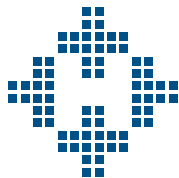# Application of Patient Safety Indicators in Manitoba: A First Look

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THE MANITOBA CENTRE FOR HEALTH POLICY

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.

Members of MCHP consult extensively with government officials, health care administrators, and clinicians to develop a research agenda that is topical and relevant. This strength along with its rigorous academic standards enable MCHP to contribute to the health policy process. MCHP undertakes several major research projects, such as this one, every year under contract to Manitoba Health. In addition, our researchers secure external funding by competing for other research grants. We are widely published and internationally recognized. Further, our researchers collaborate with a number of highly respected scientists from Canada, the U.S. and Europe.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Introduction

Although there has always been an interest in patient safety, a heightened awareness emerged after the publication of the landmark Institute of Medicine (IOM) Report, *To Err is Human: Building a Safer Health System* (Institute of Medicine, 2000). The Report included estimates of the prevalence of in-hospital adverse events and the numbers of people who died annually in U.S. hospitals as a result of medical error. According to the IOM Report, adverse events occur in 3 to 4% of all hospitalizations, and between 44,000 and 98,000 patients die each year in U.S. hospitals as a result of medical error. These estimates were alarming and sparked renewed investigations into the safety of patients in hospital. Since the publication of the IOM Report, additional estimates of the frequency and severity of in-hospital adverse events have been derived. Depending on the event and case definition, the frequency of adverse events ranges from 5 to 20% of hospitalizations. Under-reporting is also acknowledged.

Much of the research to date on in-hospital patient safety has been completed through medical records review. The impact of such research on the practice and policy environments has been significant. Notwithstanding the quality of the information derived, medical record reviews are time consuming, labour intensive and expensive. Limited but important research on patient safety has been completed using large databases. While some of this research has focussed on specific types of events (e.g., stroke-related fatalities), the Agency for Healthcare Research and Quality (AHRQ) has developed indicators of patient safety which cover a broad range of surgical, medical and obstetric events (Romano et al., 2003). The contribution of these indicators to the study of in-hospital patient safety is significant because of the breadth of coverage. For example, multiple indicators of compromised patient safety related to surgical procedures have been developed (i.e., thromboembolism, accidental puncture/laceration, hemorrhage) for which comparisons of rates can be made between regions, hospitals, sexes and age groups. This type of information allows for the identification of areas of concern (e.g., high rates of post-operative hemorrhage at hospitals in a particular region) which can then be targeted with more intensive investigation (e.g., medical record review, case review).

Study Objectives

Given the potential contribution of administrative data to patient safety-related policy and practice, the Manitoba Centre for Health Policy (MCHP), as part of its contract with Manitoba Health, set out to develop

patient safety indicators using the MCHP Population Health Research Data Repository (Repository), and to identify and describe patterns of events which may indicate that patient safety had been compromised. Specific objectives of this exploratory study were:

1. To develop patient safety indicators using the MCHP Repository
2. To assess the frequency and distribution of the indicators
3. To compare indicators across regions and hospitals

Terminology

Patient safety is a rapidly growing field of study and there exist multiple definitions of relevant terms. Consistency in use of terms across studies has not been achieved. Three common concepts that are relevant to this study are defined below.

Patient Safety – the reduction and mitigation of unsafe acts within the health care system, as well as through the use of best practices shown to lead to optimal patient outcomes (CPSI, 2003).

Medical Error – the failure to complete a planned action as intended or the use of a wrong plan to achieve an aim (Institute of Medicine, 2000; CPSI, 2003).

Adverse Event – an injury caused by medical management rather than by the underlying disease or condition of the patient (Brennan et al., 1991). Some, but not all adverse events are avoidable. A commonly described example of the difference between an avoidable and unavoidable adverse event concerns antibiotic administration. An allergic reaction to a new antibiotic would be an unavoidable adverse event. An allergic reaction following administration of an antibiotic to a patient with a known, recorded allergy to that medication is an example of an avoidable adverse event.

Project Goal

The indicators used in this report should be considered as *screening tools* for the possibility of compromises to patient safety. The goal was to use the indicators to identify processes of care that may warrant further attention. Another important consideration is that the estimates contained in this report cannot be directly attributed to medical error. The indicators are screening tools which should be used to target further investigations into the circumstances surrounding the events. Medical error may be but one explanation. The benefits of the indicators rest in the breadth of comparative investigation allowed and the ensuing targeted efforts at investigation and intervention.

Methods

A Working Group comprising representatives from Manitoba Health, the Winnipeg Regional Health Authority (WRHA), and practicing clinicians was established to advise and provide feedback on the project. Indicators were selected and developed based on a review of the literature, the feasibility of using administrative data, and the input of physician Working Group members. Based on these criteria the following indicators of compromised patient safety were selected for this report: (1) A selection of "Patient Safety Indicators" (PSIs) developed by AHRQ in the U.S., and (2) measures of complications related to laparoscopic cholecystectomy (removal of gallbladder).

Data Sources

The analyses for this report were based on the administrative data contained in the Repository, which is housed at MCHP. Specific administrative files used in this study were the hospital discharge abstracts data, physician claims, and the vital statistics registry. Five years of data were used in this project, covering the periods from April 1, 1999 through March 31, 2004 (i.e., fiscal years 1999/2000–2003/04).

General Inclusion and Exclusion Criteria

General inclusion criteria for the study are: Manitoba residents, aged 19 years and older during the study period. Psychiatric and obstetric patients are excluded from the study, except for the specific obstetric patient safety indicators.

AHRQ Patient Safety Indicators (PSIs)

The AHRQ developed 20 indicators of patient safety. We modified 10 for inclusion in this study. Modification of the definitions was required because of different coding practices between the Manitoba hospital discharge abstracts database and the U.S. database. The primary reason for non-inclusion of 10 AHRQ indicators was too few events in Manitoba during the study period. An important feature of the Patient Safety Indicators is that they were developed to measure complications of hospital-based care among a group of patients for whom the complication seemed preventable or highly unlikely. In other words, the Patient Safety Indicators were not designed to derive estimates of the events among all hospital patients, but only among those who were likely not at risk of experiencing the event as a result of their medical condition. To accomplish this, most Patient Safety Indicators have a specific set of inclusion and exclusion criteria. For example, the inclusion criteria for 'birth trauma' are: live births. Excluded from this category are pre-term infants with a birth trauma diagnosis for cerebral or subdural hemorrhage, as well as infants diagnosed with osteogenesis imperfect who had a birth trauma diagnosis of injury to skeleton. However,

some Patient Safety Indicators did not have any specific exclusion criteria. For example, the inclusion criteria for 'accidental puncture or laceration' are all surgical discharges with ICD-9 CM codes denoting accidental puncture or laceration (e.g., accidental cut, puncture, perforation or laceration during a procedure) in any secondary diagnosis field. The following indicators were selected for study:

- death in low-mortality medical Case Mix Groups (CMGs)
- death in low-mortality surgical CMGs
- iatrogenic pneumothorax
- post-operative hemorrhage/hematoma
- post-operative thromboembolism
- post-operative abdominopelvic wound dehiscence
- accidental puncture/laceration among surgical cases
- birth trauma (injury to neonate)
- obstetrical trauma, vaginal deliveries with instruments
- obstetrical trauma, vaginal deliveries without instruments

Indicator definitions and indicator-specific inclusion/exclusion criteria are found in Appendix A and B.

Cholecystectomy (Removal of Gallbladder)

Cholecystectomy was chosen because it is a high-volume procedure, meaning that a large number are completed every year. The procedure is also completed in almost every Regional Health Authority (RHA) so comparisons on outcomes can be made across regions. The following ICD-9 CM code was used to identify laparoscopic cholecystectomy: 51.23. The following indicators were investigated as possible complications associated with cholecystectomy: post-operative hemorrhage/hematoma, accidental puncture or laceration and subsequent biliary surgery. Subsequent biliary surgery was investigated because it is a marker for bile duct injury, which is the most serious complication at cholecystectomy. This category includes the following procedures: extrahepatic biliary ducts, plastic reconstruction, with CBD end-to-end anastomosis; extrahepatic biliary ducts and gastrointestinal tract direct CBD-GI anastomosis; and extrahepatic biliary and gastrointestinal tract, Roux-en-y hepatico-jejunostomy. ICD-9 CM and tariff codes were used to identify these complications (See Appendix B).

Reporting

Patient Safety Indicators (PSI)

Rates of patient safety indicators were age- and sex-adjusted to the 2001/02 Manitoba in-patient hospital dataset. Because the indicators are in the development phase, results are presented anonymously, meaning that while rates are reported by hospital, the identity of the hospital has been con-

cealed. Where possible, two graphs are presented for each patient safety indicator. One of the graphs includes rates at the two Winnipeg tertiary hospitals plus the U.S. rate for urban teaching hospitals as reported by Romano and colleagues (2003). A second graph includes the Manitoba community hospitals and the U.S. urban community hospital rate as reported by Romano and colleagues (2003).

Comparisons were made between individual Manitoba hospitals and the U.S. average rates on most indicators. The AHRQ PSI rates represent U.S. national estimates, and are therefore useful for comparison purposes. Comparison to U.S. rates have not been made for death in low-mortality medical and surgical CMGs because the U.S. rates are reported by Diagnostic Related Groups (DRGs). Comparisons of rates of accidental puncture/laceration are also not possible because the U.S. rate by hospital type combined surgical and medical cases, and we reviewed only surgical cases.

Cholecystectomy
The age- and sex-adjusted rates of laparoscopic cholecystectomy are reported by the RHA in which people live. Cholecystectomy rates were age- and sex-adjusted to the 2001 Manitoba population. Because we were interested in the provision of care by hospital and hospital type, rates of possible complications are assigned to the hospital at which the cholecystectomy was performed. For example, the outcomes of the individual from North Eastman RHA who had their laparoscopic procedure performed at a Winnipeg community hospital, would be assigned to the Winnipeg community hospital, and not to the rural hospital category. If a patient is transferred, the procedure is still attributed back to the original hospital of surgery.

Because the indicators of potential complications are in the development phase, results are presented anonymously, meaning that while rates are reported by hospital, the identity of the hospital has been concealed. The code used for reporting patient safety indicator results by hospital is the same for the cholecystectomy indicators. The major and intermediate rural hospitals have been added to the analysis of cholecystectomy because the procedure is completed at many hospitals in this grouping.

Hospitals included in the analysis are listed in Table 1.

Table 1: Manitoba hospitals included in analysis

Winnipeg Tertiary	Winnipeg Community	Brandon Community	Major/Intermediate Rural	
Health Sciences Centre	Concordia	Brandon	Altona	Neepawa
	Grace		Beausejour	Portage
St. Boniface	Seven Oaks		Steinbach	The Pas
	Victoria		Boundary Trails	Ste. Rose
			Carman	Selkirk
			Dauphin	Souris
			Churchill	Swan River
			Flin Flon	Virden
			Gimli	Thompson
			Minnedosa	

Source: Manitoba Centre for Health Policy, 2006

Contributing Factors

We investigated the possible contributions of patient comorbidity and socioeconomic status (SES) on rates of patient safety indicators. The comorbidity index is a measure of the general level of sickness of individuals relative to the entire population. The index is derived from the Adjusted Clinical Group (ACG) system, which is a population/patient case-mix adjustment system developed by researchers at Johns Hopkins University School of Hygiene and Public Health. In this study, the morbidity index refers to a measure of the general level of sickness of individuals relative to the average Manitoban. ACGs were calculated based on all physician visits and hospitalizations for a one-year period prior to the hospitalization of interest. An important limitation of the index is that morbidity can be underestimated among ill individuals who either do not seek, or lack access to medical care.

The socioeconomic factor index (SEFI) is a score that reflects non-medical social determinants of health and include factors such as age, single-parent status, female labour force participation, unemployment and education. SEFI is calculated at the following geographic levels: RHA and RHA districts (Community Areas for Winnipeg). A score is assigned based on person's area of residence.

Statistical Comparisons

Patient Safety Indicators (PSIs)
Comparisons were made between individual Manitoba hospitals and the U.S. average rates on most indicators. The AHRQ PSI rates represent U.S. national estimates, and although the rates cannot be considered benchmarks, they are useful for comparison purposes given that we are using these indicators for the first time in Manitoba. Confidence limits (99%) were derived for estimates on the individual Manitoba hospitals. The difference in PSI

rates between individual Manitoba hospitals and the U.S. average was considered statistically significant if the U.S. average value fell outside the confidence interval of the individual hospital estimates.

Cholecystectomy

Comparisons on possible complications were made between individual hospitals or hospital types and the Manitoba average rates. Confidence limits (99%) were derived for estimates on the individual hospitals and hospital types. The difference in rates between individual hospitals and the Manitoba average was considered statistically significant if the Manitoba average value fell outside the confidence interval of the individual hospital and hospital-type estimates.

Clinical Significance

The clinical significance of select patient indicators was assessed by determining the risk of death among patients with a recorded occurrence of the indicator relative to those who did not have a recorded occurrence of the indicator. The relative risk of death was determined as follows:

$$RR = \frac{proportion\ of\ deaths\ among\ relevant\ cases\ with\ a\ recorded\ occurrence\ of\ a\ PSI}{proportion\ of\ deaths\ among\ relevant\ cases\ without\ a\ recorded\ occurrence\ of\ a\ PSI}$$

Due to the small numbers of events and deaths for most of the patient safety indicators, only a select number of indicators could be included in this portion of the analysis. Patient safety indicators included in this portion of the analysis are:

- post-operative thromboembolism
- accidental puncture/laceration
- iatrogenic pneumothorax
- post-operative hemorrhage/hematoma
- post-operative abdominopelvic wound dehiscence

Results

Patient Safety Indicators (PSIs)

The age- and sex-adjusted rates of patient safety indicators for Manitoba hospitals are found in Table 2.

Table 2: Age and sex-adjusted rates of patient safety indicators (PSIs) for Manitoba hospitals per 100 related hospitalizations, 1999/2000 – 2003/04

Patient Safety Indicator	Number of Relevant Cases	Number of Events	Adjusted Rate (%)
Death in low mortality surgical CMGs	50,063	140	**0.38**
Death in low mortality medical CMGs	41,584	455	**1.17**
Post-operative thromboembolism	113,483	778	**0.74**
Accidental puncture/laceration, surgical cases	113,737	1,538	**1.36**
Iatrogenic pneumothorax	211,708	216	**0.10**
Post-operative hemorrhage/hematoma	104,531	258	**0.26**
Post-operative abdominopelvic wound dehiscence	28,231	109	**0.46**
Injury to neonate	52,556	126	**0.24**
Obstetrical trauma, vaginal delivery, with instrumentation	3,442	735	**21.34**
Obstetrical trauma, vaginal delivery, without instrumentation	38,410	1,153	**3.00**

Overall, the rates of patient safety indicators were very low. Rates ranged from 0.10% for iatrogenic pneumothorax ("punctured lung"), to 3% for obstetrical trauma associated with vaginal births when no instruments were used. One rate that stands out is that for obstetrical trauma in vaginal deliveries when instruments were used. The rate was 21.34%. Instrument use during delivery is a high-risk procedure that is used to prevent further harm to the baby.

Rates increased with age for most of the non-obstetric patient safety indicators. Rates of the following PSIs were greater in males than females: post-operative thromboembolism (except for those aged 75years and older), post-operative hemorrhage/hematoma and post-operative abdominopelvic wound dehiscence.

Small but statistically significant differences in rates of patient safety indicators were observed between individual hospitals and U.S. average rates (Tables 3a and 3b). At the Manitoba tertiary hospitals rates of iatrogenic pneumothorax (hospital A), post-operative hemorrhage/ hematoma (hospitals A and B), and post-operative wound dehiscence (hospitals A and B) were statistically greater than the rates reported for U.S. urban teaching hospitals. Rates of post-operative thromboembolism (hospitals A and B), injury to neonate (hospitals A and B) and obstetric trauma for vaginal deliveries (both instrument-assisted and no instruments) (hospitals A and B) were statistically lower than rates reported for U.S. urban teaching hospitals. Differences were also found for community hospitals. Rates at some Manitoba community hospitals were statistically greater than at U.S. urban community hospitals on the following indicators: iatrogenic pneumothorax

(hospital E), post-operative hemorrhage/hematoma (hospital C), and post-operative wound dehiscence (hospital C). Rates of injury to neonate at hospital 1 were statistically lower than the U.S. rate, and rates of obstetrical trauma for vaginal deliveries, without the use of instruments were statistically lower at Manitoba community hospitals 1 and 2, than the rates reported for U.S. urban community hospitals.

Table 3a: Rates of patient safety indicators statistically greater at Manitoba hospitals compared to U.S. hospitals

Patient Safety Indicator	Hospital	Manitoba Hospital Rate	U.S. Hospital Rate	
Iatrogenic pneumothorax	A	0.19	Tertiary	0.07
	E	0.15	Community	0.07
Post-operative hemorrhage/hematoma	A	0.33	Tertiary	0.21
	B	0.33	Tertiary	0.21
	C	0.33	Community	0.20
Post-operatvie abdominopelvic wound dehiscence	A	0.75	Tertiary	0.20
	B	0.41	Tertiary	0.20
	C	1.00	Community	0.19

Source: Manitoba Centre for Health Policy, 2006

Table 3b: Rates of patient safety indicators statistically lower at Manitoba hospitals compared to U.S. hospitals

Patient Safety Indicator	Hospital	Manitoba Hospital Rate	U.S. Hospital Rate	
Post-operative thromboembolism	A	0.80	Tertiary	1.04
	B	0.54	Tertiary	1.04
Injury to neonate	A	0.17	Tertiary	0.65
	B	0.22	Community	0.68
	1	0.15	Community	0.68
Obstetrical trauma, vaginal deliveries with instruments	A	21.23	Tertiary	27.64
	B	22.76	Tertiary	27.64
Obstetrical trauma, vaginal deliveries without instruments	A	3.18	Tertiary	9.30
	B	3.11	Tertiary	9.30
	1	2.41	Community	8.08
	2	2.62	Community	8.08

Source: Manitoba Centre for Health Policy, 2006

Comparisons to U.S. rates for accidental puncture/laceration and death in low-mortality CMGs (surgical and medical) were not possible. Differences within Manitoba were observed. Rates of accidental puncture/laceration may be statistically different at tertiary hospital A and community hospital C, compared to the other included Manitoba hospitals, given that the confidence limits surrounding the rates at hospitals A and C did not encompass the confidence limits surrounding the rates at any of the other hospitals. Rates of death in low-mortality medical case mix-groups (CMGs) are greater than the 1% benchmark at community hospitals D and F.

Laparoscopic Cholecystectomy
Rates of accidental puncture/laceration and post-operative hemorrhage/hematoma were statistically greater at community hospital C than the Manitoba average rates. An interesting volume:outcome relation-

ship was observed in relation to repair of biliary ducts as a result of injury during laparoscopic cholecystectomy. We compared the rate of reconstructive surgery by the volume of laparoscopic surgeries completed over the study period. Comparison is made between hospitals at which fewer than 500 laparoscopic cholecystectomy procedures were completed during the study period, those at which between 500 and 999 procedures were completed during the study period, and those at which 1,000 and more procedures were completed during the study period.

The overall rate of biliary reconstruction performed on laparoscopic patients during the study period was 0.2%. An inverse relationship between number of laparoscopic cholecystectomy procedures performed and rate of reconstructive surgery is observed. The rate of biliary reconstruction at hospitals which performed fewer than 500 laparoscopic procedures was 0.5%, while the rate at hospitals which performed between 500 and 999 procedures was 0.25%, and 0.13% at hospitals which performed 1,000 or more procedures during the study period. The trend was statistically significant (χ^2=10.4, p<0.01).

Factors influencing observed rate differences

Several factors may have accounted for differences in observed rates including: case complexity; practice patterns (i.e., policies directing provision of care by hospital personnel); practitioner experience and skill; patient characteristics such as age, level of sickness, comorbidities, and socioeconomic background; and coding.

Because we do not have detailed information about the hospitals and patients included in the U.S. study, we were not able to assess the impact of these various factors on the observed differences between the U.S. and Manitoba hospitals. However, we were able to assess the impact of some of the above factors on the rates observed within the Manitoba setting.

In general, the Manitoba hospitals that had the highest operative and post-operative surgical patient safety indicator rates, also had the highest surgical case complexity and the sickest patients. However, such a relationship was not always found. For example, statistically greater rates of death in low-mortality CMGs were found for two community hospitals. Differences in age or level of sickness were not found between those hospitals and the remaining community hospitals. In addition, rates of some of the surgical patient safety indicators at one community hospital were similar to those at tertiary hospitals, yet, on average, case complexity and patient morbidity were lower. Injury to neonate was also high at one community hospital. These indicators require further exploration to determine the factors that may have influenced these differences.

In addition to differences in case complexity, patient comorbidity and SES, differences in coding practices at the hospitals included in this study may have influenced the reported results. If coding practices vary systematically by hospital, then differences in rates reported in this study may be related to such coding issues. Coding practices therefore also warrant further investigation.

Limitations

Coding

There are at least two steps in the coding process that can affect the accuracy of administrative data: recording of the event by the physician, and abstraction of the event by the health records technician. Physicians are required to provide summaries of the patient's hospital stay, operative reports (if applicable) and reasons for the hospitalization (i.e., medical diagnoses). If events are not reported by physicians at this stage, there may be no evidence of their occurrence in the administrative database (some events may be recorded by other health care professionals, but abstractors generally do not read the entire medical record at the time of abstraction). The second step in the process involves the coding of hospital reports by health records technicians. Health records technicians translate the information recorded in the medical record into ICD-9 CM codes. Factors that may influence differences in coding practices at this level include training and experience of individual technicians, and institutional practices. While the patient safety indicators represent major medical events, some are more non-precise than others (e.g., accidental puncture/laceration is less precise than pulmonary embolism). For this reason, it is possible that the more precise indicators (e.g., pulmonary embolism) would be more reliably reported and coded than less precise indicators (e.g., accidental puncture/laceration). Thus, while most of the patient indicators represent major medical events, further validation will be necessary to examine the relative influence of coding practices on the observed results.

Some of the statistical differences found between the U.S. and Manitoba hospitals may reflect coding issues. For example, rates of post-operative abdominopelvic wound dehiscence at Manitoba hospitals are 2 to 5 times greater than rates reported by Romano (2003) for U.S. hospitals. Within Manitoba, a large difference was found for rates of injury to neonate. Such large differences warrant further examination.

Scope of Study

The patient safety indicators included in this report do not represent an exhaustive listing of possible indicators of patient safety. In addition, most of the indicators relate to surgical procedures. However, in previous patient safety research, adverse events related to surgical procedures have been found

to be the most frequently reported type of patient safety concern. Nonetheless, there are many other indicators of patient safety and patient safety concerns that are not addressed in this report. In addition, we were not able, with administrative data, to examine the impact of many factors that influence in-hospital patient safety (e.g., personnel, environment and organizational factors).

Clinical Significance of Events
With administrative data we are able to detect the occurrence of recorded events, but generally are not able to comment on their clinical significance. With respect to this study we may have captured events that had minimal effect on patients, in addition to those that resulted in serious complications, disability and death. In an attempt to address this issue, we estimated the relative risk of death for five of the patient safety indicators. The relative risk value represents the risk of death among patients who had a recorded occurrence of the patient safety indicator compared to patients who did not have a recorded occurrence of the indicator. For example, among surgical patients the relative risk of death among those who had a recorded occurrence of post-operative thromboembolism was 7.2 times greater than among patients who did not have a recorded occurrence of a post-operative thromboembolism.

Table 4: Risk of death among patients with a recorded occurrence of a patient safety indicator compared to patients without a recorded occurrence of the patient safety indicator

Patient Safety Indicator	Risk of Death Compared to Patients without a Recorded Occurrence of the Patient Safety Indicator (99% CI)
Post-operative thromboembolism	7.2 (6.0, 8.8)
Accidental puncture/laceration	2.9 (2.3, 3.6)
Iatrogenic pneumothorax	5.5 (4.3, 7.0)
Post-operative hemorrhage/hematoma	4.3 (2.7, 6.7)
Post-operative abdominopelvic wound dehiscence	3.5 (1.8, 6.6)

Source: Manitoba Centre for Health Policy, 2006

The relative risk estimates are crude estimates, meaning that we have not controlled for factors such as comorbidity or complexity. In addition, we cannot state that the cause of death for this group of patients was one of the indicators under investigation (e.g., post-operative thromboembolism). However, the findings do seem to suggest clinical significance. Further investigation of these estimates are warranted.

Validation

Researchers at MCHP and beyond have spent considerable effort at ensuring the validity and reliability of administrative data systems. For example, administrative data have been validated against chart reviews and surveys,

and researchers at other sites have replicated our work to ensure reliability (i.e., are we using the same codes to identify specific conditions; is statistical language the same?). (Roos et al., 2005; Hux et al., 2002; Roos and Nicol, 1999; Roos et al., 1993; Roos et al., 1982). In regard to this study, internal validation has been completed. First, face validity was confirmed through extensive discussion with clinical researchers involved with the project. Second, we also reviewed the application by health records technicians of "C" codes. The "C" code refers to post-admission comorbidity, which is a condition that arises after admission and has a significant influence on length of stay or management in hospital. We determined the proportion of surgical patient safety indicators that had a "C" code attached to them. This code is applied fairly consistently across the province. Over 90% of the surgical patient safety indicators we identified for this study had a "C" code attached to them. This may imply a complication of treatment. These data are found in Table 5.

Table 5: Percentage of patient safety indicators identified as post-admission comorbidity

Patient Safety Indicator	% with "C" Code
Iatrogenic pneumothorax	92%
Post-operative hemorrhage	98%
Post-operative thromboembolism	90%
Post-operative abdominopelvic wound dehiscence	95%
Accidental puncture/laceration, surgical cases	94%

Source: Manitoba Centre for Health Policy, 2006

Conclusions and Recommendations

Overall, rates of patient safety indicators at Manitoba hospitals are low. Small, but statistically significant differences were found between Manitoba and U.S. hospitals. Differences were also found within Manitoba. Case complexity and patient morbidity may account for some of the observed rate differences. Coding practices may also have influenced some of the results. Validity of the indicators was assessed via two measures, and this preliminary work is encouraging regarding the robustness of the indicators.

Recommendation #1
Validation of the patient safety indicators should be completed to determine the extent to which coding practices have influenced observed results. This validation should be undertaken as part of a research program with active participation of regional stakeholders.

Validation should include two processes. First, a review of the medical records identified through the administrative database should be undertaken to determine if events occurred as coded. For example, an accidental punc-

ture/laceration for a particular patient is found through a search of the administrative data. Is this event confirmed in that patient's medical record? Second, a random sample of records should be drawn to determine the occurrence of a particular event (e.g., hemorrhage). A "back-check" should then be completed with the administrative data to determine what proportion of events identified via medical record review were recorded and found in the administrative data. These validation procedures should be completed at multiple sites to allow for comparisons of coding procedures.

Recommendation #2
Once the validity of the patient safety indicators is established, Manitoba Health should support regions in using the indicators on a regular basis as one component in the efforts to enhance patient safety.

Recommendation #3
Given the cost-effectiveness and overall usefulness of these indicators to regions, MCHP should work with stakeholders (i.e., Manitoba Health, RHAs, clinicians) to develop additional patient safety indicators that can address areas not included in this report (e.g., in-hospital falls).

Recommendation #4
Research using a systems approach should be undertaken to examine factors that contribute to adverse events and incidents which compromise the safety of patients in hospital. A retrospective review of charts, incident reports and other documents (e.g., operating room slates) should be undertaken, in conjunction with the validation piece described above, to review factors that contributed to the findings in this report. A prospective study should be undertaken to examine events which compromise patient safety in "real-time" and should include review of charts and other relevant documents, interviews, and observation. Factors investigated for both components include patient factors, personnel issues, environment issues, local and regional policies, and work-life processes (e.g., decision-making processes).

Recommendation #5
Manitoba Health should take a lead in supporting further efforts at validation and development of patient safety indicators.

CHAPTER 1: INTRODUCTION

Much debate and interest has happened as a result of a U.S. report that stated that between 44,000 and 98,000 individuals die in U.S. hospitals annually, as a result of medical error.

The publication of the landmark Institute of Medicine (IOM) Report, *To Err is Human: Building a Safer Health System*, garnered much debate and heralded an increased interest in patient safety issues worldwide (Institute of Medicine, 2000). The item in the report that captured the greatest attention was the estimate of the numbers of individuals who die in U.S. hospitals annually as a result of medical error: between 44,000 and 98,000. These estimates were taken from two large patient safety studies in the U.S.: the Harvard Medical Practice Study (Brennan et al., 1991) and a follow-up study in Utah and Colorado (Thomas et al., 2000a). Both studies were multi-stage reviews of random samples of medical records. Using similar methodologies, researchers reported adverse events occurring in approximately 4% of hospitalizations in New York in 1984 (Harvard Medical Practice Study), and 3% of hospitalizations in Utah and Colorado in 1992.

Additional estimates of the frequency and severity of in-hospital adverse events have since been derived. Depending on case definition, estimates range from 5 to 20% of hospitalizations. Under-reporting of adverse events is also acknowledged (Thomas et al., 2000a; Thomas and Brennan 2000b; Schimmel 2003; Leape, 1994; Cullen et al., 1995; Institute of Medicine 2000; Wilson et al., 1995; Baker et al., 2004; Aylin et al., 2004).

Much of the research to date on in-hospital patient safety has been completed through medical records review. The impact of such research on the practice and policy environments has been significant. Notwithstanding the quality of the information derived, medical record reviews are time consuming, labour intensive and expensive. Limited but important research on patient safety has been completed using large databases. While some of this research has focused on specific types of events (e.g., stroke-related fatalities, drug reactions, post-surgical fatalities) (Goldacre et al., 2002; Roberts and Goldacre 2003; Slonim et al., 2003), the Agency for Healthcare Research and Quality (AHRQ), using administrative data, has developed indicators of patient safety which cover a broad range of surgical, medical and obstetric events (Romano et al., 2003). The AHRQ, is a public health service agency in the U.S. whose mission is to improve the quality, safety, efficiency, and effectiveness of health care for all Americans (see www.ahrq.gov). The contribution of these indicators to the study of in-hospital patient safety is significant because of the breadth of coverage. This breadth relates to both types and levels of information. For example, multiple indicators of compromised patient safety related to surgical procedures have been developed (i.e., post-operative thromboembolism; accidental puncture/laceration; post-operative hemorrhage/hematoma) for which comparisons of rates can be made between regions, hospitals, sexes and ethnic groups (where data are available). This type of information allows for the identification of areas of

concern (e.g., high rates of post-operative hemorrhage at hospitals in a particular region) which can then be targeted with more intensive investigation (e.g., medical record review, case review).

Given the potential impact of administrative data on policy and practice, MCHP, as part of its contract with Manitoba Health, set out to develop indicators of patient safety using the MCHP Repository, and to identify and describe patterns of events which may indicate that patient safety had been compromised. Specific objectives of this exploratory study were:

1.   To develop indicators of compromised patient safety using the administrative claims data in the Population Health Research Data Registry housed at MCHP (herein referred to as the Repository)
2.   To assess the frequency and distribution of the indicators
3.   To compare indicators across regions and hospitals

1.1   Terminology

Patient safety is a rapidly growing field of study and there exist multiple definitions of relevant terms. Consistency in use of terms across studies has not been achieved. Three common concepts that are relevant to this study are defined below. The Canadian Patient Safety Institute (CPSI) has published a comprehensive patient safety dictionary that provides guidance to those interested in the field (see www.cpsi-icsp.ca).

Patient Safety – the reduction and mitigation of unsafe acts within the health care system, as well as through the use of best practices shown to lead to optimal patient outcomes (CPSI, 2003).

Medical Error – the failure to complete a planned action as intended or the use of a wrong plan to achieve an aim (Institute of Medicine, 2000; CPSI, 2003).

Adverse Event – an injury caused by medical management rather than by the underlying disease or condition of the patient (Brennan et al., 1991). Some, but not all adverse events are avoidable. A commonly described example of the difference between an avoidable and unavoidable adverse event concerns antibiotic administration. An allergic reaction to a new antibiotic would be an unavoidable adverse event. An allergic reaction following administration of an antibiotic to a patient with a known, recorded allergy to that medication is an example of an avoidable adverse event.

1.2   Project Goal

Were rates at certain hospitals greater than others? Were any red flags raised?

The indicators used in this report should be considered **screening tools** for the possibility of compromises to patient safety. The goal was to use the indicators to identify processes of care that may warrant further attention. In other words, were rates at certain hospitals greater than at others? Were any red flags raised? An important consideration is that the estimates contained in this report cannot be directly attributed to medical error. The indicators are screening tools which should be used to target further investigations into the circumstances surrounding the events. Medical error may be but one explanation. The benefits of the indicators rest in the breadth of investigation allowed and the ensuing targeted efforts at investigation and intervention.

1.3   Systems Approach

Due to the complexity of health care provision, a broader systems approach to patient safety is advantageous.

Although medical error has received a great deal of attention in the patient safety debate, it is only one component of the complex phenomenon of patient safety. However, when some type of in-hospital adverse event occurs, attention is directed to the outcome, and to identifying contributing factors. The contributing factors most actively pursued are the personnel; in other words, the primary objective of investigations into adverse events has been to discover those responsible. In research, many investigations have focused on identification of preventable adverse events and assessing the extent to which medical error is responsible (see literature review below). Using current patient safety parlance, investigation has been focused primarily at the "sharp end" of the spectrum, meaning the intersection point between patient and health care providers.   Most clinicians, academics and decision-makers involved in patient safety discussions currently recognize the complexity of health care provision and therefore advocate for a broader systems approach when analyzing and making recommendations on patient safety.

A systems approach is generally thought to contain at least these three elements: structure, process and outcome. According to one formulation, as described by the National Steering Committee on Patient Safety (2002), structure is best described as the "supporting network of essential parts that are present and/or contribute to all actions and activities" (p.6) and includes personnel (e.g., are there sufficient numbers? Do they have appropriate training and experience?); equipment (is it present? up-to-date? in working order?); environment (e.g., does the physical design enhance or detract from performance?); and administration (e.g., is there an organizational culture of safety?). Process is described as "what is done and how it is done", and includes communication, problem-solving, decision-making and conflict resolution. Examples of process include strategies to identify high-risk activities, and intervention with strategies to reduce predicted hazards. Outcome

refers to the product, result or effect. Outcomes can refer to physical and psychological well-being of patients and are measured in a variety of ways (p.6). Attempts at addressing in-hospital patient safety must incorporate the above components. Personnel remain one important aspect of the system, but not the sole focus of investigation or intervention. Advocates of a systems approach recommend structuring the workplace to enhance the work life of personnel.

The patient's underlying medical conditions should be included in any attempt to untangle the contributing factors.

Interestingly, the preceding model does not include the patient, or more specifically, the interaction of the system and the patient. One of the assumptions of the current discourse on patient safety is that we are investigating events which are outside of the patient. In other words, the events are not related to any underlying medical condition of the patient. For example, if a surgical patient receives the wrong dose of anesthetic and suffers some adverse event as a result of the medication error, the event would not be the result of an underlying physical condition, but may be the result of faulty equipment or operation of the equipment. On the other hand, a patient with a bleeding disorder who suffers a hemorrhage during or after surgery would be at high-risk for this event because of their underlying condition. However, most situations are not clear cut. Untangling the contribution of the myriad of factors is not an easy task, but the patient and his/her underlying medical conditions should be included in the equation.

1.4   Targeted Review of the Literature

Although the field of patient safety is fairly new, there is a burgeoning literature. Some of the seminal work and two smaller Canadian studies are summarized to provide context for the current study.

Harvard Medical Practice Study

The Harvard Medical Practice Study was the first study to provide population-based estimates of in-hospital adverse events. The design was a two-phase review of a random sample of 31,000 medical records at 28 hospitals in New York state in 1984 (Brennan et al., 1991). Included in the study were adult non-psychiatric patients. The first review was completed by registered nurses or medical records specialists who applied a standard screening form to assess the possibility of an adverse event. An adverse event was defined as "an injury that was caused by medical management (rather than the underlying disease) and that prolonged the hospitalization, produced a disability at the time of discharge, or both" (p.370). The second stage of review was completed by physicians (board-certified internists or surgeons). Using a standard review instrument, physicians assessed the medical records that met at least one of the screening criteria from stage one for evidence of adverse events and negligence (defined as "care that fell below the standard expected of physicians in their community"; the concept of negligence in

this study reflects tort law and issues of medical malpractice). Included in this review were adverse events that occurred prior to the incident hospitalization, but were discovered in the incident hospitalization. Adverse events were found in 3.7% of all hospitalizations; 27.6% of these were assessed as occurring due to negligence (the overall rate of adverse events due to negligence was 1%). Adverse events associated with a surgical procedure were the most common (48% of all adverse events) (Leape et al., 1991). This category included bleeding, wound healing, injury during the operation, emboli, pneumonia and infections. Adverse events associated with surgical procedures were assessed as the least likely to be caused by negligence (17%). The next most common adverse event was medication related, of which 18% were assessed as being caused by negligence. Brennan and colleagues (1991) estimated that among the almost 2.8 million people discharged from New York hospitals in 1984, there were 98,609 adverse events, of which 27,179 involved negligence. They concluded that there is a significant amount of injury to patients in hospital.

The Utah and Colorado Study

Using a similar methodology, a random sample of hospitalizations in 1992 (n=15,000) from a representative sample of Utah and Colorado hospitals were assessed for adverse events. Medical records underwent a similar two-stage review process. An adverse event and negligence were defined in the same way as the Harvard Medical Practice Study. Similar to the Harvard Study, adverse events that occurred prior to the incident hospitalization and were either: (a) the cause of the incident hospitalization, or (b) detected during the incident hospitalization, were included. Adverse events occurred in 3% of hospitalizations. Of the adverse events, 32.6% in Utah, and 27.5% in Colorado were assessed to be caused by negligence. Adverse events associated with a surgical procedure were the most common (45%); of these, 17% were assessed as being caused by negligence. Medication-related adverse events were the next most common (19%); 35% were assessed as being caused by negligence. These results are consistent with the Harvard Medical Practice Study.

The Quality in Australian Health Care Study

A study similar to the Harvard Medical Practice and Utah and Colorado studies was completed in the states of New South Wales and South Australia. A random sample of 14,000 hospitalizations in 1992 were reviewed by a similar two-stage process. Adverse event was defined in the same way as the two American studies. Reviewers did not attempt to assess negligence, but rather assessed preventability, which is associated with quality improvement rather than malpractice. A much higher rate of adverse events was found; 16.6% of hospitalizations had an adverse event associated with them. Fifty-one percent of these adverse events were assessed as preventable (Wilson et al., 1995).

The prevalence of adverse events was substantially greater in the Australian study compared with the two U.S. studies. Thomas and colleagues (2000c) reviewed the Australian and Utah and Colorado studies and found that methodological differences accounted for some, but not all, of the differences in adverse event estimates. For example, a lower threshold was required to define causation by medical management in the Australian study, compared with the U.S. study. In addition, the Australian reviewers included events which occurred in the incident hospitalization but were not discovered until after discharge. When the Australian data were re-analyzed according to the Utah and Colorado methodology, the prevalence of adverse events was found to be 10.6%. This estimate is still three times greater than the American estimate. As patient and hospital characteristics did not seem to account for difference, the authors speculated that the difference may be due in part to a lower quality of care in the Australia hospitals and/or differences in medical record content and reviewer behavior.

British Hospital Study

Vincent and colleagues (2001) reviewed random samples of medical records (n=1,014) from two London hospitals in 1999 and 2000. A similar two-stage review process was used. Adverse events were defined as unintended injuries caused by medical management rather than by disease processes. Adverse events were included if they occurred in the incident hospitalization, but could have been detected at a later time. The prevalence of adverse events among the sample was 10.8%, of which 48% were assessed as preventable.

The Canadian Adverse Event Study

Using a similar methodology as the Harvard Medical Practice Study, Baker and colleagues (2004) determined the rate of in-hospital adverse events in five Canadian provinces (British Columbia, Alberta, Ontario, Quebec and Nova Scotia). In each province one teaching hospital (defined as hospitals with full-time core residency training programs in medicine and surgery), one large community hospital (100 or more beds), and two smaller community hospitals (fewer than 100 beds) were selected. No specialty hospitals were included. Medical records were randomly selected at each hospital (n=3,745). Inclusion criteria were those over 18 years of age whose stay in hospital during the 2000 calendar year was at least 24 hours. Patients with psychiatric or obstetric admissions were excluded. A two-stage review process was conducted, with nurses or health records professionals conducting the first stage, and physicians conducting the second stage. Adverse event was defined as, "unintended injury or complication that resulted in disability, death or prolonged hospital stay and was caused by health care management rather than by underlying disease process" (p. 1,684). Preventability was assessed, by physicians, using a 6-point scale. An adverse event rate of 7.5% was determined. Of these, 37% were assessed as preventable. The most common types of adverse events were associated with surgical procedures (34%) , followed by medication or fluid-related events (24%).

Other Canadian Studies

Forster and colleagues (2003) estimated the incidence and severity of adverse events after discharge from hospital using a prospective cohort design. Four hundred consecutive patients discharged home from the general medical service at an urban acute care facility were followed via medical record review and a telephone interview. Physicians completed case summaries based on phone interviews and data from patient hospitalizations, including discharge summary, ER and clinic notes, operative and procedure notes, and laboratory and diagnostic test results. Telephone interviews consisted of questions about the patient's condition since discharge. Patients were also asked about use of health services since discharge. Adverse events were defined as injuries occurring as a result of medical management; preventable adverse events were defined as events judged to have been caused by an error; and ameliorable adverse events were those events whose severity could have been decreased. Two different physicians determined occurrence of adverse events through review of the case summaries and telephone interview data using standard scoring scales. Nineteen percent (19%) of patients were assessed as having adverse events after discharge. Of these, 6% were deemed preventable and another 6% were ameliorable. Seventy-six percent (76%) of adverse events were adverse drug events and 17% were related to procedures. Examples of adverse events included non-monitoring of electrolyte levels post-discharge despite indications related to post-discharge medications; discharge from hospital prior to arranging of home care services contributed to a fall in an elderly frail patient; adverse drug interaction not captured in timely manner; and misdiagnoses. The authors concluded that adverse events were frequent in the discharge period, some of which could have been prevented with simple strategies.

Finally, Forster (2004) and colleagues completed a two-stage review of 500 random hospitalizations to identify adverse events, and the timing and location of the adverse events (i.e., did they occur prior to or during the incident hospitalization?). The prevalence of adverse events among this sample was determined to be 13%. Thirty-seven percent of these were deemed preventable. The most common type of adverse events were medication-related (50%), followed by those related to surgical procedures (31%) and nosocomial infections (19%). Sixty-one percent (61%) of the adverse events occurred prior to the incident hospitalization. Of these, 31% occurred during ambulatory care (e.g., physician's office, home or nursing home), 25% occurred during a previous hospitalization, and 5% during a previous emergency department visit. Interestingly, pre-hospital events that occurred in the ambulatory setting were predominantly medication-related and were often preventable (45%). Those that occurred in previous hospitalizations were frequently surgical-related and deemed less preventable (25%). In this sample, adverse events were common, however, only one-third were assessed

as preventable. Interestingly, a good proportion of adverse events occurred in the ambulatory setting, which has implications for patient safety intervention in other than hospital settings.

Impact of Adverse Events

Researchers using similar medical record review methodologies in a number of countries have demonstrated that adverse events are not uncommon in the hospital setting. But what is the impact of these adverse events? Most of the studies reviewed above assessed impact through outcomes such as length of hospital stay, disability (temporary or permanent), readmission to hospital and death. For example, reviewers for the Harvard Medical Practice estimated the degree of disability that resulted from an adverse event using a 6-point scale originally developed for insurance purposes. The majority of adverse events were associated with a disability that persisted for less than six months (70.5%), but 2.6% were responsible for permanent disability and 13.6% led to death (Brennan et al., 1991). In the Utah and Colorado study, 16.6% of operative adverse events resulted in permanent disability; 3.9% of operative adverse events judged to be negligent resulted in permanent disability. Medication-related adverse events resulted in permanent disability in 9.7% of cases, and 2.7% of cases judged to be negligent. Death occurred in 8.8% of negligent adverse events (Thomas et al., 2000c). In Australia, disability associated with the majority of adverse events resolved within 12 months. However, in 13.7% of adverse events, disability was permanent. Five percent of patients with adverse events died as a result of the event (Wilson et al., 1995). In the UK study, most adverse events were associated with minimal impairment or resolution within one month; 19% resulted in moderate impairment; 6% in permanent impairment; and 8% contributed to death. The authors estimated that the adverse events identified in this study resulted in almost 1,000 extra days in hospital, of which 46% were preventable (Vincent et al., 2001). In the Canadian Adverse Event Study, most adverse events (64%) were associated with no disability or minimal disability that resolved within six months. However, 5% of adverse events resulted in permanent disability and 16% resulted in death (Baker et al., 2004). Thus, while most adverse events resulted in little permanent disability, 3 to 5% in all studies were assessed as leading to permanent disability and 5 to 16% resulted in death.

Criticism of In-Hospital Adverse Event Studies

There has been a fair amount of criticism in the literature regarding estimates on the impact of adverse events, especially in relation to the number of deaths due to medical error as reported in the Institute of Medicine (IOM) *To Err is Human* Report (McDonald et al., 2000; Hughes, 2000; Honig et al., 2000; Anderson, 2000; Hayward and Hofer, 2001). Critics contend that while the discussion of patient safety and recommendations made in the IOM Report was sound and timely, the estimates of death due

to medical error were reported without context or the caveats placed by the original researchers. As Hayward and Hofer (2001) argue, if the estimated number of deaths due to medical error in U.S. hospitals is correct (i.e., 44,000 – 98,000 deaths per year), "then the health care system is a public health menace of epidemic proportions" (p. 415). Critics of these estimates cite two major limitations of the studies upon which the estimates were based. First, the methodologies favor high-severity cases and no control group was included to provide "baseline" rates of death. In other words, the risk of death among a similar group of patients, among whom adverse events did not occur, is not known; and second, the level of agreement between physician reviewers on identification of adverse events as being pre-ventable or due to negligence, or causing death, was low to moderate (0.24 – 0.47; most reported a kappa coefficient, which corrects for agreement by chance). Thus, there was not often good agreement between reviewers on the chances of a different (better) outcome had care been optimal. Hayward and Hofer (2001) also demonstrate in a Veterans Administration patient sample, that the majority of patients whose deaths were assessed as preventa-ble had optimal care been provided, would not have survived longer than three months post-discharge. Thus, patient prognosis may be an important factor in such studies, but is not accounted for.

1.5 Summary

As critics of the preceding studies are quick to point out, their critiques are not meant to undermine the research or minimize the consequences of adverse events on patient safety and quality of care. Rather, they are meant to serve as a reminder to be aware of the context and limitations of the research. Researchers using similar medical record review methodologies in a number of countries have demonstrated that adverse events are not uncommon in the hospital setting, and neither is their impact insignificant. Research on the occurrence of adverse events is vital, therefore, because it is the first step in the long process of analysis (i.e., why are they occurring?) and intervention, with the ultimate goal of prevention.

Administrative Data and Patient Safety
The preceding limited literature review provides an indication of the depth of information that can be obtained from medical record reviews. The labour intensiveness of the work is also evident. Administrative data are beginning to be used as a complement to medical record reviews in research on the prevalence of, and factors associated with, adverse events. Administrative data offer the advantage of breadth of coverage. Researchers affiliated with AHRQ in the U.S., have completed seminal work with administrative data.

The AHRQ, is a public health service agency in the U.S. whose mission is to improve the quality, safety, efficiency, and effectiveness of health care for all Americans (see www.ahrq.gov). In the 1990's, researchers at AHRQ, using administrative data, developed a set of indicators to identify potential occurrences of compromised patient safety (Miller et al., 2001). Romano and colleagues (2003) later expanded and refined these initial indicators through an extensive process of indicator identification, definition and validation. The indicators, which are termed 'patient safety indicators', were defined using ICD-9 CM codes and built on the work of Iezonni (1994), who had previously developed indicators of complications of hospital care, also using administrative data, in addition to Miller (2001). Romano and colleagues developed 34 indicators; 20 were accepted for use (full list provided in Table 1.1). While many of the indicators relate to surgical procedures (e.g., anesthesia reactions and complications, post-operative hemorrhage/hematoma), obstetric and medical events are also represented.

Table 1.1: AHRQ patient safety indicators (2003)

AHRQ Patient Safety Indicators
Anesthesia reactions and complications
Death in low-mortality medical DRGs
Death in low-mortality surgical DRGs
Decubitus ulcer
Failure to rescue
Foreign body left during procedure
Iatrogenic pneumothorax
Infection due to medical care
Post-operative hip fracture
Post-operative hemorrhage/hematoma
Post-operative physiologic or metabolic derangement
Post-operative respiratory failure
Post-operative thromboembolism
Post-operative septicemia
Post-operative abdominopelvic wound dehiscence
Accidental puncture/laceration, surgical cases
Accidental puncture/laceration, medical cases
Transfusion reaction
Birth Trauma; injury to neonate
Obstetric trauma, vaginal delivery with instrumentation
Obstetric trauma, vaginal delivery without instrumentation
Obstetric trauma, cesarean delivery

Source: Manitoba Centre for Health Policy, 2006

These 20 indicators were applied to the 1995–2000 Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS), which is a database containing hospital utilization data from approximately 1,000 hospitals in 28 American states. Weights were applied to derived estimates to obtain national estimates. Estimates were provided for U.S. non-federal acute care hospitals and reported by age and sex, race and hospital type. In general, patient safety events increased with age and were greater among African Americans compared to caucasians. Incidence was greater at urban teaching hospitals compared to urban non-teaching and rural hospitals.

CHAPTER 2:   METHODS

2.1   Overview

A Working Group comprising representatives from Manitoba Health, the WRHA, and practicing clinicians was established to advise and provide feedback on the project. Indicators were selected and developed based on a review of the literature, the feasibility of using administrative data, and the input of physician Working Group members. Based on these criteria the following indicators of compromised patient safety were selected for this report: (1) a selection of "Patient Safety Indicators" (PSIs) developed by AHRQ in the U.S., and (2) measures of complications related to laparoscopic cholecystectomy (removal of gallbladder). The hospitals included in the analyses completed for this report are listed in Table 2.1. Only tertiary and community hospitals were included in the analyses using the Patient Safety Indicators (Chapter 3). The PSI analyses were restricted to tertiary and community hospitals because the types of procedures that may place patients at risk for the events represented by the indicators are most common at these types of facilities and less common at rural hospitals. The major and intermediate hospitals were included in the analyses of laparoscopic cholecystectomy (Chapter 4) because laparoscopic cholecystectomy is completed at all hospitals listed in Table 2.1.

Patient safety indicator analyses were restricted to tertiary and community hospitals. Procedures that place patients at risk are usually done at these types of facilities.

Table 2.1: Manitoba hospitals included in analysis

Winnipeg Tertiary	Winnipeg Community	Brandon Community	Major/Intermediate Rural	
Health Sciences Centre	Concordia	Brandon	Altona	Neepawa
	Grace		Beausejour	Portage
St. Boniface	Seven Oaks		Steinbach	The Pas
	Victoria		Boundary Trails	Ste. Rose
			Carman	Selkirk
			Dauphin	Souris
			Churchill	Swan River
			Flin Flon	Virden
			Gimli	Thompson
			Minnedosa	

Source: Manitoba Centre for Health Policy, 2006

2.2   Data Sources

The analyses for this report were based on the administrative data contained in the Repository, which is housed at MCHP. The Repository is a comprehensive database that contains records for all Manitobans' contacts with physicians, hospitals, home care, personal care homes, and pharmaceutical prescriptions. The Repository records are anonymous, as prior to data transfer Manitoba Health processes the records to encrypt all personal identifiers

and remove all names and addresses. Specific files used in this study were the hospital discharge abstracts data, physician claims, and the vital statistics registry. Five years of data were used in this project, covering the periods from April 1, 1999 through March 31, 2004 (i.e., fiscal years 1999/2000–2003/04).

2.3   General Inclusion and Exclusion Criteria

Inclusion criteria for the study are: Manitoba residents, aged 19 years and older during the study period. Psychiatric and obstetric patients are excluded from the study, except for the specific obstetric patient safety indicators.

2.4   Indicator Selection and Development

We addressed two essential components in the selection and development of patient safety indicators. First, the data necessary to measure each indicator needed to be readily accessible in the routinely generated administrative data available to MCHP. Second, practicing clinicians needed to accept the validity of each indicator as an acceptable measure of potential patient safety problems in the hospital environment. Based on this, indicators of possible patient safety problems selected for use in this study are: (1) a selection of Patient Safety Indicators developed by AHRQ and (2) measures of possible complications related to laparoscopic cholecystectomy.

The AHRQ-developed patient safety indicators provided us with indicators that were specifically developed for use with administrative data and have been validated. In addition, the AHRQ-developed patient safety indicators cover a broad range of diagnoses and patient types such that their use allowed a broad review of patient safety across the province.

Cholecystectomy surgery is a high-volume procedure in Manitoba, and is performed at hospitals in almost every RHA; this allowed for regional comparisons. In addition, one of the members of the Working Group (MT) has extensive surgical experience with open and laparoscopic procedures, as well as any procedures required as a result of complications during the cholecystectomy.

AHRQ-Based Patient Safety Indicators

As described in Chapter 1, most of the research on patient safety issues has used data derived from medical record review. However, the AHRQ in the U.S. has, for the past decade, been involved in the development and validation of indicators of complications of care and patient safety using administrative data (Romano et al., 2003; Miller et al., 2001; Iezonni et al., 1994).

PSIs were not designed to estimate the events among all hospital patients, but only for those who were not likely to be at risk of experiencing the event as a result of their medical condition.

Romano and colleagues report on the development and validation of 20 patient safety indicators (PSI); these indicators are listed in Table 1.1. One of the important features of the AHRQ Patient Safety Indicators is that they were developed to measure complications of hospital-based care among a group of patients for whom the complication seemed preventable or highly unlikely. In other words, the PSIs were not designed to derive estimates of the events among all hospital patients, but only among those who were likely not at risk of experiencing the event as a result of their medical condition. To accomplish this, AHRQ set out inclusion and exclusion criteria for most PSIs. For example, the inclusion criteria for 'birth trauma' are: live births. Excluded from this category are pre-term infants with a birth trauma diagnosis for cerebral or subdural hemorrhage, as well as infants diagnosed with osteogenesis imperfect who had a birth trauma diagnosis for injury to skeleton.   Some PSIs did not have any specific exclusionary criteria. For example, the criteria for 'accidental puncture or laceration' are all surgical discharges with ICD-9 CM codes denoting accidental puncture or laceration (e.g., accidental cut, puncture, perforation or laceration during a procedure) in any secondary diagnosis field (full AHRQ definitions and ICD-9 CM codes are found at www.quality indicators.ahrq. gov/data/hcup/qirefine.htm). A full listing of all PSIs used in this report including inclusion and exclusion criteria is found in Appendix A. The ICD-9 CM codes for each PSI are found in Appendix B.

Selection Process

A thorough review of the AHRQ PSI definitions resulted in the selection and subsequent modification of the indicators listed in Table 1.1. The following indicators were selected for the study:

- death in low-mortality surgical CMGs
- death in low-mortality medical CMGs
- iatrogenic pneumothorax
- post-operative hemorrhage/hematoma
- post-operative thromboembolism
- post-operative abdominopelvic wound dehiscence
- accidental puncture/laceration among surgical cases
- birth trauma (injury to neonate)
- obstetrical trauma, vaginal deliveries with instruments
- obstetrical trauma, vaginal deliveries without instruments

Reasons for exclusion of the other AHRQ indicators include too few events during the study period, incompatibility of coding styles across datasets, and non-specificity of indicator (e.g., failure to rescue).

Modification Process

Because of different coding practices between the Manitoba hospital discharge abstracts database and the dataset used by AHRQ in the develop-

ment of the PSIs, some modifications of the AHRQ PSI definitions were necessary. The following codes used in the HCUP dataset are not comparably defined in the Manitoba hospital discharge dataset: 'principal diagnosis', 'primary diagnosis', and 'secondary diagnosis' (see Table 2.2). In the AHRQ dataset 'principal diagnosis' refers to the condition that was present at admission and was assigned as the reason for the admission. 'Primary diagnosis' refers to the diagnosis that is responsible for the majority of the hospitalization. This may or may not be the same as the principal diagnosis. A 'secondary diagnosis' field refers to conditions that occur during the hospitalization, but are neither the reason for admission nor the main reason for the stay in hospital. In the Manitoba database, 'primary diagnosis' (P) is a code for pre-admission comorbidity diagnosis and refers to the diagnosis that had a significant influence on the patient's hospitalization. This may be similar to the AHRQ principal diagnosis. However, it is not consistently coded across the province. The 'most responsible diagnosis' (M), refers to the condition that is responsible for the majority of the hospitalization length of stay. In Manitoba, each hospitalization can be assigned up to 16 diagnoses (i.e., dx01-dx16). The most responsible diagnosis is a mandatory code that is assigned to the first diagnosis field (i.e., dx01). 'Secondary diagnosis' (S) refers to the diagnosis that may or may not have significantly contribute to the patient's hospitalization. This is not consistently recorded in the province. 'Complication, post-admission comorbidity' (C) refers to a condition that arises after admission and has a significant influence on length of stay or management in hospital. This is fairly consistently coded, but cannot

Table 2.2: Comparison of diagnostic codes between AHRQ dataset and Manitoba database

AHRQ	Manitoba Hospital Discharge Abstracts
Principal Diagnosis - refers to a condition that was present at admission and was assigned as responsible for the admission.	Primary diagnosis (P) - code for pre-admission co-morbidity diagnosis that had a significant influence on the patient's hospitalization. - not consistently coded.

Primary Diagnosis
  - diagnosis that is responsible for the majority of the hospitalization.
  - May or may not be the same as principal diagnosis.
	Most Responsible Diagnosis (M)
	  - the condition that is responsible for the majority of the hospitalization length of stay.
	  - Mandatory coding.
	  - Occupies dx01.

Secondary Diagnosis
- conditions that occur during the hospitalization.
	Complication, Post-admit comorbidity (C)
	  - condition that arises after admission and has a significant influence on length of stay or management in hospital.
	  - Fairly consistent coding.

	Secondary Diagnosis (S) - diagnosis that may or may not significantly contribute to the patient's hospitalization.

be considered completely comparable to the AHRQ 'secondary diagnosis'. Two modifications to the AHRQ PSI definitions were required. First, when the AHRQ definition specified any 'secondary diagnosis field', we included any diagnoses found in fields dx02-dx16 and excluded any diagnosis identified as the 'most responsible diagnosis' (i.e., dx01). Second, instead of DRGs, we used CMGs. Therefore, the patient safety indicator, *'death in low-mortality DRGs'*, became *'death in low-mortality CMGs'*. CMGs and DRGs are both patient classification systems that group patients into clinically similar categories based on diagnoses and other hospital data. CMGs are a Canadian patient classification system, while DRGs are an American patient classification system.

The Canadian Institute for Health Information (CIHI) recently modified some of the AHRQ PSI definitions (CIHI, 2004) and we followed their definitions for 'death in low-mortality CMGs'; 'obstetrical trauma, vaginal deliveries with instruments'; 'obstetrical trauma, vaginal deliveries without instruments'; 'post-operative thromboembolism'; and 'accidental puncture/laceration' (see Appendix A and B). Differences in coding that exist between the Manitoba and CIHI datasets are reviewed in Table 2.3.

Table 2.3: Comparison of diagnostic codes between Manitoba and CIHI databases

CIHI Discharge Abstract Database	Manitoba Hospital Discharge Abstracts
Type 1 Pre-Admit Comorbidity Diagnosis - the diagnosis which has a significant influence on the patient's hospitalization.	Primary diagnosis (P) - code for pre-admission co-morbidity diagnosis that had a significant influence on the patient's hospitalization. - not consistently coded.
Type 2 Post-Admit Comorbidity Diagnosis - the diagnosis which describes a condition arising during the patient's hospitalization	Complication, Post-admit comorbidity (C) - condition that arises after admission and has a significant influence on length of stay or management in hospital. Fairly consistent coding.
Type 3 Secondary Diagnosis - the diagnosis which did not significantly contribute to the patient's hospitalization	Secondary Diagnosis (S) - diagnosis that may or may not significantly contribute to the patient's hospitalization.
Type 9 External Cause of Injury Diagnosis	External Cause of Injury (E)

Source: Manitoba Centre for Health Policy, 2006

2.5   Reporting

Rates of patient safety indicators were age- and sex-adjusted to the 2001/02 Manitoba in-patient hospital. Because the indicators are in the development phase, results are presented anonymously, meaning that while rates are reported by hospital, the identity of the hospital has been concealed. Where possible, two graphs are presented for each patient safety indicator. One of the graphs includes rates at the two Winnipeg tertiary hospitals plus the U.S. rate for urban teaching hospitals as reported by Romano and colleagues

(2003). A second graph includes the Manitoba community hospitals and the U.S. urban community hospital rate as reported by Romano and colleagues (2003).

Comparisons were made between individual Manitoba hospitals and the U.S. average rates on most indicators. The AHRQ PSI rates represent U.S. national estimates, and are therefore useful for comparison purposes. Comparison to U.S. rates have not been made for death in low-mortality medical and surgical CMGs because the U.S. rates are reported by DRG. Comparisons of rates of accidental puncture/laceration are also not possible because the U.S. rate by hospital type combined surgical and medical cases, and we reviewed only surgical cases.

2.6   Cholecystectomy

2.6.1   Definition

The following ICD-9 CM codes were used to identify cholecystectomy: 51.22 (open) and 51.23 (laparoscopic). Both inpatient and outpatient (day surgery) procedures were included. During the five-year study period, 1999/2000– 2003/04, 13,219 laparoscopic procedures and 1,160 open procedures were performed. The analysis for this report will be restricted to laparoscopic procedures. Approximately 7% of laparoscopic procedures were converted to open during the procedure. This means that these procedures were initially scheduled as laparoscopic, began as laparoscopic, and because of complexity or other difficulties were converted to open procedures. These converted cases were included in the laparoscopic category in all analyses in this report.

2.6.2   Definitions of Possible Complications

The following indicators were investigated as possible complications associated with laparoscopic cholecystectomy: post-operative hemorrhage/hematoma, accidental puncture or laceration, and subsequent biliary surgery. Subsequent biliary surgery was investigated because it is a marker for bile duct surgery, which is the most serious complication of cholecystectomy. This category includes the following procedures: extrahepatic biliary ducts, plastic reconstruction, with CBD end-to-end anastomosis; extrahepatic biliary ducts and gastrointestinal tract direct CBD-GI anastomosis; and extrahepatic biliary and gastrointestinal tract, Roux-en-y hepatico-jejunostomy. ICD-9 CM and tariff codes were used to identify these complications (Appendix B).

2.6.3   Rates of Cholecystectomy

The rates of laparoscopic cholecystectomy were age- and sex-adjusted to the 2001/02 Manitoba population and are reported by the RHA in which people live. In other words, if an individual from North Eastman RHA has a

laparoscopic cholecystectomy at a Winnipeg community hospital, the event will be assigned to the North Eastman RHA in the calculation of the rate for residents of that RHA.

2.6.4 Rates of Possible Complications

Because we are interested in the provision of care by hospital and hospital type, rates of possible complications are assigned to the hospital at which the surgery was performed. For example, the outcomes of the individual from North Eastman RHA who had their laparoscopic procedure performed at a Winnipeg community hospital would be assigned to the Winnipeg community hospital, and not to the rural hospital category.

2.6.5 Reporting

Because the indicators of potential complications are in the development phase, results are presented anonymously, meaning that while rates are reported by hospital, the identity of the hospital has been concealed. The code used for reporting patient safety indicator results by hospital is the same for the cholecystectomy chapter. For example, hospital A refers to the same hospital in Chapter 3 (Patient Safety Indicators) and Chapter 4 (Cholecystectomy). The major and intermediate hospitals have been added to Chapter 4. Individual hospitals within the category are not identified. (Hospital categories have been identified in Chapter 3, i.e., tertiary and community).

2.7   Morbidity Index

The morbidity index is a measure of the general level of sickness of individuals relative to the entire Manitoba population. The index is derived from the ACG system, which is a population/patient case-mix adjustment system developed by researchers at Johns Hopkins University School of Hygiene and Public Health. The ACG case-mix adjustment system characterizes clinical conditions from ICD-9 diagnoses extracted from physician reimbursement claims and hospital discharges. It is a risk adjustment tool developed to measure the illness burden (morbidity) of individual patients / enrolled populations and their expected or actual consumption of health services. This system quantifies morbidity by grouping individuals based on their age, gender and all known medical diagnoses assigned by their health care providers over a defined time period (typically one year). The ACG system measures health status by grouping patient diagnoses (based on ICD-9 CM codes) into clinically meaningful groups, based on expected clinical outcomes and resource use. Calculation of the ACG is based on physician visits and hospital stays for a period of one year prior to the index date of interest. In addition to grouping individuals by all known medical diagnoses, they are also grouped based on their age and sex (Reid et al., 2002).

In this study, the morbidity index refers to a measure of the general level of sickness of individuals relative to the average Manitoban. The index was calculated separately for Winnipeg and non-Winnipeg residents because on average, Winnipeg residents have more physician visits than non-Winnipeg residents, and therefore may appear more ill than they may be. ACGs were calculated based on all physician visits and hospitalizations for a one-year period prior to the hospitalization of interest. To construct the morbidity index, we first determined each individual's ACG category, which reflected his/her level of sickness over the past year. Then a 'morbidity weight' (i.e., the average provincial costs per ACG) was assigned to each individual to estimate their morbidity. The morbidity index was derived by dividing the average ACG cost for each condition under study (i.e., the sum of the groups ACG morbidity weights divided by the number in the group), by the overall provincial average (Reid et al., 1999). Index values less than one indicate that the group under study is healthier than the general population, (either Winnipeg or non-Winnipeg) while values greater than one indicate that the group is less healthy than the average Manitoban. In this study we explored the relationship between morbidity and the rates of patient safety indicators and complications. An important limitation of this index is that morbidity can be underestimated among ill individuals who either do not seek, or lack access to medical care.

2.8   Socioeconomic Factor Index (SEFI)

SEFI is a score that reflects non-medical social determinants of health and include factors such as age, single-parent status, female labour force participation, unemployment and education (Martens et al., 2002). SEFI is calculated at enumeration area and assigned to residents based on postal codes. The lower the SEFI score, the more favourable the socioeconomic conditions. In this study we explored the relationship between socioeconomic position and rates of patient safety indicators and complications.

2.9   Statistical Comparison

2.9.1 Patient Safety Indicators (PSI)

Comparisons were made between individual Manitoba hospitals and the U.S. average rates on most indicators. The AHRQ PSI rates represent U.S. national estimates, and although the rates cannot be considered benchmarks, they are useful for comparison purposes given that we are using these indicators for the first time in Manitoba. Confidence limits (99%) were derived for estimates on the individual Manitoba hospitals. The difference in PSI rates between individual Manitoba hospitals and the U.S. average was considered statistically significant if the U.S. average value fell outside the confidence interval of the individual hospital estimates.

2.9.2 Cholecystectomy

Comparisons on possible complications were made between individual hospitals or hospital types and the Manitoba average rates. Confidence limits (99%) were derived for estimates on the individual hospitals and hospital types. The difference in rates between individual hospitals and the Manitoba average was considered statistically significant if the Manitoba average value fell outside of the confidence interval of the individual hospital and hospital-type estimates.

2.9.3 Relative Risk of Death (RR)

The potential impact of select patient indicators on patient outcomes was assessed by determining the risk of death among patients with a recorded occurrence of the indicator relative to those who did not have a recorded occurrence of the indicator. The relative risk of death was determined as follows:

$$RR = \frac{proportion\ of\ deaths\ among\ relevant\ cases\ with\ a\ recorded\ occurrence\ of\ a\ PSI}{proportion\ of\ deaths\ among\ relevant\ cases\ without\ a\ recorded\ occurrence\ of\ a\ PSI}$$

Due to the small numbers of events and deaths for most of the patient safety indicators, only a select number of indicators could be included in this portion of the analysis. Patient safety indicators included in this portion of the analysis are:

- post-operative thromboembolism
- accidental puncture/laceration
- iatrogenic pneumothorax
- post-operative hemorrhage/hematoma
- post-operative abdominopelvic wound dehiscence

Comparisons among hospitals are possible for post-operative thromboembolism, accidental puncture/laceration and post-operative hemorrhage/hematoma.

CHAPTER 3:   PATIENT SAFETY INDICATORS (PSIS)

Rates of the patient safety indicators (PSIs) were derived for Manitoba terti-ary and community hospitals. Hospitals included in this report are listed in Table 2.1. Rates for Manitoba hospitals are based on data covering the five-year period from 1999/2000–2003/04.

The age- and sex-adjusted rates of patient safety indicators for included Manitoba hospitals are listed in Table 3.1. The "number of relevant cases" is found in column 2 and represents the number of patients "at risk" for the event, as defined by AHRQ or CIHI. This number is the denominator in calculations of crude and adjusted rates. The numbers of events are found in column three and are determined by the inclusion criteria for each PSI as defined by AHRQ or CIHI. The age- and sex-adjusted rate per 100 is found in column four. The final two columns contain the 99% upper and lower confidence limits. Definitions and inclusion/exclusion criteria (including ICD-9 CM codes) for each PSI are found later in this chapter and in Appendix A and B.

Table 3.1: Age and sex-adjusted rates of patient safety indicators (PSIs) for Manitoba hospitals per 100 related hospitalizations, 1999/2000 – 2003/04

Patient Safety Indicator (PSI)	Number of Relevant Cases	Number of Events	Adjusted Rate (%)	Lower Limit (99%)	Upper Limit (99%)
Death in low mortality surgical CMGs	50,063	140	.38	.30	.48
Death in low mortality medical CMGs	41,584	455	1.17	1.04	1.32
Post-operative thromboembolism	113,483	778	.74	.67	.81
Accidental puncture/laceration, surgical cases	113,737	1,538	1.36	1.27	1.46
Iatrogenic pneumothorax	211,708	216	.10	.08	.12
Post-operative hemorrhage/hematoma	104,531	258	.26	.22	.30
Post-operative abdominopelivic wound dehiscence	28,231	109	.46	.35	.59
Injury to neonate	52,556	126	.24	.19	.30
Obstetrical trauma, vaginal delivery, with instrumentation	3,442	735	21.34	19.61	23.22
Obstetrical trauma, vaginal delivery, without instrumentation	38,410	1,153	3.00	2.78	3.24

Overall, the rates of patient safety indicators were very low. Rates ranged from 0.10% for iatrogenic pneumothorax ("punctured lung"), to 3% for obstetrical trauma associated with vaginal births when no instruments were used. One rate that stands out is that for obstetrical trauma in vaginal deliveries when instruments were used. The rate was 21.34%. Instrument use during delivery is a high-risk procedure that is used to prevent further harm to the baby.

3.1   Distribution by Age and Sex

The crude rates of each PSI are provided in Table 3.2, by sex and age groups. Rates are provided per 100 in columns three to six for the following age groups: non-obstetric PSIs: 19-39, 40-64, 65-74, and 75 years and over; obstetric PSIs: 12-21, 22-28, 29-36 and 37 years and over.

Table 3.2: Crude rates of patient safety indicators (PSIs) per 100 related hospitalizations by age group and sex, 1999/2000 – 2003/04

Patient Safety Indicator	Sex	Age Group			
		19-39	40-64	65-74	75+
Death in low-mortality surgical CMGs	Male	0	.08	.37	.85
	Female	s	.09	.28	.92
Death in low-mortality medical CMGs	Male	s	.35	.89	2.60
	Female	s	.25	.66	3.01
Post-operative thromboembolism	Male	.35	.61	.97	1.03
	Female	.17	.38	.74	1.28
Accidental puncture/laceration, surgical cases	Male	.96	1.23	1.53	1.59
	Female	1.23	1.35	1.51	1.35
Iatrogenic pneumothorax	Male	.07	.11	.10	.12
	Female	.06	.08	.15	.12
Post-operative hemorrhage/hematoma	Male	.21	.27	.42	.36
	Female	.19	.17	.21	.24
Post-operative abdominopelvic wound dehiscence	Male	.38	.39	.90	1.11
	Female	s	.14	.47	.33
	Sex	Age Group			
		12-21	22-28	29-36	37+
Obstetrical trauma, vaginal delivery, with instruments	Female	20.9	20.05	22.88	20.63
Obstetrical trauma, vaginal delivery, without instruments	Female	2.94	2.82	3.31	2.43

s data suppressed due to small numbers of events. MCHP does not report events

Source: Manitoba Centre for Health Policy, 2006

Rates increased with age for most of the non-obstetric patient safety indicators. Rates of the following PSI's were greater in males than females: post-operative thromboembolism (except for those aged 75 years and older), post-operative hemorrhage/hematoma and post-operative abdominopelvic wound dehiscence.

3.2   Differences Between Hospitals

Small but statistically significant differences in rates of patient safety indicators were observed between individual hospitals and U.S. average rates. The rates of events for Manitoba and U.S. hospitals are presented in Figures 3.1 to 3.10b.

Death in Low-Mortality Surgical CMGs
Definition: This indicator refers to in-hospital deaths among patients in surgical CMGs that have an overall in-hospital mortality rate of less than 1% in the CIHI Benchmarking database (CIHI, 2004).

Number of Relevant Cases (Denominator): Surgical CMGs with in-hospital mortality rate <1%.

Inclusion Criteria (Number of Events): Patients assigned to a Surgical CMG with an in-hospital mortality rate of less than 1%, who died.

Examples of procedures within this category include: ventricular shunt revision, PTCA, carpal tunnel release, extraocular procedures, reconstructive ENT procedures, sinus procedures, cardiac catheterization with ventricular tachycardia, abdominal laparoscopy, hip replacement, knee replacement, adrenal and pituitary procedures, parathyroid procedures, major gynecological procedures of ovaries or adnexal, and radical prostatectomy.

Exclusion Criteria: Patients with any code for trauma, immunocompromised state, or cancer.

Comparisons among hospitals in Manitoba are provided in Figure 3.1.

Figure 3.1: Rates of Death in Low-Mortality Surgical CMG by Hospital, 1999/2000 – 2003/04

Age- and sex-adjusted

Rates per 100

Source: Manitoba Centre for Health Policy, 2006
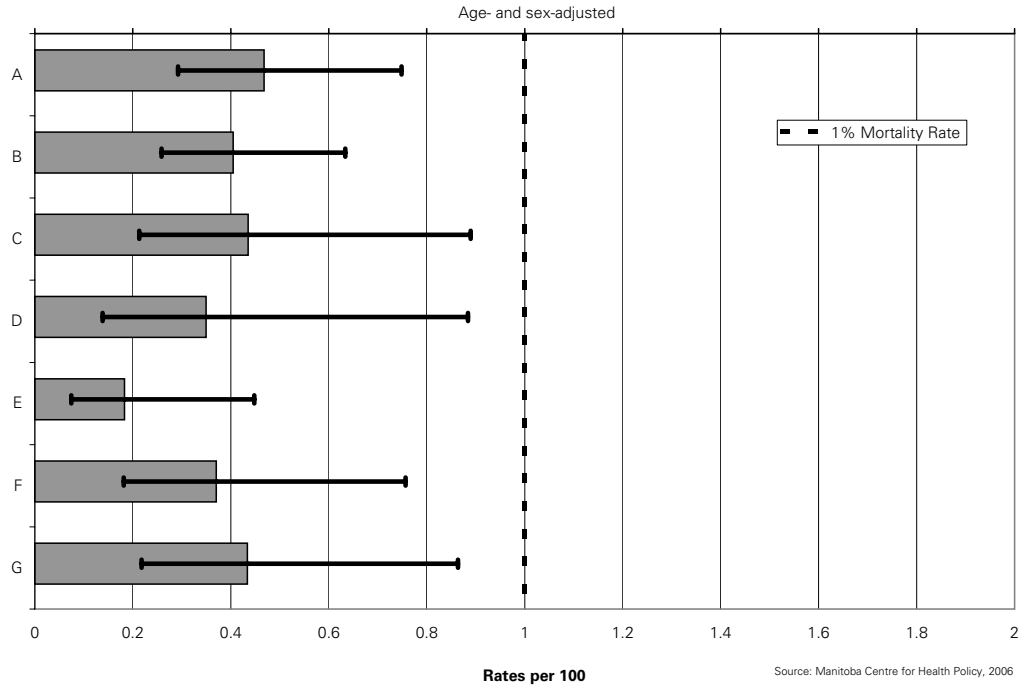
Rates of death in low-mortality surgical CMGs ranged from 0.18% to 0.47%, all below the 1% CIHI benchmark (CIHI, 2004).

Death in Low-Mortality Medical CMGs
Definition: This indicator refers to in-hospital deaths among patients in medical CMGs that have an overall in-hospital mortality rate of less than 1% in the CIHI Benchmarking database (CIHI, 2004).

Number of Relevant Cases (Denominator): Medical CMGs with in-hospital mortality rate <1%.

Inclusion Criteria (Number of Events): Patients assigned to a Medical CMG with an in-hospital mortality rate of less than 1%, who died.

Examples of diagnoses within this category include viral meningitis, seizure and headache, influenza, epistaxis, tracheobronchitis, asthma, syncope and collapse, inflammatory bowel disease, G.I. obstruction, cellulites, hematuria, male reproductive system inflammation, female reproductive infection, weight bearing injuries, minor lower extremity fractures, red blood cell disorders, and viral illness.

Exclusion Criteria: Patients with any code for trauma, immunocompromised state, or cancer.

Comparisons among hospitals in Manitoba are provided in Figure 3.2.

Figure 3.2: Rates of Death in Low-Mortality Medical CMG by Hospital, 1999/2000 – 2003/04
Age- and sex-adjusted

Rates per 100

Source: Manitoba Centre for Health Policy, 2006
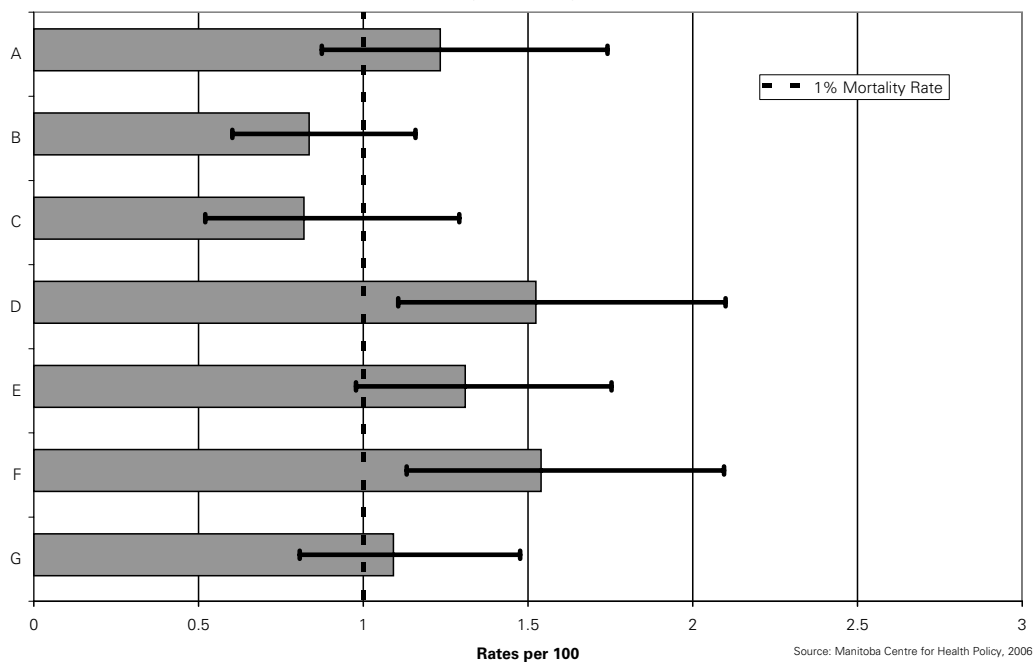
The rate of death in low-mortality medical CMGs ranged from 0.82% to 1.54%. Rates at hospitals D and F are statistically greater than the 1% benchmark (i.e., the confidence intervals do not include the 1% benchmark), whereas all other hospitals are similar to the overall 1% benchmark.

Post-Operative Thromboembolism
Definition: This indicator refers to cases of pulmonary embolism (PE) or deep-vein thrombosis (DVT) that occur post-operatively.

Number of Relevant Cases (Denominator): All surgical discharges, defined by CMGs (Appendix B).

Inclusion Criteria (Number of Events): Surgical patients with a post-admission deep vein thrombosis or patients with post-admission pulmonary embolism.

Exclusion Criteria: Patients whose most responsible diagnosis was post-operative thromboembolism. In this way we attempted to eliminate patients who presented to hospital with the problem. Also excluded were patients with a secondary procedure code for complication or other interruption of the vena cava when the procedure occurred on the day of or previous to the day of the principal procedure.

Comparisons between Manitoba and U.S. hospitals are provided in Figure 3.3a and 3.3b.

Figure 3.3a: Rates of Post-Operative Thromboembolism by Tertiary Hospitals, 1999/2000 – 2003/04

Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006
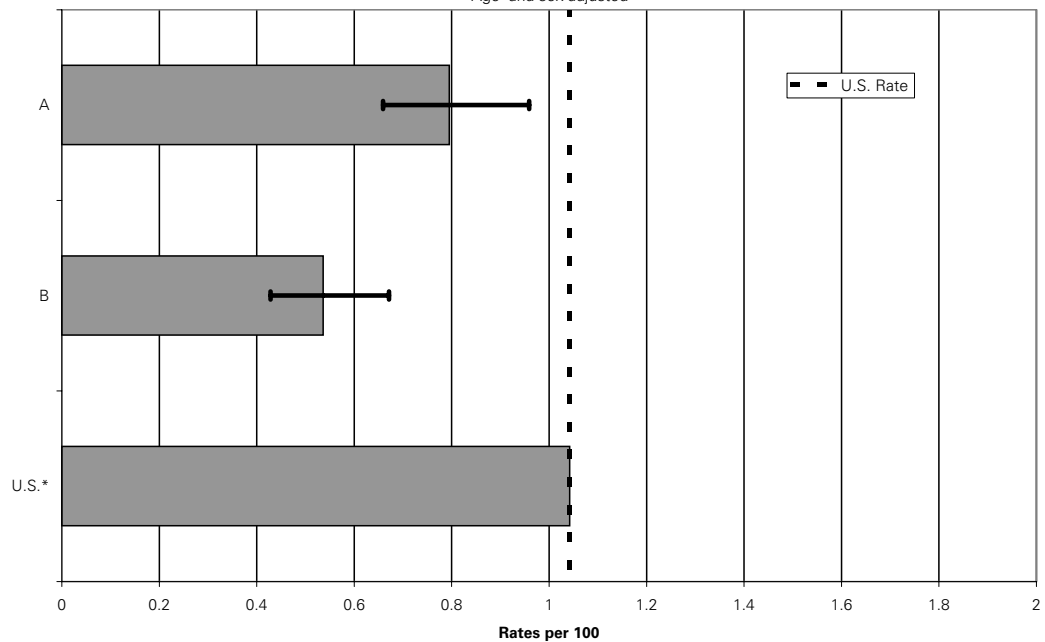
Figure 3.3b: Rates of Post-Operative Thromboembolism by Community Hospitals, 1999/2000 – 2003/04
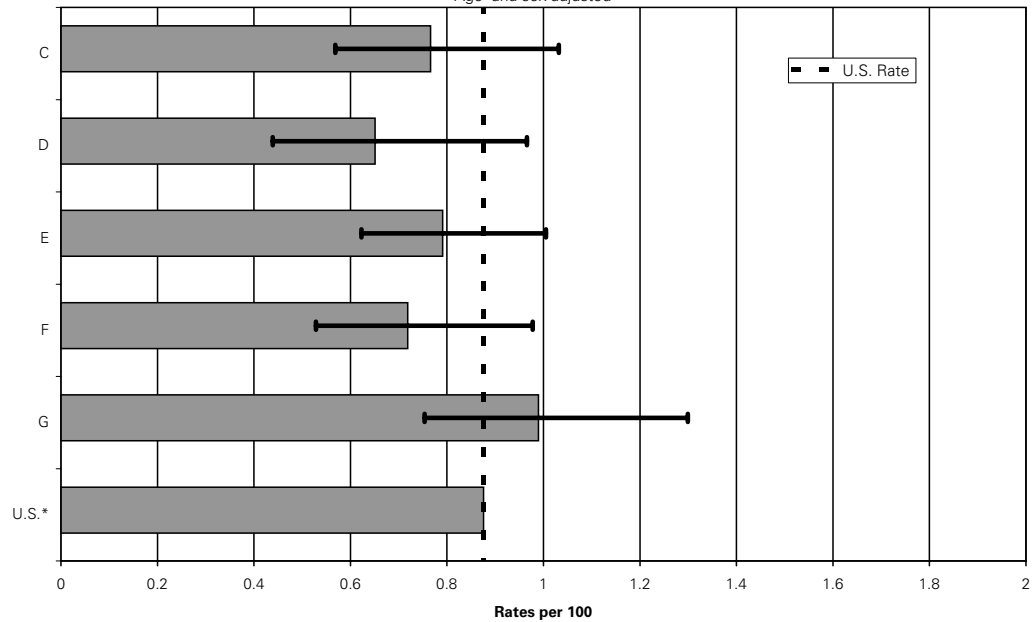
Age- and sex-adjusted

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006

Rates of post-operative thromboembolism at tertiary hospitals A (0.80%) and B (0.54%) are statistically lower than the reported U.S. rate of 1.04%. No statistical differences were found between the rates at Manitoba community hospitals (ranging from 0.65% - 0.99%) and the U.S. urban community hospital rate of 0.88%.

Accidental Puncture or Laceration During Surgical Procedures
Definition: This indicator captures reported occurrences of accidental cuts, punctures, perforations or lacerations during a surgical procedure.

Number of Relevant Cases (Denominator): All surgical discharges, defined by surgical CMGs (Appendix B).

Inclusion Criteria (Number of Events): All surgical patients who had a post-admission accidental puncture or laceration.

Exclusion Criteria: No specific exclusions.

Rates at Manitoba hospitals are found in Figure 3.4.

Figure 3.4: Rates of Accidental Puncture/Laceration by Tertiary and Community Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted

Rates per 100

Source: Manitoba Centre for Health Policy, 2006

The rate of accidental puncture or laceration during a surgical procedure ranged from 0.58% to 2.21%. The confidence intervals surrounding the rates observed for tertiary hospital A (2.15%) and community hospital C (2.21%) do not encompass those of the other hospitals. This may suggest a statistical difference in rates between those two Manitoba hospitals and the others.

Iatrogenic Pneumothorax
Definition: This indicator captures cases of pneumothorax ("punctured lung") caused by medical care.

Denominator (Number of Relevant Cases): Surgical and medical discharges, defined by DRGs.

Inclusion Criteria (Number of Events): All medical and surgical discharges with a code for iatrogenic pneumothorax in any secondary diagnosis field.

Exclusion Criteria: Patients with a diagnosis of trauma and those who have had thoracic surgery, lung or pleural biopsy or specified cardiac surgery (as defined by DRGs, Appendix B).

Rates of iatrogenic pneumothorax at Manitoba and U.S. hospitals are presented in Figures 3.5a and 3.5b.

Figure 3.5a: Rates of Iatrogenic Pneumothorax by Tertiary Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006

Figure 3.5b: Rates of Iatrogenic Pneumothorax by Community Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006

The rate of iatrogenic pneumothorax at Manitoba tertiary hospital A (0.19%) was statistically greater than the U.S. urban teaching hospital rate of 0.073%, whereas hospital B (0.06%) was similar. Rates of iatrogenic pneumothorax at all of the Manitoba community hospitals were similar to the U.S. non-teaching rate (0.07%) except for hospital E (0.15%) was significantly greater.

Post-Operative Hemorrhage/Hematoma
Definition: This indicator captured cases with codes for postoperative hemorrhage in a secondary diagnosis field **and** control of hemorrhage in any secondary procedure field, or postoperative hematoma in a secondary diagnosis field **and** drainage of hematoma in a secondary procedure field. These procedure codes must be on the same day or after the principal procedure.
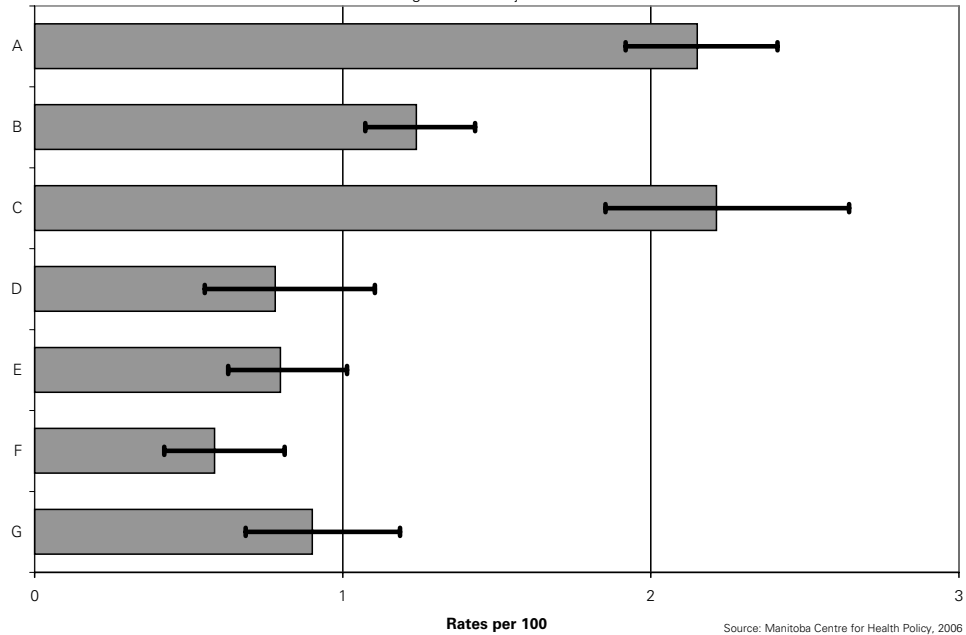
Number of Relevant Cases (Denominator): All surgical discharges, defined by DRGs (Appendix B).

Inclusion Criteria (Number of Events): All surgical discharges, with ICD-9 CM codes for postoperative hemorrhage or postoperative hematoma in any secondary diagnosis field **AND** code for postoperative control of hemorrhage or drainage of hematoma in any secondary procedure code field. Procedure code for postoperative control of hemorrhage or hematoma must occur on the same day or after the principal procedure.

Exclusion Criteria: No specific exclusions.

Age- and sex-adjusted rates of postoperative hemorrhage or hematoma are found in Figures 3.6a and 3.6b.

Figure 3.6a: Rates of Post-Operative Hemorrhage/Hematoma by Tertiary Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted
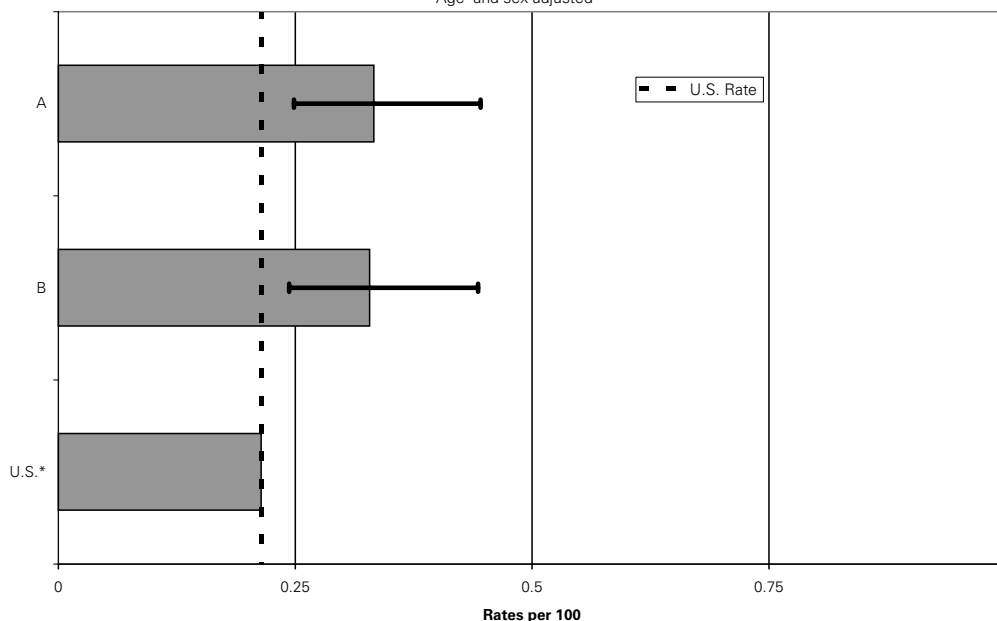
Rates per 100

* The U.S. rate is based on hospitalizations from 2000   Source: Manitoba Centre for Health Policy, 2006

Figure 3.6b: Rates of Post-Operative Hemorrhage/Hematoma by Community Hospitals, 1999/2000 – 2003/04

Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006
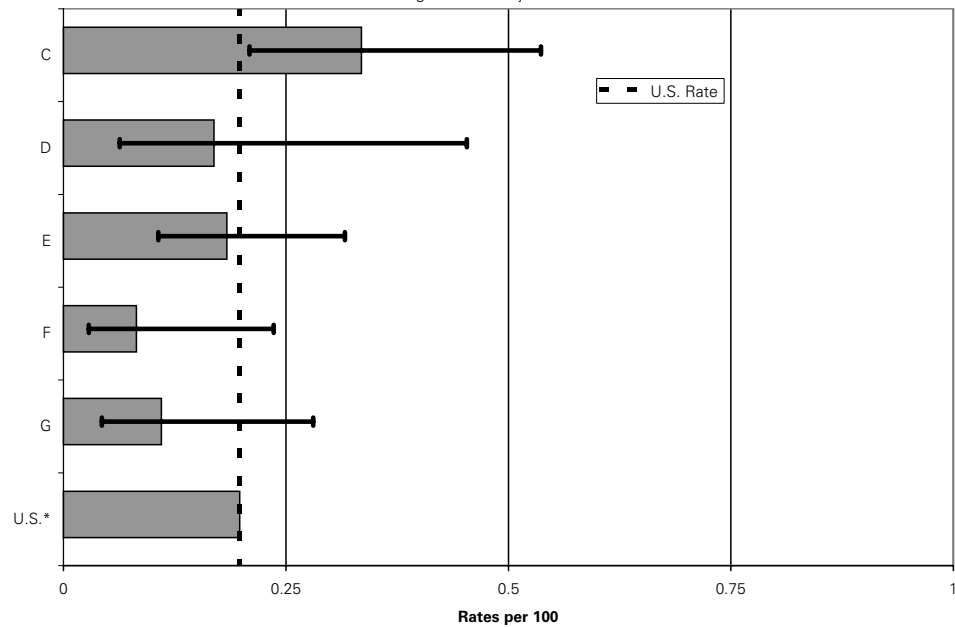
Rates of post-operative hemorrhage/hematoma at tertiary hospital A (0.33%) and tertiary hospital B (0.33%) are statistically greater than the rate at U.S. urban teaching hospitals (0.21%). The rate of post-operative hemorrhage/ hematoma is statistically greater at one, Manitoba community hospital C (0.33%) than the rate reported for U.S. urban community hospitals (0.20%), but the other four hospitals show rates similar to the U.S. rate.

Post-Operative Abdominopelvic Wound Dehiscence
Definition: This definition captures surgical cases that required re-closure of the surgical site as a result of its opening post-operatively. These cases required a second procedure.

Number of Relevant Cases (Denominator): All abdominopelvic surgical discharges, defined by abdominopelvic procedure codes (Appendix B).

Inclusion Criteria (Number of Events): All abdominopelvic surgical discharges with ICD-9 CM code for re-closure of postoperative disruption of the abdominal wall in any secondary procedure field.

Exclusion Criteria: No specific exclusions.

The age-and sex-adjusted rates of postoperative abdominopelvic wound dehiscence are presented in Figures 3.7a and 3.7b.

Figure 3.7a: Post-Operative Abdominopelvic Wound Dehiscence by Tertiary Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted
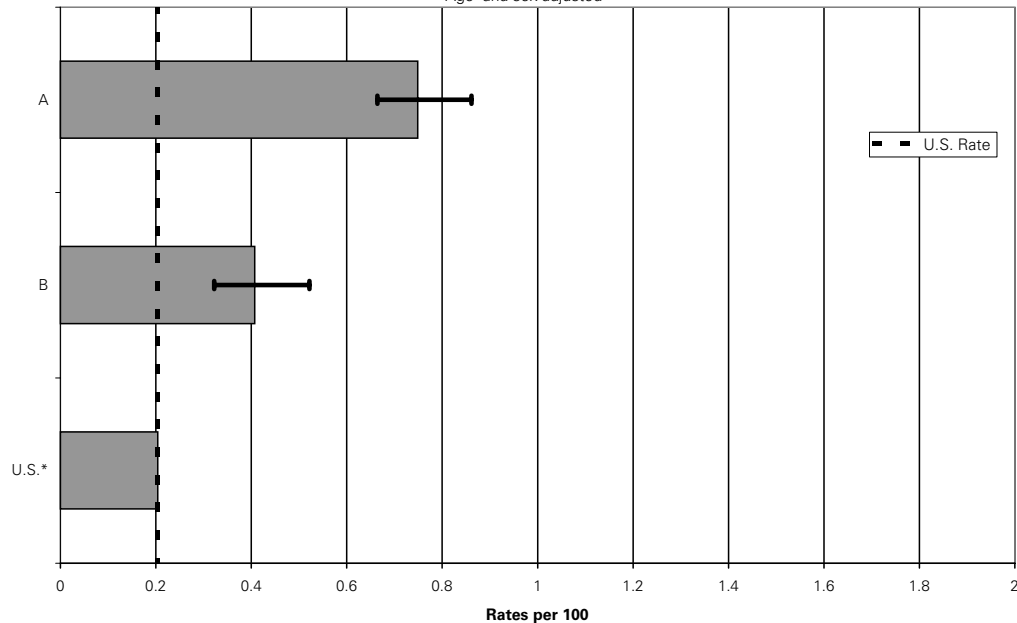
* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006

Figure 3.7b: Post-Operative Abdominopelvic Wound Dehiscence by Community Hospitals, 1999/2000 – 2003/04

Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006
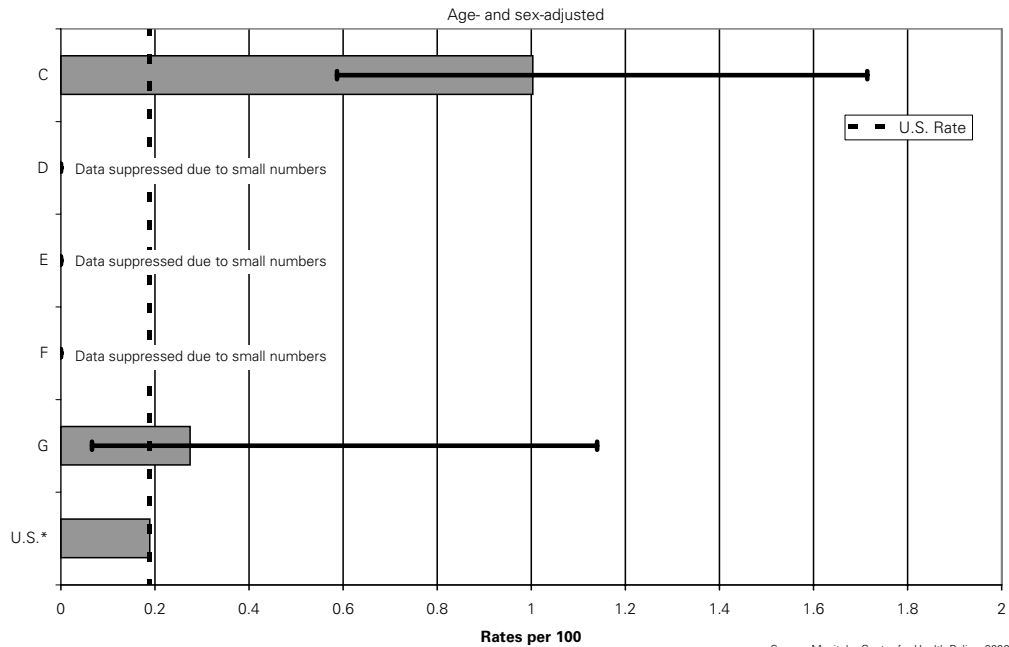
Rates of post-operative abdominopelvic wound dehiscence at tertiary hospitals A (0.75%) and B (0.41%) are statistically greater than the rate at U.S. urban teaching hospitals (0.20%). The rate of post-operative abdominopelvic wound dehiscence at Manitoba community hospital C (1.00%) was statistically greater than the rate at U.S. urban community hospitals (0.19%), whereas hospital G was similar.

Injury to Neonate
Definition: This indicator captures birth trauma among live births during the study period. Birth trauma includes subdural and cerebral hemorrhage; fracture of long bones or skull; injury to spine and spinal cord; phrenic nerve paralysis; eye damage; hematoma of liver (subcapsular), testes, vulva; rupture of liver or spleen; scalpel wound; traumatic glaucoma; and unspecified birth trauma.

Denominator (Number of Relevant Cases): Live births.

Inclusion Criteria (Number of Events): Live births with a diagnosis of birth trauma, defined by ICD-9 CM codes.

Exclusion Criteria: Pre-term infants who had a birth trauma diagnosis code for cerebral or subdural hemorrhage. Also excluded infants diagnosed with osteogenesis imperfect who had a birth trauma diagnosis code for injury to skeleton.

Comparisons between Manitoba and U.S. tertiary and community hospitals are found in Figures 3.8a and 3.8b.

Figure 3.8a: Rates of Injury to Neonate by Tertiary Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006
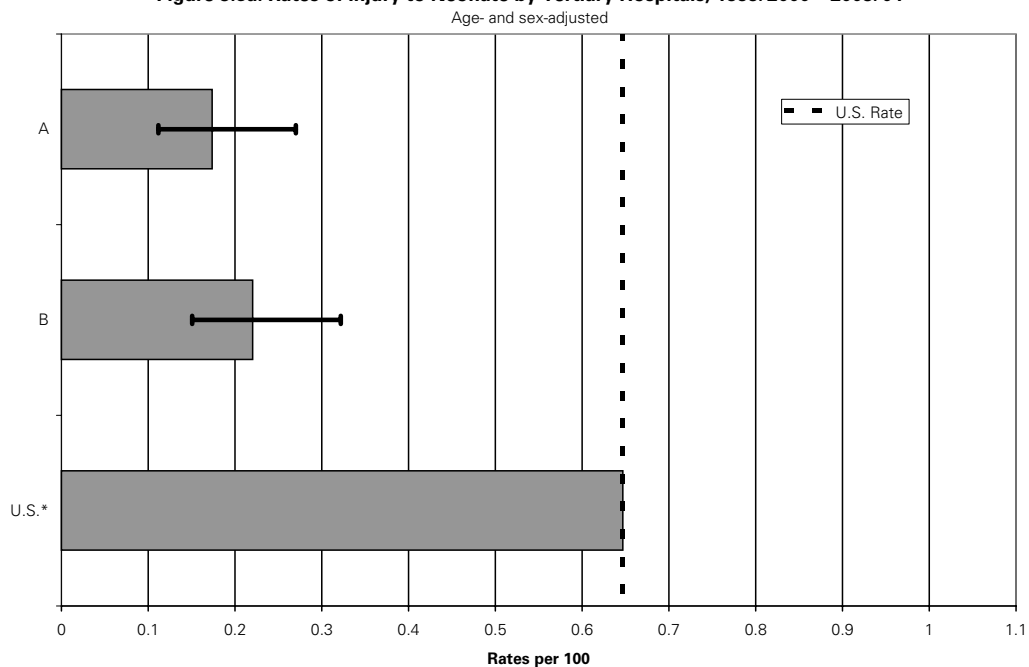
Figure 3.8b: Rates of Injury to Neonate by Community Hospitals, 1999/2000 – 2003/04
Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006
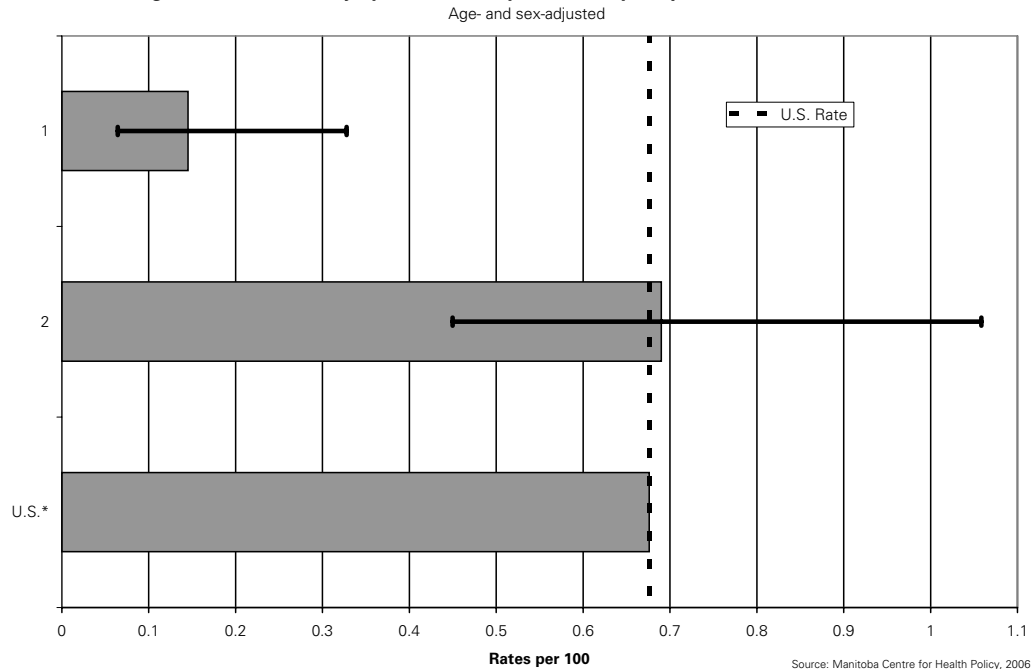
The rate of injury to neonate at tertiary hospitals A (0.17%) and B (0.22%) were statistically lower than the rate at U.S. urban teaching hospitals (0.65%). The rate at one Manitoba community hospital (0.15%) was statistically lower than the rate at U.S. urban community hospitals (0.68%), while the rate at the other Manitoba community hospital (0.69%) was not statistically different from the U.S. rate (0.68%). The confidence limit surrounding the rate observed for hospital 2 does not encompass those of any of the other Manitoba hospitals, suggesting a statistical difference from all other Manitoba hospitals.

Obstetrical Trauma for Vaginal Deliveries, with Instrumentation
Definition: This indicator captures cases of obstetric trauma associated with instrument-assisted vaginal deliveries. Obstetric trauma includes fourth-degree perineal lacerations; laceration of the cervix, vaginal wall or sulcus; injury to bladder or urethra; and repair of obstetric lacerations of the uterus, cervix, corpus uteri, bladder, urethra, rectum and sphincter ani.

Denominator (Number of Relevant Cases): All instrument-assisted vaginal delivery discharges, defined by CMGs and ICD-9 CM procedure codes.

Inclusion Criteria (Number of Events): All instrument-assisted vaginal delivery discharges with obstetric trauma (Appendix B).
Exclusion Criteria: No specific exclusions.

Comparisons between Manitoba and U.S. hospitals are found in Figures 3.9a and 3.9b. The proportions of deliveries using instruments are also provided in these Figures.

**Figure 3.9a: Rates of Obstetrical Trauma, Vaginal Delivery With Instruments
by Tertiary Hospitals, 1999/2000 – 2003/04**
Age- and sex-adjusted
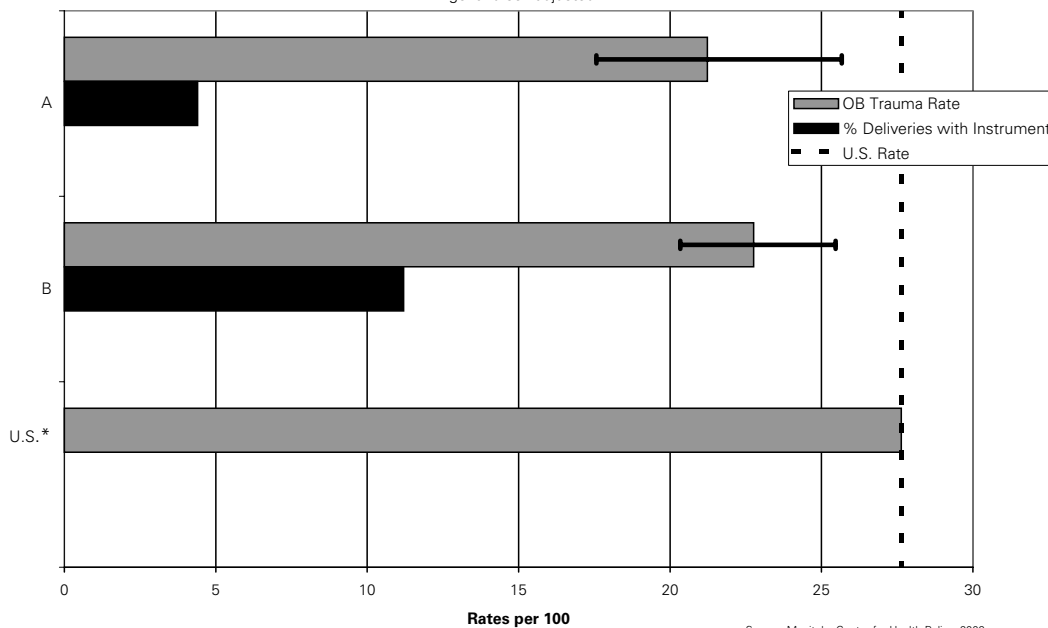
Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006

**Figure 3.9b: Rates of Obstetrical Trauma, Vaginal Delivery With Instruments
by Community Hospitals, 1999/2000 – 2003/04**

Age- and sex-adjusted

* The U.S. rate is based on hospitalizations from 2000 **Rates per 100** Source: Manitoba Centre for Health Policy, 2006
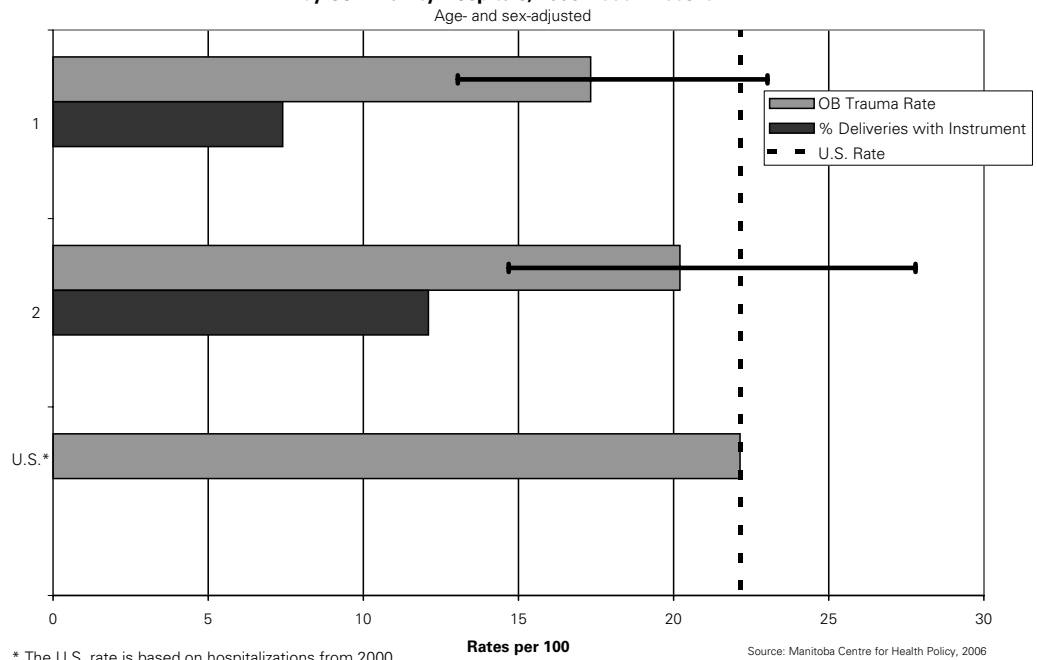
The rates of instrument-assisted obstetrical trauma for vaginal deliveries at Manitoba tertiary hospital A (21.23%) and hospital B (22.76%) were statistically lower than the rate reported for U.S. urban teaching hospitals (27.64%). No statistical differences were found for rates of instrument-assisted obstetrical trauma for vaginal deliveries between Manitoba community hospitals 1 (17.33%) and 2 (20.21%), and U.S. urban community hospitals (22.14%).

Obstetrical Trauma for Vaginal Deliveries, without Instrumentation
Definition: This indicator captures cases of obstetric trauma associated with vaginal deliveries when no instruments were used. Obstetric trauma includes fourth-degree perineal lacerations; laceration of the cervix, vaginal wall or sulcus; inure to bladder or urethra; and repair of obstetric lacerations of the uterus, cervix, corpus uteri, bladder, urethra, rectum and sphincter ani.

Denominator (Number of Relevant Cases): Vaginal delivery discharges (Appendix B).

Inclusions (Number of Events): All vaginal delivery discharges with obstetric trauma (Appendix B).

Exclusions: Instrument-assisted vaginal deliveries.

Comparisons between Manitoba and U.S. urban tertiary and community hospitals are found in Figures 3.10a and 3.10b.

Figure 3.10a: Rates of Obstetrical Trauma, Vaginal Delivery Without Instruments by Tertiary Hospitals, 1999/2000 – 2003/04
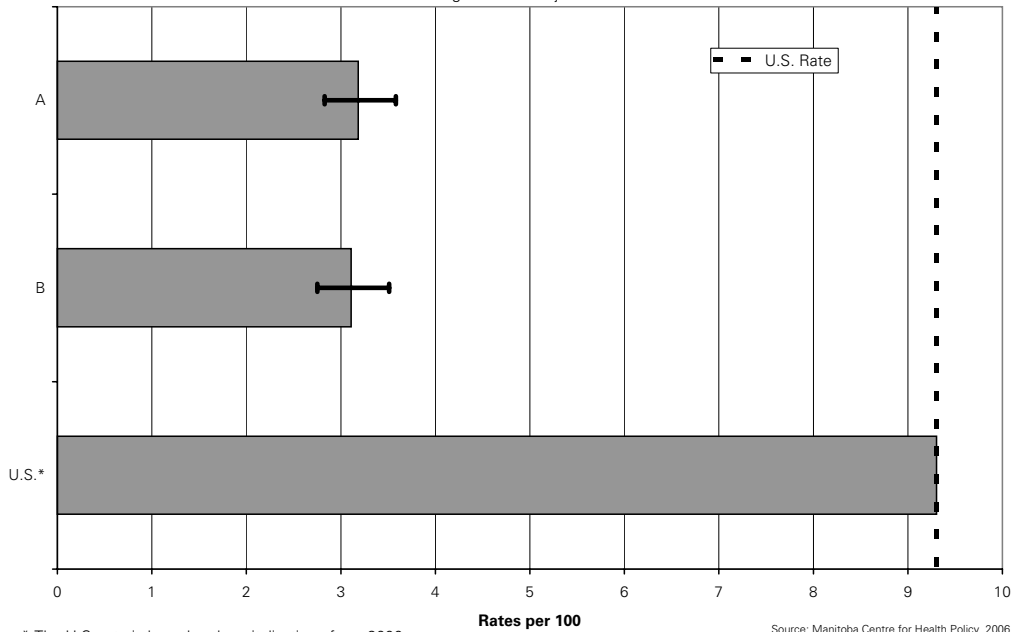
Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006

Figure 3.10b: Rates of Obstetrical Trauma, Vaginal Delivery Without Instruments by Community Hospitals, 1999/2000 – 2003/04

Age- and sex-adjusted

Rates per 100

* The U.S. rate is based on hospitalizations from 2000

Source: Manitoba Centre for Health Policy, 2006
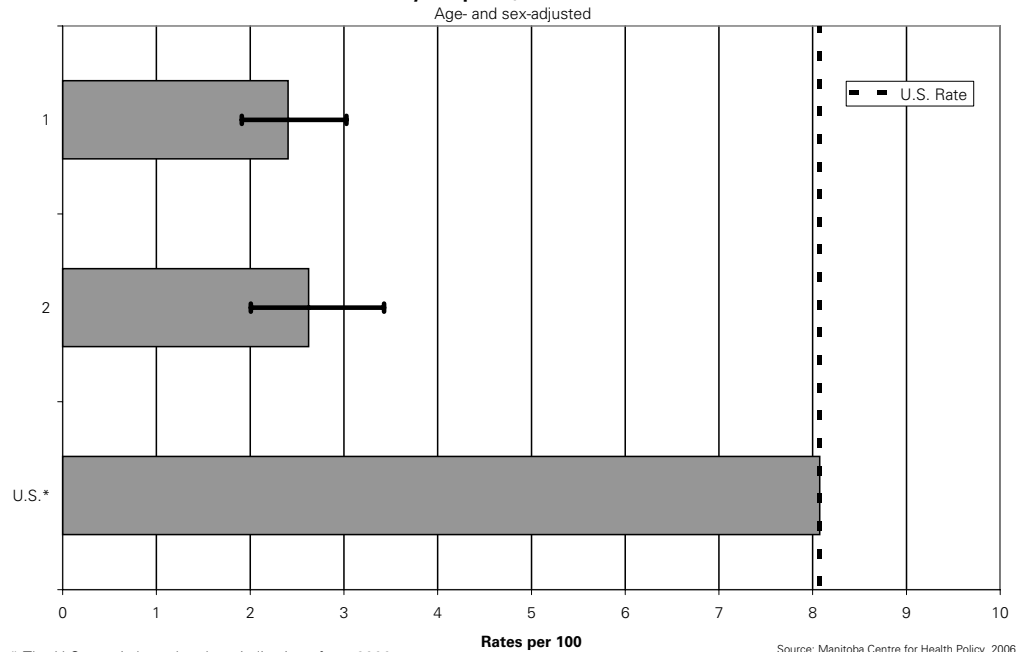
The rates of obstetric trauma associated with vaginal deliveries without the use of instruments were statistically lower at both Manitoba tertiary hospital A (3.18%) and hospital B (3.11%) than the rate for U.S. urban teaching hospitals (9.30%). Rates at Manitoba community hospital 1 (2.41%) and hospital 2 (2.62%) were also statistically lower than the rate reported for U.S. urban community hospitals (8.08%).

3.3   Summary

Rates of the 10 patient safety indicators at Manitoba and U.S. urban teaching and community hospitals are summarized in Tables 3.3a and 3.3b. At the Manitoba tertiary hospitals rates iatrogenic pneumothorax (hospital A), post-operative hemorrhage/hematoma (hospitals A and B), and post-operative wound dehiscence (hospitals A and B) were statistically greater than the rates reported for U.S. urban teaching hospitals. Rates of post-operative thromboembolism (hospitals A and B), injury to neonate (hospitals A and B) and obstetric trauma for vaginal deliveries (both instrument-assisted and no instruments) (hospitals A and B) were statistically lower than rates reported for U.S. urban teaching hospitals. Differences were also found for community hospitals. Rates at some Manitoba community hospitals were statistically greater than at U.S. urban community hospitals on the following indicators: iatrogenic pneumothorax (hospital E), post-operative hemorrhage/hematoma (hospital C), and post-operative wound dehiscence (hospital C). Rates of injury to neonate

at hospital 1 were statistically lower than the U.S. rate, and rates of obstetrical trauma for vaginal deliveries, without the use of instruments were statistically lower at Manitoba community hospitals 1 and 2, than the rates reported for U.S. urban community hospitals.

Rates of accidental puncture/laceration may be statistically different at tertiary hospital A and community hospital C, compared to the other included Manitoba hospitals. Rates of death in low-mortality medical CMGs are greater than the 1% benchmark at community hospitals D and F.

Table 3.3a: Summary of medical and surgical patient safety indicator rates, Manitoba and U.S. hospitals

Patient Safety Indicator	Manitoba Hospitals							U.S. Hospitals	
	Tertiary		Community					Tertiary	Community
	A	B	C	D	E	F	G		
Death in low mortality surgical CMGs *	**0.47-**	**0.40-**	**0.44-**	**0.35-**	**0.18-**	**0.37-**	**0.43-**	N/A	N/A
Death in low mortality medical CMGs *	1.23	0.84	0.82	**1.52+**	1.31	**1.54+**	1.09	N/A	N/A
Post-operative thromboembolism	**0.80-**	**0.54-**	0.77	0.65	0.79	0.72	0.99	1.04	0.88
Iatrogenic pneumothorax	**0.19+**	0.06	0.06	0.05	**0.15+**	0.05	0.08	0.07	0.07
Post-operative hemorrhage/ hematoma	**0.33+**	**0.33+**	**0.33+**	0.17	0.18	0.08	0.11	0.21	0.20
Post-operative abdominopelvic wound dehiscence	**0.75+**	**0.41+**	**1.00+**	S	S	S	0.27	0.20	0.19

+   rate is significantly greater than the U.S. average rate
–   rate is significantly lower than the U.S. average rate
s   data suppressed due to small number of events
N/A   not applicable to this
*   rate compared to benchmark of 1%

Source: Manitoba Centre for Health Policy, 2006

Table 3.3b: Summary of obstetric patient safety indicator rates, Manitoba and U.S. hospitals

Patient Safety Indicator	Manitoba Hospitals				U.S. Hospitals	
	Tertiary		Community		Tertiary	Community
	A	B	1	2		
Injury to neonate	**0.17-**	**0.22-**	**0.15-**	0.69	0.65	0.68
Obstetrical trauma, vaginal delivery, with instruments	**21.23-**	**22.76-**	17.33	20.21	27.64	22.14
Obstetrical trauma, vaginal delivery, without instruments	**3.18-**	**3.11-**	**2.41-**	**2.62-**	9.30	8.08

+   rate is significantly greater than the U.S. average rate
–   rate is significantly lower than the U.S. average rate
s   data suppressed due to small number of events
N/A   not applicable to this

Source: Manitoba Centre for Health Policy, 2006

CHAPTER 4:   LAPAROSCOPIC CHOLECYSTECTOMY

4.1   Descriptive Information

Cholecystectomy was chosen for review because it is a high-volume proce-
dure, meaning that a large number are completed every year. The procedure
is also completed in almost every RHA so comparisons on outcomes can be
made across regions. During the five-year study period from April 1, 1999
through March 31, 2004, 14,379 cholecystectomy procedures were per-
formed in Manitoba on Manitoba residents. Of these, 92% (13,219) were
laparoscopic procedures and the remaining 8% (1,160) were open proce-
dures. The analysis for this report will be restricted to laparoscopic proce-
dures.

The age- and sex-adjusted rates of laparoscopic cholecystectomy by the
RHA in which people reside is presented in Figure 4.1. The rate of chole-
cystectomy ranged from 2.72 per 1,000 Assiniboine RHA residents to 6.0
per 1,000 residents of Burntwood RHA. The rates of cholecystectomy were
statistically greater than the Manitoba average for the following RHAs:
North Eastman, Interlake, Norman, Parkland and Burntwood. Rates of
cholecystectomy were significantly lower than the Manitoba average in
Assiniboine and Winnipeg RHAs. The number of cholecystectomy proce-
dures completed per year increased by 2.5% over the study period, with
2,568 procedures in 1999/2000 and 2,633 in 2003/04.

**Figure 4.1: Rates of Laparoscopic Cholecystectomy
by RHA of Residence per 1,000 Residents, 1999/2000 – 2003/04**
Age- and sex-adjusted

Source: Manitoba Centre for Health Policy, 2006
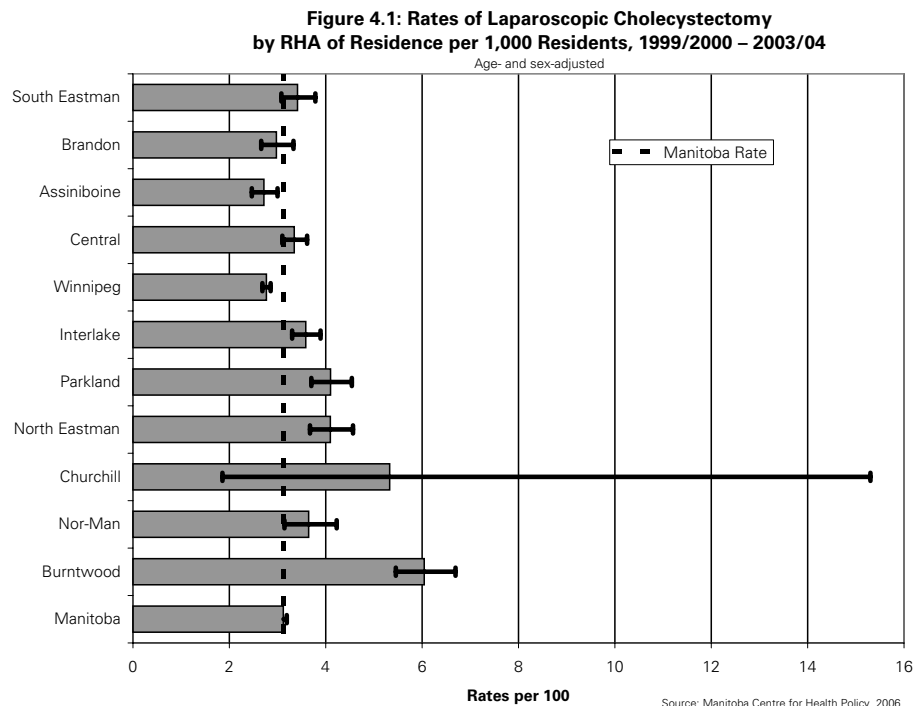
Cholecystectomy procedures were performed at hospitals throughout the province. The majority (57%) of the procedures were performed at community hospitals (Brandon, Concordia, Grace, Seven Oaks and Victoria). The distribution of laparoscopic cholecystectomy by hospital type is presented in Table 4.1.

Table 4.1: Distribution of laparoscopic cholecystectomy procedures by hospital, 1999/2000 – 2003/04

	Laparoscopic Procedures	
Hospital type	**Number**	**Per cent of All Laparoscopic Procedures**
Tertiary (A and B)	2,075	16%
Community (C – G)	7,530	57%
Major/Intermediate Rural (H)	3,614	27%
Manitoba	13,219	100%

Source: Manitoba Centre for Health Policy, 2006

Seventy-five percent (75%) of the individuals who had a cholecystectomy over the study period were women. Thirty-six percent (36%) of individuals who had laparoscopic cholecystectomy procedures during the study period were aged 19-34; 46% were aged 40-64; 11% were aged 65-74; and 7% were aged 75 and over. Thus, the majority of the procedures were completed on young to middle-aged adults.

4.2   Percent Inpatient and Length of Stay

Over the study period, 46% of patients having laparoscopic cholecystectomy procedures in the province were treated as inpatients, meaning they were admitted to hospital and stayed at least one night. There was great variation in the proportion of inpatient procedures across hospital types. At Winnipeg tertiary centres, 68% of surgeries were treated as inpatient procedures. At community hospitals a wide range in the percentage of procedures completed as inpatient was found (16% at hospital D to 45% at hospital C). Inpatient procedures accounted for 82% of procedures at major and intermediate rural hospitals (H). The proportion of procedures completed on an inpatient basis decreased over the study period at hospitals A, C and H. (Table 4.2).

Table 4.2: Percentage of laparoscopic cholecystectomy procedures completed as inpatients by hospital and year, 1999/2000 – 2003/04

Hospital	1999/2000	2000/01	2001/02	2002/03	2003/04	Total
A	98.5	69.1	59.0	60.2	49.5	67.0
B	64.0	73.8	75.5	66.3	62.4	68.4
C	52.1	54.3	46.7	39.7	32.8	45.2
D	11.8	16.8	16.1	19.6	15.8	16.0
E	23.2	22.6	23.6	24.2	27.9	24.1
F	35.9	13.5	23.8	23.0	20.0	22.6
G	20.6	15.1	15.9	18.1	16.2	17.2
H	90.4	86.0	86.1	81.1	68.9	82.2
Manitoba	**51.1**	**46.9**	**46.5**	**45.8**	**40.7**	**46.2**

Source: Manitoba Centre for Health Policy, 2006

The mean and median lengths of stay, and total number of days in hospital are listed in Table 4.3. Because the mean is affected by extreme values, cholecystectomy patients whose stay in hospital was greater than 30 days were excluded from the analysis (0.4% laparoscopic patients had lengths of stay greater than 30 days). Therefore the minimum and maximum lengths of stay for patients included in this portion of the analysis were one day and 30 days, respectively. The median length of stay refers to the point at which half of the patients had shorter stays and half had longer stays.

Table 4.3: Length of stay for laparoscopic cholecystectomy patients by hospital, 1999/2000 – 2003/04

Hospital	Mean LOS (inpatients)	Median LOS (inpatients)	% Procedures completed as Inpatient	Total days in hospital
A	3.4	2	67%	2,333
B	4.6	3	68%	3,291
C	3.7	2	45%	1,620
D	4.5	3	16%	1,089
E	5.7	4	24%	1,916
F	5.5	4	23%	1,836
G	5.4	4	17%	2,045
H	2.4	1	82%	6,995
Manitoba	**3.5**	**2**	**46%**	**21,125**

Source: Manitoba Centre for Health Policy, 2006

The mean and median lengths of stay for laparoscopic patients were 3.5 and 2 days, respectively. Mean length of stay did not decrease over time at any hospital or hospital type. Over the five-year study period, patients who underwent laparoscopic procedures spent 21,125 days in hospital.

4.3   Possible Complications Related to Cholecystectomy Surgery

Possible complications related to laparoscopic cholecystectomy procedures investigated for this report include accidental puncture/laceration, hemorrhage/hematoma and subsequent biliary surgery.

Rates of accidental puncture or laceration and hemorrhage/hematoma related to laparoscopic cholecystectomy procedures are found in Figures 4.2 and 4.3 by hospital or hospital type. Rates of accidental puncture were statistically greater at the community hospital C (2.23%) than the Manitoba average rate (0.96%) and lower at hospital H (0.55%). Rates of hemorrhage/hematoma were also significantly greater at community hospital C (2.32%) than the Manitoba average (0.85%), with all other hospitals being similar to the overall Manitoba average.

Figure 4.2: Rates of Accidental Puncture/Laceration with Laparoscopic Cholecystectomy by Hospital, 1999/2000 – 2003/04

Source: Manitoba Centre for Health Policy, 2006

Figure 4.3: Rates of Hemorrhage/Hematoma with Laparoscopic Cholecystectomy by Hospital, 1999/2000 – 2003/04

Age- and sex-adjusted

Rates per 100

Source: Manitoba Centre for Health Policy, 2006
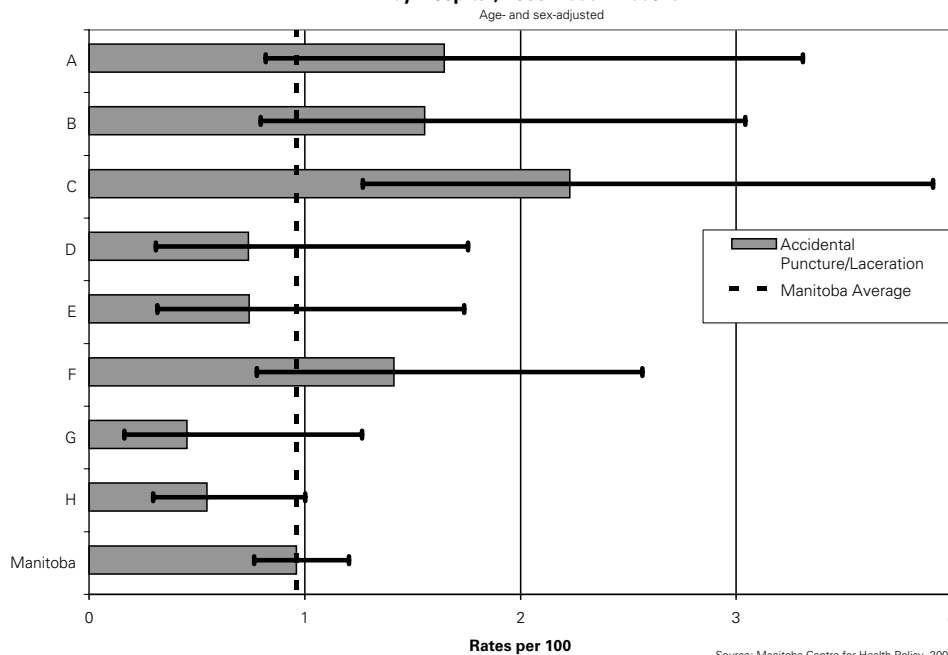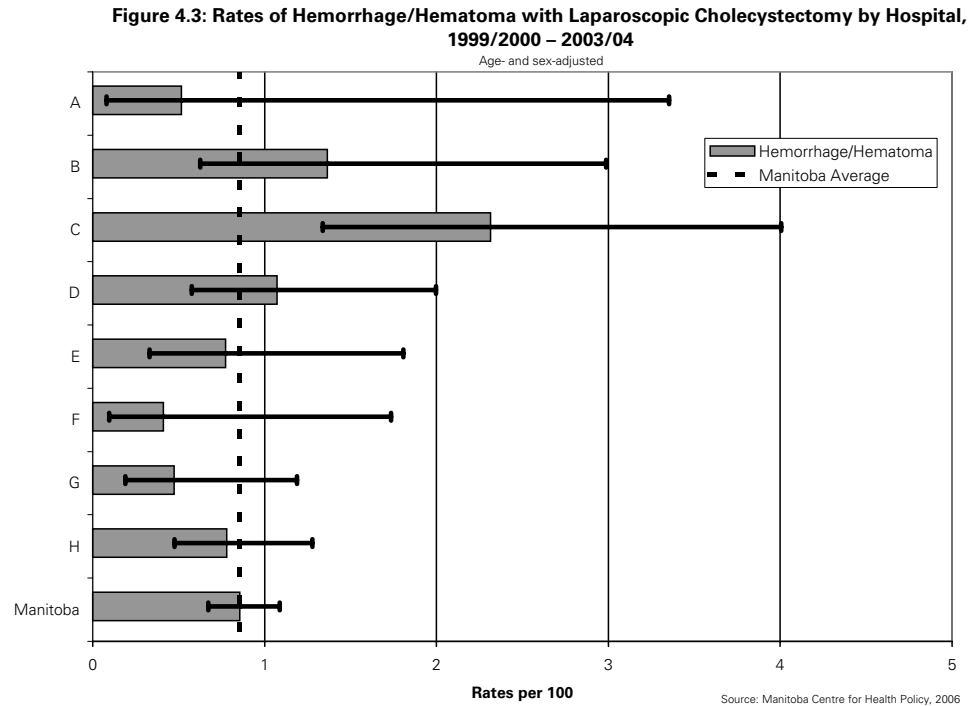
As a result of an injury to biliary ducts during a laparoscopic cholecystectomy, biliary reconstruction may be required. The overall rate of biliary reconstruction performed on laparoscopic patients during the study period was 0.2%. The rate of reconstructive procedures by hospital laparoscopic surgical volume is presented in Figure 4.4. Comparison is made between hospitals at which fewer than 500 laparoscopic cholecystectomy procedures were completed during the study period, those at which between 500 and 999 procedures were completed during the study period, and those at which 1,000 and more procedures were completed during the study period. Biliary reconstruction was assigned to the hospital at which the laparoscopic cholecystectomy was performed. This means that if a laparoscopic procedure was performed at hospital D and the reconstructive procedure was performed at hospital B, the reconstructive procedure would be assigned to hospital D, the site of the cholecystectomy.

**Figure 4.4: Rates of Reconstructive Biliary Surgery Following Laparoscopic Cholecystectomy
by Surgical Volume, 1999/2000 – 2003/04**
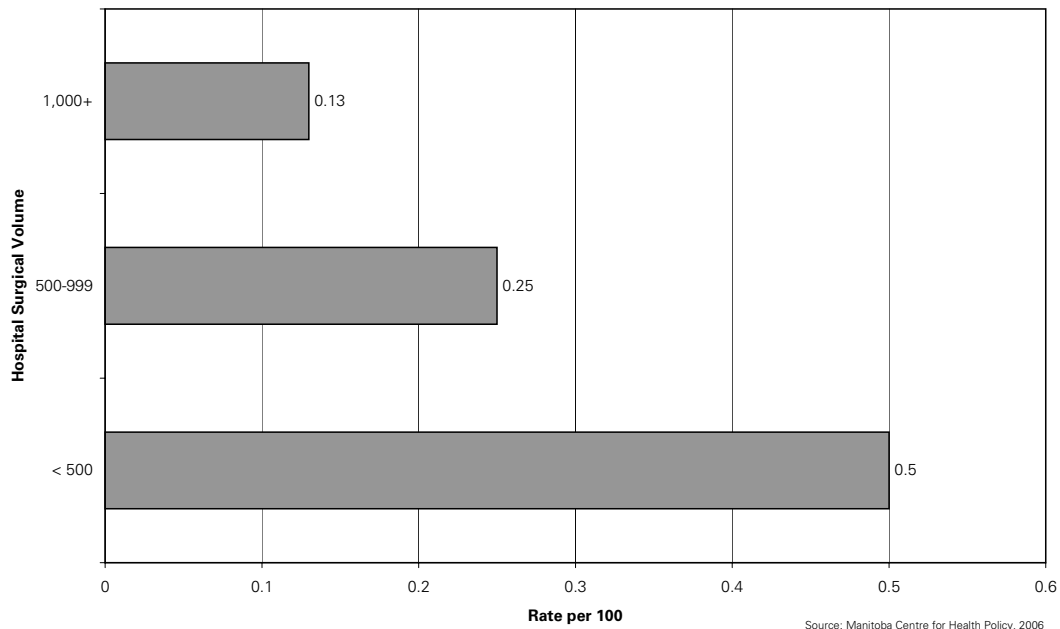
Source: Manitoba Centre for Health Policy, 2006

An inverse relationship between number of laparoscopic cholecystectomy procedures performed and rate of reconstructive surgery is observed. The rate of biliary reconstruction at hospitals which performed fewer than 500 laparoscopic procedures was 0.5%, while the rate at hospitals which performed between 500 and 999 procedures was 0.25%, and 0.13% at hospitals which performed 1,000 or more procedures during the study period. The difference in rate of biliary surgery following laparoscopic cholecystectomy was statistically significant (χ^2=10.4, p<0.01).

Admission to an Intensive Care Unit
One measure of severity of illness is admission to an intensive care unit (ICU). Rates of admission to an ICU following laparoscopic cholecystectomy are provided in Table 4.4. Included in this analysis are patients whose ICU admission occurred the day the cholecystectomy was performed or sometime after the surgery. Excluded from this portion of the analysis were any cases in which an ICU stay preceded the cholecystectomy surgery. Rates of admission to an ICU following laparoscopic cholecystectomy ranged from 0.40% at Hospital D to 1.1% at Hospital B. Reasons for admission to ICU included, hemorrhage, cardiac complications, respiratory complications, post-operative shock, pulmonary insufficiency, airway obstruction, cardiac arrest, aspiration, perforation of gallbladder and peritonitis.

**Table 4.4: Rates of admission to an intensive
care unit following laparoscopic cholecystectomy
by hospital, per 100, 1999/2000 – 2003/04**

Hospital	% Admission to ICU
A	s
B	1.1
C	0.9
D	0.4
E	0.5
F	0.6
G	0.5
H	0.7
Manitoba	**0.6**

Source: Manitoba Centre for Health Policy, 2006

Mortality

The all-cause mortality rate within 30 days of a laparoscopic cholecystecto-my was 0.13% (17 deaths out of 13,219 laparoscopic procedures). The mean and median ages of those who died were 75.3 and 76 years, respectively. There were too few deaths to compare hospitals or hospital types.

Discussion

Summaries of length of stay and complications are found in Table 4.5.

**Table 4.5: Summary of outcomes of laparoscopic cholecystectomy,
1999/2000 – 2003/04**

Hospital	Percent inpatient (%)	LOS (Days)		POTENTIAL COMPLICATIONS		
		Mean	Median	Accidental puncture (%)	Hemorrhage/ Hematoma (%)	ICU Admission (%)
A	67	3.4	2	1.65	0.52	s
B	68	4.6	3	1.56	1.37	1.1
C	45	3.7	2	**2.23+**	**2.32+**	0.9
D	16	4.5	3	0.74	1.07	0.4
E	24	5.7	4	0.74	0.77	0.4
F	23	5.5	4	1.41	0.41	0.6
G	17	5.4	4	0.45	0.47	0.5
H	82	2.4	1	0.55	0.78	0.7
Manitoba	**46**	**3.5**	**2**	**0.96**	**0.85**	**0.6**

+   rate is statistically greater than the Manitoba average rate.
–   rate is statistically lower than the Manitoba average rate.
s   data suppressed due to small numbers of events. MCHP does not report data when cell size
    is < 6 events.

Source: Manitoba Centre for Health Policy, 2006

Inpatient Laparoscopic Cholecystectomy

Several factors may have contributed to the overall high proportion of laparoscopic cases treated as inpatients, including years covered in the study, case complexity, surgical complications, bed availability and hospital practice regarding use of beds. The laparoscopic procedure was introduced a few years prior to the beginning of the study period (1999/2000). Prior to its introduction, cholecystectomy procedures were completed via the open method. As experience with the laparoscopic procedure increased, the proportion of the procedures completed on an outpatient basis (i.e., no hospital stay required) increased. This may be the case at Hospitals A and H which have the largest decreases in proportion of cases treated as inpatient over the study period.

Another factor which influences whether or not a patient will require a hospital stay is pre- and post-procedure morbidity. Prior to hospitalization, the average level of sickness among patients who had a laparoscopic cholecystectomy was greatest at hospitals A, B and C, followed by the remaining community hospitals and rural hospitals. When the incident hospitalization was considered, the average level of sickness among patients was greatest at the tertiary hospitals (B and A), followed by the community hospitals and the major and intermediate rural hospitals. Thus, the level of sickness among patients who had a cholecystectomy during the study period was greatest among those whose procedures were completed at the two Winnipeg tertiary hospitals. Therefore, the higher proportion of inpatient procedures at these facilities may reflect the overall level of morbidity of these patients both prior to and after the procedure.

As described in the Methods section, the laparoscopic category included procedures that were scheduled to be completed via the laparoscopic method, but because of complexity or other difficulties, were converted to the open procedure. Once procedures are converted to the open method, a stay in hospital becomes necessary. Thus, such cases would contribute to the proportion of laparoscopic cases treated as inpatients. The rate of conversion from laparoscopic to open is provided by hospital and year in Table 4.6. During the study period 7% of all laparoscopic procedures were converted to open. The rate of conversion ranged from 5% at Hospital D to 11% at Hospital B.

Table 4.6: Percentage of laparoscopic cholecystectomy converted to open cholecystectomy by hospital and year, 1999/2000 – 2003/04

Hospital	1999/2000	2000/01	2001/02	2002/03	2003/04	All years
A	14%	9%	6%	12%	7%	10%
B	9%	13%	13%	11%	8%	11%
C	9%	9%	7%	10%	6%	8%
D	4%	4%	4%	8%	3%	5%
E	13%	8%	9%	9%	9%	9%
F	12%	9%	10%	9%	7%	9%
G	8%	8%	7%	9%	5%	7%
H	6%	5%	5%	5%	6%	5%
Manitoba	8%	7%	7%	8%	6%	7%

Source: Manitoba Centre for Health Policy, 2006

The average length of stay following laparoscopic cholecystectomy ranged from 2.4 to 5.7 days. At all hospitals, the average level of sickness was greater among those patients whose procedures were completed as inpatient versus those completed as outpatients. In other words, length of stay reflects, in part, the morbidity of patients.

CHAPTER 5: DISCUSSION

The rates of the patient safety indicators are low, even when considering the variation observed among individual hospitals. For example, the rates for most indicators were at or below 1% of all relevant cases. The highest rates were observed for obstetrical complications involving use of instruments, which is a procedure completed in high-risk situations to prevent further harm. But what do these rates mean? Is a post-operative thromboembolism rate of 0.67% too high, or is it within "acceptable" limits, given that all medical procedures carry some risk? Benchmarks for the indicators used in this report do not exist, with the exception of the indicators for *'death within low-mortality medical and surgical CMGs*, which defined groups of cases for which the **usual** in-hospital mortality rate is less than 1%. In general, "acceptable" levels of complications have not been defined, although average rates have been, and comparisons are made to assess deviations from these. Following this framework, we compared rates observed for Manitoba hospitals to those reported for U.S. hospitals. While the two sets of estimates are not directly comparable because of some methodological and health care delivery practice differences, general comparisons are possible because of similarities in design and indicator definitions.

These data repre-sent useful first steps in the con-tinuing develop-ment of patient safety indicators and establishment of benchmarks.

The purpose of the comparison was not to evaluate performance. That is, we were not attempting to determine if we in Manitoba are doing "better" or "worse" than public hospitals in the U.S. on select patient safety indicators. Rather, these data represent useful first steps in the continuing development of patient safety indicators and establishment of benchmarks. Comparison with the AHRQ data was completed to determine if the indicators were performing similarly to other studies. Indicators where there was statistical differences in rates between Manitoba and U.S., or within Manitoba itself, should be targeted for further review to assess reasons behind the observed differences.

5.1   Factors influencing observed rate differences

Several factors may have accounted for differences in observed rates including: case complexity; practice patterns (i.e., policies directing provision of care by hospital personnel); practitioner experience and skill; patient characteristics such as age, level of sickness, comorbidities, and socioeconomic background; and coding.

Because we do not have detailed information about the hospitals and patients included in the U.S. study, we were not able to assess the impact of these various factors on the observed differences between the U.S. and Manitoba hospitals. However, we are able to assess the impact of some of the above factors on the rates observed within the Manitoba setting.

In general, the Manitoba hospitals that had the highest operative and post-operative surgical patient safety indicator rates, also had the highest surgical case complexity and the sickest patients. However, such a relationship was not always found. For example, statistically greater rates of death in low-mortality CMGs were found for two community hospitals. Differences in age or level of sickness were not found between those hospitals and the remaining community hospitals. In addition, rates of some of the surgical patient safety indicators at one community hospital were similar to those at tertiary hospitals, yet, on average, case complexity and patient morbidity were lower. Injury to neonate was also high at one community hospital. These indicators require further exploration to determine the factors that may have influenced these differences.

5.2   Study Limitations

Coding

There are at least two steps in the coding process that can affect the accuracy of administrative data: recording of the event by the physician, and abstraction of the event by the health records technician. Physicians are required to provide summaries of the patient's hospital stay, operative reports (if applicable) and reasons for the hospitalization (i.e., medical diagnoses). If events are not reported by physicians at this stage, there may be no evidence of their occurrence in the administrative database (some events may be recorded by other health care professionals, but abstractors generally do not read the entire medical record at the time of abstraction). The second step in the process involves the coding of hospital reports by health records technicians. Health records technicians translate the information recorded in the medical record into ICD-9 CM codes. Factors that may influence differences in coding practices at this level include training and experience of individual technicians, and institutional practices. While the patient safety indicators represent major medical events, some are less precise than others (e.g., accidental puncture/laceration is more non-precise than pulmonary embolism). For this reason, it is possible that the more precise indicators (e.g., pulmonary embolism) would be more reliably reported and coded than less precise indicators (e.g., accidental puncture/laceration). Thus, while most of the patient indicators represent major medical events, further validation will be necessary to examine the relative influence of coding practices on the observed results.

Further validation is necessary to examine the relative influence of coding practices on the observed results.

Some of the statistical differences found between the U.S. and Manitoba hospitals may reflect coding issues. For example, rates of post-operative abdominopelvic wound dehiscence at Manitoba hospitals are 2 to 5 times

greater than rates reported by Romano (2003) for U.S. hospitals. Within Manitoba, a large difference was found for rates of injury to neonate. Such large differences warrant further examination.

Scope of Study
The indicators of compromised patient safety included in this report do not represent an exhaustive listing of possible patient safety events. Rather, we have provided estimates of a select group of indicators, by hospital and hospital type, for a five-year time period. Most of the indicators used for this report relate to surgical procedures. Importantly, in previous patient safety research, adverse events related to surgical procedures have been found to be the most frequently reported type of patient safety concern (Leape et al., 1991; Thomas et al., 2000a; Baker et al., 2004). Another frequently occurring in-hospital patient safety event is medication-related adverse events. Because the administrative data do not contain information on in-hospital medication use we were unable to provide estimates of the frequency of in-hospital medication-related events. Thus, while not exhaustive, we have provided a breadth of information on a select group of important indicators.

Clinical Significance of Events
With administrative data we are able to detect the occurrence of recorded events, but generally are not able to comment on their clinical significance. With respect to this study we may have captured events that had minimal effect patients, in addition to those that resulted in serious complications, disability and death. In an attempt to address this issue, we estimated the relative risk of death for five of the patient safety indicators. The relative risk value represents the risk of death among patients who had a recorded occurrence of the patient safety indicator compared to patients who did not have a recorded occurrence of the indicator. For example, among surgical patients the relative risk of death among those who had a recorded occurrence of post-operative thromboembolism was 7.2 times greater than among patients who did not have a recorded occurrence of a post-operative thromboembolism.

Table 5.1: Risk of death among patients with a recorded occurrence of a patient safety indicator compared to patients without a recorded occurrence of the patient safety indicator

Patient Safety Indicator	Risk of Death Compared to Patients without a Recorded Occurrence of the Patient Safety Indicator (99% CI)
Post-operative thromboembolism	7.2 (6.0, 8.8)
Accidental puncture/laceration	2.9 (2.3, 3.6)
Iatrogenic pneumothorax	5.5 (4.3, 7.0)
Post-operative hemorrhage/hematoma	4.3 (2.7, 6.7)
Post-operative abdominopelvic wound dehiscence	3.5 (1.8, 6.6)

Source: Manitoba Centre for Health Policy, 2006

The relative risk estimates are crude estimates, meaning that we have not controlled for factors such as comorbidity or complexity. In addition, we cannot state that the cause of death for this group of patients was one of the indicators under investigation (e.g., post-operative thromboembolism). However, the findings do seem to suggest clinical significance. Further investigation of these estimates are warranted.

Contributing Factors

We investigated the contribution of factors such as case complexity, patient morbidity and SES on differences in observed rates between hospitals. Thus, it may not be unexpected that rates of patient safety indicators are higher at hospitals which have, on average, the highest case complexity, and patients who are among the sickest and are from the lowest socioeconomic strata. Although these supplemental data indirectly help us understand the observed differences, we have not directly controlled for contributing factors, primarily because of the small numbers of events relative to the large number of "at risk" cases. For example, in the five-year study period there were a total of 1,538 accidental puncture/laceration events out of a possible 113,737 "at risk" cases. The number of cases at individual hospitals ranged from 56 to 642. Attempting to adjust for contributing factors using statistical modeling can be imprecise when there is a large imbalance between the number of cases and the number "at risk" (Zhan & Miller, 2003). Another factor influencing the imprecision in statistical modeling in relation to this project is the limited information available in the administrative data concerning contributors to patient safety events. If we agree that a full understanding of patient safety events requires a systems approach because of the multiple points in the system at which patient safety can be compromised, then a model that includes only limited factors is insufficient.

5.3   Strengths

5.3.1   Validation

Researchers at MCHP and beyond have spent considerable effort at ensuring the validity and reliability of administrative data systems. For example, administrative data have been validated against chart reviews and surveys, and researchers at other sites have replicated MCHP research to ensure reliability (i.e., are we using the same codes to identify specific conditions; is statistical language the same?), (Roos, Gupta, Soodeen et al., 2005; Hux, Ivis, Flintoft et al., 2002; Roos and Nicol, 1999; Roos, Mustard, Nicol et al., 1993; Roos, Roos, Cageorge, et al., 1982). In regard to this study, internal validation has been completed. First, face validity was confirmed through extensive discussion with clinical researchers involved with the project. Second, we also reviewed the application by health records technicians of "C" codes. The "C" code refers to post-admission comorbidity, which is a condition that arises after admission and has a significant influence on

length of stay or management in hospital. We determined the proportion of surgical patient safety indicators that had a "C" code attached to them. This code is applied fairly consistently across the province. Over 90% of the surgical patient safety indicators we identified for this study had a "C" code attached to them. This may imply a complication of treatment. These data are found in Table 5.2.

Table 5.2: Percentage of patient safety indicators identified as post-admission comorbidity

Patient Safety Indicator	% with "C" Code
Iatrogenic pneumothorax	92%
Post-operative hemorrhage	98%
Post-operative thromboembolism	90%
Post-operative abdominopelvic wound dehiscence	95%
Accidental puncture/laceration, surgical cases	94%

Source: Manitoba Centre for Health Policy, 2006

5.4   Conclusions and Recommendations

Overall, rates of PSIs at Manitoba hospitals are low.

Overall, rates of patient safety indicators at Manitoba hospitals are low. Small, but statistically significant differences were found between Manitoba and U.S. hospitals. Differences were also found within Manitoba. Case complexity and patient morbidity may account for some of the observed rate differences. Coding practices may also have influenced some of the results. Validity of the indicators was assessed via two measures, and this preliminary work is encouraging regarding the robustness of the indicators.

Recommendation #1
Validation of the patient safety indicators should be completed to determine the extent to which coding practices have influenced observed results. This validation should be undertaken as part of a research program with active participation of regional stakeholders.

Validation should include two processes. First, a review of the medical records identified through the administrative database should be undertaken to determine if events occurred as coded. For example, an accidental puncture/laceration for a particular patient is found through a search of the administrative data. Is this event confirmed in that patient's medical record? Second, a random sample of records should be drawn to determine the occurrence of a particular event (e.g., hemorrhage). A "back-check" should then be completed with the administrative data to determine what proportion of events identified via medical record review were recorded and found in the administrative data. These validation procedures should be completed at multiple sites to allow for comparisons of coding procedures.

Recommendation #2
Once the validity of the patient safety indicators is established, Manitoba Health should support regions in using the indicators on a regular basis as one component in the efforts to enhance patient safety.

Recommendation #3
Given the cost-effectiveness and overall usefulness of these indicators to regions, MCHP should work with stakeholders (i.e., Manitoba Health, RHAs, clinicians) to develop additional patient safety indicators that can address areas not included in this report (e.g., in-hospital falls).

Recommendation #4
Research using a systems approach should be undertaken to examine factors that contribute to adverse events and incidents which compromise the safety of patients in hospital. A retrospective review of charts, incident reports and other documents (e.g., operating room slates) should be undertaken, in conjunction with the validation piece described above, to review factors that contributed to the findings in this report. A prospective study should be undertaken to examine events which compromise patient safety in "real-time" and should include review of charts and other relevant documents, interviews, and observation. Factors investigated for both components include patient factors, personnel issues, environment issues, local and regional policies, and work-life processes (e.g., decision-making processes).

Recommendation #5
Manitoba Health should take a lead in supporting further efforts at validation and development of patient safety indicators.

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GLOSSARY

Accidental Puncture or Laceration

An accidental puncture or laceration is an unintended cut, puncture, perforation or laceration of tissue during a surgical procedure.

Adjusted Clinical Group (ACG)

The Adjusted Clinical Group (ACG) (formerly Ambulatory Care Group) case-mix adjustment system characterizes clinical conditions from ICD-9 CM diagnoses extracted from physician reimbursement claims and hospital discharges. It is a risk adjustment tool developed to measure the illness burden (morbidity) of individual patients and their expected or actual consumption of health services. This system quantifies morbidity by grouping individuals based on their age, gender and all known medical diagnoses assigned by their health care providers over a defined time period (typically one year). In the current analyses, ACG was used to calculate the morbidity index as a measure of physical health in the one year prior to the hospitalization of interest. The ACG is fully described in the following reference documents:

The Johns Hopkins University Bloomberg School of Public Health, Health Services Research & Development Center. *The Johns Hopkins ACG® Case-Mix System Version 6.0 Release Notes*. (Editor in Chief: Jonathan P. Weiner). The Johns Hopkins University. April, 2003.

The Johns Hopkins University Bloomberg School of Public Health, Health Services Research & Development Center. *The Johns Hopkins ACG® Case-Mix System Documentation & Application Manual Version 5.0*. (Senior Editor: Jonathan P. Weiner). The Johns Hopkins University. October, 2001.

Adjusted Rates

Most of the rates shown in this report were directly standardized to the 2001/02 Manitoba hospital inpatient population to control for different age and sex distributions of different hospitals. This adjustment mathematically removes the effects of different population structures so that the rates for all hospitals could be fairly compared. The adjusted values shown are those which the hospital would have had if its age and sex distribution was the same as the standard population.

Adverse Event

An adverse event is an injury caused by medical management rather than by the underlying disease or condition of the patient. Adverse events may be avoidable, such as leaving a foreign object in a patient after a procedure, or unavoidable, such as an allergic reaction to medication administered for the first time.

Age Calculations

For most indicators in this report, age is calculated as of date of admission to hospital in both the numerator and the denominator. Exceptions include where the denominator is the entire Manitoba population, not the inpatient hospital population, in which case age is calculated as of December 31 of each study year. The age groups used for standardization in this report were: 19-39, 40-64, 65-74 and 75+ years for non-obstetrical indicators, and 12-21, 22-28, 29-36 and 37+ years for obstetric indicators.

Aggregated Diagnostic Group (ADG)

The Aggregated Diagnostic Group (ADG) (formerly Ambulatory Diagnostic Group) are part of the ACG case-mix system. The ACG method groups every ICD-9 CM medical diagnosis code assigned to a patient into 32 different ADGs based on five clinical and expected utilization criteria: 1) duration of the condition (acute, recurrent, or chronic); 2) severity of the condition (e.g., minor and stable versus major and unstable); 3) diagnostic certainty (symptoms focusing on diagnostic evaluation versus documented disease focusing on treatment services); 4) etiology of the condition (infectious, injury, or other); and 5) specialty care involvement (medical, surgical, obstetric, haematology, etc.). For this report, ADGs were calculated in the one year prior to the index hospitalization as a measure of morbidity before the event of interest. The greater number of ADGS an individual is assigned to indicate a greater level of sickness over the time period, with the presence of six or more ADGs implying a significant morbidity burden. Specific information can be obtained in the documentation on ACGs and ADGs (The Johns Hopkins University Bloomberg School of Public Health, 2003 and 2001. See the full reference above under ACG.)

Birth Trauma: Injury to Neonate

Birth trauma is an injury to a newborn during birth. Birth trauma includes subdural and cerebral hemorrhage; fracture of long bones or skull; injury to spine and spinal cord; phrenic nerve paralysis; eye damage; hematoma of liver (subcapsular), testes, vulva; rupture of liver or spleen; scalpel wound; traumatic glaucoma; and unspecified birth trauma.

Calendar Year

A calendar year runs from January 1 to December 31.

Case-Complexity

Case-complexity was calculated for each hospital during the study period (fiscal years 1999/2000–2003/04) using a case-mix hospital costing methodology based on refined diagnostic-related groups (RDRGs). In this methodology, clinically similar cases (i.e., cases that can be expected to use similar amounts of hospital resources) are grouped based on principal diagnosis, secondary diagnoses, surgical procedures (type and extent), age, sex, discharge

status, comorbidity and complications. Relative case weights have been developed based on Maryland cost data and Canadian length of stay data. Weights were assigned to each type of case and further adjusted for non-acute days, outliers (i.e., longer lengths of stay than the benchmark), transfers or deaths. These weights were than applied to each hospital's separations and the average weight for each hospital in Manitoba was taken as a measure of that hospital's clinical complexity based on resource use. Note that since the majority of the indicators in this report relate to surgical procedures, surgical case complexity was used.

Case Mix Group (CMG)
CMGs represent a Canadian patient classification system, based on the most responsible diagnosis, used to group and describe types of in-patients discharged from acute-care hospitals. Based on the most-responsible diagnosis, the CMG grouper assigns each hospital abstract to one of 25 mutually exclusive major clinical categories (MCCs). MCCs are based on body systems (e.g., diseases of the circulatory system, diseases of the respiratory system). Within each MCC, cases are classified as medical or surgical and CMGs are assigned accordingly. Cases within the same CMG are subsequently assigned to typical or atypical categories. Typical cases represent the completion of a full course of treatment at a single hospital. Atypical cases denote one of four categories: deaths, sign-outs, transfers and long-stay outliers.

Cholecystectomy
Cholecystectomy refers to the surgical removal of a gallbladder, which is done if it is inflamed, blocked, filled with gallstones, or cancerous. It can be done through an abdominal incision (open cholecystectomy) or through smaller incisions using a small video camera on a tube called a laparoscope (laparoscopic cholecystectomy).

Converted Procedure
In this report a converted procedure refers to a cholecystectomy procedure where the planned method of surgery was laparoscopic, but during the procedure it became necessary to make a larger abdominal incision and revert to the open method of surgery. A conversion from the laparoscopic method to the open method is necessary due to the complexity of the surgery or other difficulties.

Crude Rate
A crude rate is the count of events in a given area (i.e., RHA or hospital), divided by total population at risk of experiencing the event in the area. In contrast to adjusted rates, crude rates are not adjusted for confounding variables such as age and/or sex.

Data Suppression
Data was suppressed when the event count or population count was five or less. Data are not suppressed when the actual event count is zero.

Death in Low Mortality Medical CMGs
This is the number of in-hospital deaths among patients in medical Case Mix Groups with an expected mortality rate of less than 1% based on the CIHI Benchmarking database. Examples of diagnoses within these CMGs include viral meningitis, seizure and headache, influenza, epistaxis, tracheobronchitis, asthma, syncope and collapse, inflammatory bowel disease, G.I. obstruction, cellulites, hematuria, male reproductive system inflammation, female reproductive infection, weight bearing injuries, minor lower extremity fractures, red blood cell disorders, and viral illness.

Death in Low Mortality Surgical CMGs
This is the number of in-hospital deaths among patients in surgical Case Mix Groups with an expected mortality rate of less than 1% based on the CIHI Benchmarking database. Examples of procedures within these CMGs include: ventricular shunt revision, PTCA, carpal tunnel release, extraocular procedures, reconstructive ENT procedures, sinus procedures, cardiac catheterization with ventricular tachycardia, abdominal laparoscopy, hip replacement, knee replacement, adrenal and pituitary procedures, parathyroid procedures, major gynecological procedures of ovaries or adnexal, and radical prostatectomy.

Deep Vein Thrombosis (DVT)
A deep vein thrombosis is a blood clot (thrombus) that develops in a deep vein, usually in the leg. This can happen if the vein is damaged or if the flow of blood slows down or stops. DVTs can occur if a patient experiences prolonged bed-rest or surgery without proper precautions.

Denominator at Risk
For this report, the denominator at risk for a given indicator is the number of patients in hospital who actually have a low probability of complications or of experiencing an event where patient safety may have been compromised. Patients who are at greater risk for complications during their hospital stay are not included in the denominator at risk.

Diagnostic Related Group (DRG)
The DRGs an American case-mix classification system that group together patients into meaningful patient categories that are similar clinically in terms of diagnosis and treatment, and in their consumption of hospital resources, thus allowing comparisons of resource use across hospitals with varying mixes of patients. The DRG grouper software uses the principal diagnosis, secondary diagnoses, surgical procedures, age, sex and discharge status of the

patients treated to assign a DRG to a patient. This system is used primarily in the U.S. as a method of funding hospitals.

Fiscal Year
The fiscal year starts on April 1 and ends the following March 31. For example, the 2003/04 fiscal year would be April 1, 2003 to March 31, 2004, inclusive.

Hospital Assignment
Virtually all analyses in this report allocate patients to the hospital where the service was provided, regardless of where the patient lived. For example, if a resident of Brandon RHA travels to Health Sciences Centre for a procedure, that procedure contributes to the rate for Health Science Centre patients.

Iatrogenic Pneumothorax
Iatrogenic pneumothorax refers to a punctured lung. A puncture of the lung can occur during procedures such as insertions of intercostal catheters and drains, thoracentesis, central line insertion and intubation for mechanical ventilation.

In-Hospital Mortality Rates
This is the adjusted rate of deaths for patients who died while admitted to hospital.

Inpatient Hospital Stay
An in-patient hospital stay refers to any hospital admission in which the patient stays in hospital for one or more days.

Laparoscopic Cholecystectomy
Please see Cholecystectomy

Length of Stay (LOS)
The LOS is the number of days of care in hospital for an inpatient hospitalization. One method to calculate LOS is to subtract the discharge date from the admission date.

Medical Error
Medical error is the failure to complete a planned action as intended or the use of a wrong plan to achieve an aim.

Morbidity Index
In this study, the morbidity index refers to a measure of the general level of sickness of individuals relative to the average Manitoban, and is specific to each indicator. The morbidity index is derived from cost data and the ACG system, which is a population/patient case-mix adjustment system developed

by researchers at Johns Hopkins University School of Hygiene and Public Health. ACGs were calculated based on all physician visits and hospitalizations for a one-year period prior to the hospitalization of interest to obtain a measure of morbidity before the index event. To construct the morbidity index, we first determined each individual's ACG category, which reflected his/her level of sickness over the past year. Then the average provincial hospital cost per ACG was assigned as a morbidity weight to each individual to estimate their morbidity. The morbidity index was derived by dividing the average ACG cost for each condition under study (i.e., the sum of the groups ACG morbidity weights divided by the number in the group), by the overall provincial average. The index was calculated separately for Winnipeg and non-Winnipeg residents, because on average, Winnipeg residents have more physician visits than non-Winnipeg residents, and therefore may appear more ill than they may be. An individual healthier than the average Manitoban would have an index value less than one, while an individual sicker than the average Manitoban would have an index value greater than one.

Number at Risk
Please see Denominator at Risk

Obstetrical Trauma: Vaginal Delivery, with Instrumentation
Obstetric trauma during instrument-assisted vaginal delivery is an injury to the mother while giving birth by vaginal delivery with the aid of birthing instruments such as forceps or vacuums. Obstetric trauma includes fourth-degree perineal lacerations; laceration of the cervix, vaginal wall or sulcus; injury to bladder or urethra; and repair of obstetric lacerations of the uterus, cervix, corpus uteri, bladder, urethra, rectum and sphincter ani. C-section deliveries are not included.

Obstetrical Trauma: Vaginal Delivery, without Instrumentation
Obstetric trauma during vaginal delivery without instrumentation is an injury to the mother while giving birth by vaginal delivery without the aid of birthing instruments. Obstetric trauma includes fourth-degree perineal lacerations; laceration of the cervix, vaginal wall or sulcus; injury to bladder or urethra; and repair of obstetric lacerations of the uterus, cervix, corpus uteri, bladder, urethra, rectum and sphincter ani. C-section deliveries are not included.

Open Cholecystectomy
Please see Cholecystectomy

Patient Safety
Patient safety is achieved through the reduction and mitigation of unsafe acts within the healthcare system, as well as through the best practices shown to lead to optimal patient outcomes.

Patient Safety Indicator (PSI)
A patient safety indicator is an estimate of possible compromise to patient safety. A PSI estimate cannot be directly attributed to medical error. The indicators are screening tools which should be used to identify processes of care that may warrant further investigation.

Post-Operative Abdominopelvic Wound Dehiscence
Post-operative abdominopelvic wound dehiscence is the unintentional opening of a surgical wound of the abdomen after surgery. These cases require a second procedure to re-close the surgical site.

Post-Operative Hemorrhage or Hematoma
A post-operative hemorrhage refers to a loss of blood occurring after a surgical procedure that is copious enough to threaten health or life. A post-operative hematoma is a localized swelling filled with blood, commonly referred to as a bruise, resulting from a break in a blood vessel after a surgical procedure.

Post-operative Thromboembolism
A post-operative thromboembolism refers to a blood clot that occurs after surgery, either in a deep vein, usually in the leg (deep-vein thrombosis) or in an artery of the lung (pulmonary embolism). Walking and staying active as soon as possible after surgery can reduce the risk of post-operative thromboembolism. Other preventive measures include compression stockings (plastic sleeves that fit around the legs and help circulate the blood).

Prophylactic Measures
Prophylactic measures are measures designed to prevent the occurrence of an adverse event, a disease or its dissemination. In this report, prophylactic measures include standard protocols, procedures or actions such as compression stockings during surgery to prevent post-operative blood clots.

Pulmonary Embolism (PE)
A pulmonary embolism is a blockage of an artery in the lungs by fat, air, clumped tumor cells, or a blood clot. The most common cause of a pulmonary embolism is a blood clot in the veins of the legs, called a deep vein thrombosis (DVT). Many PE clear up on their own, though some may cause severe illness or even death.

Reconstructive Biliary Surgery
Reconstructive biliary surgery is a subsequent procedure to repair the bile ducts as a result of an accidental cut or injury to the ducts during a laparoscopic cholecystectomy. Biliary reconstruction is assigned to the hospital at which the laparoscopic cholecystectomy was performed. This means that if a laparoscopic procedure was performed at hospital A and the reconstructive

procedure was performed at hospital B, the reconstructive procedure would be assigned to hospital A, the site of the cholecystectomy.

Refined Diagnostic Related Group (RDRGs)
RDRGs are a refined version of the DRG classification system that further classifies patient cases into levels of severity and complexity based on the presence of comorbidities and complications and their impact on resource use.

Relative Risk
Also known as the rate ratio or risk ratio, the relative risk is a ratio of the proportion (or rate) of the event in one population over the proportion (or rate) of the event in the reference population. In this report, the relative risk of in-hospital death for an indicator is the mortality rate for the patients who experienced the adverse event, divided by the mortality rate for the patients who were at risk for, but did not experience, the adverse event.

Socioeconomic Factor Index (SEFI)
The SEFI is a score based on data from the 2001 census that reflects non-medical social determinants of health and include factors such as age, single-parent status, female labour force participation, unemployment and education. SEFI is calculated at geographic level of Dissemination Area (DAB) and then assigned to residents based on their postal codes. SEFI scores less than zero indicate more favourable socioeconomic conditions, while SEFI scores greater than zero indicate less ideal socioeconomic conditions.

Socioeconomic Status (SES)
An individual's SES is characterized by the economic, social and physical environments in which they live and work, as well as demographic and genetic factors. In this report SES was approximated using SEFI.

Please see Adjusted Rates

Statistical Comparisons
Statistical comparisons were made between individual Manitoba hospitals or hospital types and population average rates to determine whether a large difference in a hospital's rate for a given indicator was statistically significantly different or just due to chance. For each Patient Safety Indicator, the rate for each Manitoba tertiary or community hospital was compared to U.S. tertiary or community hospital average rates, respectively, as reported in the AHRQ patient safety report, A National Profile of Patient Safety in U.S. Hospitals by Romano et al., 2003. For laparoscopic cholecystectomy, the rate for each Manitoba hospital or hospital type was compared to the Manitoba average rate in the study period. Confidence limits (99%) were derived for estimates on the individual hospitals and hospital types. The

difference in rates between individual hospitals and the population (either MB or U.S.) average rate was considered statistically significant if the average rate fell outside of the confidence interval of the individual hospital estimates. Comparisons to U.S. rates have not been made for death in low-mortality medical and surgical Case Mix Groups because the U.S. rates are reported by Diagnostic Related Groups, which is an American patient classification system. Comparisons of rates of accidental puncture/laceration are also not possible because the U.S. rate by hospital type combined surgical and medical cases, and we reviewed only surgical cases.

APPENDIX A: PATIENT SAFETY INDICATOR DEFINITIONS

These definitions, with the exception of CMG PSIs, were taken from Romano et al. (2003). The CMG PSI definitions were taken from the CIHI Acute Care Hospital Report (2003). Please see Appendix B: PSI Codes in this report for diagnostic codes used for the terms in italics below.

Indicator	Definition
Accidental Puncture or Laceration	All surgical discharges with ICD-9-CM code denoting *accidental puncture or laceration* in any secondary diagnosis field. (No specific exclusions)
Birth Trauma: Injury to Neonate	All *live births* with ICD-9-CM codes for *birth trauma* in any diagnosis field. **Exclude**: Infants with diagnosis codes for *cerebral or subdural hemorrhage* AND any diagnosis code of *preterm infant* (defined by a birth weight of less than 2500 g and a gestation period of less than 37 weeks.) Also exclude infants with diagnosis codes for *injury to skeleton* AND any diagnosis code of *osteogenesis imperfecta*.
Cholecystectomy	All medical or surgical discharges with ICD-9-CM codes for *cholecystectomy* in any procedure field.
Death in Low Mortality Medical CMGs	All surgical and medical discharges with disposition of deceased AND in *low mortality medical CMGs* with less than 1% mortality rate. **Exclude**: Patients with any code for *trauma*, *immunocompromised state*, or *cancer*.
Death in Low Mortality Surgical CMGs	All surgical and medical discharges with disposition of deceased AND in *low mortality surgical CMGs* with less than 0.5% mortality rate. **Exclude**: Patients with any code for *trauma*, *immunocompromised state*, or *cancer*.
Iatrogenic Pneumothorax	All surgical and medical discharges with ICD-9-CM code of *iatrogenic pneumothorax* in any secondary diagnosis field. **Exclude**: Patients with any diagnosis of *trauma*. Also exclude patients with any code indicating *thoracic surgery* or *lung or pleural biopsy* or *cardiac surgery*.

Appendix A continued

Obstetric Trauma: Vaginal Delivery with Instrumentation	All *vaginal delivery* discharges with ICD-9-CM codes for *instrument-assisted delivery* in any procedure field AND ICD-9-CM codes for *obstetric trauma* in any diagnosis or procedure field. (No specific exclusions)
Obstetric Trauma: Vaginal Delivery without Instrumentation	All *vaginal delivery* discharges with ICD-9-CM codes for *obstetric trauma* in any diagnosis or procedure field. **Exclude**: Patients with procedure codes for *instrument assisted delivery* in any procedure field.
Post-operative Hemorrhage or Hematoma	All surgical discharges with ICD-9-CM code for *postoperative hemorrhage* in any secondary diagnosis field AND ICD-9-CM code for *control of hemorrhage* in any secondary procedure field OR ICD-9-CM code for *postoperative hematoma* in any secondary diagnosis field AND ICD-9-CM code *drainage of hematoma* in any secondary procedure field. Procedure code for control of hemorrhage or drainage of hematoma must occur on the same day or after the principal procedure. (No specific exclusions)
Post-operative Thromboembolism	All surgical discharges with ICD-9-CM codes for *deep vein thrombosis* or *pulmonary embolism* in any secondary diagnosis. **Exclude**: Patients with a most responsible diagnosis of *deep vein thrombosis*. Also exclude patients with secondary procedure code for *interruption of the vena cava* when this procedure occurs on the day of or previous to the day of the principal procedure.
Post-operative Wound Dehiscence	All *abdominopelvic* surgical discharges with ICD-9-CM codes for *reclosure of postoperative disruption of abdominal wall* in any secondary procedure field. (No specific exclusions)

APPENDIX B: PATIENT SAFETY INDICATOR CODES

These codes, with the exception of CMG codes, were taken from Romano et al. (2003). CMG codes were taken from the CIHI Acute Care Hospital Report (2003).

Indicator Term	Codes
Abdominopelvic Procedures	**ICD-9 Procedure Codes**: 38.04, 38.06, 38.07, 38.14, 38.16, 38.24, 38.36, 38.37, 38.44, 38.46, 38.47, 38.57, 38.64, 38.66, 38.67, 38.84, 38.86, 38.87, 39.1, 39.24, 39.25, 39.26, 40.52, 40.53, 41.2, 41.33, 41.41, 41.42, 41.43, 41.5, 41.93, 41.94, 41.95, 41.99, 42.4, 42.41, 42.42, 42.53, 42.54, 42.55, 42.56, 42.63, 42.64, 42.65, 42.66, 42.91, 43.0, 43.19, 43.3, 43.42, 43.49, 43.5, 43.6, 43.7, 43.81, 43.89, 43.91, 43.99, 44, 44.01, 44.02, 44.03, 44.11, 44.15, 44.21, 44.29, 44.31, 44.39, 44.4, 44.41, 44.42, 44.5, 44.61, 44.63, 44.64, 44.65, 44.66, 44.69, 44.91, 44.92, 450, 45.01, 45.02, 45.03, 45.31, 45.32, 45.33, 45.34, 45.41, 45.49, 45.5, 45.51, 45.52, 45.61, 45.62, 45.63, 45.71, 45.72, 45.73, 45.74, 45.75, 45.76, 45.79, 45.8, 45.90, 45.91, 45.92, 45.93, 45.94, 45.95, 46.01, 46.03, 46.10, 46.11, 46.13, 46.20, 46.21, 46.22, 46.23, 46.40, 46.41, 46.42, 46.43, 46.50, 46.51, 46.52, 46.60, 46.61, 46.62, 46.63, 46.64, 46.72, 46.74, 46.76, 46.80, 46.81, 46.82, 46.91, 46.92, 46.93, 46.94, 46.99, 47.09, 47.19, 47.2, 47.91, 47.92, 47.99, 48.41, 48.49, 48.5, 48.75, 50.0, 50.12, 50.21, 50.22, 50.29, 50.3, 50.4, 50.51, 50.59, 50.69, 51.03, 51.04, 51.13, 51.21, 51.22, 51.31, 51.32, 51.33, 51.34, 51.35, 51.36, 51.37, 51.39, 51.41, 51.42,51.43, 51.49, 51.51, 51.59, 51.61, 51.62, 51.63, 51.69, 51.71, 51.72, 51.79, 51.81, 51.82, 51.83, 51.89, 51.92, 51.93, 51.94, 51.95, 51.99, 52.01, 52.09, 52.12, 52.22, 52.3, 52.4, 52.51, 52.52, 52.53, 52.59, 52.6, 52.7, 52.80, 52.81, 52.82, 52.83, 52.92, 52.95, 52.96, 52.99, 53.00, 53.01, 53.02, 53.03, 53.04, 53.05, 53.10, 53.11, 53.12, 53.13, 53.14, 53.15, 53.16, 53.17, 53.21, 53.29, 53.31, 53.39, 53.41, 53.49, 53.51, 53.59, 53.61, 53.69, 53.7, 54.0, 54.11, 54.19, 54.22, 54.23, 54.3, 54.4, 54.59, 54.63, 54.64, 54.71, 54.72, 54.73, 54.74, 54.75, 54.92, 54.93, 54.94, 54.95, 55.51, 55.52, 55.53, 55.54, 55.61, 55.69, 55.7, 55.83,

Appendix B continued

	55.84, 55.85, 55.86, 55.87, 55.91, 55.97, 55.98, 56.51, 56.52, 56.61, 56.62, 56.71, 56.72, 56.73, 56.74, 56.75, 56.83, 56.84, 56.85, 56.86, 56.89, 56.95, 57.71, 57.79, 57.82, 57.87, 59.00, 59.02, 59.09, 60.12, 60.14, 60.15, 60.3, 60.4, 60.5, 60.61, 60.72, 60.73, 60.79, 60.93, 65.09, 65.12, 65.21, 65.22, 65.29, 65.39, 65.49, 65.51, 65.52, 65.61, 65.62, 65.71, 65.72, 65.73, 65.79, 65.89, 65.92, 65.93, 65.94, 65.95, 65.99, 66.01, 66.02, 66.31, 66.32, 66.39, 66.4, 66.51, 66.52, 66.61, 66.62, 66.63, 66.69, 66.71, 66.72, 66.73, 66.74, 66.79, 66.92, 66.97, 68.0, 68.13, 68.14, 68.3, 68.4, 68.6, 68.8
Accidental Puncture or Laceration	**ICD-9 CM Diagnosis Codes**: 998.2, E87.00-E87.09
Birth Trauma, Cerebral or Subdural Hemorrhage	**ICD-9 CM Diagnosis Code**: 767.0
Birth Trauma, Injury to Skeleton	**ICD-9 CM Diagnosis Codes**: 767.3, 767.4
Birth Trauma, Other	**ICD-9 CM Diagnosis Codes**: 767.7, 767.8, 767.9
Cancer	**ICD-9 CM Diagnosis Codes**: 140.0-165.9, 170.0-172.9, 174.0-176.9, 179-208.91, 238.6, 273.3, V10.00-V10.9
Cancer	**Diagnosis Related Groups**: 010, 011, 064, 082, 172, 173, 199, 203, 239, 257, 258, 259, 260, 274, 275, 303, 318, 319, 338, 344, 346, 347, 354, 355, 357, 363, 367, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 473, 492
Cardiac Surgery	**Diagnosis Related Groups**: 103, 104, 105, 106, 107, 108, 109, 110, 111
Cholecystectomy	**ICD-9 Procedure Codes**: 51.22, 51.23
Control of Postoperative Hemorrhage	**ICD-9 CM Procedure Codes**: 28.7, 38.80-38.89, 39.41, 39.98, 49.95, 57.93, 60.94
Drainage of Postoperative Hematoma	**ICD-9 CM Procedure Codes**: 18.09, 54.0, 54.12, 59.19, 61.0, 69.98, 70.14, 71.09, 75.91, 75.92, 86.04
Iatrogenic Pneumothorax	**ICD-9 CM Diagnosis Code**: 512.1
Immunocompromised State	**ICD-9 CM Diagnosis Codes**: 042, 136.3, 279.00-279.4, 279.8, 279.9, 996.8-996.89, V42.0, V42.1, V42.6-V42.89
Immunocompromised State	**ICD-9 CM Procedure Codes**: 33.5-33.52, 33.6, 37.5, 41.0-41.09 50.51, 50.59, 52.80-52.83,

Appendix B continued

	52.85, 52.86, 55.69
Immunocompromised State	**Diagnosis Related Groups**: 488, 489, 490
Instrument Assisted Delivery	**ICD-9 CM Procedure Codes**: 72.0, 72.1, 72.21, 72.29, 72.31, 72.39, 72.4, 72.51, 72.53, 72.6, 72.71, 72.8, 72.9
Interuption of Vena Cava	**ICD-9 CM Procedure Code**: 38.7
Laparoscopic Cholecystectomy	**ICD-9 Procedure Code**: 51.23
Live Births	**ICD-9 CM Diagnosis Codes**: 764.0-764.29, 764.9-765.19, 766.0-766.2, 767.0-771.8, 772.0-773.5, 774.0-774.7, 775.0- 776.9, 777.1-779.6, 779.8-779.9, V30.0-V37.2, V39.0-V39.2
Live Births	**Diagnosis Related Groups**: 385, 386, 387, 388, 389, 390, 391
Low Mortality Medical CMGs	**Case Mix Groups:** 017, 018, 022, 060, 063, 104, 108, 109, 114, 115, 145, 146, 213, 233, 235, 240, 242, 285, 286, 289, 294, 297, 329, 397, 399, 402, 407, 409, 411, 413, 447, 452, 454, 483, 527, 529, 532, 534, 535, 536, 561, 562, 594, 596, 685, 688, 690, 691, 692, 693, 694, 696, 704, 735, 736, 756, 757, 761, 846, 850, 851, 852, 910
Low Mortality Surgical CMGs	**Case Mix Groups:** 004, 005, 006, 054, 055, 057, 076, 077, 083, 084, 085, 087, 088, 186, 189, 193, 194, 204, 211, 216, 217, 218, 260, 261, 262, 264, 265, 266, 269, 271, 315, 317, 352, 354, 359, 360, 363, 365, 369, 372, 376, 377, 378, 379, 381, 382, 425, 429, 432, 435, 437, 438, 476, 477, 478, 479, 500, 502, 504, 509, 510, 512, 525, 551, 552, 554, 576, 577, 578, 579, 581, 582, 583, 584, 586, 587, 657, 664, 666, 669, 670, 703, 804, 805, 892, 908
Lung or Pleural Biopsy	**ICD-9 CM Procedure Codes**: 33.26, 33.28, 34.24
Medical CMGs	**Case Mix Groups:** 010, 011, 012, 013, 014, 015, 017, 018, 019, 020, 021, 022, 028, 029, 060, 062, 063, 100, 101, 102, 104, 107, 108, 109, 113, 114, 115, 116, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 200, 205, 206, 207, 208, 212, 213, 219, 220, 222, 225, 226, 229, 232, 233, 234, 235, 237, 240, 242, 279, 281, 285, 286, 289, 290, 294, 297, 323, 324, 325, 326, 329, 391, 392, 393, 394, 397, 398, 399, 401, 402, 404, 407, 409,

Appendix B continued

	411, 413, 414, 439, 440, 443, 446, 447, 452, 454, 483, 485, 487, 488, 489, 521, 522, 524, 525, 526, 527, 529, 530, 532, 534, 535, 536, 538, 560, 561, 562, 563, 592, 594, 595, 596, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 704, 709, 710, 730, 735, 736, 737, 751, 756, 757, 761, 763, 811, 813, 818, 823, 831, 834, 841, 842, 846, 847, 849, 850, 851, 852, 860, 861, 862, 863, 864, 865, 866, 867, 868, 895, 898, 910, 997, 999
Medical DRGs	**Diagnosis Related Groups**: 009-035, 043-048, 064-074, 078-102, 112, 121-145, 172-190, 202-208, 235-256, 271-284, 294-301, 316-333, 346-352, 366-369, 372-373, 376, 379-380, 382-384, 395-399, 403-404, 409-414, 416-423, 444-455, 457, 460, 462-467, 475, 487, 492
Obstetric Trauma	**ICD-9 CM Diagnosis Codes**: 664.30, 664.31, 664.34, 665.30, 665.31, 665.34, 665.40, 665.41, 665.44, 665.50, 665.51, 665.54
Obstetric Trauma	**ICD-9 CM Procedure Codes**: 75.50-75.52, 75.61, 75.62
Open Cholecystectomy	**ICD-9 Procedure Code**: 51.22
Osteogenesis Imperfecta	**ICD-9 CM Diagnosis Code**: 756.51
Post-operative Deep Vein Thrombosis	**ICD-9 CM Diagnosis Codes**: 451.11, 451.19, 451.2, 451.81, 451.9, 453.8, 453.9
Post-operative Hematoma	**ICD-9 CM Diagnosis Code**: 998.12
Post-operative Hemorrhage	**ICD-9 CM Diagnosis Code**: 998.11
Post-operative Pulmonary Embolism	**ICD-9 CM Diagnosis Codes**: 415.1, 415.11, 415.19
Post-operative Respiratory Failure	**ICD-9 CM Diagnosis Codes**: 518.81, 518.84
Preterm Infant	**ICD-9 CM Diagnosis Codes**: 765.01-765.08, 765.11-765.18, 765.22-765.27
Reclosure of Postoperative Disruption Of Abdominal Wall	**ICD-9 CM Procedure Code**: 54.61
Reconstructive Biliary Surgery	**Physician Tariff Codes**: 3520, 3522, 3524
Surgical CMGs	**Case Mix Groups:** 001, 003, 004, 005, 006, 007, 040, 050, 051, 052, 053, 054, 055, 057, 075, 076, 077, 078, 081, 082, 083, 084, 085, 086, 087, 088, 089, 090, 091, 092, 093, 125, 126, 127, 128, 129, 175, 176, 177, 178, 179, 181, 182, 183, 184, 185, 186, 188, 189, 191, 193, 194, 201, 202, 203, 204, 210, 211, 215,

Appendix B continued

	216, 217, 218, 250, 251, 252, 253, 255, 258, 260, 261, 262, 264, 265, 266, 269, 271, 310, 311, 312, 313, 314, 315, 317, 320, 350, 351, 352, 354, 355, 356, 358, 359, 360, 361, 362, 363, 365, 367, 368, 369, 372, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 425, 427, 428, 429, 432, 434, 435, 436, 437, 438, 476, 477, 478, 479, 480, 482, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 512, 514, 550, 551, 552, 554, 555, 575, 576, 577, 578, 579, 581, 582, 583, 584, 585, 586, 587, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 700, 701, 703, 725, 728, 733, 734, 750, 803, 804, 805, 830, 832, 833, 840, 880, 881, 882, 883, 884, 885, 887, 890, 891, 892, 893, 900, 901, 902, 906, 908
Surgical DRGs	**Diagnosis Related Groups**: 001-008, 036-042, 049-063, 075-077, 103-108, 110, 111, 113-120, 146-171, 191-201, 209-213, 216-220, 223-234, 257-268, 269-270, 285-293, 302-315, 334-345, 353-365, 370-371, 374-375, 377-378, 381, 392-394, 400-402, 406-408, 415, 424, 439-443, 458-459, 461, 468, 471, 472, 476-479, 480-486, 488, 491, 493-503
Thoracic Surgery	**ICD-9 CM Procedure Codes**: 31.21, 31.45, 31.73, 31.79, 31.99, 32.09, 32.1, 32.21, 32.22, 32.28, 32.29, 32.3, 32.4, 32.5, 32.6, 32.9, 33.0, 33.1, 33.25, 33.26, 33.27, 33.28, 33.31, 33.32, 33.34, 33.39, 33.41, 33.42, 33.43, 33.48, 33.49, 33.50, 33.51, 33.52, 33.6, 33.92, 33.93, 33.98, 33.99, 33.29, 33.33, 34.01, 34.02, 34.03, 34.05, 34.09, 34.1, 34.21, 34.22, 34.23, 34.24, 34.25, 34.26, 34.27, 34.28, 34.29, 34.3, 34.4, 34.51, 34.59, 34.71, 34.72, 34.73, 34.74, 34.79, 34.81, 34.82, 34.83, 34.84, 34.85, 34.89, 34.93, 34.99, 40.61, 40.62, 40.63, 40.64, 40.69, 42.01, 42.09, 42.10, 42.11, 42.12, 42.19, 42.21, 42.25, 42.31, 42.32, 42.39, 42.40, 42.41, 42.42, 42.51, 42.52, 42.53, 42.54, 42.55, 42.56, 42.58, 42.59, 42.61, 42.62, 42.63, 42.64, 42.65, 42.66, 42.68, 42.69, 42.7, 42.81, 42.82, 42.83, 42.84, 42.85, 42.86, 42.87, 42.89, 44.65, 44.66, 81.04
Trauma	**ICD-9 CM Diagnosis Codes**: 800.0-807.6,

Appendix B continued

	808.0-808.59, 808.8-812.59, 813.00-813.54, 813.80-814.19, 815.00-815.19, 817.0, 817.1, 818.0, 818.1, 819.0, 819.1, 820.00-820.32, 820.8-821.39, 822.0, 822.1, 823.00-823.42, 823.80-825.39, 827.0, 827.1, 828.0, 828.1, 829.0, 829.1, 830.0-833.19, 835.00-835.13, 836.0-837.1, 838.00-838.19, 839.00-852.59, 853.00-853.19, 854.00-854.19, 860.0-861.32, 862.0-862.39, 862.8-863.59, 863.80-864.19, 865.00-865.19, 866.00-866.13, 867.0-868.19, 869.0, 869.1, 870.0-871.7, 871.9-872.12, 872.61-872.69, 827.71-874.5, 874.8-875.1, 876.0, 817.61, 877.0, 877.1, 878.0-880.29, 881.00-882.2, 884.0, 884.1, 884.2, 887.0-887.7, 890.0, 890.1, 890.2, 891.0, 891.1, 891.2, 892.0, 892.1, 894.0, 894.1, 894.2, 896.0-896.3, 897.0-897.7, 900.00-900.03, 900.1, 900.81, 900.82, 900.89, 900.9-901.42, 901.81-902.59, 902.81-903.5, 903.8-925.2, 9260-926.19, 926.8- 927.3, 927.8- 928.3, 928.8-929.9, 940.0-940.5, 940.9-941.59, 942.00- 942.59, 943.00- 943.59, 944.00-944.58, 945.00- 948.44, 948.50-949.5, 952.00-952.19, 952.2-952.4, 952.8-953.5, 953.8, 953.9, 958.0- 958.8
Trauma	**Diagnosis Related Groups**: 002, 027, 028, 029, 030, 031, 032, 033, 072, 083, 084, 235, 236, 237, 440, 441, 442, 443, 444, 445, 446, 456, 457, 458, 459, 460, 484, 485, 486, 487, 491, 504, 505, 506, 507, 508, 509, 510, 511
Vaginal Delivery	**Case Mix Groups**: 606, 607, 608, 609, 610, 611

APPENDIX C: GENERAL EXCLUSION CRITERIA

Non-Obstetric PSI and Cholecystectomy Patients:

- Manitoba residents at least 19 years of age at time of admission to hospital were included. Residents who could not be assigned to a RHA or residents with a Public Trustee postal code were excluded.

- Obstetrical discharge abstracts were excluded. For PSI patients, only inpatient admissions were included. For cholecystectomy patients, both inpatient and outpatient admissions were included.

- Patients with surgical or medical DRGs or CMGs (as applicable) were included. Patients with an obstetric or psychiatric DRG or CMG were excluded.

- Small Rural Hospitals, Long Term Care Hospitals, Personal Care Homes and Hospitals outside of Manitoba were excluded.

Obstetric PSI Patients:

- Manitoba female residents were included. Residents who could not be assigned to a RHA or residents with a Public Trustee postal code were excluded.

- Only inpatient, obstetric admissions were included.

- Small Rural Hospitals, Long Term Care Hospitals, Personal Care Homes and Hospitals outside of Manitoba were excluded.

Recent MCHP Publications

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Key Events and Dates in the Manitoba Health Care System, 1990 to 2003, compiled by Fred Toll

2002

Improving Children's Health: How Population-Based Research Can Inform Policy - The Manitoba Experience, Canadian Journal of Public Health, Volume 93, Supplement 2, November/December 2002

Monitoring the Acute Care Sector: Key Measures and Trends, Healthcare Management Forum Supplement, Winter 2002

Estimating Personal Care Home Bed Requirements, by Norman Frohlich, Carolyn De Coster, and Natalia Dik

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Health and Health Care Use of Registered First Nations People Living in Manitoba: A Population-Based Study, by Patricia J Martens, Ruth Bond, Laurel Jebamani, Charles Burchill, and others.