **BMD-guided** | | | | |
| **Period*Region** | | | | |
| After-Brandon | 6.7 (1.7, 26.1) | 0.0062 | 11.0 (3.4, 35.4) | <.0001 |
| After-Rural/Northern Other | 1.5 (0.4, 5.9) | 0.5515 | 1.8 (0.6, 5.7) | 0.3355 |
| After-Rural south western | 4.9 (1.3, 19.1) | 0.022 | 9.1 (2.8, 29.3) | 0.0002 |
| After-Winnipeg | reference | | reference | |
| **Region** | | | | |
| Brandon | 0.3 (0.1, 0.7) | 0.0091 | 0.3 (0.1, 0.6) | 0.0014 |
| Rural Other | 0.5 (0.2, 1.4) | 0.1906 | 0.4 (0.2, 0.9) | 0.0259 |
| Rural south western | 0.2 (0.1, 0.5) | 0.0012 | 0.1 (0.0, 0.2) | <.0001 |
| Winnipeg | reference | | reference | |
| **Period** | | | | |
| After | 2.0 (0.8, 5.2) | 0.166 | 2.6 (1.2, 6) | 0.0219 |
| Before | reference | | reference | |

**Figure C.5: Relative Rate for New Non-Hormonal Osteoporosis Treatment in the Period After Establishing the Brandon Bone Density Testing Service.** Values greater than one indicate greater treatment rates whereas values less than one indicate lower treatment rates. Winnipeg is the reference region. 95% confidence limits are shown. * P<0.05, ** P<0.01, *** P<0.0001.



## C.5 Conclusions

- Overall osteoporosis treatment rates have been relatively stable in early menopausal women (1995-2002) but have shown a large increase among older women, a pattern seen across all regions.
- The highest rate of treatment occurs in early menopausal women (age 50-65) and is predominantly preventive (i.e., without preceding fracture or BMD test). In those who have had BMD testing, only a minority have BMD results in the osteoporotic category.
- Older menopausal women (over age 65) are more likely to have treatment initiated following fracture or a BMD test. In those who have had BMD testing, a majority have BMD results in the osteoporotic category.
- Local availability of BMD testing greatly increases the likelihood that osteoporosis will be BMD-guided. The majority of the osteoporosis treatment prescribed in older menopausal women from the Brandon region was BMD-guided.
- There was no evidence that the introduction of local BMD testing led to an decrease in overall or preventive/empiric osteoporosis treatment rates (through a shift in practice pattern) or an increase in overall or preventive/empiric osteoporosis treatment rates (through non-specific sensitization).
- Local availability of BMD testing was associated with a reduction in the use of newer non-hormonal agents in some subgroups, and had a neutral effect on overall use of these agents.

## Summary

We have found that the Physician Services Claims database severely underestimates bone densitometry physician services in Manitoba. Research questions related to bone densitometry must therefore have access to additional data sources, such as the provincial BMD Database. The latter has been shown to be highly complete and accurate in a random chart audit and matching of personal identifier information. The BMD Database also includes test-related information that could be useful in outcomes assessment (e.g., fractures) or assessing patterns of care (e.g., medication prescribing). The use of clinical datasets, such as the BMD Database, can be seen to complement existing administrative data sources, and their combination creates rich opportunities for research that can not be achieved with either source alone. For example, we have been able to explore changes in BMD testing and osteoporosis treatment following introduction of the Brandon bone densitometer. The findings are consistent with an increase in BMD-guided treatment and a decrease in the use of newer non-hormonal osteoporosis agents for preventive/empiric treatment in some subgroups. Importantly, the introduction of BMD testing was not associated with a significant change in overall osteoporosis medication prescribing for any group. This would be expected to translate into more cost-effective targeting of treatment, particularly for newer, more expensive agents. Having established the feasibility and utility of using the Manitoba BMD Database to answer relevant research questions, further applications are envisaged.

# APPENDIX D.3: REPEAT CORONARY ANGIOGRAPHY AND REVASCULARIZATION PROCEDURES FOLLOWING INITIAL PERCUTANEOUS CORONARY INTERVENTION AND CORONARY ARTERY BYPASS SURGERY

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## Background

Percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) are commonly performed in patients with obstructive coronary artery disease (CAD) to relieve ischemic symptoms and potentially to improve prognosis. However, CAD often remains a problem as atherosclerosis usually is progressive. In addition, PCI specifically is associated with a higher risk of recurrent symptoms and ischemia in the first year due to restenosis in up to 20% resulting in repeat target vessel revascularization. Restenosis can often be treated with repeat PCI but at times requires CABG. Conversely, ischemic events following CABG are initially less common but increase over the years due to bypass conduit occlusion, especially with saphenous vein grafts (SVG). The rate of SVG failure is 8% at 1 year, 38% at 5 years and 75% at 10 years. Repeat revascularization is required in about 4% of patients at 5 years, 19% at 10 years. The left internal mammary artery has 10 year patency rates of 95%. Revascularization following CABG with PCI or less commonly with repeat CABG is sometimes needed. In addition, patients treated with either procedure are at risk of recurrent ischemic events due to progression of atherosclerosis in their native vessels.

In Manitoba, invasive cardiac procedures are only performed at the two tertiary teaching hospitals, Health Sciences Centre and St. Boniface General Hospital. The first PCI was performed in Manitoba in 1982. Early PCI involved balloon angioplasty with relatively high rates of acute thrombotic complications (requiring emergency CABG in up to 7%) and later clinical restenosis of up to 30% (typically occurring 3-9 months post-procedure). In recent years, the majority of PCI procedures use intracoronary stents (up to 90% of cases) with the virtual elimination of the need for emergency CABG (<1%). Stent use with PCI became particularly frequent since 1995, the year that the corresponding ICD-9-CM procedure code was established. Stent use became frequent as the combination of ASA and a thienopyridine replaced the inferior and more complicated regimen of heparin and coumadin in the mid 1990's. In addition, the frequency of revascularization particularly with PCI has been steadily climbing with patients having more complex coronary anatomy and comorbidity undergoing invasive procedures with subsequent revascularization.

The chance of repeat coronary angiography and subsequent revascularization following initial revascularization with PCI or CABG is not described for large populations over long-term follow-up. An individual may remain free of further ischemia or undergo repeat coronary angiography with possible repeat revascularization with PCI or CABG. The frequency of repeat procedures is important as it represents a significant clinical and economic problem.

Guidelines for coronary angiography following PCI and CABG have been developed by the American Heart Association and the American College of Cardiology. A low threshold for coronary angiography in patients following PCI and CABG is recommended in patients with recurrent ischemic symptoms to determine the need and suitability for repeat coronary revascularization. There are no equivalent Canadian recommendations or data known on the rate of repeat coronary angiography or intervention.

Many factors influence referral for coronary angiography. Clinical acuity, age, sex, comorbidity, geography, and physician specialty all could affect the rates of referral in patients following an initial revascularization procedure. As a result significant differences may exist in the treatment of similar patients depending on these clinical and demographic factors. These factors could change over time.

The abstraction of procedure codes related to coronary angiography, PCI and CABG in the hospital separation file is likely to be highly accurate since these are major hospital procedures. Medical claims for coronary angiography and PCI are generated by cardiologists (procedural claims) and radiologists (interpretation codes). Both data sources could theoretically be used but their respective completeness and accuracy is uncertain. For example, if an angiogram is followed by angioplasty (with or without stent insertion) at the same sitting (so-called ad hoc angioplasty) then this will generate separate cardiologist billings for the two procedures but may generate one or two radiologist interpretation claims. Ad hoc angioplasty now makes up the majority of such procedures. Conversely, a planned PCI usually does not require a repeat diagnostic angiogram and may generate one or more radiologist interpretation claims. Different practice patterns and billing styles may exist at Health Sciences Centre and St. Boniface General Hospital. Thus, it is difficult to predict the relative completeness of the two sources of claims data. Ultimately, we concluded it is instructive for the three sources of administrative data to be cross-validated against one another. A cross-walk of the relevant codes is presented in the Table 1.

**Table 1: Procedure crosswalk for cardiology**

| Cardiology/Surgery Tariff | Radiology Tariff | ICD-9-CM Procedure |
|---|---|---|
| Coronary angiogram:<br>2307 Selective coronary artery arteriogram<br>2308 and left heart cath<br>2325 and right heart cath<br>2327 and both left and right heart cath | 7175* Selective coronary angiogram<br>7176* with left or right heart cath | 88.55 CORONAR ARTERIOGR-1 CATH<br>88.56 CORONAR ARTERIOGR-2 CATH<br>88.57 CORONARY ARTERIOGRAM NEC |
| PCI revascularization:<br>6267 PTCA single coronary artery<br>6268 two coronary arteries<br>6270 three coronary arteries | None (except 7175-6 as above) | 36.01 PTCA-1 VES/ATH W/O AGENT<br>36.02 PTCA-1 VES/ATH W AGENT<br>36.05 PTCA-MULTIPLE VESSEL/ATH<br>(36.0 before 1986) |
| 6278* Insertion of stent single coronary art<br>6279* two coronary arteries<br>6280* three coronary arteries | None (except 7175-6 as above) | 36.06 INSERT OF COR ART STENT |
| CABG revascularization:<br>2407 Coronary bypass graft, single<br>2409 two<br>2411 three<br>2413 four<br>2415 five<br>2417 six or more<br>2456** Repeat open heart procedure | None | 36.1x HEART REVASC BYPASS ANAS |

* 6278, 6279 or 6280 always accompanied by 6267, 6268 or 6270.
** 2456 is used to exclude repeat CABG patients from the inception cohort.

## Objectives

1) To compare the completeness of physicians claims data on coronary angiography and PCI for cardiologists and radiologists with the hospital separation file ICD-9-CM procedure codes.

2) To determine the rate of patients having had initial coronary angiography, PCI or CABG after 1987/88 (inception cohort).

3) To determine the rate and timing of repeat coronary angiography and repeat revascularization with PCI or CABG following initial revascularization with PCI or CABG for the inception cohort.

## Data Sources

Physician Services Claims file (1984/85-2001/02): To identify selective coronary angiography, PCI (percutaneous transluminal balloon angioplasty with or without stenting), and coronary artery bypass graft surgery (CABG).

Hospital Separation file (1984/85-2001/02): To identify coronary angiography procedures and cardiac revascularization procedures (CABG or PCI). Although procedures were identified from the hospital separation file, it should be noted that this does not necessarily indicate that they are performed as an inpatient procedure. Most of these procedures are now per-

formed on outpatients as a day procedure. Angiography and PCI are done on outpatients, but it reads as though all patients are 'hospitalized' for these. (The identification of invasive cardiac procedures will be limited to Health Sciences Centre and St. Boniface General Hospital since these are the only facilities where these are actually performed, though community hospitals sometimes include the procedure code in the discharge abstract if an inpatient has been transferred to HSC/SBGH for the procedure. The timing of repeat procedures will be categorized as occurring within the first 30 days of the initial procedure (usually reflecting an acute thrombotic complication), between 30 days and one year (usually reflecting restenosis post PCI or early graft occlusion) or after the first year (usually reflecting progression in native vessel atherosclerosis or later vein graft occlusion). The date of initial revascularization was defined at the date of initial PCI or CABG.

Registry file (1984/85-2001/02): To determine RHA of residence, age and sex.

## Population

All Manitoba Health registrants age 18 or older (as of the first day or during the reporting year) who are long-term Manitoba residents (ie., present continuously in the Registry File from 1984/85 until the present unless deleted due to death). Rates will be derived for the whole population and stratified for geographic region and time following initial revascularization (<30 days, 30 days to one year, and >1 year). Age- and sex-adjusted rates will be presented.

## Data Definitions (see Table 1)

**Coronary Angiogram:**

Medical claims-based (procedural):
Tariff codes 2307, 2308, 2325, or 2327.
Medical claims-based (interpretation):
Tariff codes 7175 or 7176.
Hospital separation-based:
ICD-9-CM procedure codes 88.55, 88.56, or 88.57.

**Revascularization Procedure:**

Medical claims-based:
PCI: Tariff codes 6267, 6268 or 6270 (excludes 6278, 6279 or 6280 since always accompanied by preceding code).
CABG: Tariff codes 2407, 2409, 2411, 2413, 2415, or 2417 (excludes 2406 and 2321 since always accompanied by preceding code).
To avoid double counting of procedures where multiple tariff codes were submitted by a physician (or possibly even a surgical assistant), all related claims for the same patient with the same service date were counted as one procedure.

**Hospital Separation-Based:**

PCI: ICD-9-CM procedure codes 36.01, 36.02, 36.05 or 36.06 (36.0 before 1986). (No attempt will be made to distinguish PCI without stent insertion from PCI with stent insertion.)
CABG: ICD-9-CM procedure code 36.1x. (No attempt will be made to distinguish CABG without an arterial conduit from CABG with an arterial conduit.)

**Initial Revascularization:**

No record of previous PCI or CABG prior to 1987/88 in medicals claims or hospital separation files. Operationally, 1984/85 will be used as the horizon for looking for previous CABG or PCI. Individuals whose first CABG tariff code includes 2456 will also be considered to be a "re-do" and excluded from the inception cohort.

**RHA Residence:**

Based upon forward sortation address (FSA) for address recorded in the registry file and assigned to one of two categories: Winnipeg RHA and non-Winnipeg RHAs.

**Concordance (%):**

100% x (count when both data sources agree) / (count from either data source)

**Rates:**

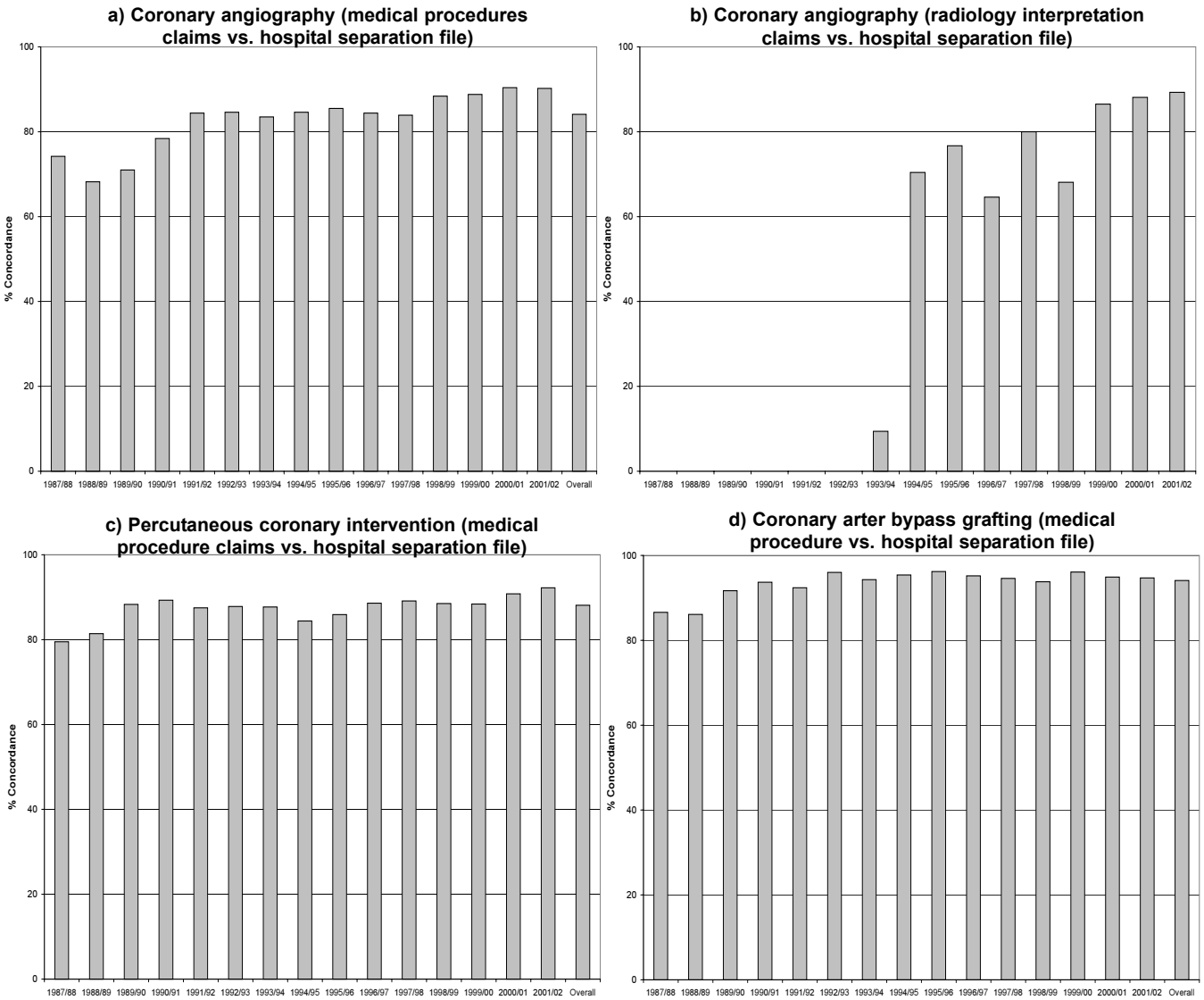
Annual Manitoba cardiac procedure rates (per 1,000) were population-based and derived from hospital separation data. Overall rates were age- and gender-adjusted (gender-stratified rates were age-adjusted only). Rates for repeat cardiac procedures were expressed as the fraction of those individuals undergoing initial revascularization who subsequently under went a repeat procedure. Repeat procedure rates were not adjusted for age, gender, or death.

## Results

### 1. Completeness of Physician Claims Data

The completeness of physician claims data for coronary angiography and PCI for cardiologists and radiologists was compared with the hospital separation file ICD-9-CM procedure codes for procedures that occurred from 1987/88 until 2001/02 (Figure 1). For comparative purposes it was assumed that the hospital procedure codes most closely reflects the true number of procedures. Independent validation of this number would require manual chart review of tens of thousands of procedures which is well beyond the scope of this deliverable.

**Figure 1. Concordance Between Administrative Data Sources of Cardiac Procedures**




### *Coronary Angiography*

Overall, a fair concordance of 82.9% for coronary angiography was found between medical procedural claims and hospital separation data. Slightly more medical procedural claims than hospital procedures were noted. The concordance was less than 75% for 1987-1990 despite a relatively low rate of angiography during those years. Over 88% concordance was noted from 1999-2002. The discordance between the data sets appeared nearly balanced (ie. approximately equal numbers of procedures appearing in only medical claims or only hospitalization files).

Poor overall concordance (54.2%) was found between radiology interpretation claims and hospital separation data with far fewer radiology interpretation claims. No interpretation codes were noted during the first 6 years from 1987-1993. Further investigation revealed that prior to 1994 radiologists

were reimbursed through hospitals using 'batch billing' and did not submit fee-for-service claims. Over 85% concordance was noted from 1999-2002. The hospital procedures appear to be much more complete. Therefore, the radiology interpretation claims are unsuitable for identifying patients undergoing coronary angiography over the time course of the deliverable. Even if restricted to later years, a reduction in concordance would be found if a planned angioplasty results in a radiology interpretation of both angiography and angioplasty procedures.

### *Percutaneous Intervention (PCI)*

A fair to good overall concordance (88.1%) for PCI was found between medical procedural claims and hospital separation data. Slightly more medical procedural claims than hospital procedures were noted. Prior to 1992 medical procedural claims appear to be more complete, but after 1992 hospital procedural claims are probably more complete. A marked increase in PCI occurred over time.

### *Coronary Artery Bypass Grafting (CABG)*

A good overall concordance of 94.7% for CABG was found between medical procedural claims and hospital separation data. Again, more medical procedural claims than hospital procedures were noted. Concordance was constant over time.

### *Implications*

There is only a fair to good agreement between the two data sources with the hospital separation data probably more reflective of the true numbers. The reasons for the discrepancies are not obvious. Errors in actual claims submissions and their processing are potential factors. Hospital separation data may also potentially introduce error especially if repeat procedures were performed during the same hospitalization. An attempt at cross validation with the HSC and SBGH catheterization lab databases for the inception cohort was attempted to help resolve the issue but also became problematic, possibly reflecting an inability to accurately classify patients as residents of Manitoba during the period analyzed.

Concordance for these procedures ideally should be well over 90% to ensure that an accurate understanding of these clinically and fiscally important procedures. Prospective evaluation of the methods used to define and tabulate these procedures would help to resolve many of these differences.

## 2. Rates of Cardiac Procedures

### *Coronary Angiography*

The age- and sex-adjusted rates of coronary angiography defined from the hospital separation file were determined for the overall Manitoba population and for specific regions. In 1987/88 the rate was 1.27 per 1000 reaching a

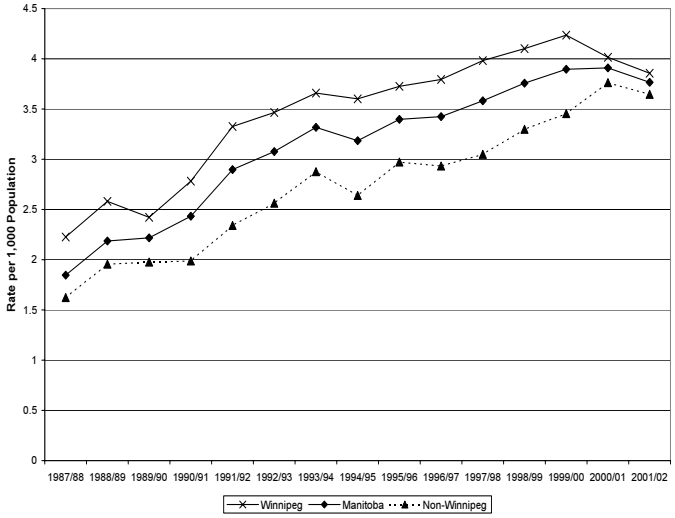
peak of 3.90 per 1000 in 2000/01. It fell slightly to 3.76 per 1000 in 2001/02. Residents of Winnipeg were more likely to undergo coronary angiography than non-Winnipeg residents until 1999 (Figure 2), with the last two years of data show virtually identical rates. The rates of coronary angiography were higher for men than for women across all age groups. Coronary angiography rates have increased dramatically in older men and women, but have been relatively stable prior to age 55. The relative increase is greatest in older men and women (after age 75).

### *Initial Percutaneous Intervention (PCI)*

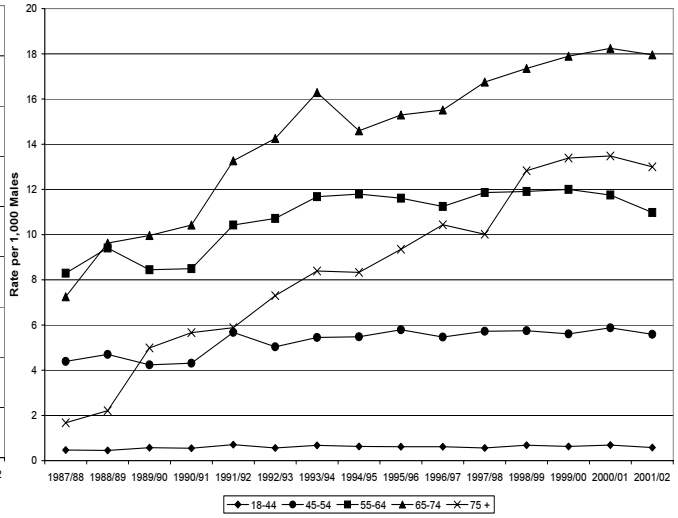
Rates for PCI were determined for the overall Manitoba population and specific regions. For the Manitoba population, the rate of PCI during 1987/88 was 0.36 per 1000 climbing to 0.93 per 1000 in 2001/02. Residents of Winnipeg were much more likely to undergo PCI than non-Winnipeg residents until 1999 (Figure 3). From then on, similar rates of PCI were noted. With respect to age and sex, similar changes in PCI to those found with coronary angiography were found with increases in men and women particularly over age 65. Once again, the relative increase is greatest in men and women after age 75.

**Figure 2: Rates of Coronary Angiography in Manitoba (per 1,000)**

**a) Age- and sex-standardized rates of coronary angiography**




**b) Age-specific rate of coronary angiography (males)**




**c) Age-specific rate of coronary angiography (females)**

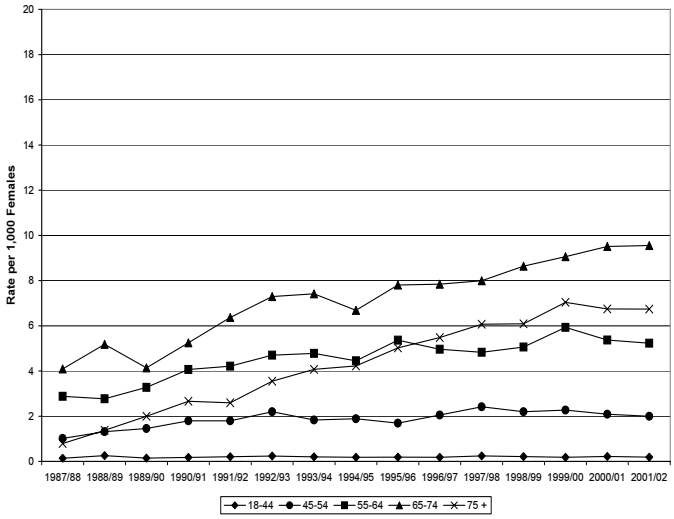
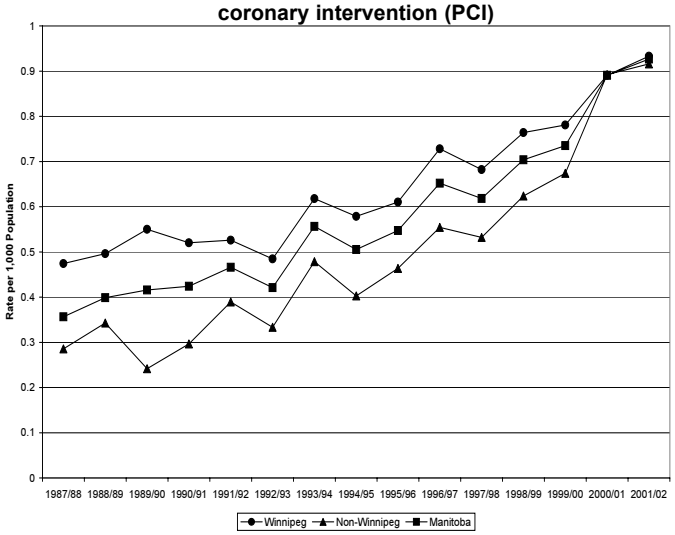
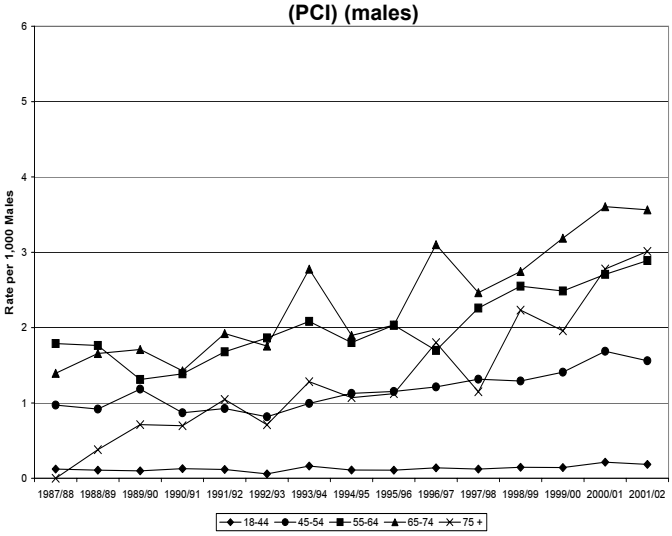


**Figure 3: Rates of Initial Percutaneous Coronary Intervention (PCI) in Manitoba (per 1,000)**

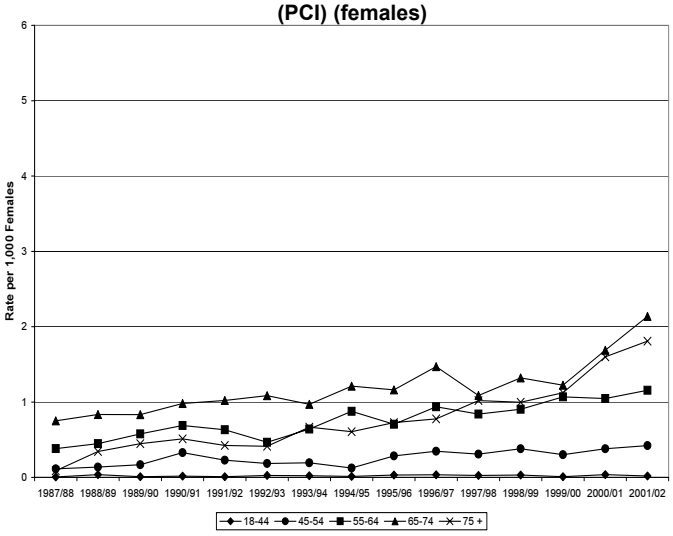
a) Age- and sex-standardized rate of initial percutaneous coronary intervention (PCI)




b) Age-specific rate of percutaneous coronary intervention (PCI) (males)




c) Age-specific rate of percutaneous coronary intervention (PCI) (females)




### *Initial Coronary Artery Bypass Grafting (CABG)*

For the Manitoba population, the rate of CABG during 1987/88 was 0.49 per 1000. This climbed to 1.0 in 1998/99. Then rates of CABG decreased to 0.85 per 1000 by 2001/02. Non-Winnipeg residents appear similarly to be less likely to undergo CABG through the earlier years of analysis. In 2001/02, similar rates were noted between rural and urban residents (Figure 4). Changes in the rates of CABG followed a similar pattern for men and women among different age groups as were found with coronary angiography and PCI.

### *Implications*

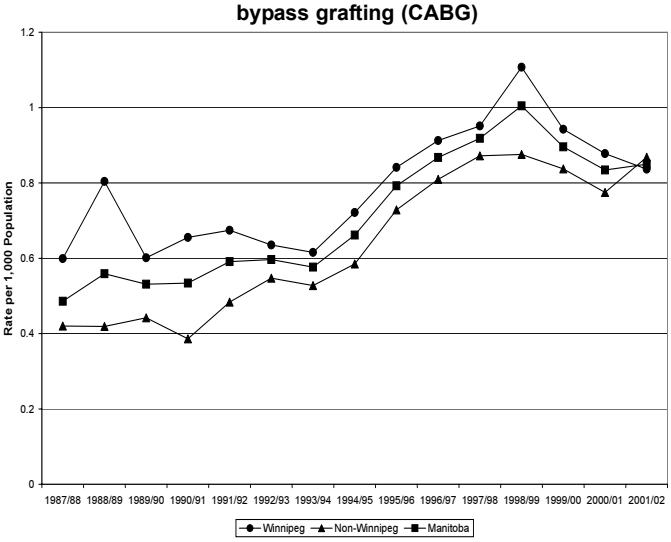
The rates of cardiac procedures increased dramatically from 1987-88 until 1999-2000 with an apparent leveling off in the rate of coronary angiography in the last two years of data. The rates of revascularization also increased during the same period with CABG initially increasing to a peak in 1998-99 and slightly decreasing over the latter few years. The reduction in CABG may in part be due to some patients undergoing PCI in place of CABG.

Differences due to age, sex and geography appear to have lessened during the latter part of the study period. Men over 55 comprise the majority of patients undergoing cardiac procedures. Women remain less likely to be referred for cardiac procedures, even in the older age groups where the

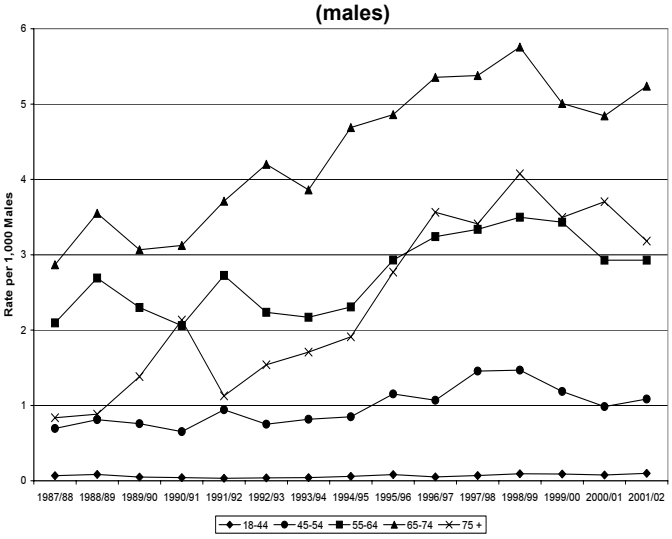
prevalence of CAD should be similar to men. Gender differences have been observed elsewhere in Canada and in the US. Whether this relates to a true gender bias or differences in disease severity cannot be determined from administrative data alone (see Ghali WA: Sex differences in access to coronary revascularization after cardiac catheterization: importance of detailed clinical data. Ann Intern Med. 2002;136(10):723-32).

**Figure 4: Rates of Initial Coronary Artery Bypass Grafting (CABG) in Manitoba (per 1,000)**

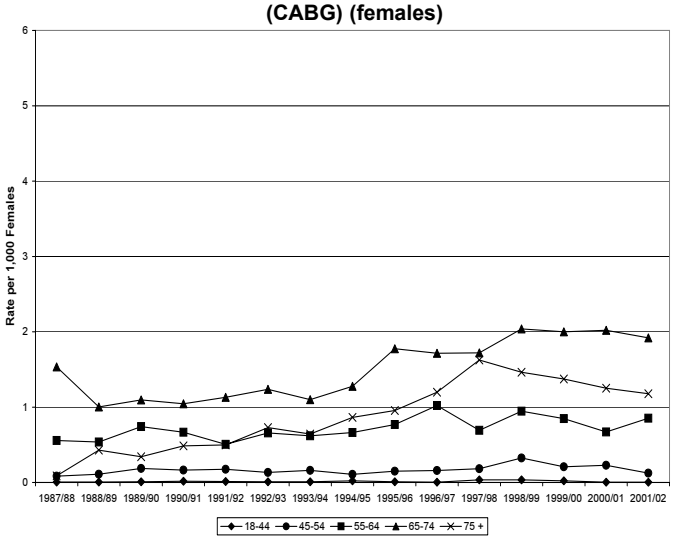
a) Age- and sex-standardized rate of initial coronary artery bypass grafting (CABG)




b) Age-specific rate of coronary artery bypass grafting (CABG) (males)




c) Age-specific rate of coronary artery bypass grafting (CABG) (females)




## 3. Rate of repeat coronary angiography, PCI and or CABG after initial revascularization

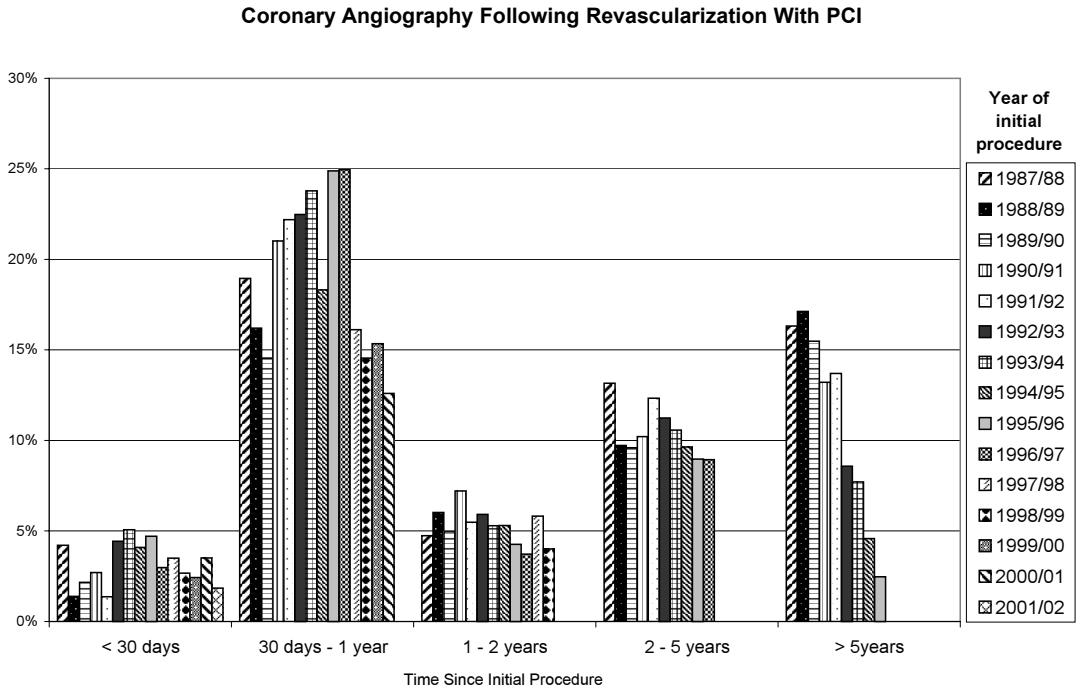
Few coronary angiograms are performed within 30 days of initial revascularization consistent with a low incidence of subacute thrombosis from PCI (<5%) or suspected early graft occlusion (<1%). As expected coronary angiography between 30 days and 1 year was much more likely following PCI than CABG, given that restenosis post-PCI occurs within 9 months and that symptomatic graft occlusion is relatively rare during the first few years after CABG. Figure 5 shows the percent of patients undergoing coronary angiography for specific time periods following initial revascularization with PCI or CABG.

The rates of repeat coronary angiography and repeat revascularization are shown in Figures 6 and 7 respectively. These figures present the year of the initial procedure and the cumulative rate of revascularization in subsequent years on the left, and the 3-year time period of the initial procedure and the cumulative rate of revascularization in years on the right. These four charts show how rates of revascularization have changed over the 15-year period. Figure 8 shows the actual numbers of revascularization procedures over the same time period.

The change in early (day 30 to 1 year) repeat cardiac procedure rates in those individuals who underwent initial PCI revascularization was assessed using simple linear regression between the year of initial procedure and the rate of repeat procedure (i.e., the dependent variable was the rate of repeat procedures and the independent variable was the year of the initial procedure). Individuals undergoing initial PCI revascularization in 2002-03 were excluded from this analysis due to incomplete follow up data to the end of year 1. PCI revascularization was much less frequently performed in earlier years, and therefore each year's rate was weighted appropriately (using the inverse variance of the point estimate). Weighted linear regression showed a trend towards a decline in coronary angiography rates over time ($r=-0.45$, $P=0.11$). This may relate to more widespread use of coronary stenting since the late 1990s. Individuals who have had previous PCI frequently need additional cardiac procedures, and the rate of coronary angiography following PCI approaches 50% at 5 years and 100% at 10 years. No change in the rate of coronary angiography following CABG was apparent. Overall, an individual is much less likely to undergo coronary angiography following CABG at 5 and 10 years (15% and 30%) than following PCI.

For those patients with prior PCI, the number of subsequent early (day 30 to 1 year) revascularization procedures (PCI or CABG) decreased significantly in later years (weighted linear regression $r=-0.53$, $P=0.05$). This decrease became evident after 1996 (1987/90 11%, 1990/93 13%, 1993/96 14%, 1996/99 9%, 1999/01 7%). By five years following PCI approximately 35% had undergone repeat revascularization and this reached 50% at 10 years. PCI represents the majority of revascularization procedures with CABG making up about one-third. For those patients with prior CABG much lower rates of repeat revascularization with either PCI or redo-CABG were noted and this was stable over the duration of study. Repeat revascularization occurred in less than 5% at 5 years and about 10% at 10 years, predominately with PCI.

**Figure 5: Per cent of Patients Undergoing Coronary Angiography Following Initial Revascularization with Either Percutaneous Coronary Intervention (PCI) or Coronary Artery Bypass Grafting (CABG) According to the Intervening Time Period.** (Data years with incomplete follow up are excluded. Shorter follow up explains the declining rate of angiography more than 5 years post-revascularization.)



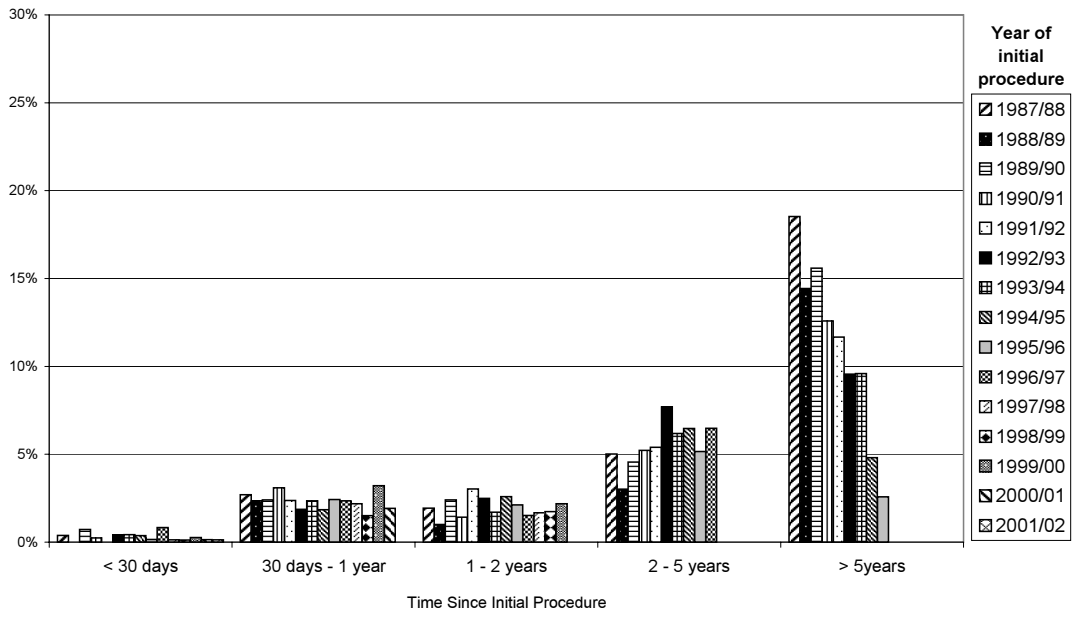



**Figure 6: Cumulative Rates of Repeat Coronary Angiography After Initial Percutaneous Coronary Intervention (PCI) or Coronary Artery Bypass Grafting (CABG)** according to calendar year of procedure (left) and years since Initial procedure as consecutive three year groups (right). (Total exceeds one in some cases due to multiple coronary angiograms per person.)

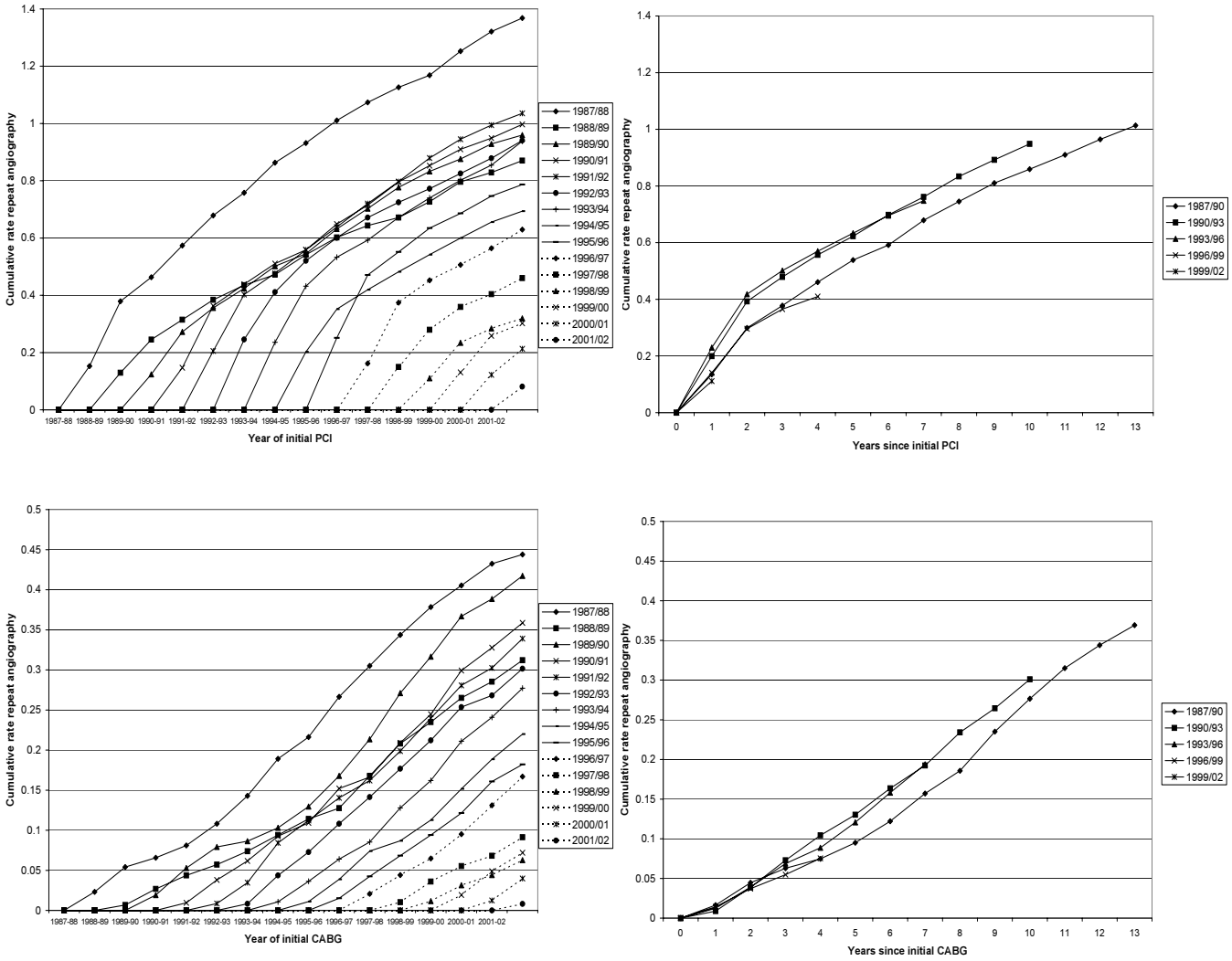


**Figure 7: Cumulative Rates of Repeat Revascularization With Either Percutaneous Coronary Intervention [PCI] or Coronary Artery Bypass Grafting (CABG) According to the Intervening Time Period**

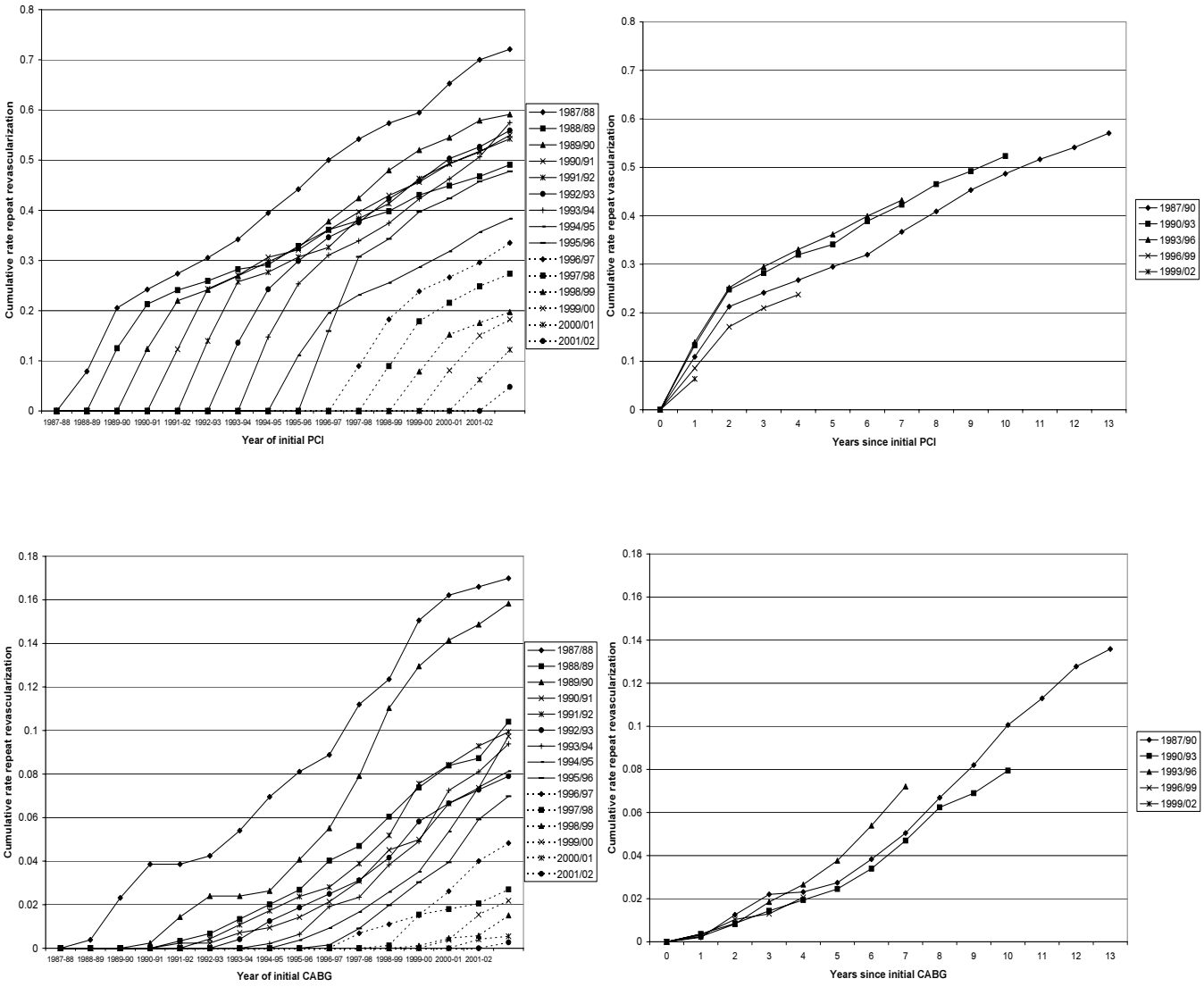
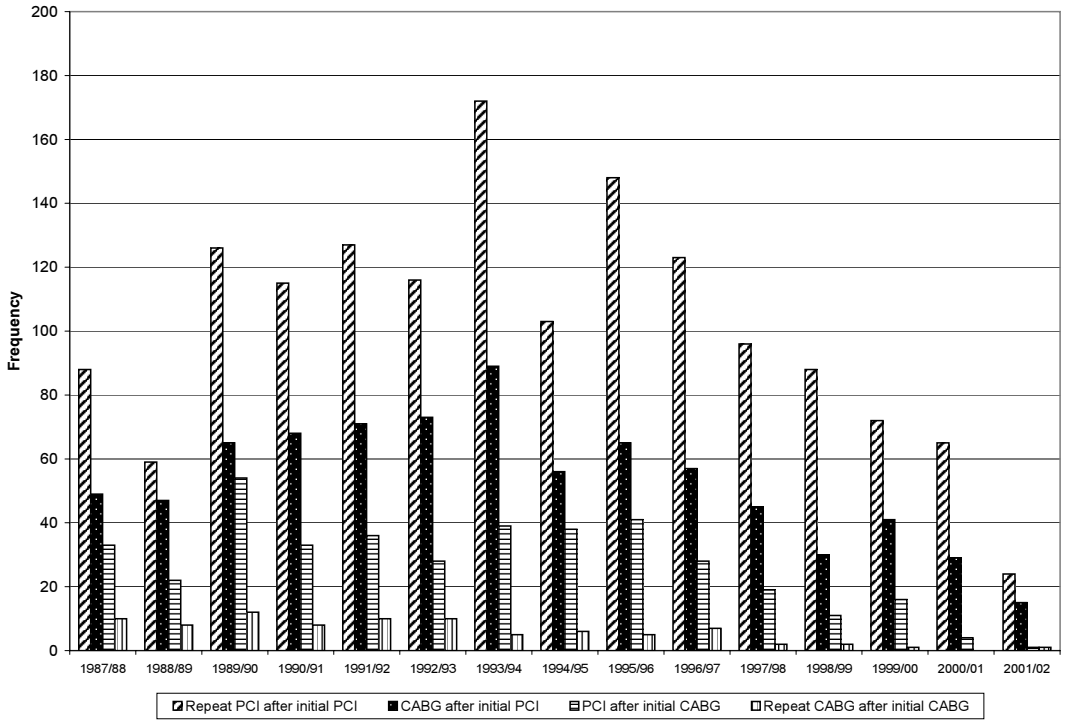


**Figure 8: Repeat Revascularization With Either Percutaneous Coronary Intervention (PCI) or Coronary Artery Bypass Grafting (CABG) Following Initial PCI or CABG (absolute numbers)**




## Conclusions

Challenges remain in accurately defining and counting the number of cardiac procedures performed in the Province of Manitoba. Despite coronary angiography, PCI and CABG being major procedures a discrepancy between data sources remain. Further prospective analysis of the various data sources to identify and hopefully eliminate these discrepancies is recommended.

There has been a dramatic change in the evaluation and treatment of CAD from 1987 until 2001, and the relative increase is greatest in men and women older than 75. Differences in the rates of angiography, PCI and CABG appear to have lessened between Winnipeg and non-Winnipeg residents. As expected following revascularization, the rate of repeat coronary angiography and subsequent revascularization is much higher after initial PCI than with initial CABG. A slight reduction in coronary angiography and repeat revascularization rates in the year following initial PCI was seen during the later study years. This may reflect a reduction in symptomatic restenosis due to widespread stent use, but should be confirmed in further studies in which the nature of the PCI (stent vs. non-stent) is included as an explanatory variable. Our analysis is limited by being unable to control for factors known to predict early restenosis (lesion length and vessel diameter). The need for repeat cardiac procedures in the years following PCI remains a

major problem for these patients. For those patients who become symptomatic following PCI then repeat PCI is the predominant method of repeat revascularization with subsequent CABG occurring in a significant minority. For those who become symptomatic following CABG, subsequent PCI remains the predominant revascularization modality and only rarely does repeat CABG occur. The much lower rate of coronary angiography following CABG may reflect greater protection from disease progression in native coronary arteries and the limited rate of disease progression in the bypass grafts within 10 years. Our analysis was unable to control for factors known to predict graft patency such as the use of arterial conduits and vessel diameter and rates were not adjusted for death. The high rate of further angiography, PCI or CABG after initial PCI (and likely after initial CABG if analysis is extended beyond 10 years) underscores that these cardiac patients remain at high risk despite having undergone a coronary revascularization procedure. It is known that revascularization should always be associated with aggressive risk factor modification such as smoking cessation, and treatment of dyslipidemia and hypertension.