

An Evaluation of the Quality of Administrative Data relating to hip and knee replacement surgery



April 2000

AN EVALUATION OF THE QUALITY OF ADMINISTRATIVE DATA RELATING TO HIP AND KNEE REPLACEMENT SURGERY

George H. Pink, PhD¹⁻²

Wendy Young, MA^{4*}

Joan Porter, MSc,^{5*}

Ian McKillop, PhD^{1,3}

¹ Institute for Clinical Evaluative Sciences
Toronto, Ontario

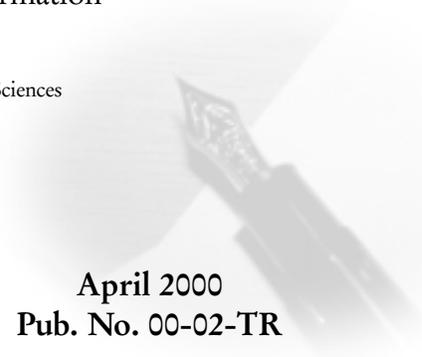
² Department of Health Administration, University of Toronto
Toronto, Ontario

³ School of Business & Economics, Wilfrid Laurier University
Waterloo, Ontario

⁴ PhD Student, Department of Health Administration, University of Toronto
Toronto, Ontario

⁵ Canadian Institute for Health Information
Toronto, Ontario

*Formerly with Institute for Clinical Evaluative Sciences
Toronto, Ontario



April 2000
Pub. No. 00-02-TR

Table of Contents

Abstract	2
Introduction	3
Methods	5
Study Population.....	5
Canadian Institute for Health Information.....	5
Ontario Hospital Financial and Statistical System Data.....	6
Evaluative Measures	6
Results	9
Completeness	9
Consistency	9
Reasonableness.....	10
Discussion	11
Conclusions	13
References	14
Appendices	15

Abstract

Objective: To evaluate the completeness, consistency and reasonableness of orthopedic surgery-related administrative data that were collected and reported by Ontario hospitals after the adoption of a standardized information system coding convention.

Design: Discharge abstract data from all Ontario hospitals reporting hip or knee replacements in fiscal years 1994/95, 1995/96 and 1996/97 were compared with procedure-specific statistical and financial data reported to the provincial Ministry of Health by the same hospitals.

Outcome Measures: Completeness was assessed by examining the extent to which hospitals reported joint replacement data in all three of the datasets examined. Consistency was assessed by examining the relative difference between values for similar data elements found in different datasets. Reasonableness was assessed by examining the extent to which hospital financial records reported hip or knee prosthetic expenses that fell within study defined parameters.

Results: Approximately 50 per cent of facilities maintained complete statistical and financial data in each of the first two years under study. By 1996/97, 59 per cent of hospitals providing hip replacements and 64 per cent providing knee replacements had complete data. The number of hip replacements reported in hospital statistical data tended to exceed the number reported in discharge abstract records, while the number of knee replacements identified in hospital statistical data was generally less than that found using discharge abstract data. Of the hospitals with complete data, less than half had data that were consistent between datasets for either hips or knees in the three years under study. Interestingly, despite the inconsistency with respect to counting joint replacement procedures, most hospitals with complete data reported reasonable prosthetic expenditures according to the definition used in this study.

Conclusions: Notwithstanding the adoption of standardized specifications for the collection and maintenance of financial and statistical data by Ontario hospitals, data reported to the Ministry of Health using these specifications appear to be incomplete and inconsistent when compared to another data source. This impedes the expected usefulness of these data elements for planning, management and research, and suggests that caution is warranted when using these data.

1.0 Introduction

Statistical and financial data are used extensively for decisions at all levels of health care systems in many jurisdictions. For example, in the U.S., introduction of the Prospective Payment System for Medicare patients and the focus on managed care and integrated delivery systems have led to substantial investments in information systems that link clinical and financial data to yield detailed patient level financial information. As a result of recent reforms to the National Health Service in the U.K., hospital administrators now recognize that accurate data on patient numbers, as well as patient costs, are integral to fully reconcilable budgets and accountability to stakeholders.¹ In Ontario, the Joint Policy and Planning Committee (JPPC) makes hospital funding recommendations to the Ministry of Health based in part on the financial and statistical data collected and submitted by individual hospitals according to specifications outlined in the *Guidelines for Management Information Systems in Canadian Health Care Facilities*. (In Canada, the comprehensive specifications for the design of clinical and financial information systems used by hospitals are maintained by the Canadian Institute for Health Information and are known as the Management Information System (MIS) Guidelines.

Accompanying this reliance on detailed information for decision-making is a growing conviction that the quality of data needs to be improved.^{2,3} The consequences of generating reports based on unreliable numbers may be far-reaching; bad data, which are often expensive to collect and process, lead to bad decisions.^{4,5} In general, hospitals that manage according to inaccurate clinical and financial data will be unable to determine the kinds of facilities, programs, equipment and medical specialties needed.⁶ Surgeons who use poor quality administrative data in their research may report inaccurate findings and draw erroneous conclusions.

The purpose of this study is to examine the quality of hospital-specific statistical and financial data for hip and knee replacement surgery that have been organized and reported in accordance with the Ontario Hospital Reporting System (OHRS) Guidelines. (The OHRS Guidelines are an enhancement of the MIS chart of accounts in which Ontario has tailored national requirements to local needs.)

Specifically, this study examines the completeness, consistency and reasonableness of hip and knee replacement reporting over a three-year period by comparing discharge abstract data with procedure-specific statistical and financial data from hospital accounting systems. The study refers to discharge abstract data as CIHI (Canadian Institute for Health Information) data, after the organization responsible for maintaining the national abstracting database. (CIHI maintains a number of databases of which the national discharge abstract database is but one.) The designation of discharge abstract data as the comparator in this study is predicated on research indicating the reliability and validity of such sources, particularly for major events and procedures, of which hip and knee replacements may be counted as examples of the latter.⁷ The study refers to data collected by an individual hospital related to the statistical and financial activities of the hospital as OHRS data.

A number of factors made hip and knee replacement an appropriate procedure to examine. Major joint replacements are provided at sufficient sites, and in sufficient volumes, as to ensure the sample included hospitals from across the province. Joint replacement is also a relatively homogenous procedure, making joint replacement patients a relatively well-defined group that is

easy to identify. And lastly, the significant costs associated with prosthetic implants and the special attention given to joint replacement programs by the Ontario Ministry of Health through its previous "Life Support" and current "Priority Program" funding, helps promote the appropriate capture of activity levels and costs among hospitals providing replacement procedures. In fiscal year 1994/95, the total volume of hip replacements in Ontario was 6,905 at an average hospitalization cost of \$9,990 (1988 Cdn \$). Hip replacement surgery in Ontario increased at an average annual rate of seven per cent between 1989/90 and 1991/92, subsequently slowing to an approximately one per cent per annum increase over the period 1991/92 to 1994/95, while knee replacement procedures increased 15 per cent and seven per cent over these respective time periods.⁸

This study answers the following questions:

(1) *With respect to completeness:*

To what extent do hospitals report OHRS statistical and OHRS financial and CIHI discharge abstract data for hip and knee replacements? Is the completeness of the 1996/97 and 1995/96 data different from the 1994/95 data? Does completeness vary by hospital type?

(2) *With respect to consistency:*

To what extent is the reporting of OHRS statistical data consistent with the reporting of CIHI data for hip and knee replacements? Is the consistency of the 1996/97 and 1995/96 data different from the 1994/95 data? Does consistency vary by hospital type?

(3) *With respect to reasonableness:*

To what extent can the reported prosthetic expenses be considered reasonable? Is the reasonableness of the 1996/97 and 1995/96 data different from the 1994/95 data? Does reasonableness vary by hospital type?

2.0 Methods

2.1 Study Population

The population studied includes all Ontario hospitals for which either discharge abstract data or internal accounting records indicated the hospital performed hip or knee replacement surgery in 1994/95, 1995/96 or 1996/97. A complete listing of the 100 hospitals in the study population is provided in Appendix A.

Two sources of data are used in the analysis. Discharge abstract data are obtained from databases developed by CIHI. Statistical and financial accounting records are obtained from databases maintained by the Ontario Ministry of Health. These data are linked by the hospital facility number.

2.2 Canadian Institute for Health Information Data

Information on all hospital discharges in Ontario is routinely collected by CIHI and includes institution number (the Ministry of Health augments the CIHI data in a number of respects including the mapping of institution numbers to facility numbers), patient demographics, Ontario Health Insurance Plan (OHIP) numbers, start and end dates of hospitalization, surgical procedures performed, and diagnoses associated with the admission. All inpatient and same-day surgery records with a Canadian Classification of Procedures (CCP)⁹ code indicating a total or revision hip replacement, or total knee replacement, in 1994/95, 1995/96 or 1996/97 were abstracted. A number of hospitals report procedures using the International Classification of Disease-Clinical Modification system (ICD9-CM) in which case CIHI maps ICD9-CM codes to CCP procedure codes. Certain patient demographic information, such as patient name and address, were not released to the researchers.

The abstracting process revealed a few hospitals reporting joint replacement surgery being performed on an outpatient basis (a highly unusual delivery modality for joint replacement surgery). The abstracting process also identified several hospitals performing a relatively small number of procedures per year. (Again, highly unusual, as the infrastructure and expertise required to support joint replacement surgery usually argues for performing these procedures in higher volumes to ensure clinical familiarity.) To minimize the chance of obvious coding errors existing in the reference database, hospitals reporting fewer than 10 hip or knee replacements in any fiscal year, as well as hospitals appearing to provide joint replacements on an outpatient basis, were contacted by letter and asked to reabstract the patient's chart to confirm the CIHI documentation. Five hospitals were removed when it was confirmed that the inpatient replacement procedures (n=6) at these institutions were miscoded. Six same-day surgery cases were also found to have been incorrectly coded and were removed from the dataset.

Each discrete joint replacement counted as one procedure. An individual who underwent a bilateral replacement, therefore, contributed a count of two. Hip fractures as a result of trauma or cancer which resulted in a total joint replacement, and out-of-province residents who had a replacement procedure in Ontario were included in the study data.

2.3 Ontario Hospital Financial and Statistical System Data

Since 1994, all Ontario hospitals have maintained statistical and financial information system records using specifications outlined in the OHRS Guidelines. One component of the OHRS is a chart of accounts which is used to classify and record the various activities and financial transactions of the hospital. Hospitals submit an annual summary of their chart of account balances to the Ontario Ministry of Health. The data become part of the province-wide Ontario Hospital Financial and Statistical System (OHFSS). Although there are some edit checks in place, data submitted to the OHFSS are not audited.

Specific account numbers are used by hospitals to report statistical and financial data pertaining to major joint replacement procedures. Hospitals are required to report the number of total hip and/or knee replacements under the Ministry of Health Life Support program statistical accounts. Hip replacements involving unipolar prostheses (e.g. Moore or Thompson) and used in the treatment of some hip fractures are excluded. In the statistical accounts, joint replacements are categorized as: inpatient total hip, inpatient total knee and outpatient total knee.

The costs associated with the prosthetic devices are reported under the revenue and expense accounts as either *Medical & Surgical Supplies - Prostheses* or *Patient Specific Supplies - Prostheses*. The medical and surgical supplies cost includes the “cost of artificial replacement hips [knees], as well as the components used in assembling and fitting such items,” (*Ontario Hospital Reporting System User Guide*, p.77).¹⁰ The patient-specific supplies include the “cost of artificial replacement hips [knees], with a unit value of \$250 or greater, which can be identified with the treatment of specific patients, as well as the components used in assembling and fitting such items” (*Ontario Hospital Reporting System User Guide*, p. 78).

The CIHI and OHRS data were subsequently merged by facility number resulting in a dataset that included the replacement counts from both data sources as well as the expenses associated with providing these services. Data from institutions that merged in 1995/96 or 1996/97 were reported as separate entities in the year prior to the change and under the merged facility number thereafter. The specific CCP codes used to extract the CIHI discharge abstract information, as well as OHRS chart of account codes used to identify statistical and financial joint procedure data in the Ontario Hospital Financial and Statistical System, appear in Appendix B.

2.4 Evaluative Measures

Our methodology draws from the JPPC reference document, *Proposal for the Implementation of Non-Financial Data Audits in Ontario Hospitals*,¹¹ prepared by the Data Quality Sub-Committee of JPPC (which has disbanded since publication of its report), and Williams and Young.¹² Three performance measures were used in the analysis: completeness, consistency and reasonableness. An assessment of completeness was made for all hospitals in the population. Consistency and reasonableness could only be assessed for those hospitals with complete information.

Due to small cell counts, peer groups (based on the 1995/96 designation assigned by the JPPC), were collapsed to three categories: Specialty/Teaching (Peer groups 0, 1 and 2); large community (Peer groups 3 and 4); and small community (Peer groups 5, 6 and 7).

Completeness, defined as the ratio of hospitals that reported OHRS statistical *and* OHRS financial *and* CIHI discharge abstract data to the total number of facilities identified by either OHRS or CIHI data as having provided joint replacement procedures, was measured separately for hip and knee replacements as well as by year and hospital grouping.

Consistency was evaluated by comparing the raw and relative differences in joint replacement counts between the CIHI and OHRS data. Unlike raw differences, the relative difference accounts for the magnitude of the difference relative to a baseline value. For example, a large volume hospital that undercounts by 10 procedures has a smaller relative impact than a low volume hospital undercounting by the same number. The relative difference between CIHI and OHRS counts of joint replacement type r at hospital i in year j is defined as:

$$D_{rij} = \frac{(O_{rij} - C_{rij})}{C_{rij}}$$

where O_{rij} is the OHRS count of replacement type r at the i th hospital in the j th year and C_{rij} is the CIHI count of replacement type r at the i th Hospital in the j th year.

A hospital was determined to have consistent data if the relative difference between procedure counts found in the discharge abstract data differed by less than five per cent from the procedure counts reported in the hospital's information system.

Reasonableness was assessed by comparing a hospital's unit prosthetic cost to a range of prosthetic costs deemed to be feasible. Definition of the reasonable range was based on work by Cheung et al,¹³ who surveyed 76 Ontario hospitals in 1993-94 and found a range of \$650-\$3,559 for the average hip prosthetic cost and \$1,178-\$3,960 for the average knee cost. In calculating a reasonable range for the 1994/95 expenditure data, hip and knee implant prices reported by Cheung and colleagues were deflated by 2.5 per cent based on estimates of price decreases for the period quoted by several prosthetic suppliers. Price changes between 1994/95-1995/96 and 1995/96-1996/97 were provided by a consultant to the medical supply industry who has tracked contract and non-contract prosthetic prices over several years. This led to the further deflation of the reasonable range in 1995/96 by 2 per cent for hips while that of knees by 5 per cent and in 1996/97 by 6 per cent and 14 per cent, respectively.

The average prosthetic expense for hospital i in year j is defined as:

$$E_{ij} = \frac{\sum_e P_{eij}}{C_{rij}}$$

where P_{eij} is the dollar amount of expense type e at the i th hospital in the j th year, and where C_{rij} is the total number of replacements of type r according to discharge abstract data at the i th Hospital in the j th year.

A hospital was determined to have reasonable prosthetic expenses if its average unit cost was within the range for the type of replacement and year. Reasonableness was measured for both types of replacements in each of the three years under study.

The study was conducted under existing research and data agreements between the Institute for Clinical Evaluative Sciences and the Ontario Ministry of Health.

3.0 Results

3.1 Completeness

The distribution of hospitals providing joint replacement surgery in each of three fiscal years and by data source is shown in Appendix C and Appendix D. Overall, it can be seen that a greater number of institutions performed hip surgery than knee surgery in each fiscal year. A small number of hospitals reported joint replacement costs or activities in their OHRS data, although CIHI discharge abstract data indicated that no such procedures had been performed. The opposite was also true. For example, 18.8 per cent of institutions providing knee replacements in 1994, 16.1 per cent in 1995, and 3.9 per cent in 1996, according to CIHI discharge abstract data, did not report any procedures of this type in their OHRS data submission (Appendix D). The proportion of institutions with complete hip/knee data (i.e. CIHI and both OHRS fields were reported), was higher in 1996/97 than in either of the two earlier fiscal years.

Large community hospitals comprised the major share of the study population of both replacement types in each fiscal year. In 1994/95, 50.6 per cent of all institutions providing hip replacements were large community institutions (Appendix C). It can be seen that the Specialty/Teaching group of hospitals had a higher completeness rate than did large community or small community groupings. For example, in 1996/97, 15 (88.2 per cent) Specialty/Teaching hospitals providing hip replacement services submitted complete OHRS data whereas 27 (60 per cent) large community hospitals and only eight (34.8 per cent) small community did likewise (Appendix C). The ratio of data completeness, by hospital group, was higher at Specialty/Teaching and large community (hip and knee) hospitals in the third year of the study than in either of the two previous years. Completeness of the small community hip and knee data demonstrated little change over the three years of observation. Of those institutions that provided joint replacements according to CIHI discharge data but did not submit corresponding OHRS data, the majority was comprised of large community hospitals in each fiscal year.

3.2 Consistency

The number of hip and knee replacements provided by hospital group, data source and year among institutions with complete data is shown in Appendix E and Appendix F. It can be seen that in the aggregate hip replacement procedures were overreported by hospitals in their OHRS data (relative to CIHI counts), while knees were underreported in each fiscal year. There does not appear to be a pattern of over or underreporting within a replacement type. For example, in 1994/95 the largest difference of underreporting knee replacements was 84 for large community hospitals whereas in 1995/96 it was 229 at Specialty/Teaching (Appendix F). Meanwhile, small community hospitals overcounted knees, according to OHRS in 1994/95, and undercounted in each of the following two fiscal years.

The distribution of the relative differences in joint replacement counts by hospital group and year is shown in Appendix G and Appendix H. In each year studied it can be seen that more than half of all hospitals had CIHI abstract counts indicating joint replacements that differed by more than five per cent from the same counts being maintained internally in the hospital's OHRS dataset.

The proportion of institutions (hip) with a relative difference greater than 10 per cent was lower in the third year of the study, while the proportion of institutions (hip and knee) with less than a five per cent discrepancy or no difference between counts was higher than either of the two previous fiscal years. Although not shown, the single largest relative difference in hip and knee counts in 1994/95 was 200 per cent and 57 per cent, respectively, while in 1995/96 it was 105 per cent for hips, and 79 per cent for knees, and in 1996/97, 171 per cent and 30 per cent for the respective categories. In the case of the institution with a 105 per cent discrepancy in hip counts, 101 hip replacements were supported by CIHI discharge abstract data while in the corresponding OHRS statistical account, 207 replacements were reported as having been performed. It is interesting to note that when the consistency threshold was narrowed to ± 2 per cent, the proportion of institutions that could be said to have consistent data was approximately half of that when ± 5 per cent was used (not shown).

3.3 Reasonableness

Mean prosthetic costs by hospital group and year are shown in Appendix I and Appendix J. In each fiscal year, Specialty/Teaching hospitals had the lowest unit hip or knee cost while small community hospitals had the highest. Specialty/Teaching hospitals hip and knee prosthetic costs demonstrated the highest variability in each of 1994/95 and 1995/96 according to the coefficient of variation. In two of the three years under study, large community hospitals had the least variation in prosthetic expense for hips while the small community group had the least for knees in all years examined. Overall, there was greater variation evident with hip prosthetic costs than there was with knee prostheses.

The distribution of hospitals according to the reasonableness of their prosthetic costs is shown in Appendix K and Appendix L. In each fiscal year examined, more than 80 per cent of institutions with complete data had reasonable unit costs according to the definition employed in this study. While not shown, one Specialty/Teaching institution had a unit hip cost below the reasonable range in 1994/95 and in the following year reported an above range unit knee cost.

4.0 Discussion

The OHRS Guidelines provide a mechanism for the standardized reporting of financial and statistical data by Ontario Hospitals. The purpose of this study was to evaluate three dimensions of orthopedic surgery data quality following the implementation of the OHRS Guidelines by Ontario Hospitals in April, 1994.

The finding that the completeness of the OHRS joint replacement data was limited to half of those institutions providing procedures of this type in each of the first two years of data collection is interesting as these were, from the outset, mandatory reporting fields (mandatory fields are OHRS chart of account categories the Ministry of Health requires hospitals to maintain). There is some suggestion that type of institution predicted completeness of reporting. Specialty/Teaching hospitals had higher completion rates in each fiscal year when compared with those of large and small community hospitals. One explanation may be that Specialty/Teaching hospitals had more experience in the management of OHRS Guideline compliant information systems than large and small community hospitals.

In a pre-OHRS survey of hospital administrators in Ontario, Lave and Jacobs¹⁴ reported that 70 per cent of respondents felt, "Patient statistics and workload measurement data should be independently verified"(p.28). When the JPPC Data Quality Sub-Committee¹¹ conducted an audit feasibility study in the fall of 1994, they reported that only two of six non-financial data elements were auditable. The reasons cited for the inability to audit were ambiguous definitions and the lack of appropriate internal control systems in the five hospitals sampled. Indeed, the definitional conundrum was also evident in this study.

For example, it is not known whether hospitals count procedures or individuals when tabulating the OHRS joint replacement information. If the latter applies, then undercounting by the number of bilateral procedures would occur. In addition, hospitals that include hip fractures treated with unipolar prosthetics will inflate the joint replacement count. Unipolar implants are not eligible for Life Support funding and as such must be excluded from the statistical counts. The systematic difference in counts between CIHI and OHRS records (overcounting of hips and undercounting of knees) would seem to support both of the above definitional issues. It is suggested that to ensure uniform interpretation and information capture, clinical input is needed in the development of statistical account definitions. Moreover, while hospital finance departments may collect the statistical data variously from health records, the operating room, and purchasing, it is not known whether one data source is preferable to others in terms of accuracy.

With regard to miscoding, the OHRS statistical account 'outpatient knee replacement' was identified as a potential source of error. For example, at one institution, three outpatient knee replacements reported in the OHRS were in fact non-replacement knee procedures while at another, three outpatient ophthalmologic procedures had been miscoded as knee replacements.

Two institutions that did not submit any CIHI abstracts for outpatient knee replacements, recorded 37 and 58 outpatient procedures respectively in the OHRS statistical accounts. Knees replaced on an outpatient basis are a rarity (over the 3-year study period there were no outpatient

knee replacements performed in Ontario), and the presence of an outpatient data field in the OHRS Guidelines for a service of this complexity is puzzling.

Although we have reported the aggregate experience in terms of over or undercounting, there were instances of extreme differences at the hospital level. For example, according to CIHI discharge abstract data, Hospital A provided 264 hip replacements in 1994/95 yet reported zero in its OHRS statistical accounts. In the same hospital and fiscal year, 293 knee replacements were completed while 417 were recorded in the hospital's internal information system. It may be that Hospital A aggregated replacements of both types for reporting purposes, i.e., hip and knee accounts were not differentiated. However if this were true then replacements were underreported by 140. It should be noted that a small component of the difference in counts may be attributable to periodicity, that is, patient data are reported in the month discharged while OHRS accounts are recorded in the month performed.

Although the Ontario Ministry of Health allowance for incremental prosthetic expenses has not changed since the inception of the Life Support program (\$2,200 for hips and \$2,800 for knees), in the data examined here the overall mean cost (and variation in cost) was higher for hips in each fiscal year than it was for knees. The variation in expense was considerable, ranging from one hospital reporting a cost of \$16 per hip device in 1994/95 to another reporting that a comparable device cost \$8,133. Nonetheless, the mean prosthetic hip and knee costs in each fiscal year and among all hospital groups save one (small community, hip 1995/96), fall within the range reported in a survey of Ontario hospitals' purchasing practices for hip and knee prostheses.¹³ These survey prices, however, were based on primary prosthetic expenditures and exclude revision implants, the latter of which tend to be more expensive.

It has been shown that performance indicators, such as the unit supply cost per joint replacement, can be developed from these data. It was reassuring to find that most hospitals (over 80 per cent) reported direct costs for prosthetic devices that appear to be reasonable according to the definition used in this study. Caution is nonetheless warranted before passing judgement as to the reasonableness of direct cost information found in OHRS data as a whole. An assessment of reasonableness could only be performed for those hospitals that submitted complete data, which was approximately 50 per cent of the population. No inference as to the reasonableness of prosthetic cost data by the remaining 50 per cent of hospitals can be made.

That several hospitals reported unreasonable costs may be the result of inconsistent accounting practices and/or definitional inadequacies. In the case of the former, some hospitals for convenience purposes may have chosen to expense prosthetic devices upon receipt rather than assigning them to inventory and recording the expense when used. With regard to the adequacy of the expense definitions, those hospitals with prostheses expenditures above or below the range considered reasonable may have, for example, included non-related material and supplies and hence inflated the average expense or excluded those items which should not have been and thus deflated prosthetic costs. As noted above regarding statistical definitions, clinical input in defining the spectrum of materials to include in the financial accounts is recommended.

Finally, a large number of institutions did not submit any joint replacement financial data (Appendix C and Appendix D). Clearly, this is one area of the OHRS data submissions that would benefit from an internal review process in these hospitals; a process which is likely to be straightforward given the identifiable nature of prosthetic hardware.

5.0 Conclusions

The OHRS Guidelines were implemented in 1994/95 permitting comparison of the inaugural experience of hospitals, in terms of joint replacement reporting, with that of two subsequent fiscal years. One of the objectives of this study was to provide performance feedback, in the aggregate, to hospitals, the Ontario Ministry of Health, and other stakeholders including clinicians. The OHRS data appear to be incomplete and inconsistent when compared to another data source. This impedes the expected usefulness of the OHRS data for funding, management and research purposes.

To the extent that activity measures are incomplete and inconsistent, development of funding formulae using these data as input may result in the misallocation of scarce resources. Furthermore, effective planning requires high quality information about the volume and types of services provided. At present, the OHRS data may not be sufficiently robust to allow for that to happen. And lastly, although the OHRS Guidelines represent a comprehensive and well developed standard of reporting practice, our findings demonstrate that researchers must be cognizant of the limitations inherent in data collected in accordance with the OHRS Guidelines when choosing to use these data in their studies.

In summary, in answer to the questions posed earlier:

(1) *With respect to completeness:*

About one-half of hospitals reported both CIHI and OHRS statistical and financial data for hip and knee replacements in the first two years of data collection. The completeness of the 1996/97 data was greater than the earlier years. Specialty/Teaching hospitals had consistently higher completeness ratios than did large community or small community hospitals.

(2) *With respect to consistency:*

The reported number of hip replacements in the OHRS statistical data exceeded the number in the CIHI data and the reported number of knees in the OHRS statistical data was less than the number in the CIHI data. Consistency of counts diminished in the second year of the study for replacements of both types. When the data were disaggregated to hospital groups, consistency varied widely between years and no pattern emerged.

(3) *With respect to reasonableness:*

Among hospitals with complete data, most reported prosthetic expenses that could be considered reasonable according to the definition employed in this study. Reasonableness, by hospital group, could not be interpreted with any confidence due to small cell counts.

References

1. Söderlund N, Milne R, Gray A, Raftery J. Differences in hospital casemix, and the relationship between casemix and hospital costs. *J of Public Health Med* 1995;17:25-32.
2. Bialzak ML, Broccolino D. Knowing your costs: the key to financial success of ambulatory surgery centers under prospective payment. *J Ambulatory Care Manag* 1993;16:12-21.
3. Hobbs FD, Hawker A. Computerised data collection: practicability and quality in selected general practices. *Fam Pract* 1995;12:221-226.
4. Hopwood AG. *Accounting and Human Behaviour*. Englewood Cliffs: Prentice Hall; 1976.
5. Kahn MG. Clinical databases and critical care research. [Review] [16 refs]. *Crit Care Clin* 1994;10:37-51.
6. Young DW, Pearlman LK. Managing the stages of hospital cost accounting. *Healthcare Fin Manag* 1993;47:58-64.
7. Hospital Medical Records Institute (HMRI), Ontario Hospital Association, Ontario Ministry of Health. *Report of the Ontario Data Quality Reabstracting Study*. Toronto: Ontario Hospital Association, 1991.
8. Naylor CD, DeBoer DP.: Variations in selected surgical procedures and medical diagnoses by year and region. Total Hip and Knee Replacement. In: Goel V, Williams JI, Anderson GM, Blackstien-Hirsch P, Fooks C, Naylor CD, (eds): *Patterns of Health Care in Ontario*, 2nd Ed., Canadian Medical Association, Ottawa, 1996:54.
9. Statistics Canada. Canadian Centre for Health Information. Nosology Reference Centre. *Canadian classification of diagnostic, therapeutic, and surgical procedures*. Ottawa: Minister of Industry, Science and Technology, 1993.
10. Ontario Ministry of Health, Ontario Hospital Association. *Ontario Hospital Reporting System User Guide*. Version 1. Joint Policy and Planning Committee, 1993.10.
11. Ontario Ministry of Health, Ontario Hospital Association. *Proposal for the implementation of non-financial data audits in Ontario Hospitals*. Prepared by the Data Quality Sub-Committee, Reference Document #2-14. Joint Policy and Planning Committee, March 3, 1995.
12. Williams J.I., Young W. *Inventory of studies on the accuracy of Canadian health administrative databases*. ICES Technical Report No. 96-03-TR. December 1996.
13. Cheung CM, Paterson JM, Gort EH, Williams JI. A survey of Ontario Hospitals? Purchasing practices for hip and knee prostheses. *Cdn J Surg*. 1998;41:309-315.
14. Lave JR, Jacobs P. The attitudes of Ontario Hospitals toward transitional funding: response to a survey. *Healthcare Manag Forum* 1993;6:25-33.

Appendices

Appendix A. Ontario Hospitals Providing Hip and/or Knee Replacement 1994/95-1996/97

Brantford General	Port Colborne General
Brockville General	Queensway Carlton
Cambridge Memorial	Quinte Healthcare Corp.–Belleville Site
Central*	Quinte Healthcare Corp.–Prince Edward County
Chatham Kent Health Alliance-Public Gen Hosp	Ross Memorial
Chatham Kent Health Alliance-St. Joseph's	Rouge Valley Health System–Ajax & Pickering
Children's Hospital of Eastern Ontario	Rouge Valley Health System-Centenary Site
Collingwood General and Marine	Royal Victoria
Cornwall General	Sarnia General
Credit Valley Hospital	Sault Area Hospitals-General Site
Doctors Hospital*	Sault Area Hospitals-Plummer Site
Grand River Hospital Corp.	St Joseph's-Brantford
Greater Niagara General	St Joseph's Hospital & Home-Guelph
Grey Bruce Health Services-Markdale Site	St Joseph's-Hamilton
Grey Bruce Health Services-Meaford Site	St Joseph's Health Centre-London
Grey Bruce Regional Health Ctr-Owen Sound	St Joseph's Health Centre- Sarnia
Guelph General	St Joseph's Health Centre–Toronto
Halton Healthcare Services Corp.-Oakville Site	St. Joseph's Care Group-Thunder Bay
Hamilton Civic	St Mary's General-Kitchener
Hamilton Health Sciences Corp.	St Michael's
Hopital Montfort	St. Michael's-Wellesley Site
Hotel Dieu St. Catharines	St Thomas-Elgin General
Hotel Dieu Cornwall	Stratford General Hospital
Hotel Dieu Kingston	Sudbury Regional Hospital-Memorial Site
Hotel Dieu St. Catharines	Sunnybrook & Women's Health Sciences Centre
Hotel Dieu Windsor*	Sunnybrook & Women's HSC-Ortho & Arthritic
Hospital for Sick Children	Sunnybrook & Women's HSC-Women's Coll
Humber River Regional Hospital-Church St Site	Temiskaming
Humber River Regional Hospital-Finch Site	The Scarborough Hospital-General Division
Humber River Regional Hospital-Keele Site	The Scarborough Hospital-Grace Division
Joseph Brant Memorial	Thunder Bay Regional Hospital-Port Arthur Site
Kingston General	Thunder Bay Regional Hospital-McKellar Site
Kirkland and District	Tillsonburg District Memorial
Lakeridge Health Corp.-Oshawa Site	Timmins and District
Lennox and Addington County General	Toronto East General and Orthopaedic
London Health Sciences Ctr-University Campus	Toronto Hospital
London Health Sciences Ctr-Victoria Campus	Trillium Health Centre-Mississauga Site
Markham-Stouffville	Trillium Health Centre-Queensway Site
Meaford General	Welland County General
Mount Sinai	West Parry Sound Health Centre
North Bay Civic*	William Osler Health Ctr-Brampton Memorial
North Bay General-McLaren Site	William Osler Health Centre-Etobicoke
North York General	Windsor Hotel Dieu Grace
North York Branson	Windsor Regional-Metropolitan Campus
Orillia Soldiers' Memorial	Windsor Western Hospital Centre Inc.*
Ottawa-Civic Campus	Woodstock General
Ottawa-General Campus	York Central
Ottawa-Riverside	York County
Perth and Smiths Falls District-Perth Site	
Perth and Smiths Falls District-Smith Falls Site	
Peterborough Regional Health Ctr-Civic Site	
Peterborough Regional Health Ctr-St. Joseph's	

*closed or merged between 1994/95 and 1996/97
Source: CIHI

Appendix B. CIHI Procedure Codes - OHS Secondary Statistical and Financial Codes

Data Source	Description	Hip	Knee
CIHI (CCP*)	Total replacement	93.51	93.41
	Other total replacement	93.59	NA
OHS	Life Support Statistical Accounts:		
	Total joint – Inpatient	5651010	5651015
	Total joint – Outpatient	NA	5652015
	Secondary Financial Accounts:		
Medical & Surgical Supplies	46027	46028	
Patient Specific Supplies	56027	56028	

* CCP codes reflect procedures that qualify under the OHS definitions

Sources:

(CCP) Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures
(OHS User Guide, Version 1) Ontario Hospital Reporting System

Appendix C. Distribution of Hospitals with Complete and Incomplete Data*

(Completeness) HIP

1994/95	Specialty/ Teaching	Large Community	Small Community	All (%)
Complete data	12	20	9	41 (47.1)
OHRs financial data missing	3	10	2	15 (17.2)
OHRs statistical data missing	2	9	8	19 (21.8)
OHRs statistical and financial data missing	0	5	4	9 (10.3)
CIHI abstract data missing	0	0	3	3 (3.5)
TOTAL	17	44	26	87
1995/96				
Complete data	14	22	9	45 (51.1)
OHRs financial data missing	2	8	3	13 (14.8)
OHRs statistical data missing	2	8	6	16 (18.2)
OHRs statistical and financial data missing	2	6	2	10 (11.4)
CIHI abstract data missing	0	1	3	4 (4.5)
TOTAL	20	45	23	88
1996/97				
Complete data	15	27	8	50 (58.8)
OHRs financial data missing	1	7	3	11 (12.9)
OHRs statistical data missing	0	7	7	14 (16.5)
OHRs statistical and financial data missing	0	0	4	4 (4.7)
CIHI abstract data missing	1	4	1	6 (7.1)
TOTAL	17	45	23	85

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health

Appendix D. Distribution of Hospitals with Complete and Incomplete Data***(Completeness)
KNEE**

1994/95	Specialty/ Teaching	Large Community	Small Community	All (%)
Complete data	11	19	8	38 (47.5)
OHRs financial data missing	5	10	2	17 (21.3)
OHRs statistical data missing	0	6	2	8 (10.0)
OHRs statistical and financial data missing	0	9	6	15 (18.8)
CIHI abstract data missing	0	1	1	2 (2.5)
TOTAL	16	45	19	80
1995/96				
Complete data	13	22	8	43 (53.0)
OHRs financial data missing	3	8	3	14 (17.3)
OHRs statistical data missing	0	6	3	9 (11.1)
OHRs statistical and financial data missing	1	9	3	13 (16.1)
CIHI abstract data missing	1	1	0	2 (2.5)
TOTAL	18	46	17	81
1996/97				
Complete data	14	27	8	49 (63.6)
OHRs financial data missing	2	6	3	11 (14.3)
OHRs statistical data missing	0	8	4	12 (15.6)
OHRs statistical and financial data missing	0	0	3	3 (3.9)
CIHI abstract data missing	0	1	1	2 (2.6)
TOTAL	16	42	19	77

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health

Appendix E. Number of Joint Replacements Reported*§

(Consistency) HIP

1994/95	Specialty/ Teaching	Large Community	Small Community	All
OHRs	2,703	1,618	442	4,763
CIHI	2,561	1,634	428	4,623
Difference	142	(16)	14	140
1995/96				
OHRs	2,809	1,838	421	5,068
CIHI	2,780	1,717	408	4,905
Difference	29	121	13	163
1996/97				
OHRs	3,400	2,488	337	6,225
CIHI	3,301	2,366	376	6,043
Difference	99	122	(39)	182

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health
§ Among institutions with complete data

Appendix F. Number of Joint Replacements Reported*§**(Consistency)
KNEE**

1994/95	Specialty/ Teaching	Large Community	Small Community	All
OHSR	2,020	1,494	461	3,975
CIHI	2,031	1,578	425	4,034
Difference	(11)	(84)	36	(59)
<hr/>				
1995/96				
OHSR	2,487	2,050	610	5,147
CIHI	2,716	2,059	638	5,413
Difference	(229)	(9)	(28)	(266)
<hr/>				
1996/97				
OHSR	2,805	3,082	581	6,468
CIHI	2,877	3,075	630	6,582
Difference	(72)	7	(49)	(114)

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health
 § Among institutions with complete data

Appendix G. Distribution of Relative Differences in Joint Replacement Counts*§

**(Consistency)
HIP**

1994/95	Specialty/ Teaching	Large Community	Small Community	All (%)
No difference OHS-CIHI		0	3	3 (7.3)
<5% difference	0	7	1	15 (36.6)
5-10% difference	1	4	1	6 (14.6)
≥ 10% difference	4	9	4	17 (41.5)
TOTAL	12	20	9	41
1995/96				
No difference OHS-CIHI	0	1	1	2 (4.4)
<5% difference	5	6	1	12 (26.7)
5-10% difference	2	3	2	7 (15.6)
≥ 10% difference	7	12	5	24 (53.3)
TOTAL	14	22	9	45
1996/97				
No difference OHS-CIHI	2	0	3	5 (10.0)
<5% difference	5	14	0	19 (38.0)
5-10% difference	3	3	1	7 (14.0)
≥ 10% difference	5	10	4	19 (38.0)
TOTAL	15	27	8	50

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health

§ Among institutions with complete data

Appendix H. Distribution of Relative Differences in Joint Replacement Counts*§**(Consistency)
KNEE**

1994/95	Specialty/ Teaching	Large Community	Small Community	All (%)
No difference OHRS-CIHI	1	2	1	4 (10.5)
<5% difference	4	7	3	14 (36.8)
5-10% difference	5	4	1	10 (26.3)
≥10% difference	1	6	3	10 (26.3)
TOTAL	11	19	8	38
1995/96				
No difference OHRS-CIHI	2	1	2	5 (11.6)
<5% difference	3	9	2	14 (32.6)
5-10% difference	2	6	3	11 (25.6)
≥10% difference	6	6	1	13 (30.2)
TOTAL	13	22	8	43
1996/97				
No difference OHRS-CIHI	1	3	0	4 (8.2)
<5% difference	4	13	3	20 (40.8)
5-10% difference	5	5	1	11 (22.4)
≥10% difference	4	6	4	14 (28.6)
TOTAL	14	27	8	49

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health
 § Among institutions with complete data

Appendix I. Cost per Prosthetic Device*§

HIP

1994/95	Specialty/Teaching	Large Community	Small Community	All
Number	12	20	9	41
Mean Price	\$2,199	\$2,210	\$2,506	\$2,272
Range	\$16 - \$8,133	\$831 - \$3,454	\$1,561 - \$3,732	\$16 - \$8,133
Coefficient of variation	0.91	0.28	0.35	0.53
<hr/>				
1995/96				
Number	14	22	9	45
Mean Price	\$2,223	\$2,399	\$4,217	\$2,708
Range	\$724 - \$8,113	\$723 - \$7,256	\$1,620 - \$15,847	\$723 - \$15,847
Coefficient of variation	0.81	0.52	1.05	0.89
<hr/>				
1996/97				
Number	15	27	8	50
Mean Price	\$1,650	\$1,979	\$2,929	\$2,032
Range	\$275 - \$2,681	\$515 - \$4,966	\$1,396 - \$6,601	\$275 - \$6,601
Coefficient of variation	0.44	0.45	0.59	0.53

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health
§ Among institutions with complete data

Appendix J. Cost per Prosthetic Device*§**KNEE**

1994/95	Specialty/Teaching	Large Community	Small Community	All
Number	11	19	8	38
Mean Price	\$2,193	\$2,219	\$2,235	\$2,215
Range	\$1,229 - \$5,096	\$839 - \$4,136	\$1,631 - \$2,626	\$839 - \$5,096
Coefficient of variation	0.48	0.37	0.15	0.36
<hr/>				
1995/96				
Number	13	22	8	43
Mean Price	\$1,822	\$2,001	\$2,321	\$2,007
Range	\$20 - \$4,685	\$139 - \$4,097	\$1,389 - \$3,359	\$20 - \$4,685
Coefficient of variation	0.59	0.39	0.28	0.43
<hr/>				
1996/97				
Number	14	27	8	49
Mean Price	\$1,802	\$2,047	\$2,157	\$1,995
Range	\$381 - \$4,868	\$1,032 - \$4,314	\$1,370 - \$3,713	\$381 - \$4,868
Coefficient of variation	0.59	0.36	0.35	0.42

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health

§ Among institutions with complete data

Appendix K. Distribution of Hospital's Prosthetic Costs*§

**(Reasonableness)
HIP**

1994/95	Specialty/Teaching	Large Community	Small Community	All (%)
Below range <\$634	1	0	0	1 (2.4)
Within range of reasonable costs (\$634-\$3,470)	10	20	7	37 (90.2)
Above range >\$3,470	1	0	2	3 (7.3)
TOTAL	12	20	9	41
1995/96				
Below range <\$621	0	0	0	0
Within range of reasonable costs (\$634-\$3,401)	13	20	6	39 (86.7)
Above range >\$3,401	1	2	3	6 (13.3)
TOTAL	14	22	9	45
1996/97				
Below range (<\$584)	2	1	0	3 (6.0)
Within range of reasonable costs (\$854-\$3,197)	13	24	6	43 (86.0)
Above range (>\$3,197)	0	2	2	4 (8.0)
TOTAL	15	27	8	50

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health

§ Among institutions with complete data

Appendix L. Distribution of Hospital's Prosthetic Costs*§**(Reasonableness)
KNEE**

1994/95	Specialty/Teaching	Large Community	Small Community	All (%)
Below range <\$1,149	0	1	0	1 (2.6)
Within range of reasonable costs (\$1,149 – \$3,861	10	16	8	34 (89.5)
Above range >\$3,861	1	2	0	3 (7.9)
TOTAL	11	19	8	38
1995/96				
Below range <\$1,091	2	2	0	4 (9.3)
Within range of reasonable costs (\$1,091 - \$3,668)	10	19	8	37 (86.1)
Above range >\$3,668	1	1	0	2 (4.6)
TOTAL	13	22	8	43
1996/97				
Below range (<\$938)	3	0	0	3 (6.1)
Within range of reasonable costs (\$938 - \$3,154)	10	24	7	41 (83.7)
Above range (>\$3,154)	1	3	1	5 (10.2)
TOTAL	14	27	8	49

* Data Sources: Canadian Institute for Health Information (CIHI), Ontario Ministry of Health

§ Among institutions with complete data