Hospital Case Mix Costing Project

1991/92

METHODOLOGICAL APPENDIX

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INTRODUCTION TO APPENDIX

In contrast to the body of the report, the Appendix contains an expanded explanation of the methodology including more details on its critical aspects. The Appendix also presents more information on Refined Diagnosis Related Groups (RDRGs), the case mix classification system employed in the study, and the Maryland dataset employed to develop case cost weights and per diem weights.

The Appendix also contains information on tests performed on the data, and results in addition to those contained in the body of the report.

Finally, the Appendix analyzes the differences between Manitoba teaching and community hospital costs, and compares these differences with those between similar hospitals in Alberta and Ontario.

APPENDIX A: OVERVIEW OF METHODOLOGY FOR CALCULATING COST PER WEIGHTED CASE

Basic Framework

This Appendix provides a detailed description of the key calculations and adjustments employed in this study. Each section also briefly describes methods adopted in other case mix costing approaches to deal with common problems.

The RDRG classification system (version 5) initially groups each hospital's inpatient cases into 334 medical or surgical categories, referred to as Adjacent DRGs (ADRGs), based on combinations of ICD-9-CM diagnosis and procedure codes, as well as other hospital abstract data. Each ADRG is then subdivided into different levels of severity based on additional diagnoses, or CCs, expected to have a varying impact on resource use. Medical ADRGs are divided into three levels of severity based on CCs that have no/minor, moderate, or major impact on resource use. Surgical ADRGs include a fourth level of severity based on CCs that have a catastrophic impact on resource use. This partitioning of ADRGs results in 1,170 potential RDRG categories.

The RDRGs were designed to be clinically coherent, with cases using relatively similar resources grouped together. Although there are limitations to the degree to which this is possible when the number of ICD-9-CM codes mapped into 1,170 RDRGs exceeds 10,000, it is expected that the RDRGs provide an increased level of sensitivity to severity of illness compared to both DRGs and CMGs.

For each RDRG, a standardized relative case weight (RCW) was calculated based on Maryland charge information and Manitoba lengths of stay. Such weights are used in case-mix costing to represent the expected relative cost of treating the average case in the RDRG. Relativity among RCWs is established by indexing the average case costs of each RDRG against the average case cost for all RDRGs, which is assigned a value of 1.00. Hence the anticipated cost of a case in an RDRG with an RCW of 1.37 is 37% above the overall average case cost; a case in an RDRG with an RCW of .81 is expected to be 19% cheaper than the average.

A high RCW index does not necessarily imply that the average case in the RDRG involves a high intensity of expensive servicing, as one might think on the surface. RDRGs with comparatively long lengths of stay and low daily intensities of servicing will often have high case weight indices.[1] Indeed, the inter RDRG variability of lengths of stay is much greater than the variability in average costs per day. This means that length of stay is usually the principal determinant of a high case weight index.

A hospital's cost per weighted case is the ratio of its own inpatient costs for the year divided by its total weighted cases. To calculate the hospital's total weighted cases, the denominator of the ratio, one multiplies its annual case volumes for each RDRG by its corresponding standard RCW and sums the results. These weights are then fine tuned, mainly to account for the prevalence of atypical cases whose costs tend to be poorly explained by the RCW for typical cases. Inpatient costs for the hospital, derived mainly from HS-1 data, exclude the costs of the hospital's outpatient activities, its non-patient care activities and the overheads associated with these activities.[2] The total inpatient cost (the numerator of the cost per weighted case ratio) consists of direct costs of inpatient care, the inpatient shares of diagnostic and therapeutic cost centres that serve both inpatients and outpatients, plus indirect overhead

[1] The rehabilitation RDRGs, for example, have relatively high weights owing to their comparatively long average lengths of stay. Conversely, normal deliveries have low weights because of their relatively short lengths of stay.

[2] The direct costs of teaching programs — educators' salaries and trainee remuneration — are an example of such non patient care costs.

costs allocated by a quasi-step-down methodology. The allocation methodology and the various related adjustments required to improve data comparability are detailed in Appendix G below entitled **Allocation Methodology and Adjustments.** The Manitoba Centre for Health Policy and Evaluation's (MCHPE) study includes the costs and weights of long-term care cases, unlike most other case mix costing approaches.

Costs per weighted case enable one to compare hospital inpatient costs across different classes of hospitals with different mixes of patients. A hospital's average cost per weighted case may exceed the provincial average because its average length of stay exceeds the provincial average for its mix of patients and/or its cost per day exceeds the average for its patient mix. In addition to case mix, one must examine the other variables that drive costs to determine whether a hospital's comparatively high case costs result from inefficiency or some other cause. The Manitoba average cost is used in this study as the benchmark for cost per weighted case calculations at the hospital level, thus the relativity that is established is within-Manitoba relativity. If Manitoba case costs are anomalous, then the frame of reference would not be ideal for the benchmarking of apparent excess costs.[3]

Additional Information on RCWs and Atypicals Adjustments

MCHPE's model adjusts typical RCWs for classes of cases whose average case costs differ systematically from the typical weights for the RDRGs to which they belong. These classes, denoted as 'atypicals', consist of outlier cases, cases that end in death, cases with long-term care (LTC) days, transferred-in cases, and transferred-out cases.[4] The model applies special weights to the non-acute portions of cases, when the patient is panelled for placement in a

[3] Various studies have shown that Manitoba hospitals have higher nursing costs per patient day and that Manitoba teaching hospitals are more expensive than their counterparts. Manitoba hospitals also have generally longer lengths of stay than Maryland hospitals.

[4] The daily costs of these atypical cases and their behaviour over different portions of the stay were inferred from Maryland data. The length of stay effects were derived from Manitoba data.

personal care home or receiving care on a long-term unit.[5] These adjustments are detailed in Appendix sections **C: Outlier Approaches** and **D: Non-Acute Days, E: Transfers and Deaths**.

MCHPE derived the standardized typical RCW for each RDRG from the 1991 and 1992 Maryland Health Services Cost Review Commission (HSCRC) datasets, which include the charges for acute care patients in all Maryland general hospitals. This means that the RCW for an RDRG is largely based on the average charge for treating the average patient in the RDRG in the average Maryland acute general hospital in 1991 and 1992. Refer to the section **K: Features of Maryland Dataset** for more information.

By regulation, Maryland hospitals' charges must reflect the costs of care: Maryland hospitals are unable to vary their percentage mark ups for different services.[6] Hence, markups are equiproportional across services, and relative charges and estimated relative costs are the same for all services.[7] Inasmuch as we are only interested in the Maryland relativities, we may use the words "costs" and "charges" interchangeably when we refer to the Maryland financial data employed in the development of the Manitoba case weights.

An adjustment to Maryland RDRG charges is required to generate the RCWs for typical cases in Manitoba. This study employs a methodology, also used by other Canadian researchers, of adjusting the American weights to reflect differences in Canadian average lengths of stay for typical cases. The average length of stay in an RDRG is one determinant of its average cost. Thus, a Maryland case weight for an RDRG is a function of its Maryland average length of stay. In adjusting the Maryland charge weight by the difference between the average lengths

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[5] These weights were largely based on Manitoba data.
[6] See Section K.
[7] Of course, the actual costs must be estimated.

of stay in the two jurisdictions, using the per diem marginal cost (daily cost) for the RDRG, one revalues the original Maryland RDRG typical case weight to take into account the generally longer Manitoba average lengths of stay.[8] Additional information about this adjustment is presented in the section entitled **B: Acute Care Marginal Cost Adjustments**.

The relative case weights are known as 'standardized' weights because the weight that any Manitoba hospital receives for a case depends only on its RDRG class and its RCW and typical or atypical status.[9] The weight is otherwise independent of the actual costs of treating the particular patient. For example, each Manitoba hospital would be credited with the same RCW for a typical case in an RDRG irrespective of whether the specific case were more expensive than the RDRG average or whether the hospital is generally a very inefficient and high cost institution.

Another important adjustment to the Manitoba data, described in the section entitled **F: Separated and Census Days**, ensures a congruency between the census patient days, which are head counts of inpatients at midnight, and separated patient days, which are the total patient days from admission to separation of patients who separated in a year. The latter, which are ordinarily used in calculating the weights in the denominator of case-mix costing approaches, do not necessarily correspond closely to the former, which drive the costs in the numerator. When inconsistencies are large, costs per weighted case are unreliable and tend to be unstable through time.

A schematic overview of the methodology is provided in the flow chart accompanying this section. This flow chart is a more detailed version of Figure 1 in the body of the paper. All

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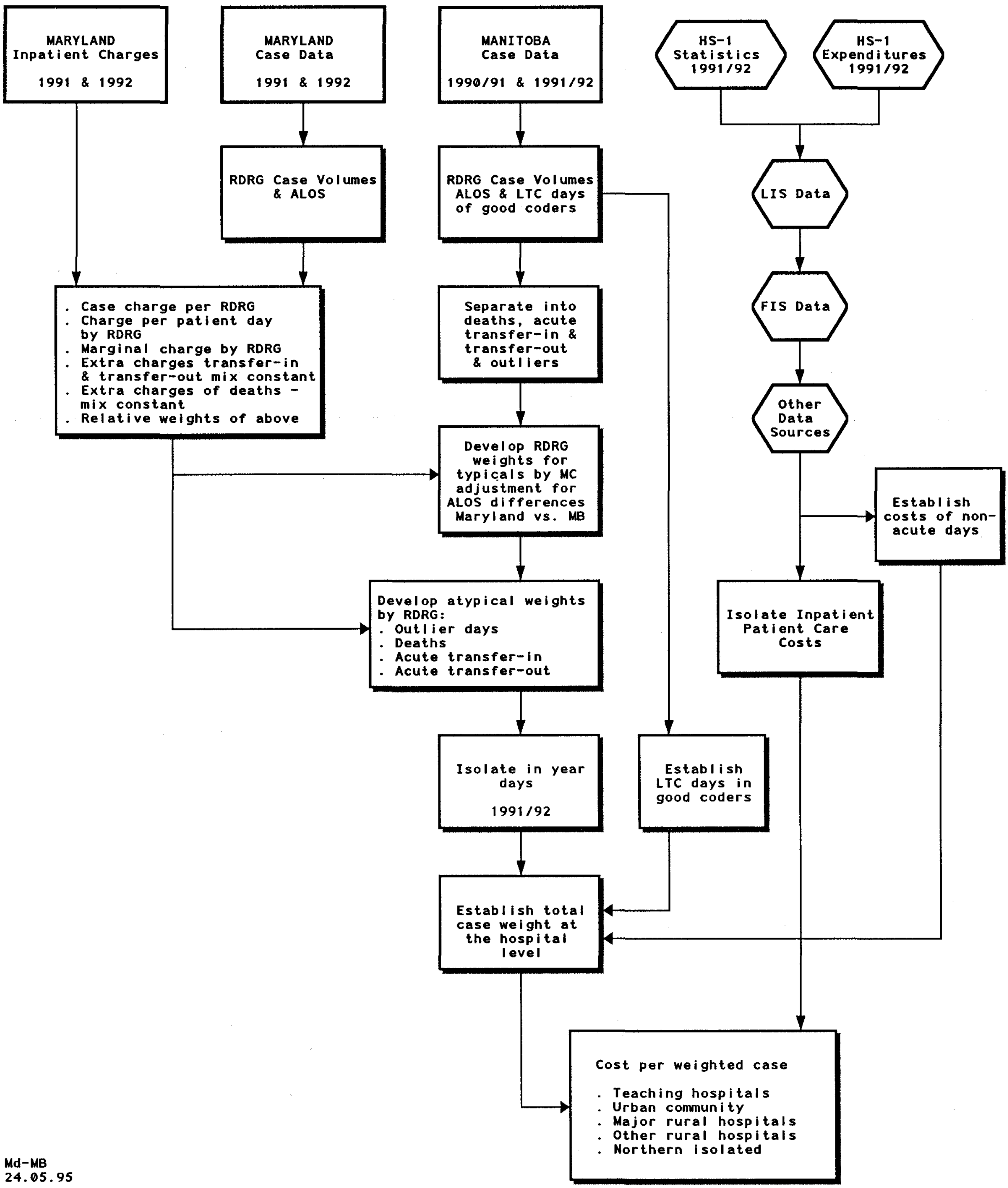
[8] Of course, this adjustment reduces the Maryland case weight in the minority of cases when the Manitoba average length of stay for an RDRG is shorter.

[9] This disregards the adjustment for non-acute days, which is made at the hospital level.

the major steps in this process of developing hospital specific costs per weighted case are illustrated. The left side shows how the Maryland charge and case data are brought together, and the output that is produced from the combination of the two. The boxes in the centre show how Manitoba case data are manipulated and eventually combined with the Maryland charge data to develop Manitoba case weights. Finally, the right boxes show how Manitoba hospital costs and statistics are employed to isolate inpatient costs and develop weights for non-acute days. Manitoba case weights and case costs are combined in the final steps to calculate costs per weighted case.

Flow Chart
Calculations of Cost per Weighted Case



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Low Frequencies

Several RDRGs both in the Maryland and Manitoba datasets had low frequencies. In any RDRG with fewer than 15 cases we estimated ALOS for Manitoba and average costs and ALOS for Maryland. This was done to ensure stability across RDRGs and to provide data in those instances where there were no cases in a Maryland RDRG but there were cases in Manitoba.

While this was an important step, any difficulties related to erroneous estimations will not be large as there are few cases involved (less than 1% of the Manitoba cases were in RDRGs where either costs or ALOS were estimated using this method). The process which was employed for this estimation involved using information from an adjacent RDRG which had 15 or more cases as a starting point and making an adjustment according to the RDRG severity level using average changes across RDRG levels within the same category: surgical obstetrics, medical obstetrics, surgical or medical. RDRGs grouped in the "other" category were calculated differently as there are very different types of disease categories within this grouping. For this group all adjustments were made using additional information only from the Major Diagnostic Category (MDC) into which the RDRG is classified.

Using this method we were able to maximize use of related information in order to obtain stable ALOS and average costs in RDRGs with few cases. When none of the RDRGs within an ADRG[10] had sufficient cases for a starting point, the mean for the 0-level RDRG for the Major Diagnostic Category (MDC) within the same group was used. This was necessary for only 26 RDRGs.

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[10] An ADRG is a group of RDRGs which have the same most responsible diagnosis and/or primary procedure but different levels of comorbidities and complications.

Use of Maryland Data

The study employed Maryland acute care inpatient charge data for several purposes. The main use was to develop initial weights for RDRGs. These weights became the final Manitoba relative case weights (RCWs) for typical cases after length of stay adjustments for differences between Maryland and Manitoba average lengths of stay at the RDRG level were done.

The Maryland dataset also provided the information required for estimating the marginal costs of incremental acute days in RDRGs. The adjustments to typical case weights for acute outlier days and some of the calculations of the in-year portions of case weights for stays in more than one fiscal year employed these marginal costs.

Finally the Maryland data were used to calculate the per diem costs of other atypical cases: transfer-in cases, transfer-out cases and cases that ended in death. The costs of atypical cases differ systematically from the typical cases in corresponding RDRGs.

Allocation Method

The cost allocation — the way in which indirect costs are distributed to direct patient care cost centres — also has a bearing on the relative weights of the different RDRGs. One of MCHPE's precursor studies, which readers may refer to for general background, deals with allocation methodologies in detail.[11] Some of the features of the Maryland method are summarized below.

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[11] Michael Loyd & Associates. Manitoba Centre for Health Policy and Evaluation Hospital Cost Allocation Methodology *(HCAM)*, 1992.

- Hospital administration, general accounting, medical records, patient accounting and nursing administration are allocated together. For allocating between inpatient and total outpatient areas, the costs are divided based on quasi-equivalent inpatient admissions (QEIPA), which assign values of 1.0 to admissions, and 0.5 to day surgery visits and 0.125 to other visits. A different allocation method is then used to further divide the resultant total outpatient costs into two components: 'ambulatory' (ER, clinics, day surgery) and 'outpatient' (i.e. outpatient shares of D&T).

- The calculated inpatient overhead costs are then allocated to specific inpatient departments based on inpatient costs of (i) purely inpatient cost centres and (ii) the inpatient shares of patient care cost centres that commonly serve both inpatients and outpatients (for example, lab radiology, EKG). Thus nursing cost centres with comparatively high direct costs per day will receive higher overhead allocations.

- The units of measure for separating the inpatient and outpatient costs of most D&T services are similar to those generally used in Canada, except that when relative value units (RVUs) are employed, American RVU systems are used. Also in Maryland, labour and delivery services are costed to patients based on RVUs.

- Allocation bases are another area of interest in allocation approaches. The Maryland allocation bases for selected areas are shown in brackets: plant operations and maintenance (square footage), housekeeping (hours assigned), laundry and linen (pounds consumed), purchasing and stores (other expenses incurred), and central supply, pharmacy and social services (drugs, M&S, and admissions).

- Cost allocation methods and bases are standardized in Maryland.[12] This is not always so in other American state and national systems.[13]

- Nursing costs reflect cross-sectional differences in the cost per patient day by clinical service area. No workload measurement system is employed to allocate nursing costs by patient within nursing service cost centres.

- Costs of nursing in-service training staff are grouped in the nursing administration cost centre.

- Maryland charges are broken into eight subcomponents called charge "buckets". These charge buckets reflect the direct costs of the eight specified "revenue centres" plus overhead costs allocated to each.
    - Daily charge (inc. admission services)
    - Operating room charge
    - Drug charge
    - Radiology charge
    - Laboratory charge
    - Supplies charge (Medical & Surgical only [M&S])[14]
    - Therapies charge
    - Other charges[15]

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[12] Only the allocation of costs to ancillary operations, unregulated programs, and the like are left to hospitals' discretion as well as the allocation of data processing costs.
[13] An example is the New York costs used for HMRI's original RIWs. Network Inc., Final Report, *New York State SIW Project*, Methods, March 20, 1985:51.
[14] Canadian hospitals usually report general supplies and other expenses separately from salary costs. The costs of general supplies and expenses are reported together with salary costs in the Maryland charge buckets.
[15] Other charges include such services as L&D and diagnostics apart from radiology and laboratory.

- The drugs and M&S buckets include direct costs, allocations of central supply and pharmacy (drugs only), and overhead allocations to central supply and pharmacy.

- Costs of medical administration, and education programs including students remuneration, are reported in the dataset. Interns, residents and other students' salary costs are captured in the cost centres where these individuals work. Payments to physicians for clinical services are excluded, even when the hospital is the paymaster.

In general, the Maryland approach for identifying inpatient costs resembles some aspects of the HCAM approach piloted by MCHPE, and MCHPE's subsequent simplified HS-1 based (Wallian) approach, both of which yielded very similar results despite methodological differences.[16,17,18] One of the major differences between the HCAM and Wallian approaches was in their allocations of overhead costs. The former employed regression models to allocate the overheads of various plant services departments, whereas the latter allocated all costs based on the paid hours in direct care areas. That they yielded very similar results is evidence of the robustness of the approaches.[19]

The Maryland step-down allocation methodology allocates plant services on the basis of square footage in direct patient care areas. There will be some relationship between square footage and the number of employees working in an area (Wallian allocation base). This

[16] Michael Loyd and Associates, 1992 op. cit. p9.
[17] Wall, R., C. DeCoster, N.P. Roos. Estimating Per Diem Costs for Manitoba Hospitals: A First Step, *Manitoba Centre for Health Policy and Evaluation*, 1994
[18] The Wall approach yielded results very similar to SBGH's modified Barer-Evans approach.
[19] Of course, different allocation approaches that are robust in their determination of costs at the aggregate inpatient level are less likely to be comparable at a service level.

seems to be confirmed by the fact that the HCAM regressions contained square footage as one of the explanatory variables, and that the HCAM and Wallian approach yielded almost identical results, to the Manitoba methodology in this study. Thus there is every reason to believe that the Maryland approach will be compatible with that used in this report.

Another distinctive feature of the Maryland methodology is its use of an equivalent patient day weight method to allocate hospital administration (broadly defined), medical records and a few other minor overhead costs to inpatient and outpatient activities. HCAM allocated hospital administration, a department of major quantitative importance, with weights calculated by a regression model. Thus, the HCAM also employed output weights to allocate medical records and hospital administration, but it distributed these costs on a more disaggregated, weighted basis.

MCHPE's experience is that the results of allocations using reasonable but different approaches are robust when used for the determination of total inpatient costs. The inpatient costs of five urban community hospitals derived from two distinct methods each using different sources of cost data differed by only 0.2 to 3.6%.[20] MCHPE's application of the Wallian method to isolate the inpatient costs of one of Manitoba's teaching hospitals and the hospital's application of a third allocation methodology, the Barer-Evans approach, also yielded comparable results. MCHPE's experience parallels findings in the literature. Other studies have also shown that the inconsistent use of cost centre configurations and allocation bases such as hours or square footage makes little difference to cost allocation results when results are considered at an aggregative level such as in the current study.[21] Consequently, it is reasonable to conclude that there is a sufficient degree of congruence between the Maryland

[20] Wall, op.cit. p28-29.
[21] Ashby, Jack. The Accuracy of Cost Measures Derived from Medicare Cost Report Data, *Prospective Payment Assessment Commission, Technical Report Series, Intramural Report*, 1993: 4-5.

allocation results used in weights and MCHPE's approach used to isolate Manitoba hospitals' inpatient costs.

APPENDIX B: ACUTE CARE MARGINAL COSTS ADJUSTMENTS

The marginal cost of a case is the incremental cost of an additional day of care. Generally, the marginal costs for most types of cases decrease after the first few days because some costs tend to be incurred disproportionally in the front end of a stay. Surgery and obstetrics cases are obvious examples. Surgery cases usually incur the operating room charges at the beginning of a stay. If a surgical case involves an open heart procedure or a complex neurosurgery procedure, then a post-operative stay in an intensive care unit may also increase the average daily front-end costs. Similarly, obstetrics cases generally incur the labour and delivery costs at the beginning of the stay, thus raising the overall average cost per day above daily marginal costs later in the stay. In these and other types of cases, diagnostic testing also tends to occur somewhat disproportionally in the first days of the stay, thus adding another reason why marginal costs tend to fall below average daily costs as the stay progresses.

This study employed marginal costs of RDRGs for three purposes: to adapt Maryland cost weights to the generally longer Manitoba lengths of stay; to adjust the weights for outlier cases; and to adjust the weights for in-year days. The first adjustment is required because all case weights derive from an implicit length of stay, which is one of their determinants. The Maryland average length of stay is the implicit stay associated with any Maryland RDRG typical case weight.[22] If the Maryland length of stay in an RDRG suddenly increased by one day, then all other things being constant, the Maryland cost weight of this RDRG would increase by the marginal cost of an incremental day. Similarly, if the average length of stay for this RDRG is two days longer in Manitoba, then the adoption of the unadjusted Maryland cost weight as the Manitoba case weight would understate the latter by two days times the

[22] In this study, no trims were applied to Maryland RDRGs because there was no reason to classify some cases as outliers.

marginal weight.[23] Consequently, MCHPE's approach, like those of HMRI[24] and Jacobs et al, adjusts each American case weight by the difference between the average lengths of stay in the American and the Canadian jurisdictions multiplied by the marginal costs of the particular case mix group.[25,26]

In brief, the outlier adjustment provides additional weights for cases that stay well beyond the average for typical cases. The rationale is that cases that stay far longer than average are likely to be justified for medical reasons or because of structural system problems, such as a shortage of personal care home beds or lack of home care. Conversely, it is assumed that stays exceeding the average by shorter periods are more likely to reflect discretionary interhospital differences in case management. Based on these assumptions, cases (called outliers) exceeding a formula-driven threshold (called the trim point) receive extra weights for days beyond the RDRG average. Cases exceeding the average but discharged before the trim are credited only with typical weights.[27] Details of the adjustment for outliers are contained in **Appendix C: Outlier Approaches**.

The final use of the marginal cost per diem is to isolate the in-year portion of weights of multi-year cases. For example, under MCHPE's methodology, hospitals with typical cases that begin in 1991/92 and separate in 1992/93 are not credited with weights for days in the latter year, which is outside of the study period. By subtracting the marginal cost weight of any such days occurring before the RDRG average length of stay, one credits the hospital

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[23] This approach implicitly employs the average in the Canadian dataset as the standard of measure. A Manitoba standard accepts the Manitoba average length of stay as the standard for calibration even if the province's lengths of stay were inordinate by other standards.

[24] HMRI is now known as CIHI (Canadian Institute for Health Information). Because the references contained in this paper have HMRI in the title we have not altered them.

[25] Jacobs, P., Bay, K. and Hall, E.M. RDRG V3.0 Case and Day Weights: A Research Report Submitted to the Technical Working Committee, *Alberta Health*, January 1993,9-10.

[26] HMRI Resource Intensity Weight 1990 Re-Development Project, Final Report, September 1990,26.

[27] The objective was to develop weights based on expected LOS and expected resource use.

only with weights for the 1991/92 portion of the case.[28] Section **F: Separated Days and Census Days** of the Appendix explains the concepts more fully.

Published analyses on the marginal costs of DRGs are available but none are available for RDRGs, which one would expect, a priori, to behave differently. In DRG-based analyses without the severity dimension, there is always a strong possibility that longer and shorter cases in the same case-mix group are heterogeneous, the former tending to be more severe, as reflected in their longer lengths of stay. RDRGs should provide a truer measure of the marginal cost of similar cases.

HMRI calculated the marginal costs of its CMGs by assumption. It assumed that certain costs such as operating room, post anaesthesia recovery room, labour and delivery and emergency room are incurred only at the outset of a stay.[29] HMRI then assumed that the remainder of costs, which it labelled "routine and ancillary" (RA), were spread evenly over the duration of the stay. No provision was made for differences between the five types of cases — surgical obstetrics, medical obstetrics, surgical, medical and other. The same formula applied to each.

The American Health Care Financing Administration (HCFA) established the marginal cost payment for day outliers at 60% of the estimated average per diem for a DRG based on the geometric mean of the average length of stay.[30,31] Use of the geometric mean increases the effective multiplier in proportion to the ratio of the arithmetic to the geometric mean

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[28] This is consistent with the numerator, which only contains the costs of 1991/92 days.
[29] HMRI 1991, op cit. p8
[30] Carter, Grace M. and Farley, Donna O. Assessing the FY 1980 Change in Medicare PPS Outlier Policy, *Health Care Financing Review*, 1992; 14:2,69-70
[31] Keeler, E.B., Carter, G.M. and. Trude, S. Insurance Aspects of DRG Outlier Payments. *Journal of Health Economics*, 1988; 7: 197.

lengths of stay.[32] This multiplier was 1.352 in a Rand Corporation sample.[33] In this example, the percentage ratio of the marginal to the average per diem translates to 81.1% when the latter is expressed as an arithmetic mean.

Carter and Melnick pioneered the marginal cost work on DRGs, using a unique dataset that enabled them to track the daily costs of individual stays longitudinally through time.[34] They concluded that the per diem costs of cases, plotted by day of stay, are L-shaped: higher at the beginning of the stay but quickly becoming constant until separation. Carter found that marginal costs, over the horizontal range, averaged about 82.6% of the overall (arithmetic) average per diem for cases paid as day outliers.[35,36]

We had to develop our own marginal cost approach in this study because of our decision to use RDRGs for case costing. The possibility that marginal costs would vary by class of case was tested. Different marginal costs were calculated for each of the five classes: surgical obstetrics, medical obstetrics, surgery, medical and other. To analyze the marginal cost per day over the phases of the stay, we generated interval data showing the average daily charges for cases of different durations by RDRG.[37]

We developed two methodologies for testing. Method I, preferred a priori, broke charges into components and examined the behaviour of each over the 14 length of stay intervals.[38]

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[32] The geometric mean will always be lower than the arithmetic mean.

[33] Carter, Grace M. and Melnick, Glenn A. How Services and Costs Vary by Day of Stay for Medicare Hospital Stays, *Santa Monica, Rand Corporation*, March 1990:93.

[34] Ibid.

[35] Carter and Melnick, 1990, op.cit: 86.

[36] The study calculated a range of 71.5-85.3 percent depending on the definition of day outlier.

[37] Data showing the costs over different days of individual cases, like that used by Carter and Melnick, were unavailable for this study.

[38] Examples are 1-2 days, 3-5, 6-10, ..., 126-150 and 150+.

The eight Maryland cost components were collapsed for this analysis into four types of variable charges — routine charges (mostly nursing), DRLS charges (drugs, radiology, laboratory and supplies (M&S)), therapy, and other; and one fixed charge — operating room.[39,40] The behaviour of these costs was observed over the intervals in the five classes of RDRGs. Method II dropped the individual analysis of cost components and tested the behaviour of overall average daily charges in each of the five classes of cases over the 14 intervals.

Steps to Derive Total Marginal Costs

The following six steps were used to generate the total marginal costs per day in Method II and each of the component marginal costs in Method I. The overall marginal costs for any RDRG in the latter were the sum of the four elements.

1. RDRG specific average total charges (or component charges in Method I) per patient day in each of the 14 intervals 1-2 days to 150+ days were calculated.

2. Values were normalized to support combining across RDRGs. That is to say, the cell charge was divided by the overall average for the RDRG to express the cell value as a ratio to the RDRG average ('charge ratio'). This normalized for scale differences across RDRGs.

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[39] Nursing charges were treated as variable charges, even though the only variation arose from the movement of patients between wards with different average per diems. Maryland hospitals do not use workload indicators to impute different costs over the stay in a single ward as a patient's acuity level decreases prior to separation.
[40] Operating room charges are assumed to be upfront "fixed" charges, even though these costs are occasionally incurred later in the stay.

3. Deaths within two days were deleted, otherwise the interval results would have been distorted.

4. For each of the five classes, the weighted average charge ratio for each interval was calculated by multiplying the average normalized daily charge ratio for each cell and the number of cases in the cell, summing those products and then dividing by the number of cases in the interval to which the cells belong. This gave the average normalized daily charge ratio for each interval in each class. Denote this method of weighting as "column weighting".

Note that each RDRG cell within an interval has a different number of cases associated with it. The weighting described in the preceding paragraph decreased the volatility that this situation would otherwise engender[41]. Also note that the column average charge ratio for each interval was derived from a different numbers of cases. For example, the 126-150 day interval, compared with the 11-15 day interval, tended to have fewer RDRGs with cases and fewer cases in each of the represented RDRGs.

Some RDRGs have virtually no cases in the 1-2 and sometimes 3-5 day range. These RDRGs distorted the calculations of average interval charge ratios because their distributions are centred differently on the x-axis: the expensive portion of their stays would occur in a later interval than it would in orthodox cases.[42] Sensitivity tests were conducted by dividing each of the five classes into two sets: ones that had at least 10% of their numbers or an absolute number of 100 cases in interval 1-2, and those that did not.

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[41] Unrepresentative normalized charge ratios are more likely to occur when the number of cases is small. The approach gave greater weight to RDRG cells with more cases (and truer charge ratios).

[42] For example, if an RDRG had almost no discharges in the 1-2 day range, the relationship between its average costs in the 3-5 day interval relative to its average costs for all intervals would parallel the relationship between the average costs of a normal RDRG in the 1-2 day interval compared to its average for all intervals.

The resulting differences in values were significant enough that only cases satisfying either or both of the criteria were retained for calculating the MC by class of care.

The final decision to use the column weight to calculate average charge ratios for intervals was based on tests of alternative approaches such as unweighted averages, row-weighted averages and 'split sample' averages. The results of the latter were the most informative.

The "split sample" analysis involved sorting the charge ratios of RDRGs within each of the five classes by their overall ALOS (for all intervals in a row). The 'samples' were then split 'in half' into "long stay" and "short stay" RDRGs without regard to the number of cases in an RDRG. The behaviour of charge ratios over the intervals for the "long" and "short-stay" RDRGs was then compared within each of the five classes.

In the intervals containing the longer stay cases, the charge ratios of RDRGs with longer overall average stays were consistently higher than those with shorter overall average stays.[43,44] In addition, case counts showed that in the higher intervals the numbers of cases in long ALOS RDRGs exceeded those of short ALOS RDRGs by several fold. Hence, the decision of how to weight RDRGs to obtain average charge ratios for intervals in the higher range affects these RDRGs more than those with shorter average stays.

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[43] For example, the charge ratios in intervals 12-14, the final three intervals, for an RDRG with an overall 8.5 day ALOS would tend to be lower than the ratios in these intervals of an RDRG with an overall ALOS of 20 days.

[44] This pattern held even in classes such as medical and obstetrical surgery in which the differences between the row and column weighted calculations were small.

That is to say, case weights — or row weights as they are being referred to here — would put too much weight in the upper intervals on RDRGs with short average lengths of stay. These RDRGs are underrepresented in the long stay intervals and their average marginal cost ratios are unusually low in these intervals. By contrast, the column weighting approach weights RDRGs in proportion to their presence in each interval.[45] Thus, long ALOS RDRGs with their higher marginal costs predominate in the calculation of marginal costs in the higher intervals.

5. Another analysis was undertaken as a final check of the column weighting approach. This method of analysing overall daily charge ratios excluded RDRGs that did not contain minimum numbers of cases in the higher intervals. The method enabled one to analyze a set of RDRGs that had reasonable representation across the spectrum of length of stay intervals. The findings in this subset supported the column weighting approach, which was, therefore, adopted for the marginal cost calculations in the study.

6. We calculated the marginal charge ratio from the average charge ratios described above by multiplying the average interval charge ratio by the corresponding case-weighted ALOS, then subtracting the average charge for the preceding interval multiplied by its case-weighted ALOS, and finally dividing these results by the difference in ALOS for the intervals.[46] We eliminated intervals with fewer than 100 cases in a class. The marginal cost ratio is the incremental cost of an additional day.

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[45] Column and row weighted calculations yielded very similar average charge ratios in the lower intervals, which have large case counts.

[46] If the average charge ratio for the interval 1-2 in class 3 is 1.51 and that for the 3-5 interval is 1.04 and the respective ALOSes are 1.38 and 3.80, then the MC is $[(3.80 \times 1.04) - (1.38 \times 1.51)] \div (3.80 - 1.38) = 0.77$.

In deriving the overall marginal cost ratios (α) for the various types of charges in all classes, the starting point of the calculation in step 6 was the 6-10 day interval because eliminating the earlier intervals resulted in the best fitting trend lines. Marginal cost ratios for the five classes generally seemed to stabilize as of the 6-10 day interval.[47,48] These results were consistent with Carter's L-shape curves.

The total marginal cost ratios by class for Method II were as follows. The marginal cost of a surgery day, for example, was 83.3% of the average cost.

Table 1

Total Marginal Cost Ratio

Class	αs
Surgical Obs	0.924
Medical Obs	0.820
Surgical	0.833
Medical	0.870
Other	1.014

[47] The results would not change a great deal for medical and surgical cases, which are the dominant types, if the 11-15 interval were chosen as the starting point. The decision did affect the magnitude of α for obstetrical cases.

[48] Tests conducted on the cases with trims of 5 days or less show that the potential error of employing these resultant marginal cost findings to their data is small.

The marginal cost ratios for the other charge groups are as follows:

Table 2

Component Marginal Cost Ratios

	α			
Class	**Routine**	**DRLS**	**Therapy**	**Other**
Surgical Obstetrics	0.980	0.991	1.111	0.854
Medical Obstetrics	0.926	0.788	1.871	0.615
Surgical	0.965	0.811	1.119	0.854
Medical	0.935	0.793	1.210	0.566
Other	1.028	0.965	1.383	0.804

The pattern of the RDRG marginal costs observed in this study approximated that found by Carter and Melnick for all costs of Medicare patients in a DRG-based analysis. That is to say, costs were higher at the outset and the marginal cost curve soon become horizontal thereafter, approximately as of the 6-10 day interval. In our study, the generality was remarkably true for the various individual RDRGs as well as the aggregates. If the five classes were collapsed into one and the distinction between cost components were dropped, MCHPE's marginal cost ratio would have been very similar to Carter's 0.828, despite the use of different case mix systems and other methodological data differences.

The regression analysis performed alternately on case mix indices based on the two marginal cost methods described above and a third that assumed $\alpha=0.60$, showed that Method I, the chosen approach, produced the best fit. See section **I: Sensitivity Analyses** for more details.

APPENDIX C: OUTLIER APPROACHES

Outlier cases are those whose costs differ systematically from typical case costs in an RDRG because their stays are much longer than the RDRG average. Case mix costing approaches commonly assign more than the typical case weight for a small fraction of long cases that qualify as a length-of-stay outliers. The outlier approach requires a criterion or formula for classifying the most extreme lengthy stays as outliers and a method of adjusting the case weight to reflect, in whole or in part, the extraordinary costs of these cases.

In pure acute case datasets, there are essentially two reasons for handling outlier cases differently. Excluding outlier cases improves the performance of case mix approaches in explaining average costs or average lengths of stay at the patient level. As explained in the section entitled **Acute Care Marginal Cost Adjustments** (Appendix B), the RDRG typical case weight is based on an implicit length of stay, which is the average length of stay for the RDRG. At the hospital level, the provision of additional weights for outlier cases is important because the typical weights become increasingly inappropriate and unrepresentative of true costs as lengths of stay increase beyond the average for the RDRG.[49]

Case mix analysis typically assigns a full typical case weight regardless of whether the case stays less than or longer than the ALOS for a given RDRG. Thus if a hospital consistently discharges patients after the ALOS, this will be reflected in a higher average cost per weighted case. The use of a single weight for a case mix group, irrespective of length of stay, will encourage efficiency in a prospective payment funding system. But it could be inequitable if cases with exceptionally long length of stay are clinically appropriate. Hence, it

[49] Outlier weights will also improve the fit of regression models which have average weight per case as one of the independent variables and the cost per case as the dependent variable.

is common to classify cases with extremely long lengths of stay as outliers and provide credit in the form of extra weights for some or all of the days beyond the all-hospitals' average length of stay for the case mix group. The rationale is that extremely long stays are more likely to be justified clinically or because of system deficiencies than to result from poor case management. Therefore, the hospital receives additional weights so that weights are more in line with estimated case costs.

Essentially two alternative approaches to the weighting of outlier cases are commonly employed.[50] One approach provides marginal cost weights for all days in outlier cases beyond the all-hospitals' average length of stay and thereby fully compensates the hospital for the expected costs of outliers. The other provides such daily weights only for days past the trim point, which is the line of demarcation for outlier status. This approach denies hospitals weights for the days between the all-hospitals' average length of stay for the case mix group and the trim point, a period that we will denote as the "notch"[51,52]. Consequently, this approach denies the hospital full 'compensation' for anticipated outlier costs. This denial is usually based on the premise that a funding method should avoid the kind of discontinuity that would otherwise exist between a stay that was one day less than the trim point and another lasting one day beyond the trim. A large discontinuity would create an incentive for hospitals to manipulate the system by retaining until after the trim patients who could have been discharged in the notch.[53] MCHPE's method provided the full credit for days of outlier

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[50] Alberta employs a unique approach by providing .3 times the average daily relative cost weight for cases in the two lowest severity RDRGs of an ADRG and a multiplier of .7 for cases in the two highest severity RDRGs of the ADRG. No weights are provided for days in the notch. Jacobs, P., Hall, E.M., Lave, J. and Glendining, M. Alberta's Acute Care Funding Project. *Healthcare Management Forum* 1992:5,3:7

[51] HMRI's 1990 methodology compromised between the two approaches by providing half the marginal cost weight in the notch for outlier cases. The Institute began weighting at the full marginal cost per diem in the notch in its 1991 revision. *HMRI Resource Intensity Weight 1990 Re-Development Project Final Project Report*, 1990: 34, and *HMRI Resource Intensity Weights, Summary of Methodology*, 1991:26-27.

[52] Ontario's funding methodology employs a multiplier of .2 to the marginal cost per diem of outlier cases in the notch segment of the stay. The notch is the period between the ALOS of a case mix group and its trim point.

[53] There is evidence that American hospitals have not responded to the incentives of a slightly different notch discontinuity by gaming the system to maximize revenue. Carter and Farley, op. cit., 77-78

cases in the notch. There is no justification for withholding full credit in a costing study: the most accurate costing is obtained by fully crediting such days. Moreover, if incentives are not an issue, it makes no sense to penalize hospitals for the notch phase of lengthy stays that qualify as outliers and are thus deemed to be justified.[54]

No objective criterion exists for the setting of the trim point that defines outlier cases in an RDRG. Thus, outlier policies in American reimbursement systems have been described as a "mix of practicality and ideology".[55] One example of this is Congress' arbitrary affixing of the American Medicare proportion of outlier funding at 5% of total funding.[56]

Functionally, the fewer the number of outliers allowed, the greater the penalty on hospitals with long mix-adjusted lengths of stay compared to the all-hospitals' average. In a case mix costing study, the fewer the number of outlier cases allowed, the greater will be the disparity between actual costs and standardized costs, as represented by the weights.

In Manitoba, an additional complication arises from the contamination of the acute care hospital abstract dataset by days of care in designated long-term units (LTC days). Manitoba general hospitals do not discharge patients who move from an acute care unit to a long-term unit within the same hospital. Alternative level of care patients (ALC) also accounted for a large proportion of acute care unit patient days, especially in 1991/92 before remedial

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[54] Gaming of the type discussed in the sector is testable empirically. If hospitals abused a funding approach that paid for notch days in outlier cases, the policy could be changed. There is no reason to preemptively withhold compensation without evidence of abuse.

[55] Steinwald, B. and Murdock, D. Payments for Outliers under Medicare's Prospective Payment Systems. *Journal of Health Economics*, 1988: 7:292.

[56] Keeler, E.B., Carter, G.M. and Trude, S. Insurance Aspects of DRG Outlier Payments. *Journal of Health Economics*, 1988;7:292

measures were taken during Health Reform to ameliorate the problem in urban hospitals.[57] Neither problem exists in any significant degree in American acute hospital datasets. In Ontario, the first problem does not exist because patients are discharged when they move from an acute care unit to a long term care unit irrespective of whether the units are located in the same or different hospitals. Thus, there are no such long stay unit days in the dataset. The ALC problem, which does exist in Ontario, is addressed by the province's funding approach as will be discussed in Appendix D entitled **Non-Acute Days**. In Alberta, the first problem exists when a general hospital's long-term care unit does not have a separate facility number, but does not arise when there is a separate facility number. Alberta's funding methodology ignores both the problems of long-term care units and long-term patients in acute beds, thereby creating erratic results for hospitals with significant proportions of long-term care patients.[58]

Alberta's approach would provide no weights for long-term care days in the notch. It would tend to undervalue the days beyond the trim of cases in RDRGs of levels 0-1 severity because its marginal cost multiplier is only 0.3 times the overall average daily weight for these RDRGs. It would tend to overvalue the weights of long-term care days beyond the trim in RDRGs of 2-3 severity because it applies a per diem marginal cost multiplier of 0.7 times the overall average for these RDRGs. Finally, it would tend to overvalue long-term care cases that stay less than the average length of stay for the RDRG because they receive acute weights.

Given the Manitoba data constraints, MCHPE had two choices: (1) attempt to eliminate the costs of all long-stay patients from the hospital inpatient cost numerator and remove their influence from the weights in the denominator; or (2) weight the long-stay days in the denominator and retain all inpatient costs in the numerator. The success of either approach

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[57] ALC patients are long-term patients on acute wards, whereas LTC patients are long-term patients on designated long-term wards.

[58] There is no justification for penalizing a hospital for long-term cases that end in the acute RDRG notch or for not providing full non-acute marginal cost weights for long stay patients that qualify as acute outliers.

hinges on the accuracy of the estimations of long-stay costs. Both approaches are faced with the problem that some smaller Manitoba hospitals do not properly code patients receiving non-acute care.

We chose the second approach because it was more consistent with the overall objectives of the study. First, it applies a standardized weight that is independent of an individual hospital's actual costs, whereas the former employs the hospital's actual costs, to the extent that they are known.[59] Thus, the weighting of the long-term days and inclusion of the associated costs meant that general hospitals' long-term care activities would be examined, in a similar way to acute care activities, for the possibility of excess costs. For example, it is well established that hospitals which cluster long stay patients in designated units can decrease their costs both by reducing the labour inputs per patient day and by lowering the costliness of the staffing mix. All other things being constant, these hospitals would fare better under this methodology than other hospitals. By contrast, the rejected approach involved deducting the estimated actual long-term care unit costs, regardless of how high, and therefore not holding a hospital accountable for this portion of its operation. Second, these days represented a large portion of the overall activity of many of the general hospitals in the Manitoba hospital dataset. If these long-term care unit costs were excluded from consideration, the omission of such a large element of some Manitoba general hospital's inpatient activities would have detracted from the analysis.

Hospitals were surveyed to determine whether they used Manitoba Health's specific service codes for chronic, panelled or other non-acute care days. Hospitals which consistently coded the long term status of their patients are identified as "good coding" hospitals in this study;

[59] The weighting approach requires one to analyze long-term care costs over all hospitals with designated units and develop standardized weights. The second approach involves subtracting such weights from the denominator and deducting hospital-specific costs from the numerator.

hospitals which were not consistent in coding or did not code non-acute days are referred to as "poor coding" hospitals.

In addition to the other advantages, weighting the non-acute cases was expedient methodologically because there is only one source of possible error in "good coding" hospitals: the assigning of inaccurate weights. By contrast, there was an additional source of possible error in the alternative methodology: that of incorrectly estimating the actual hospital-specific non-acute care costs. In "poor coding" hospitals, which have a minority of the cases in Manitoba, there is an added risk under both methodologies of incorrect estimation of the amount of long-term care activity and the incorrect allocation of long-term weights to specific RDRGs.

We analyzed the outlier trims employed by various funding agencies and other methodologists before deciding on the trim formula in this study. HCFA has used geometric transformations and defined outliers by cost and length of stay criteria. Its trim points for day outliers, limited by the 5% ceiling on overall outlier payments, were set at the geometric mean length of stay for the DRG plus the lesser of 24 days or 3 standard deviations.[60,61] Given that data on Manitoba high cost outliers were not available, the only option in the current study was to define outliers in terms of the length of stay.

The HMRI approach, also adopted by Ontario for hospital funding, classifies cases as outliers whose lengths of stay exceed the arithmetic mean CMG plus 2.0 times the interquartile range

[60] Carter and Farley(1992), op. cit. 70.

[61] The five percent ceiling applied to total outlier payments encompassing day and cost outliers.

(denote this as k=2.0, where k is the multiplier applied to the interquartile range between the second and third quartiles and added to the third quartile value for the case mix group).[62,63]

If this trim point formula is satisfactory for Ontario, then it follows that the k value of the Manitoba trim point formula should be set lower, so that a higher proportion of Manitoba cases would be classed as outliers. In Manitoba, the trim must not only handle acute cases, as in Ontario, but it also must operate effectively in a hospital environment with a large number of patients in long-term units. Furthermore, in 1991/92, prior to Health Reform, there were many ALC patients in Manitoba's urban general hospitals in addition to those in rural hospitals. Ideally, one would have chosen a k value that would have classed as outliers all the cases with non-acute days. Then one could have further adjusted the k value to deal with the acute cases that remained. In essence, an American outlier methodology would not need to first remove the non-acute cases — they would not be in the dataset to begin with. In Ontario and Alberta, the presence of such cases would be much more limited than in Manitoba in 1991/92.

In practice, the exercise of choosing the k value was not straightforward enough to attain the ideal solution. First, the precise identification of non-acute cases was impossible in the poor coding hospitals. Second, not all of the cases that contained non-acute days could have been excluded by any realistic trim point. Indeed, some of these cases separated before the all-hospitals' RDRG typical average lengths of stay.

[62] The American approach employed the log transformation to deal with the rightward skew of the length of stay distribution. The Canadian approaches deal with the same problem by employing the interquartile range instead of transforming the data and employing standard deviations to establish the trim points.
[63] HMRI (1991), op. cit 2

This study followed the ideal approach described above to the extent possible within our data constraints. The problem of the poor coding hospitals was handled by developing the k value from analysis involving only the good coding hospitals and then extending the results to the entire dataset.

After our analysis of the data, we decided that all cases extending beyond 75 days would be considered outliers. The k value initially was set to exclude — in conjunction with the 75-day maximum — the equivalent of the number of cases with non-acute days in good coding hospitals plus 3.5% of acute care cases, the latter being a proportion similar to the HMRI proportion of outlier cases. These results were then reviewed to determine how many non-acute and acute care cases and days actually were trimmed. The RDRG ALOS coefficients of variation of the untrimmed cases were compared to those of the Maryland pure acute case dataset, on the assumption that the variability of the non-outlier data would become progressively more like that of Maryland as non-acute cases were eliminated. The k values were then reduced iteratively to sensitivity test (1) the proportions of the remaining non-acute cases and days that would be trimmed by successively smaller k values and (2) the proportions of acute cases and days that would inadvertently be trimmed.[64] A k value of 1.5 eventually emerged from the iterative process as the value that best balanced the aim of removing all of the non-acute cases and days against the constraint of not wanting to remove too high a proportion of the pure acute cases and days in the process. This k value is one that is frequently used in statistical analyses.[65]

To summarize, the analysis in this section, performed only on the good coding hospitals, was used to develop the k values, which in turn were applied to the entire dataset of hospitals to

[64] The lower the k value, the lower the trim point and the larger the number of cases classed as outliers.

[65] Additional analyses performed by MCHPE's statistician, who applied pure statistical analyses in abstract from the above considerations, suggested that the nature of the Manitoba data was such that one might justify an even lower k. However the value k=1.5 is a conservative and generic choice that is often used in statistical analyses of outliers.

establish the trim points. The cases with non-acute days were included in the dataset on which the trim points were established. Hence, we developed a lower k value than those generally used elsewhere in analyses of datasets containing only acute cases. The outlier methodology was tested and substantiated with regression models in **Appendix I: Sensitivity Analyses**.

APPENDIX D: NON-ACUTE DAYS — LONG-TERM DAYS AND ALC DAYS[66]

Calculation of Weights

The costs of non-acute days, which comprise a large proportion of total days in the Manitoba hospital dataset, are less than those of acute care days. Hence, special marginal per diem cost weights were required for Manitoba stays with long-term care unit days or phases when patients were panelled for placement in personal care homes. We needed a rigorous approach to the handling of these days because they are much more prevalent in the Manitoba dataset than in the other two provinces that have adopted case-mix costing approaches.

In its case-mix funding approach, Alberta ignores the contamination of its hospital dataset by long-term care unit days and ALC days. Cases in long-stay units and ALC cases are treated exactly like short-stay cases.[67] In Alberta, however, most long-term care units have separate facility numbers, which means that most patients that move between acute and long-term units of a single hospital are discharged. Thus the problem in Alberta is confined mostly to ALC patients. The HMRI approach is based implicity on the elimination of the estimated costs of long-stay units from the numerator in the calculation of cost per weighted case.[68] The HMRI approach anticipates that there will be no long-term care unit days in its dataset. Ontario employs the same approach for equity funding. Ontario hospitals discharge patients that move from an acute care unit to a long-term unit within the same hospital. Hence, there is no need for any conscious adjustment to remove the weights of long-term care unit days and/or cases. Only the acute portion of hospitalizations that involve long-term care unit days

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[66] ALC patients who are panelled for placement in a personal care home. The acronym refers to "alternate level of care".

[67] As noted earlier, stays in long term units will be in the Alberta dataset to the extent that general hospitals do not have separate facility numbers for their long term units. Most have separate numbers.

[68] HMRI does not actually perform calculations of costs per weighted case but it follows that this must occur given that long-term care case weights are excluded.

are weighted in the denominator. Hence, Ontario deducts estimated long-term care unit costs from hospital cost numerators.

HMRI adjusts for ALC patients in short-term units with its "blended rate". To calculate a blended weight for a CMG, HMRI multiplies the Ontario all-hospitals' proportion of the outlier days which are ALC in the CMG times a non-acute per diem, which it then adds to the product of the acute care per diem for the CMG and the proportion of acute care days. The non-acute per diem is set at the value of the marginal per diem cost of the CMG at the tenth percentile of marginal cost per diem weight distribution.[69,70] HMRI then applies this Ontario province-wide average ALC proportion to all Ontario hospitals as well as hospitals in other provinces — hospitals which may individually and/or at provincial level have proportions of ALC patients much different from the Ontario provincial average.

We developed the non-acute weight by estimating the ratio of per diem non-acute to acute costs in Manitoba for five cost components and then multiplying by the average Maryland (acute) per diem for the component. The cost components were routine costs, diagnostic and therapeutic costs (D&T), medical and surgical supplies (M&S), drugs, and other costs.

Manitoba weighted average per diem nursing costs for long-stay units in general hospitals were used in the creation of the weights in this study. The ratio of Manitoba long-stay unit nursing costs to average Manitoba short-stay unit costs, including the salary costs of a meal day, were calculated first. Then this ratio for Manitoba "routine" costs was multiplied by the average routine charge for a patient day in Maryland to estimate the relative routine cost per

[69] HMRI (1991) op. cit. 24-27
[70] In 1991, the service was carpal tunnel release.

day for long-stay portions of cases.[71] The Maryland routine charge includes allocated overhead, whereas the Manitoba ratios are based only on direct costs. The method establishes relativity with Maryland charges so that the result is an indexed weight that is consistent with acute care relative weights.

The average nursing costs in designated long-term units in Manitoba in 1991/92 was $87.98, the average dietary salary cost was $11.89 and the total routine cost was therefore $99.87.[72] The weighted average nursing cost of acute care days in Manitoba of $135.54 and the dietetic cost of $11.89 result in a corresponding total of $147.43. The $135.54 estimate of the acute nursing per diem was generated after factoring out the diluent effect of panelled and chronic patients in short-term units.[73]

The ratio of these Manitoba non-acute to acute per diems, 67.7%, was then multiplied by the average Maryland routine acute care daily charge of $446 to arrive at the routine portion of the non-acute weight, an amount of $302. This is the estimate of the Maryland costs for routine long-term care including an allocation of overhead costs.

The method described above was also used for the remaining four components of costs to generate long-term per diem weights commensurate with the Maryland acute weights. The four components were: (1) laboratory and radiology, (2) M&S, (3) drugs, and (4) other costs. Estimates of these costs for Manitoba long-stay patient days were first developed and then

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[71] This could be fine tuned by calculating the average cost of a Maryland patient day for the Manitoba mix of cases.

[72] All costs in this section are weighted by patient days to develop provincial averages. Thus large hospitals' costs receive more weight.

[73] Estimates of panelled and chronic patient days in the short-term units were provided by Manitoba Health. The $87.98 weight was applied to those days. Estimates for urban hospitals were generated from HS-1 reports of panelled and chronic days and assumptions about the proportions in short-term and long-term units.

used in conjunction with the proportions of pure acute and long-stay patient days in each hospital to estimate the corresponding short-term costs at the hospital level. The numbers of acute and long-term patient days are known, the total laboratory and radiology costs per patient day are known, consequently the acute care cost per patient day can be estimated once the LTC per diem is established from independent sources.[74]

The Manitoba non-acute D&T per diems, including general supplies, were estimated from previous regression analyses, and then inflated to include employee benefits, pharmacy costs (which were excluded from the previous regression analysis) and increases in nursing wage rates up to and including 1991/92.[75] An estimated per diem of $10.00 emerged. M&S and drug costs were estimated from the data of HSC's and SBGH's geriatrics units plus a review of selected other hospitals. A per diem of $4.50 was applied for all long-stay patients. The corresponding acute per diems were estimated at $56.07 for D&T and $41.23 for M&S and drugs. Thus the respective non-acute to acute ratios were 17.8% and 10.9%.

The long-stay per diem for D&T will be 17.8% of the overall $222 average Maryland charge per day for radiology, laboratory, therapies and other D&T, or $39.60. The M&S and drug per diem for long-stay cases is 10.9% of the Maryland average of $156, or $17.00. "Other" Maryland costs, after deducting the D&T costs estimated above, might range from to $0.00 to $46.31, depending on one's assumptions.[76]

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[74] The acute per diems are much more variable than the non-acute per diems. This is why it was preferable to estimate the long-term per diem costs of components, such as laboratory and radiology services, and then to solve for the acute care per diem.

[75] Michael Loyd & Associates (1992) op. cit. 35-37

[76] The Maryland "other" cost category contains D&T costs apart from laboratory and radiology as well as other miscellaneous costs.

The total Manitoba non-acute cost weight, expressed in Maryland dollars, is $375 with a range of $359 to $405. By contrast, the lowest acute care per diem for adults in the Maryland 1991 and 1992 dataset was $425 (RDRG 4361). This Manitoba non-acute cost in Maryland dollars converts to an RCW of .085 per day.

To recapitulate, this method first involved finding the relationship between a Manitoba long-term care component of cost and the corresponding Manitoba average acute care cost of the component. Then the product of 1) the ratio of the former to the latter Manitoba cost and 2) the Maryland acute care per diem cost of the component provided the estimated average long-term per diem cost of the component in Maryland relative dollars, with Maryland overheads included. The summation of the products of all component costs generated an estimated total Maryland non-acute per diem of $375, which is consistent with the State's average acute per diem of $908.

Rural "Good Coding" Hospitals

Unlike Ontario hospitals, Manitoba hospitals do not discharge patients when they move from acute care to long-term status within a single hospital. We therefore needed to devise a method by which we could assign the previously defined per diem non-acute weight of .085 to the appropriate days.

This method involved 2 steps—the first was to survey all hospitals to ascertain which service codes were used on the hospital abstracts to denote patients receiving long term or non-acute care. Once hospital-specific coding information was obtained, at each hospital, we determined the number of cases and days designated non-acute by the primary service code or any of the 6 additional service codes in the hospital abstract data. We then compared this number to the number of long-term Revenue days hospitals reported to Manitoba Health. The latter are composed of chronic care, respite and panelled days. If the ratio of the former days to the latter days was equal to or greater than .7, the decision was made to classify the hospital as a "good coding" hospital. The non-acute weight was applied to all non-acute days as determined by the service codes.

Rural "Poor Coding" Hospitals

If a hospital was found either not to use the service codes or they were not used consistently (ie. the ratio was less than .7), the adjustment of non-acute days was performed at the hospital level rather than the patient level. For this we relied totally on the Manitoba Health counts of panelled (ALC), chronic and respite care days.

One difficulty arising from the absence of non-acute information at the patient level is that one cannot directly connect long-stay days with their appropriate RDRG and determine whether they are inlier or outlier days. Owing to these data constraints, the only available approach was to apply an allocation formula based on overall averages.

To establish this allocation formula, the optimum method would have been to calculate the proportions of inlier and outlier non-acute days for each RDRG in rural good coders. Then one could allocate non-acute days to poor coding hospitals and divide them into inlier and outlier components commensurately with the frequencies established for the population of good coders.

For example, suppose that a rural poor coder had cases in only two of the RDRGs that, in the population of rural good coders, contained non-acute days. Suppose that RDRG A had 25% non-acute days and RDRG B had 10% non-acute days in the population of "good coding" hospitals.[77] Then long-term care unit and ALC days in acute beds would be allocated on a 2.5-1 basis.[78] After this allocation is performed, the next step would be to allocate within the RDRG to inliers and outliers. If the inlier and outlier proportions in RDRG A were 10-90% in "good coding" hospitals, then 10% would be allocated to inlier stays and the remainder to outlier days.

In practice, to simplify the programming, the long-term care days were allocated to a subset of the RDRGs that represented the highest frequency of non-acute days in each of the non-urban hospital types, maintaining the distinction between inliers and outliers. Otherwise the methodology was as described above. An analysis of the numbers of cases involved showed that the simplification would have a negligible effect on resulting hospital weighted cases.

The methodology applies a single weight to all non-acute days irrespective of whether they are ALC days or long-term care unit days.[79] The Manitoba coding of separated days is unable to distinguish between ALC and long-term care unit days. The single weight is valid only as long as the ALC patients in general hospital beds are as heavy as long-term care unit patients in terms of nursing requirements.[80] Inasmuch as the panelled patients in some nursing homes are of a much lower intensity, it is possible that the ALC patients in acute wards of some hospitals, especially rural hospitals, are more like these. Little difference in nursing costs was found in a test involving a limited amount of urban hospital data. Manitoba Health may want to study this issue in depth in the future.

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[77] The remaining 65 percent of long-stay days in the population were in RDRGs not treated by the hospital in the example.

[78] That is to say, solve for χ in the equation $2.5\chi + 1.0\chi$ = long-term care unit patient days and ALC days in non acute beds.

[79] Nor does this method distinguish between types of long-term care.

[80] To be more precise, the approach would be valid if the nursing costs of ALC patients when they are clustered in an ALC unit are identical to those of other long-term care unit patients. It is anticipated that non nursing costs will be identical.

The results of the non-acute care adjustments were tested with regression analysis. The analyses found that differences in the proportions of non-acute days had no significant affect on hospitals' costs per weight. These findings validate the adjustment.

APPENDIX E: TRANSFERS AND DEATHS

Work with DRGs and CMGs has established that death and transfer cases behave differently than other cases in the case mix groups to which they belong. To adjust for deaths and transfers, HMRI developed decay functions that applied different multipliers to the typical weights of the CMGs depending on the portion of the stay under consideration.[81] Carter, in a study of American Medicare patients, showed that the per diem costs of short-stay transfer cases exceed the cost of an average day in the applicable DRG but that the L-shaped decay function was similar to those of non-transferred cases in the same DRG.[82] No published studies have dealt with the issue of costs and average lengths of stay in an RDRG framework.

There are a priori reasons for believing that RDRGs would handle death and transfer cases better than DRGs and their CMG relatives. First, the RDRG system contains special RDRGs for medical deaths within two days of admission, a subset of deaths that is very costly on a per diem basis.[83] The presence of these RDRGs, which capture the great majority of all two-day deaths, will change the patterns of death costs in the remaining medical RDRGs with death cases. The ensuing discussions will deal only with non-medical deaths and medical deaths after two days, the ones that may require adjustments.

Second, RDRGs contain a severity overlay not present in DRGs and CMGs. The upshot is that one would expect, a priori, that death cases would tend to be concentrated in higher severity RDRGs within ADRGs. If so, this should lessen any adjustment that would have been required if high and low severity cases were lumped together as they are in DRGs and

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[81] HMRI (1991) op. cit. 14-23

[82] Carter, G.M. and Rumpel, J.D. An Evaluation of Medicare Payments for Transfer Cases. Rand/UCLA Center for Health Care Financing Policy Research, 1993. *Health Care Financing Administration Contract 500-92-0023*:p16.

[83] There is a within-two day death RDRG for each Major Diagnostic Category.

CMGs. RDRGs should similarly be better equipped to deal with adverse selection in the transferring up of very sick patients, for example, from community to teaching hospitals. Under the RDRG system, the receiving hospital would be compensated with higher weights for transfers involving cases with higher severity levels.

Several other factors distinguish our approach from others reported in the literature. We deal with both transfers in and transfers out, whereas most of the attempts to quantify the costs of transferred patients in the literature focus only on transfer outs, using hospital abstract data. Another difference stemmed from the fact that the Manitoba general hospital abstract dataset contains long-term cases and non-acute care portions of acute stays, whereas the HMRI and American Medicare datasets on which the costing of death and transfer cases were performed contain only acute stays. In consequence, MCHPE's approach had to differentiate transfers between acute institutions from other transfers, and deaths in acute portions of stays had to be handled differently than deaths in non-acute portions of stays. Transfers involving extended treatment facilities, personal care homes, specialty institutions, nursing stations and out-of-province hospitals were excluded from consideration.

There are many potential reasons for cases to be transferred between acute hospitals in the Canadian context. Some of the main ones are as follows:

- rural and isolated hospitals that do not perform surgery will transfer all candidates for surgery;
- hospitals that do not perform a particular type of surgery will transfer patients on this account;
- hospitals that do not treat a particular type of non-surgical case will transfer patients on this account;

- patients who require non-elective hospitalization while travelling may wish to be transferred to their local hospital or to the care of their local physician;
- patients may want to convalesce closer to home; and
- patients whose case is too severe for the antecedent hospital or whose risk is high may be transferred to a higher order facility.

There is little reason to suppose that any of the first four types of transfers would significantly affect the lengths of stay or the per diem costs in the receiving hospital.

Perhaps, there might be some saving because some of the work-up on these cases would have been performed by the antecedent hospital. But the impact of this would likely be small. As to the antecedent hospital, it seems likely that its lengths of stay would be below average since the transfer artificially truncates these cases.[84]

The latter two types of transfers on the foregoing list might occasion abnormal costs in the receiving hospital. In the former case, the per diem cost and the length of stay might be below the average for the RDRGs involved. In the latter, the per diem and the average lengths of stay might be comparatively higher because of adverse selection, albeit it is suggested above that RDRGs would likely moderate the magnitude of the error that this might engender in CMG or DRG-based approaches. Of course, the hospital abstract form provides no way of identifying the underlying reasons for the transfers; consequently all six types of transfers in and transfers out are classed together.[85]

[84] Bear in mind that the RDRG of the referring hospital will often be different than that of the receiving hospital, especially when surgeries are performed in the recipient hospital.

[85] An experimental analysis, performed on the Maryland cost data, that classified each type of transfer as a transfer up or transfer down did not yield better information than this simpler approach described above. A transfer up was a movement from a lower order to a higher order hospital.

We used the same approach to develop adjustment factors for death and transfer cases. First, the costs of deaths were compared to the costs of non-deaths with the same RDRG mix. The costs of transfers in and out were compared with the costs of non-transfers with the identical RDRG mix. Then costs were examined by case length of stay intervals to determine how per diem costs for cases which ended in death varied over the duration of the stay. Originally we disaggregated the data into the five clinical classes used throughout the study: medical obstetrics, surgical obstetrics, surgical, medical and other. However, the distinction was dropped for the final costings of deaths and transfers presented here because the added level of analysis contributed little information.

The Maryland dataset was our only available source of information on the costs of transfers and deaths by RDRG. Additional analyses should be performed in the future on other datasets to determine whether any of the observed patterns of transfer costs in Maryland might be affected by unique features of the state's delivery system.

The following formula describes how the case mix factor was held constant in the analyses of length of stay differences between transfer and death cases, and typical cases. The formula, presented below for purposes of illustration in terms of the transfers, deals only with the calculation of WTALOS, the average length of stay with case mix held constant.

An analogous formula also applies for calculating the case mix constant non-transferred case costs. The formula holds case mix constant for the non-transfer ALOS comparison by multiplying each RDRG ALOS by the proportion of its cases in the dataset of transferred cases. The formula for calculating the weighted ALOS for transfers in Manitoba can be expressed:[86]

[86] An example of a class of transfer is from a rural to an urban community hospital.

$$\text{WTALOS} = \frac{\Sigma(N_i * \text{NTR\_ALOS}_i)}{\Sigma N_i}$$

or, equivalently, it can be expressed as $\Sigma\alpha_i * \text{NTR\_ALOS}_i$

where

$\alpha_i = \frac{N_i}{\Sigma N_i}$ = proportion of Manitoba acute transfers in RDRG_i;

N_i = Number of transfer cases in RDRG_i

NTR_ALOS_i - the average length of stay for non-transfer patients RDRGi.

WTALOS – the overall ALOS for non-transfer cases weighted as if the mix of non-transferred cases by RDRG were identical to the mix for transfers. This enables us to compare overall transferred and non-transferred ALOSes with the effect of their differences in mixes neutralized.

Deaths Results

The Maryland data on deaths are as follows:

Table 3

	Cases Ending in Death			**Non-Death (Mix Constant)**		**Relative Indices****	
Hosp	**# Deaths**	**Daily Charge**	**ALOS**	**Daily Charge**	**ALOS**	**Daily Charge**	**I-ALOS**
Rural	1257	$967	14.17	$861	11.86	112.3	119.5
Urban	792	1236	17.76	1056	15.86	117.0	112.0
Large Teaching	7660	1411	17.16	1167	14.51	120.8	118.2
All*	9839	1381	16.90	1156	14.30	119.5	118.1

* Includes small teaching hospitals not included above.

** These indices are calculated by dividing the value for cases ending in death by the value for other cases and multiplying by 100

The ranking of average charges per day by major hospital class is intuitively reasonable: indices range from 112.3 for rural hospitals to 117.0 for urban community hospitals to 120.8 for larger teaching hospitals.[87] The death lengths of stay are clearly longer than the average for non-deaths with the same RDRG case mix, with teaching hospitals and rural hospitals having essentially same death-non-death indices (118.2 vs 119.5) — albeit the absolute rural ALOS for deaths is lower. The urban community hospitals had a lower ALOS index (112.0), despite having an absolute ALOS for deaths marginally higher (17.76) than that of teaching hospitals (17.16).

In general, one would expect that the average charges per day would begin to exceed marginal charges per day at some point as lengths of stay increase. When the Maryland charge data on deaths were examined by length of stay interval to see how charges per day varied over entire stays, the data, unexpectedly, showed that the charges per day ($1,362) were essentially independent of the length of acute stay prior to death.[88] The only exceptions to the pattern of constant average daily charges were at the extremities, which contained very few cases: the 1-2 day range for surgeries ($7,663), where charges were much higher, and the 150+ interval ($1,151), where the charges were somewhat lower.[89]

This anomalous behaviour extends also to the aggregate of non-death RDRGs with case mix held identical to that of deaths. Average charges per day were essentially constant through the ranges in which most of the cases are found. Once again, the big exception was the 1-2 day range ($3,547). Non-death cases in each of the ten RDRGs with the highest proportions of deaths, considered individually, also display the same kind of pattern as the whole.

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[87] Maryland's small teaching hospitals were eliminated from the discussion because there are none in Manitoba and they are of scant quantitative importance in the Maryland dataset.
[88] This average excludes the 1-2 day cases. The overall average including these cases was $1,381, as shown in Table 3.
[89] Cases with stays of 3-5 days duration did not seem to have a very expensive pre death component, as one might have expected from the high daily costs of 1-2 day death cases.

One implication for the methodology is that no length-of-stay adjustments are required in the death percentage add-ons for the small differences in death lengths of stay between Manitoba and Maryland inasmuch as the per diem impact of death on costs is essentially constant over the stay. Similarly, no adjustment is needed to reflect differences in the lengths of stay in various classes of hospitals in the above table.

Another implication is that a constant percentage add-on will be applied to eligible days of stays longer than two days which end in death. The average daily yield from this add-on will be different for inlier, outlier and non-acute days within an RDRG. This means, for example, that a case that stays as long as the average length of stay for the RDRG will receive the percentage add-on multiplied by the typical case weight for the RDRG. In essence, this amounts to the average weight per day, multiplied by the percentage add-on and the number of days. A case that stays beyond the trim would receive, in addition, the percentage add-on multiplied by the typical marginal cost weight for the RDRG for each day after ALOS.[90]

[90] The generic marginal cost formula (**Acute Care Marginal Cost Adjustment, Appendix B**) was not sensitive enough (nor was it intended to be) to take into account that the marginal costs of non-death cases in the ten RDRGs with the most deaths behave idiosyncratically (inasmuch as the daily marginal cost essentially equals the average cost). Hence the constant percentage add-on will slightly underestimate the costs of death days beyond the trim that are eligible for the add-on because the underlying non-death costs in these RDRGs are also underestimated (i.e., the daily marginal costs, set by a formula common to each class of case, is too low for the "death" RDRGs). The error factor for most of the cases would be about 13 percent of the marginal cost per diem for days beyond the trim because the average α for all classes is about 0.87. Given the small numbers of days and RDRGs involved, the error is small.

The Manitoba data for deaths by type of hospital are as follows:

Table 4

Hosp	Outliers Excluded				Outliers Included			
	# Deaths	ALOS	Non-Death Wt ALOS	Index ALOS	Deaths	ALOS	Non-Death Wt ALOS	Index ALOS
Rural-Other	460	12.10	8.92	135.7	755	46.41	13.38	346.9
Rural-Major	343	13.20	8.77	150.5	523	43.35	14.19	305.5
Rural-All	803	12.57	8.86	141.9	1278	45.16	13.71	329.4
Urban Community	1040	14.92	13.79	108.2	2833	49.22	23.92	205.8
Teaching	963	14.80	16.28	90.9	1320	44.97	25.83	174.1
All	2806	14.21	13.52	105.1	4111	47.96	20.89	229.6

Manitoba lengths of stay for deaths are consistently much longer than those for non-death cases — holding case mix constant — when outliers remain in the analysis, as shown in the right-hand side of the above table (Table 4). However, the evidence is mixed when only inliers are considered. The length of stay differences for death cases in Maryland and Manitoba narrow and become very similar when Manitoba inlier deaths are compared to all Maryland deaths.

Frequency distributions provided additional information on differences in death lengths of stay in the two jurisdictions. In Maryland, 91.8% of deaths (excluding early medical deaths) occur within 40 days. By contrast, the Manitoba percentage for deaths within 40 days is 73.9, which decomposes into proportions of 80.6% for cases without non-acute days and 42.8% for cases with at least one long-term care day. In Manitoba, a total of 26.7% of the non-acute death cases had lengths of stay over 150 days compared with only 3.0% of the acute death cases. Only 0.3% of Maryland cases had stays of more than 150 days.

It was clear from earlier analyses that the Maryland dataset contains only acute care cases, whereas the Manitoba dataset contains acute cases, non-acute cases and cases with phases of both. Thus, it would be illogical to expect that the costs of Manitoba deaths in long-term cases would mirror the results presented above for Maryland. Indeed, it would be hard, intuitively, to justify any percentage add-on for death days classified as long-term in good coder hospitals. If a long-term patient in a good coder hospital received extraordinary and expensive acute care before death, then one would expect that the coding would indicate that the patient was shifted to acute care prior to death. It would be logical to provide the percentage add-on to the unbroken string of acute days before death, but not to any other prior days.

Given the absence of the information necessary to differentiate between long-term and acute days in poor coders, we had to devise a formula approach to deal with the problem of long-term days.

The calculation of the death cases was undertaken based on the following specifications which flow from the foregoing analysis:

- A maximum of 40 (last 40 days prior to death) was set as the number of days eligible to receive the add-on. This cutoff, if it were applied in Maryland, would have affected only 8.8% of Maryland death cases because 91.2% of deaths in this acute care dataset occur within 40 days. The proportion of Maryland death days affected by such a maximum would be even lower, given that 40 days in the 8.8% of cases so affected would receive the add-on.[91]

- Only in-year days received the add-on (however the 40 day count began from the date of death even if death occurred in 1992/93.)

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[91] Coincidentally, HMRI's analysis of death costs found that the duration of cost effects was about 40 days. Its decay function, based on DRGs, decreased with length of stay. HMRI (1991) op. cit. 17.

- Cases with non-acute days did not receive an add-on if death occurred. An adjustment was made to "poor coding" hospitals to ensure they were not attributed extra weights. Again a simplification was employed rather than the ideal of crediting acute days of non-acute cases if they occurred within 40 days of death. Analysis showed that the simplification would have scant quantitative effect on hospitals' weighted cases.

- For outlier death cases, the weight equals the relative case weight (RCW) for typicals multiplied by the percentage add-on, plus marginal per diem weight for the RDRG multiplied by the percent add-on times the number of days beyond the ALOS, subject to the foregoing conditions and maximums.

- For cases with deaths in the notch, one can safely assume that the patient should have been in hospital in the notch; the extension of the stay beyond the all-hospitals ALOS is not indicative of bad case management when death occurs. It follows that for cases where death occurs in the notch, the weight should equal the core RCW for typicals multiplied by the percentage add-on, plus marginal per diem weight for the RDRG multiplied by the percent add-on times the number of days beyond the average length of stay, subject to the foregoing conditions and maximums. Consequently, the costing of notch and outlier death cases is identical.

- For cases staying less than the average length of stay but more than 2 days, the hospital should receive no premium in weight for patients that die before the ALOS, as they do for other patients. Obviously, having a patient die before the ALOS should not be construed as an efficiency. Thus we deducted the marginal cost per diem for each day between the date of death and the ALOS for the RDRG and added the percentage per diem to the remaining costs for the case.[92]

- For surgical, obstetrics and "other" cases in which the patient died before 3 days, a percentage add-on of 100% was added to the weight obtained by dividing the typical case

[92] We have adopted this kind of oversimplification elsewhere for expediency.

weight by the average length of stay for typicals and multiplying by the number of days (i.e. 1 or 2).[93,94]

Transfers Between Acute Institutions

The overall Maryland differences in average charges per day for transfer cases relative to the identical RDRG case mix of non-transfers is not sufficient to warrant a lot of fine-tuning. The discussion in this section will initially relate to averages irrespective of length of stay. Later, information on the pattern of costs over the stay will be provided.

As with death, transfers will be valued based on actual length of stay. The evidence about how transferring affects lengths of stay differs in Manitoba and Maryland, thus compounding the advantage of this approach.[95]

Table 5

Maryland Hosp	**Transfers In**		**Transfers Out**	
	ALOS Index*	**Daily Charge Index***	**ALOS Index***	**Daily Charge Index***
All	137.2	86.3	116.6	100.9
Large Teaching	138.1	85.4	117.9	101.7
Rural	129.6	93.7	111.8	92.1
Urban Community	142.3	88.8	128.7	91.4

* Again the index is the ratio of transfers to non-transfers multiplied by 100.

93 This is an approximation obtained by dividing the average costs per day for 1-2 day deaths by the costs of non deaths.

94 Medical deaths with 2 days are classed in the 8000 series of RDRGs.

95 The approach means that transfer length of stay differences will not effect overall efficiency calculations.

In Maryland hospitals above, the lengths of stay for **transfers in** are 29.6-42.3% longer than those of non-transfers with a constant RDRG mix. For transfers out, the stays are 11.8-28.7% longer.

Table 6
Outliers Excluded

Manitoba	Transfers In			Transfers Out		
	ALOS	Wt ALOS Non-transfers	ALOS Index	ALOS	Wt ALOS Non-transfers	ALOS Index
All	12.32	13.83	89.1	7.07	8.83	80.2
Transfers down	15.64	13.00	120.3	11.33	12.01	94.3
Transfers up	11.84	12.53	94.5	4.92	6.86	71.7

Table 7
Outliers Included

Manitoba	Transfers In			Transfers Out		
	ALOS	Wt ALOS Non-transfers	ALOS Index	ALOS	Wt ALOS Non-transfers	ALOS Index
All	40.61	50.79	60.0	13.64	13.61	103.3
Transfers down	66.76	53.23	125.4	18.29	17.96	101.8
Transfers up	22.88	39.84	57.4	10.69	10.26	104.2

In Manitoba, the lengths of stay for **non-outlier transfers in** are 10.9% **shorter** than non-transfers.[96] But for small rural hospitals, they are much longer. For transfers down, they are 20.3% **longer** and for transfers up, the more common type, they are 5.5% **shorter**. **Non-outlier transfers out** had overall lengths of stay 19.8% **shorter**, with transfer-down stays 5.7% **shorter**, and transfer-up stays 28.3% **shorter**. Hence, in Manitoba, the length of stay effect of transfers is generally opposite to that in Maryland.

[96] Case mix was held constant in all of the comparisons.

The inclusion of outliers increased the index length of stay differences between transferred-up and transferred-down cases but affected the index of transferred down cases very little. With outliers included for transfers in, transfer ups are 42.6% **shorter** than non-transfers, RDRG mix constant. However, the outlier transfer outs are all **longer** than non-transfers, but only marginally.

The Maryland daily charge indices appear above in Table 5. The per diem indices for transfers in are very similar for the three types of Maryland hospitals, ranging from 85.4 to 93.7. Given that the spread is so small between the two classes with the majority of Manitoba transfers in — teaching hospitals and urban community hospitals — we decided to simplify the transfer adjustment by undertaking no differentiation by hospital type. However, the analysis of costs of transferred cases of different duration showed that a single multiplier would be insufficient. The per diem costs of short stays are higher than those of non-transfers: 18.2% higher for stays of 1-2 days and 3.5% higher for 3-5 day stays.[97] Conversely, the per diems for stays over 5 days were only .892 times those of the non-transfers. Hence the multipliers of 1.182, 1.035 and .892 respectively were applied to the typical per diems of the RDRGs involved.

Similarly, for transfer outs, no differentiation by type of hospital was required but different multipliers were applied to cases of different duration.[98] The multipliers were .957 for 1-2 day cases, .981 for 3-5 day cases and 1.036 for longer cases.

As with death cases a maximum was applied. Maximums were counted to 44 days from the date of admission for transfer ins, and 44 days counted backwards from the date of transfer

[97] Case mix was held constant in these comparisons.
[98] Again the differences in per diem indices were especially small for the two types of hospitals most likely to transfer out, rural hospitals and urban community hospitals.

for the transfer outs. As with deaths, there was no add-on for non-acute cases. An estimation technique analogous to that for deaths was employed to adjust the "poor coding" hospitals.

APPENDIX F: SEPARATED AND CENSUS DAYS

The presence of numerous long stay cases in the Manitoba dataset creates the need for a correction to deal with incongruities between separated patient days and census patient days. Without this correction, large errors would occur in the costs per weighted case of some hospitals, especially smaller rural hospitals.

A hospital's total separated patient days in 1991/92 are the days between the dates of admission and discharge for all patients that separated in 1991/92. Its 1991/92 census patient days are the head counts of inpatients present in the hospital at daily midnight census-taking during 1991/92.[99] The latter are the patient days of all patients who stayed in the hospital in 1991/92 regardless of whether separation occurred in 1991/92.

The distinction between the two different patient day counts can be vital, depending on the properties of the dataset, because separated patient days are the ones on which the case weights representing expected costs are based in conventional case mix costing analyses, whereas census or 1991/92 (in-year days) days are driving actual hospital costs. A large discrepancy between the two will cause a hospital's cost per weighted case to be inaccurate and volatile from year to year.

The following table illustrates the concepts. In the illustration, the number of inpatients cared for by the hospital in 1991/92 is represented by the sum of w + y + x + z. The in-year days of these inpatients — the days that drove 1991/92 costs — are represented by the sum:

[99] Separated patient days are obtained in this study from hospital abstract forms. They also are reported on HS-1 reports. Census patient days are reported on HS-1s only.

Census Patient Days $= \Sigma^{w}PD^{91}_{i} + (x \bullet 365) + \Sigma^{y}PD^{91}_{i} + \Sigma^{z}PD^{91}_{i}$ (see Table 8 for full explanation).[100] On the other hand, the patients used to create inpatient weights in orthodox case mix costing analyses are represented by the sum of w + y and their patient days are represented by (Separated Days $= \Sigma^{w}PD^{90}_{i} + \Sigma^{w}PD^{91}_{i} + \Sigma^{y}PD^{91}_{i}$). The numbers and the mix of separated and census patients and their patient days are obviously different.

The magnitude of the resulting error depends generally on the lengths of stay of the patients and the size of the overall turnover in cases relative to the stock of patients remaining in hospital at the end of the year. If the turnover is very high relative to the stock, then the patients common to both counts (w + y) will be large relative to the remaining patients (x + z). The difference between census and separated patient days will generally be small.[101] Inconsistencies will, therefore, not generally cause large errors in the case costs of American hospitals, which have very short ALOS and few patients with long stays.

Conversely, if unremedied, the problem could cause major errors in hospital costs per weighted case in the Manitoba dataset given the numbers of small hospitals and the relatively large proportion of long stay patients. If the problem were not addressed, great instability in small hospital results would be inevitable. For example, the case weights of a small hospital could be grossly understated in a year in which a high proportion of its in-year days were generated by long-term inpatients who had not separated by the year end. Its costs per weighted case would be artificially inflated because only a fraction of the actual days of care would receive weights in this year. If these patients separated the next year and other things remained constant, the hospital's costs per weighted case would be low in this subsequent year because the weights in the denominator would reflect care provided in the previous year. A review of the Manitoba hospital dataset revealed many serious incongruities between the separated and in-year days in small hospitals, some exceeding 40%. Moreover, the

[100] The superscript 91 refers to the 1991 fiscal year or, in other words, 1991/92.
[101] The incongruity could still be large if some if the separating patients had very long stays prior to 1991/92.

discrepancies in some urban hospitals, which generally were less than 3.5% but ranged as high as 7.5%, were large enough to warrant remedial action in themselves.

Although the potential error in larger hospitals is generally smaller, they are large enough under normal circumstances to warrant correction. Moreover, it is conceivable that the problem could cause large errors in the case costs of major hospitals under exceptional circumstances. An example of this arose in 1992/93 when a Health Reform initiative enabled St. Boniface and the Health Sciences Centre to discharge most of their ALC patients, thus inflating their numbers of weighted cases for the year. This would artificially drive down costs per weighted case in absence of a correction.

The Ontario funding methodology has been making a crude adjustment for differences between census and separated patient days in recent years, departing from the HMRI methodology in doing so. Ontario debits or credits the discrepancy at the rate of the per diem weight of the average typical separation in the Ontario dataset. This correction is applied after another which caps the patient days associated with any separation at 365 to eliminate days that are obviously from prior years.[102]

[102] HMRI provided this information in the differences between the HMRI and Ontario Ministry of Health approaches.

Table 8

STOCKS AND FLOWS OF PATIENTS

	N	Separated Days 1990/91 Portion	Separated Days 1991/92 Portion	Separated Cases 1991/92 Cases	1991/92 Census Patient Days
In hospital at beginning of fiscal year					
Discharged in 1991/92	w	$\Sigma^{w}PD^{90}_{i}$ $i = 1$	$\Sigma^{w}PD^{91}_{i}$ $i = 1$	w	$\Sigma^{w}PD^{91}_{i}$ $i = 1$
Not discharged in 1991/92[103]	x	0	0	0	$x \bullet 365$
Admitted During Year					
Discharged in 1991/92	y	0	$\Sigma^{y}PD^{91}$ $i = 1$	y	$\Sigma^{y}PD^{91}_{i}$ $i = 1$
Not discharged in 1991/92	z	0	0	0	$\Sigma^{z}PD^{91}_{i}$ $i = 1$

In hospital at beginning: $w + x$

In hospital at end: $x + z$

Census Patient Days = $\Sigma^{w}PD^{91}_{i} + (x \bullet 365) + \Sigma^{y}PD^{91}_{i} + \Sigma^{z}PD^{91}_{i}$

Separated Days = $\Sigma^{w}PD^{90}_{i} + \Sigma^{w}PD^{91}_{i} + \Sigma^{y}PD^{91}_{i}$

Separated Cases = $w + y$

Patients Seen (driving costs) = $w + y + x + z$

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[103] These patients will have days in 1990/91 that will eventually be included in their separated days.

The ideal approach to employing available data to calculate the in year weights is delineated below. To simplify the complexity programming requirements the ideal approach was modified in the fashion indicated below.

Steps to Obtain and Weight the Separated Patient Days that Drove Costs in 1991/92

1. Combine the files for inpatient cases that separated in 1991/92 and 1992/93.

2. Eliminate the cases that were admitted in 1992/93 and discharged in 1992/93.

3. At the individual hospital level, calculate the total separated adult, child and new born patient days driving 1991/92 costs.

   a) Tabulate only the 1991/92 days of patients separated in 1991/92 who were admitted prior to 1991/92.

   b) Tabulate all of the patient days of cases both admitted and separated in 1991/92.

   c) Tabulate only the 1991/92 days of patients who separated in 1992/93 but were admitted prior to April 1, 1992.

   d) Sum the 1991/92 separated days by hospital [(a) + (b) + (c)].

   e) Compare with the HS-1 adult, child and newborn census patient days for each hospital.

   f) The difference between the census patient day counts and the count in 3(d) (assuming no errors in hospital record keeping) is the patient days of patients who spent time in hospital in 1991/92 but still had not separated by the end of

1992/93. One would expect that the number of cases would be very small although the 1991/92 days per unseparated case might be high.

g) Calculate the total cases that spent some days in hospital in 1991/92 including those not discharged during the year. This should equal the HS-1 separated cases in 1991/92 plus the number of in patients seen in the hospital as of the end of the year.

4. Weights.

a) The 1991/92 portions of stays captured in 3(a) will generally exclude the more expensive early stages of the stay when the so-called "fixed" charges are incurred and some of the per diem variable costs are higher. In the following analyses, we consistently simplify the concept of fixed front-end charges to include only operating room charges (OR). This simplification expedites programming while introducing an infinitesimal error.

i) For cases discharged before the ALOS of the RDRG, a hospital would receive a full inlier case weight even though the stay was relatively short. When two fiscal years are involved, the best approach would be to subtract the relative fixed cost weight, because OR costs would be incurred prior to 1991/92, and then prorate the remainder to the two years in proportion to the distribution of days between the two years. This reflects the fact that the marginal cost weight would underestimate the weight of cases that stay less than the ALOS.

ii) For cases lasting longer than the RDRG ALOS but within the trim point, credit MC for 1991/92 days up to the ALOS for the RDRG. Provide no credit for days in 1991/92 after the ALOS threshold.

Hospitals would not receive credit for these days for a stay that falls fully in one year and ends in the notch. Thus the approach here is parallel.

iii) For outlier cases extending beyond the trim, credit MC times the number of days in 1991/92 beyond the RDRG ALOS. Some of the inlier weight might also be credited to 1991/92 if days before the ALOS for the RDRG were also recorded in 1991/92. In practice, the approach was simplified to attach the marginal cost weight to eligible in-year days prior to the ALOS. Thus the MC is applied to all in-year days, both before and after the RDRG ALOS.

b) The cases in 3(b) should be weighted in accordance with conventional approaches.

c) There are different calculations for the cases in 3(c) but basically all receive the fixed costs if they were admitted in 1991/92.

i) For cases admitted prior to 1991/92 the methodology is the same in the first sentence of 4(a)(iii) above. No fixed costs would be credited to 1991/92.

ii) For cases admitted in 1991/92 which stayed less than the ALOS for the RDRG, credit weights for the fixed portion to 1991/92 and apportion the remainder of the full case weights to the two years based on the proportion of days in each.

iii) For cases admitted in 1991/92 which stayed more than the RDRG ALOS but less than the trim, credit weights for the fixed costs to 1991/92 and prorate the remainder based on the 1991/92 and 1992/93 proportions of days up to and including the ALOS.

If the case spends at least the period up to the ALOS in 1991/92, the full credit applies to 1991/92.

iv) For outliers cases admitted in 1991/92 which stay beyond the trim point, marginal cost pricing will be imputed to the two years for stays beyond the RDRG ALOS in relation to the days spent in each. The inlier weight would be imputed in accordance with the proportion of days up to ALOS spent in each year with all of the fixed costs being imputed to 1991/92 and marginal costs only would be imputed to 1992/93 inlier days.

d) Patients Remaining After 1992/93

i) Inconsistencies between HS-1 census patient days and hospital abstract in-year days complicated the quantification of weights for these patients. Generally, the differences were not huge in absolute terms.

The ones that were examined in detail led to the conclusion, all things being constant, that hospital abstract data is generally more reliable.

ii) The violation of the foregoing assumption occurs when patients remain in hospital and do not separate in 1991/92 or 1992/93. When this happens, one expects the HS-1 patient days count to be higher than the hospital abstract in-year days. If both were properly reported, the former would always be higher.

iii) The timing of this project facilitated the expansion of information on the numbers of patients, their case mix and numbers of in-year days unaccounted for in 1991/92 separations data by enabling a search of the entirety of 1992/93 separations for patients who were in hospital during 1991/92. In future runs of the methodology, time constraints may preclude the scanning of the entire 12 months of a subsequent year. Thus more days would probably be subjected to a "formula" approach in the future applications.[104]

iv) Four pieces of information are available from which to diagnose and derive adjustments for non-separated patients:

- The HS-1 number of patients in hospital at the end of 1991/92.

[104] The decay function identified for 1991/92 can be employed in any new formula. That is to say, the rate at which patients from the prior year are separated in each month of the following year can be inferred from 1992/93 discharges with patient days in 1991/92.

Hospitals can calculate this number by subtraction but it is directly observable as well, being the census count at 11:59 p.m. on March 31. Thus verification is possible, but whether it occurs is doubtful.

- The summation of HS-1 daily patient day counts at census in 1991/92.

- The numbers of patients who separated in 1992/93. Calculation of the in-year days of these patients is straightforward.

- The number of in-year days for patients who separated in 1991/92.

All of the data are subject to possible hospital reporting errors, including lost hospital abstracts. The latter two numbers are also subject to possible programming errors in the application of the methodology.

The HS-1 census patient day data, and the numbers of separations (and, relatedly, the numbers of patients remaining in hospital HS-1 at year-end) are reported independently. If a hospital's census patient days are reported incorrectly, this does not imply that the numbers of separations and patients remaining are wrong, and vice versa.

v) If the patients remaining after 1992/93 > 0 and HS-1 census days < hospital abstract in-year days, then, by inference, there is an error in the reported data. Given that the hospital abstract days warrant greater credibility, assume generally that the census day counts are wrong. If so, then the need to estimate the days associated with remaining patients creates another source of error. It is also possible that the HS-1 count of patients remaining is wrong and the other data are correct. Of course, it is possible that the error involves more than one of the variables. Thus there is no sound basis for making adjustments under these circumstances. Hence none were made.

vi) If the patients remaining after 1992/93 = 0 and HS-1 census days > hospital abstract in-year days, according to hospital reported data, then the data are inconsistent. Based on a few examples that were examined in depth, it is most probable that the abstract data are correct and the census days data are wrong, although it is also possible that the number remaining is wrong and that the HS-1 census days are correct. Given the uncertainty, no adjustment in the days were undertaken in the study.

vii) If, according to reported data, the patients remaining after 1992/93 > 0 and HS-1 census days > hospital abstract in-year days, consistent indicators imply that an adjustment is required to patient days for patients remaining in hospital. The grounds are sufficient for making adjustments in this case; there is no reason to believe that any of the data are in error. Moreover, HS-1 data for most hospitals is reasonably reliable.

Given that the indicators point to the same conclusion, it is reasonable to make an adjustment in this case. Under the circumstances, the proper approach was to impute days equal to HS-1 census patient days — hospital abstract in-year days. However, to ensure that there are no errors in the patient day counts, this study put a cap on (HS-1 census days — hospital abstract in-service days)/patients remaining at the end of 1992/93.

The objective of these interventions is to achieve maximum improvement on the solution that would have been reached without an adjustment. Obviously a formula approach would not make the correct adjustment for every individual hospital unless the reported data is accurate.

APPENDIX G: HOSPITAL INPATIENT/OUTPATIENT ALLOCATION METHODOLOGY AND ADJUSTMENTS

The purpose of the allocation methodology was to isolate the costs of inpatient activities by excluding the direct costs of non-patient care and outpatient activities as well as the associated overhead costs of each. Data adjustments, undertaken in concert with this exercise, corrected hospital reporting errors or inconsistencies and improved the interhospital comparability of the resultant inpatient costs.

MCHPE mailed the description of this allocation methodology and the results of its application to all Manitoba hospitals, which were given the opportunity to request clarification and to criticize the results. MCHPE generally accepted hospitals' suggested for revisions. Most involved correcting for individual hospital idiosyncrasies or minor problems in the application of the general allocation methodology to costing of specific hospitals.

The allocation methodology employed in this study generally is very similar to one developed by Ron Wall for MCHPE.[105] The Wallian methodology is a simple approach based mainly on HS-1[106] data and generally using paid hours in the direct patient care areas as the ultimate allocation base. The approach has yielded results very close to those of MCHPE's more refined HCAM methodology in tests involving urban community hospitals, and St Boniface General Hospital's version of the Barer-Evans methodology.[107]

[105] Wall (1993) op. cit.
[106] Hospital Statistics Part I, filed annually by every Canadian Hospital to Statistics Canada.
[107] Ibid, 27-29

Several adjustments to HS-1 reported costs were undertaken in this study to deal with hospital reporting problems. First the data were subjected to tests for internal consistency. Obvious reporting errors were corrected. Next some of the inconsistencies in urban hospital's classification of costs were eliminated.

Laboratory and Imaging Services (LIS) - rural hospitals

The laboratory and imaging expenditure data reported by most rural hospitals on HS-1 forms do not reflect actual costs for several reasons. The purchased service contracts, as reported on the HS-1 forms, are based on historical (rather than current actual) data and referred-out work to other hospitals, Westman Laboratory, Red Cross and the Cadham Laboratory is not captured. The substitution of Laboratory and Imaging Service's (LIS) costs for the HS-1 reported costs and the addition of Westman Laboratory costs partially addressed this problem.

LIS, through the Rural Diagnostic Units, provides several levels of service. There are two main types of services provided. The first type involves 48 acute care hospitals which receive direct services from LIS including staffing, administration, in-service and supplies. Within this group, there are two hospitals which do not have full time LIS staff on site but are serviced from larger centres. Fifteen hospitals provide their own technologists but LIS is responsible for the administration, supplies and in-service. Three other facilities hire their own staff, purchase supplies but use LIS for administrative and support functions.[108]

The primary source of LIS cost data was 1992/93 fiscal year expenditures on salaries and operating costs. Estimates for 1991/92 were calculated using the CPI index. Hospital

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[108] Diagnostic Service in Rural Manitoba Background Information for Rural Health Reform. Laboratory and Imaging Services Branch, March 1993.

specific operating expenses, FTEs (full time equivalents) and units of work performed at each facility were available but salaries were only available on a regional basis. The ratio of a hospital's FTEs to the total for the region was used to estimate the proportion of salary expenditure for each hospital [eg. 2 FTEs/16FTEs * regional salaries]= salary bill for hospital A where the region has 16 FTEs and hospital A has 2 FTEs. When hospitals provided some of their own staff or supplies, this information was obtained from the HS-1 forms and added to the LIS data.

Westman Laboratory costs for each hospital were quantified using statistics and costs estimated by Westman Laboratory for the month of December 1992. These costs were then multiplied by 12 months to establish yearly costs. The costs were totalled and inpatient and outpatient statistics were used to apportion costs to inpatient and outpatient units.

Therapy Costs

Adjustments also were undertaken to quantify and include the costs of therapy services provided by outside agencies to inpatients and not included in the budgets of the some rural hospitals. Though rendered to inpatients, the costs of these services were contained in the budgets of provincial provider agencies servicing the smaller rural centres. The adjustments removed a comparability problem with urban hospitals and other rural hospitals that report in their HS-1 expenditure data the costs of therapy services received by their patients. Hospital staff provides the therapy services in these hospitals.

Observation Unit days

Some urban hospitals employ observation units of emergency departments as extensions of their inpatient departments when patients require admission but no inpatient beds are unoccupied. The patients often are admitted as inpatients while still in the observation unit. This results in a distortion of true inpatient and outpatient costs. To correct this problem, we estimated the costs of patients' stays in observation units after admission, deducted them from hospitals' total outpatient costs and shifted the costs to inpatient numerators.

Outpatient Nursing Costs

The final major adjustment was the imputing of outpatient nursing costs in smaller hospitals that report outpatient and inpatient nursing costs in one combined cost centre. The quantification employed the estimated paid hours per visit, generated using the data of rural hospitals with viable cost breakdowns, an estimate of rural nursing department wages per paid hour, and the number of visits reported.

The steps of the allocation summarized above are documented in more detail below. Only the mock ups of the final outputs of the allocations are shown; the spreadsheets that were used for the intermediate steps are not reproduced here. Note that italicized sections contain adjustments involving subsets of hospitals. Non-italicized sections apply to all hospitals.

Step 1 - We arranged paid hours and cost data in a standardized format (Allocation Report 1 not included here) and ensured that calculated subtotals by hospital for cost Classes A, B, C, and E agreed with the corresponding reported subtotals. Class A costs are nursing administration, inpatient nursing wards, surgical suite, obstetrical suite and other inpatient nursing costs on HS-1 09; Class B costs are outpatient nursing costs on HS-1 10, diagnostic and therapeutic costs on HS-1 10; Class C costs are administrative and supportive costs on HS-1 11; and Class E costs are medical remuneration, education programs, special research, interest and depreciation and benefits and payroll levy on medical remuneration. (See Table 10).

Urban Hospitals Only Adjustment

An adjustment was made for the benefits payments to salaried physicians, and interns-residents-other students (trainees). Paid hours are not shown on HS-1 for these individuals; consequently, they would not receive an allocation from the paid-hours based general formula in Step 4 in absence of the adjustment.

*For the community hospitals, the overall benefit rate for the hospital was applied to the medical **salaries** in HS-1 016-103*[109] *to calculate the estimated amount of benefits to be excluded. These salaries were added to the denominator for the calculation of the hospital benefit rate. For community hospitals that have a nursing or other program, a benefits amount of 7.0% was imputed to students' salaries on HS-1 (if any).*[110] *For the teaching hospitals, the hospital-provided actual salaried physician and trainee benefit amounts were deducted from total reported benefits (12-075). In the teaching hospitals, there was no simple relationship between medical salaries and benefits — some physicians did not receive benefits even though they were salaried, according to HS-1s.*

The payroll levy is rolled up on HS-1 in the last two blank lines of the administrative and supportive section of HS-1 in many hospitals (11-225 and 11-235), the supplies and other expenses column of hospital administration in others (11-085) and in the benefits cell of Misericordia Hospital (12-075). In the absence of adjustments, these roll up differences would create inconsistencies in the final allocation only in respect of the teaching medical remuneration and payments to trainees. These salary remuneration costs would not be imputed any payroll levy costs under the paid-hours based general methodology in Step 4, except in hospitals that roll the costs of the levy into benefits. The hospitals with the levy

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[109] HS-1 016-103 refers to page 16, cell 103. This notation is used throughout this section.

[110] No community hospital showed salaries for nursing program trainees in 1991/92. The salaries of other trainees at the community hospitals were ignored in the benefits payroll levy calculations, based on the situation at Seven Oaks, the only community hospital interviewed on this subject. The only community hospital with trainee salary costs in excess of $10,000 was Misericordia, which had costs of $157,375 in 1991/92.

included in benefits would have a proper allocation even without any adjustments. Manual adjustments were made through benefit calculations in the following paragraph to achieve allocational consistency in spite of the reporting differences.

The following amounts, obtained as described above, will be deducted from benefits to be allocated by paid hours in Step 4. These deducted amounts appear with excluded costs as the excluded benefits and payroll levy costs of medical salaries and salaries of internes-residents-students. Brandon, $22,858; Concordia, $99,501; Grace, $148,002; Health Sciences Centre, $1,971,665; Misericordia, $212,344; St. Boniface, $394,694; Seven Oaks, $162,484 and Victoria, $177,390.

Step 2 - We separated paid hours and costs of departments with inpatient and outpatient indicators into inpatient and outpatient components.[111] An adjustment was made to capture Observation Unit (OU) costs which should be attributed to inpatient costs ie. patients had been admitted to hospital. In order to do this we obtained estimates of inpatient days in OU for each of the facilities and costed them at $307 per day.

Table 9

INPATIENT DAYS IN OBSERVATION UNITS

Hospital	Inpatient Days	Percentage of Total Days
Brandon	0	
Grace	1086	1.0
Misericordia	2578	2.3
Victoria	1878	2.5
Concordia	2905	5.9
Seven Oaks	1132	1.1

[111] The costs and paid hours of direct care departments with indicators were separated commensurately with inpatient and outpatient shares of output. For example, if 65% of radiology units were provided to outpatients, then 65% of radiology paid hours and costs were attributed to outpatients (B(iv)). Thirty-five percent of costs and paid hours were allocated to inpatients (B(ii)).

The per diem of $307 was calculated from the financial data of the one hospital which reported separate OU costs. This $307 is composed of $204 direct costs and $103 for overhead. Surgical suite costs in Class A and specified costs in Class B were split into inpatient and outpatient components using the conventional HS-1 inpatient and outpatient indicators.

Dietetics costs in C were split into dietetics - overhead (cafeteria), dietetics - inpatient and dietetics - outpatient (including meal days supplied to other institutions) using the relevant indicators.

Rural Hospitals Only *(i.e.. all but Brandon and the Winnipeg hospitals).*

Most of the rural hospitals do not show separate costs for the outpatient oriented nursing areas included with diagnostics and therapeutics on page 10 of the HS-1. Some others seem to have reported partial costs only.[112] *It appears that these hospitals may staff an outpatient cost centre for part of the work week only (eg. day shift Monday to Friday). In these cases, costs and numbers of visits are, on the surface, incongruous.*

To estimate non-medical salary and supplies and other expenses costs for these outpatient activities in rural hospitals, we used the following formula to assign costs when the non-medical salary costs produced by the formula were higher than the non-medical salary costs (if any) shown on HS-1. After summing the visits (v) in 08-241, 08-242, 08-375 and 08-335, we then calculated the paid hours, salary and expenses component as follows:[113]

(a) *Paid hours = 1.25*V*

(b) *Non-medical salaries = 19.85 * 1.25*V*

(c) *Supplies and Expenses = 1.56*V*

[112] It appears that some small hospitals cover outpatient activities with staff from a designated outpatient cost centre for a portion of the day or work week only. Outpatient services are apparently provided by staff from inpatient cost centres at other times.

[113] This provides no allocation to surgical day care patients who go to the OR without being counted in an outpatient area. However, they will receive OR costs.

As noted above, the outpatient formula will only be used when the new calculated outpatient non-medical salary cost is greater than the old.[114] Thus, whenever this happens, all previous outpatient paid hours, non-medical salary costs and supplies and expenses in 10-011 to 10-044 are deleted.

The net remainder of the newly generated outpatient paid hours, non-medical salaries and supplies and other expenses is deducted from inpatient costs. In hospitals that do not report any outpatient costs on HS-1, all costs are deducted from inpatient cost centres. The problem is that inpatient hours and costs are not shown consistently in small rural hospitals. Thus the costs were deducted on a contingent basis with the following sequence - 9-04, 9-09 and 9-02 until all were fully deducted. This complication is necessary because rural hospitals are inconsistent in their reporting of short-term days.[115]

All of the new non-medical outpatient paid hours and costs were shown in Bii 10-011, 10-013, 10-014 and 10-015.

Note that some hospitals capture most of the supplies and expenses costs centrally. In some of these cases, there were insufficient supplies and other expenses costs in inpatient nursing areas to deduct the outpatient amounts calculated by the formula. In these instances, the supplies and expenses costs were negative in the nursing areas and were subtracted from nursing salaries when nursing salaries and supplies and expenses were combined in Step 3. This had little effect on allocations because paid hours were the basis for allocations, not salaries.

To check the calculations, we ensured that the subtotals for A, B and C remained unchanged from those in the previous step.

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[114] In effect, we are overriding hospital reported outpatient costs when our calculated costs are higher. We are doing so on the assumption that the hospitals have reported only partial outpatient costs. Hospitals had the opportunity during their reviews to comment on the method. None objected.

[115] The alternative was to combine some short-term bed categories (at the risk of loss of detail for future possible analysis options on the theme).

Step 3 - We combined all "other non-medical salaries" and "supplies and other expenses" costs for performing the allocation. However the original elements were retained to maintain flexibility for MCHPE to allocate separately if desired in the future.[116]

In the ensuring steps, we accumulated allocations iteratively with these original combined salary and supplies costs as the initial base to which new allocations were successively and progressively added.

Rural hospitals only *(i.e. all hospitals but Brandon and the Winnipeg hospitals).*[117]

The laboratory and radiology costs of rural and northern hospitals reported on HS-1 are artifacts not reflective of actual costs. Hence we developed, from Laboratory and Imaging Services (LIS) unit, EFT and cost data, hospital-specific costs to be imputed for these services, as described earlier.

The artificial HS-1 laboratory and radiology charge data for these hospitals were deleted from the spreadsheet. The imputed costs were then inserted into HS-1 10-054. The new inpatient and outpatient units were substituted into 04-131 and 04-132 respectively. The calculation of the inpatient and outpatient shares was analogous to those for any other hospital. However, all of these laboratory and radiology costs are contained in the "other supplies and expenses" cell of the laboratory section of the profile. The paid hours shown on HS-1 for hospitals with special arrangements were retained under the assumption that these are hospital employees, who should receive benefit and overhead allocations.

Prorated costs for Central Therapy Services and South Therapy Services were added to the existing physiotherapy costs of rural hospitals utilizing these services. Manual inpatient-outpatient proportions were performed.

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[116] The cell totals would have been provided to begin with if this flexibility were not to be retained. The flexibility will enable, for example, MCHPE to allocate to salaries but not supplies if warranted in specific circumstances.

[117] The imputation of Westman Lab costs to Brandon General was performed separately, but the units and costs were inserted into the spreadsheet. Thus, Brandon laboratory costs are therefore calculated analogously to those of other urban hospitals.

Again, we tested the results of the adjustments by ensuring that the Grand Total remains unchanged after the splitting of costs. This was also carried out at the end of each of the following steps.

Step 4 - Employee benefit costs[118] were allocated to elements of A, B, C and E commensurately with their shares of paid hours in these Classes. The respective shares were calculated in relation to the sum of paid hours the recipient areas in Classes A, B, C and E.

Rural hospitals only*. No benefits or payroll levies were deducted in respect of physician salaries in rural hospitals. Most of the medical remuneration costs captured in the expenditure bases of rural hospitals are fee-for-service or sessional payments, as reported on HS-1 page 016. No rural hospital indicated during the review of results that it paid significant benefits to physicians paid through hospital budgets. The correction described for urban hospitals in Step 1 could be undertaken for exceptional rural hospitals in the future if some begin to pay significant amounts in physician benefits.*

Step 5 - Combined M&S and drug costs were allocated proportionally to direct patient care areas B(i), B(iii) and Class A excluding nursing administration.

Step 6 - Combined Class C costs excluding dietetics - inpatient and dietetics - outpatient were allocated to all elements in A, B and E plus dietetics - inpatient and dietetics — outpatient commensurately with their share of total paid hours in these recipient areas.

Step 7 - Dietetics 2 - inpatient were allocated commensurately with patient days excluding nursery patient days.

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[118] The allocated employee benefit amount was the revised amount calculated after Step 1 revisions.

Sometimes hospitals, especially smaller ones, reported patient days in an HS-1 clinical service areas on page 02 even though they did not report corresponding costs for the area on page 09. When this happened, dietetics costs were assigned to a clinical area without other costs. This presented no problem for the allocation because inpatient nursing cost **totals** including allocations were employed in the end.

Step 8 - We allocated Nursing Administration Costs to A, B(i), B(iii), and E(ii) Nursing only.

Step 9 - Home care and ambulance costs were combined and then allocated solely to remaining elements of Class A commensurately with the recipients share of paid hours in Class A.[119]

Step 10 - Combined **Pharmacy**, Physical Medicine and Rehabilitation, Social Work, Chiefs and Heads and Other - Line 21 were allocated to remaining elements of Classes A, B(i) and (Biii).[120] We then ensured that total was allocated and that Grand Total were unchanged.

We calculated the following sums for **non-medical salaries and supplies costs** combined, which represent cumulative amounts at the end of Step 10.

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[119] A special adjustment was made to the overall home care costs of Health Sciences Centre. Some identifiable subcomponents were wholly outpatient and some were wholly inpatient. The separation of inpatient and outpatient portions is documented on a footnote in the allocation spreadsheet.

[120] There is an issue of whether to include Chiefs and Heads staff support costs and Chiefs and Heads medical remuneration. We excluded Chiefs and Heads costs (including benefits and levy) but included salaries of support staff.

Table 10

Layout of Summary Output
Full Inpatient-Outpatient Allocation

		Hospital A	Hospital B	Hospital N
(a)	Inpatient costs including **allocated indirect** - Add			
	(1) Class A Nursing, excluding outpatient share of surgical suite	xxx	xxx	xxx
	(2) Class B(i) Nursing - inpatient share - Page 10 Nursing Cost Centres	xxx	xxx	xxx
	(3) Class B(ii) D&T	xxx	xxx	xxx
	(4) Dietetics - inpatient share	xxx	xxx	xxx
	(5) Inpatient Total	xxx	xxx	xxx
(b)	Outpatient including allocated indirect - Add			
	(1) Surgical suite - outpatient share from Class A	xxx	xxx	xxx
	(2) Class B(iii) Nursing - outpatient share - Page 10 Nursing Cost Centres	xxx	xxx	xxx
	(3) Class B(iv) D&T	xxx	xxx	xxx
	(4) Dietetics - outpatient share from Class C	xxx	xxx	xxx
	(5) Outpatient Total	xxx	xxx	xxx
(c)	Excluded Programs - Add			
	(1) Internes and Residents Salaries Class E(i)	xxx	xxx	xxx
	(2) Education programs Class E(ii) excluding Internes and Residents	xxx	xxx	xxx
	(3) Special research Class E(iii)	xxx	xxx	xxx
	(4) Excluded Total	xxx	xxx	xxx
(d)	Excluded Other - Add			
	(1) Medical remuneration	xxx	xxx	xxx
	(2) Interest and depreciation	xxx	xxx	xxx
	(3) Excluded benefits and levy	xxx	xxx	xxx

This provides the inpatient numerators (a4) for cost per weighted case calculations using an orthodox step-down allocation methodology.

The allocations passed the tests conducted using regression analysis. See section **I: Sensitivity Analyses** for details.

APPENDIX H: HOSPITAL COST ANALYSIS REGRESSIONS

The aim of the regression models in this section is to determine the extent to which case-mix indices explain interhospital cost differences, to identify other important determinants of hospital costs and to determine the explanatory power of a model that includes these and other relevant independent variables.

Several types of hospitals are excluded from the analyses because of their anomalousness. Northern isolated hospitals are excluded throughout because their costs are extraordinary and atypical. These hospitals' low levels of activity are generally well below the servicing capacity of minimum baseline staffing. Manitoba Health continues to finance these facilities, in spite of low levels of activity, to provide their isolated catchment populations with access to services. Teaching hospitals are also excluded from the main analyses because their teaching activities are widely thought to engender costs in addition to those commensurate with the direct patient care that they provide, and the costs of the two Manitoba teaching hospitals are anomalous, as further analysis will show.[121]

The anomalousness of Manitoba's teaching and northern isolated facilities can be illustrated statistically by regressing inpatient cost per case (CCOST) on the overall case mix index (CMI). The CMI is a hospital index representing the average standardized case weights including the weights of atypical cases. Four of the five northern isolated hospitals had

[121] The direct costs of teaching activity such as the costs of interns' and residents' create no comparability problems because they can be reasonably quantified and excluded, as we have done in this study . The so-called indirect costs are more inscrutable. In regression analyses involving both community and teaching hospitals, the normal approach is to include an independent variable, such as the ratio of interns and residents to beds, to quantify the indirect costs. The results from this kind of model would be unreliable in the current context because Manitoba has only two teaching hospitals. Moreover, these hospitals seem to have costs that are high even for teaching hospitals, as further analysis will show. Thus the differentials in teaching - community hospital costs per case in Manitoba may be unrepresentative of these structural differences.

studentized residuals in excess of 2.00, the cut off for outliers at the 95% level. Indeed three of the five had values of 2.70-4.04. The residuals of all five were positive. The $\bar{R}^2$ of the model was only 23.2%. Obviously, these hospitals are systematically different from the others.

After the northern isolated facilities were removed from the model, the $\bar{R}^2$ rose to 56.1%. However, the teaching hospitals both had positive studentized residuals greater than 2.00. Inasmuch as the probability of this happening by chance is less than 6.25 in ten thousand, the statistical analysis supports the a priori conclusion that the teaching hospitals are systematically different and should therefore be excluded at this stage.[122]

The $\bar{R}^2$ of the univariate CMI model with the teaching hospitals removed rose marginally to 57.0%. It further rose to 63.59 with the addition of the occupancy rate variable (OCC), the second most important variable in terms of its explanatory power.[123] The regression cost models in the literature often contain city or town size variables and locational variables. Consequently a number of these variables, developed in a previous study, were tested.[124]

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[122] The problems might disappear if other variables, in conjunction with CMI, explain teaching hospital cost differences so that the two hospitals are no longer outliers. One candidate is bed size, which is sometimes a variable in hospital regression models. The inclusion of bed size with CMI in a two-variable model did not produce encouraging results because the two teaching hospitals then became the most influential hospitals, as measured by the covariance ratio, which measures the impact of individual observations on the parameter estimates. Health Science Centre's ratio was especially high, approaching a value of 2.0.

[123] In a model of firms under conditions of perfect competition, excess capacity would be eliminated in the longer run as competition and economic survival impelled firms to produce at minimum cost. In the publicly-funded Canadian hospital sector, if the funding agency continues to underwrite excess staffing and plant capacity costs, hospital administrators would be under no pressure to adjust staffing and plant size to optimum levels. Indeed, excess staffing in hospitals located in smaller communities, which tend to have the low occupancy rates, creates more jobs and thereby enhances the status of the hospital as an important economic asset in the community.

[124] Michael Loyd & Associates, Differences in Realized Access to Physician Services in Manitoba, February, 1993.

Two scale variables that have sometimes been found to be significant in regression cost models — beds size and numbers of cases — also were tested. Finally, an additional measure of case mix was also included to determine whether it captured case mix/servicing affects unobserved by the CMI. This variable was the proportion of intensive care unit cases for facilities with at least 250 such cases. We included the variable to determine whether CMI fully accounted for differences in intensive care usage.

The details of the final models are included below. Nonsignificant variables were dropped in most cases because there were no strong reasons based on theory for believing that any of the nonsignificant variables were key determinants of costs.

Variables

Ccost - inpatient cost per case
CMI - hospital case mix index including atypicals
Occ - occupancy rate calculated on adult, child and newborn staffed and operational beds
Icu - proportion of intensive care unit cases
North - hospitals in the Norman and Thompson Health Regions

Table 11

Regression Variables, Coefficients and P-Values

	Mean	C.V.	Coefficient	P-Value
Cases	1630.55	1.515	NA	NA
Alos	8.957	0.334	NA	NA
Ccost	2480.17	0.366	NA	NA
CMI	1.389	0.272	2052.7	0.000
Occ	56.00	0.251	-25.210	0.000
ICU	0.7844	2.993	102.49	0.000
North	0.058	0.327	699.86	0.010
Constant			919.19	0.009

n = 69

$\bar{R}^2 = 71.54\%$

F = 43.733

The model explains 71.54% of the interhospital differences in inpatient costs (CCOST), which is similar to the explanatory power of the better models of its type in the literature.[125,126,127,128] The significance of ICU reveals that this additional measure of case mix/ servicing adds a dimension to the measurement not detected by CMI. Studies in the literature have sometimes supplemented DRGs (and other similar case mix indices) with additional measures of case mix.

The coefficient of CMI implies that an increase of .1 in the index at the mean is associated with an increase of $205 in the average case cost all other things being constant. The magnitude of the OCC variable suggests that a one percent point increase in the occupancy rate decreases case costs by an average of $25.210 at the mean. At the means, an increase in the occupancy rate of 1 point will lead to provision of an additional 225.1 days of care amounting to 25.1 cases.[129] The upshot is that the new cases are being absorbed at a small increased cost of $819 per case, only 33.0% of the original case cost. The costs of each additional case amount to about $589 more than the sum of M&S, drug and food costs per patient case ($230) or about $66 per day.[130] This means that the average hospital is staffing its entire operation as if the occupancy rate were almost 100% when, in fact, it is only about 56%. In the Canadian system, this kind of hospital staffing behaviour is possible, in the absence of competitive pressures, if it is underwritten by the funding agency.[131] Previously,

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[125] A case could also be made for excluding multi-use facilities from the regression because there were some doubts about the accuracy of their separation of costs of hospital operations from their other facets. Indeed, three of the six facilities had very large positive residuals. The $\overline{R}^2$ of the model would have increased to 76.4 per cent if these hospitals were excluded.

[126] K. E. Thorpe, The Use of Regression Analysis to Determine Hospital Payment: The Case of Medicare's Indirect Teaching Adjustment. *Inquiry* 25 (Summer 1988) pp 219-231.

[127] Jeannette A. Rogoski and J. P. Newhouse, Estimating the Indirect Costs of Teaching, *Journal of Health Economics* (1992), vol. II, pp 153-171.

[128] L. G. Worthman, Shan Cretin, Review of the Literature on Diagnosis Related Groups, *Rand Corporation*, October 1986, p.5.

[129] These calculations are based on increasing the average occupancy rate of each hospital by one point. Note that the number of additional cases cannot be calculated by dividing the average number of cases by 56. The average occ is the average of individual hospital occupancy rates not the average patient days of all hospitals divided by the average beds times 365.

[130] A significant portion of the $66 per day is incurred on direct and indirect other supplies and expenses, which are distinct from staff costs.

[131] Of course, some hospitals may, like the isolated northern hospitals, have excess capacity at minimum baseline staffing levels.

for example, Manitoba Health would provide additional funding to rural hospitals if they could show that their activity levels had increased. However, Manitoba Health would not reduce funding when activity levels fell. This asymmetric policy created no incentive for hospitals to reduce staffing when activity declined. The policy has recently been changed.

The NORTH variable implies that the average case cost of northern hospitals is $699.86 or 28.2% higher than otherwise would have been expected given the magnitudes of the other independent variables. That northern hospitals' costs are higher is not surprising given the northern allowance and the generally higher costs of goods and services.

Many regression models, with cost per case or cost per patient day as the dependent variable, have either beds or cases as significant independent variables. There have been two explanations for the significance of the variables. Some economists have maintained that the BEDS term, perhaps supplemented by $BEDS^2$, represented hospitals' employment of capital and thus related to short-run capacity.[132] Others concluded that these variables measured otherwise unobserved case complexity and/or cost-increasing quality enhancing servicing scope that correlated with scale.[133] If case complexity or acuity undetected by DRGs were the crucial factors, then the use of RDRGs - instead of the more conventional DRGs - and the addition of the new case mix measure, ICU, might tend to supplant the scale proxies.

To test the latter hypothesis, we ran the basic model above without the ICU variable. The $\bar{R}^2$ was 66.75%. We then added BEDS to the remaining group of independent variables.

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[132] If both coefficients are significant and the BEDS coefficient is negative whereas the $BEDS^2$ coefficient is positive, then the average cost curve is U-shaped.

[133] The economic analyses fail to explain why many models find beds to be significant with sizable coefficients, yet most economists who have specifically analyzed economies of scale have concluded that long run average cost curves are essentially flat after a very small bed size threshold has been reached or perhaps increase very slowly at large hospital sizes.

The $\bar{R}^2$ rose to 70.06 and the BEDS coefficient of 2.133 was significant at the 0.6% level.

When CASES was substituted instead, the $\bar{R}^2$ was 69.96 and the coefficient of .0784 was significant at the 0.6% level. Thus the ICU variable possessed more explanatory power than either of the scale variables.

The final test involved including the variables ICU, BEDS and CASES with the variables CMI, OCC and NORTH in a backward stepped model. The two scale variables, CASES and BEDS, stepped out of the model. It is apparent that ICU has measured case mix/servicing differences undetected by CMI and, in doing so, superseded the influence of the two scale variables, which evidently were proxying these other case mix/servicing differences.

This model is useful for identifying the determinants of differences in costs per weighted case. But, the fact that a variable helps explain cost differences does not imply that it justifies differences. If the underlying relationships described by the models were technical in nature and represented optimums, then one could conclude that variables that explain costs also justify them. However, many of key hospital cost relationships, especially when market-driven competition is lacking, are a function of the discretionary behavioural decisions of the hospitals and their funding agencies. Before one would want to use models of this nature to explore the differences between predicted and actual costs per case at the hospital level, one would want to deal with several issues in the behavioural realm. A case in point is the occupancy rate, which would not affect the case costs as much in a competitive environment as it did in Manitoba in 1991/92. Studies have shown that the costs of empty beds in hospitals that have adjusted their staffing downward to the actual volumes are minimal.[134] Thus a low occupancy rate may explain a hospital's high case costs in the Manitoba environment but it does not justify these high costs. For another example, if a hospital were

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[134] Pauley, M. V. and P. Wilson, Hospital Output Forecasts and the Cost of Empty Hospital Beds, *Health Services Research* 21:3 (August 1986) pp 403-428.

ineffectively and inefficiently providing inordinate and inappropriate critical care, this is another poor practice that would have favourable consequences on the actual and predicted cost relationship. Finally, the findings of the analysis relate to Manitoba hospitals and the ways in which they have been historically funded. The Manitoba scale or reference point is not necessarily the optimum one.

One of the major implications of the fit of the model is that it proves that charges from an American state can be used to measure the expected costliness of Manitoba hospitals. As noted earlier, the proportion of interhospital cost differences explained by the model in this study is comparable to those of American case mix models.

APPENDIX I: SENSITIVITY ANALYSES

A number of regression tests were performed on the data. The purposes of these tests were to determine the best of alternative approaches, to check various adjustment approaches used in the study for systematic errors, and to determine whether other measures of case mix, such as the proportion of aboriginals, had a systematic affect on costs that was not measured by the hospital case mix index.

The first regression tested the three marginal cost adjustment alternatives employed in the analysis. The model, which excluded teaching hospitals and northern isolated facilities, involved a hospital level analysis with cost per case as the dependent variable. Case mix indices employing the marginal cost approach incorporated in the study (the one based on disaggregated Maryland costs per case observed over different length of stay intervals) yielded an $\bar{R}^2$ of 57.0%. Weights developed from the related method, based on the behaviour of total costs over the stay, rather than the summation of component subgroups of costs, produced an $\bar{R}^2$ of 56.4%. Obviously, in the development of weights in future years, calculating the costs on a disaggregated, component subgroup basis is not worth the extra administrative cost. Finally, the weights based on an assumed marginal cost factor of 0.6% of the average cost produced the poorest fit, 52.7%. The tests support the choice of the approach incorporated in the report.

The next regressions tested whether RDRGs properly adjusted for the classes of cases used in this study: medical obstetrics, surgical obstetrics, surgery, medical and other. The proportions of the first four were included as independent variables in a hospital level backward-stepped model with cost per weighted case as the dependent variable.[135] None of the variables were significant; all stepped out of the model. Thus the regression model identified no systematic errors in the weightings: RDRGs appear to adequately weight all of these classes of cases. This means that when case mix is taken into account by the RDRG weights developed in this study, the costs of a hospital with an anomalous case mix, such as little or no surgery activity, should not be biased relative to costs of a hospital with a high proportion of surgery cases.[136] To test various other adjustments and possible explanatory variables, the proportions of the following were included in a backward stepped model again with cost per weighted case as the dependent variable: outlier cases, cases that ended in 1-3 days, aboriginal cases, non 8000 RDRG death cases,[137] male cases, over 75-year-old cases, cases discharged before the trim, transfer in and out cases, typical cases, paediatric cases and cases with non acute days. After the backward stepping, only the percent of male cases remained significant (at the .02 level). Thus the case mix costing analysis is not biased against hospitals whose proportions of the listed types of cases, apart from male cases, are anomalous. Furthermore, the model found no systematic errors in the adjustments for atypical cases and non acute days used in this study.

The parameter estimate of the male cases was -32.964 and the $\bar{R}^2$ was 6.6%. This variable would not have much of an effect on predicted case costs at the hospital level because the percentages of males vary little between hospitals, having a percentage coefficient of variation of only 8.7%. The variable was not significant in the cost per case model employed in the Section entitled **Hospital Cost Analysis Regressions**.

[135] The traditional hospital level analysis of costs employs cost per case as the dependent variable and the average case weight index as an independent variable. In some of the analyses in this section, the case weight index is a function of some of the other independent variables under scrutiny. To surmount this problem, we used cost per weighted case as the dependent variable when it was appropriate to do so.

[136] If the surgery coefficient had had a significant positive value, the inference would have been that the RDRG weights systematically undervalued the average surgery case.

[137] Each MDC has an 8000 level RDRG for medical deaths with 48 hours of admission.

The last model analyzed some of the important indicators of whether adjustments worked properly from the perspective of their percentage share of weights rather than proportion of cases. This views the adjustments from the same perspective but using related, though slightly different, indicators.[138] The following percentages were included in a backward stepping model with cost per weighted case as the dependent variable: typical weights, death case weights, outlier case weights, transfer to weights and transfer from weights. The percentage of non acute care days was also included. None of the variables were significant at the 5% level or better. These regression results provide further substantiation of the validity of adjustments in the study. The results of these tests all confirm the key adjustments in the study for marginal costs, outliers, deaths, transfers and long term care days.

The final sensitivity test involved the allocation methodology. The amount of the outpatient allocation per case and the total outpatient costs per case were added separately to the independent variables in the best regression model developed in this study to test whether the allocation method might have over or underestimated the allocations to inpatient activities. The coefficients of the new variables in both models were nonsignificant. Thus the allocation passed the test: the models identified no systematic over or under estimation of overhead allocations, the key aspect of the allocation methodology.

[138] The percentage weights and cases would be correlated but not identical.

APPENDIX J: COST DIFFERENCES - TEACHING AND URBAN COMMUNITY HOSPITALS[139]

One of the most interesting findings of the study is the wide difference between teaching and urban community hospital costs per weighted case. The findings confirm the importance of several of the issues of Manitoba Health Reform such as the cost implications of shifting secondary services from expensive teaching hospitals to less expensive community hospitals, how to reconfigure hospital services in Winnipeg and the size of funding cuts that can be made at teaching hospitals as a result of the reductions in teaching activity.

In this section, we will briefly look at some of the implications of our findings and compare them with results of other studies. A more detailed review, though warranted, is beyond the scope of this study.

Maximum Cost of Teaching

The cost per weighted case at Manitoba teaching hospitals averaged $2,598 compared to an average of $1,922 for the six urban community hospitals including Brandon. The excess costs at the two teaching hospitals, if the community hospital average cost per case were the proper benchmark, would be $38.8 million at the Health Sciences Centre and $30.3 million at St. Boniface. If the benchmark incorporated a tougher standard, such as the $ 1,662 average cost per weighted case of the two least expensive urban community hospitals, then the respective

[139] The 1993/94 methodology will employ separations of outpatient and inpatient costs of drugs and M&S based on hospital accounting data whereas these costs were allocated in the 1991/92 model because of data inavailability in one of the major hospitals. The preliminary 1993/94 results were reviewed prior to finalizing this section to determine whether the old methodology engendered any consequential quantitative biases between community and teaching hospitals. No such biases were present.

excess costs in the teaching hospitals would be higher, at $54.9 million at the Health Sciences Centre and $41.1 million at St. Boniface. It should be noted that all these calculations are based on 1991/92 data before budget cuts and bed closures, which occurred subsequently. The effects of these changes will be reflected in the forthcoming case mix study based on 1993/94 data.

If all the excess costs were indirect costs stemming from teaching activities, what is the total cost of teaching activities to the health care sector? One would want to add the direct costs of interns' and residents' salaries to these figures because they have hitherto been excluded. The Medical School estimated that 60% of the total of 372 intern and resident full time equivalents should be allocated to the Health Sciences Centre and the remaining 40% to St. Boniface. On this basis we allocate $7.5 of the $12.5 million in interns' and residents' salaries and benefits to the former and $5.0 million to the latter. The medical remuneration of chiefs and heads of staff, which is higher in Manitoba teaching hospitals than urban community hospitals, should also be added back.[140] We will not do so here because additional clarifications would have been necessary. Without chiefs and heads payments, the total cost of teaching under benchmark 1 was $46.3 million at the Health Sciences Centre and $35.3 at St. Boniface. The costs per intern or resident at the institutions were $207,000 and $238,000 respectively. The calculations under benchmark 2 are respective totals of $62.4 and $46.1 millions and costs per intern or resident of $280,000 and $310,000.

The upshot of this analysis is that if all the excess costs at the Health Sciences Centre and St. Boniface were owing to their teaching activities, the annual costs per intern and resident would be in the range of $207,000 to $310,000, excluding payments to chiefs and heads.

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[140] Supplies and other expenses for the chiefs and heads and their staffs are in the indirect costs retained in the study.

Although some might argue that all of the excess costs of the two hospitals arise from their teaching activities, this position is hard to justify, as we shall show below.

Interprovincial Comparisons

We performed a brief comparative analysis of the relationship between teaching and community hospital costs in Manitoba, Alberta and Ontario using secondary source information that was readily available. There are some inconsistencies in the methods used in the three provinces to develop the data. Manitoba and Alberta use RDRGs to measure case mix, whereas Ontario uses CMGs. The methods differ in other ways as well such as in their handling of long-term care cases, the costing of incremental days, allocation methods and the handling of weights in the notch between the average length of stay for an RDRG and the trim point. Another difference between provinces is the average hospital wage rates. As a result of these differences, an interprovincial comparison of absolute costs per weighted case would not be tenable with the readily available data employed here. Instead, we compare the relativity of the ratios of costs (teaching versus major urban community, and teaching versus other community hospitals) between provinces. This eliminates many of the potential problems stemming from methodological inconsistencies. One problem that remains, and could affect the gaps between community and teaching hospitals in other provinces, is that medical remuneration is retained in Alberta and Ontario[141,142]. The presence of medical remuneration certainly affects comparisons of absolute case costs between Manitoba and the other two provinces.

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[141] A test of the Manitoba data showed little difference between the teaching and urban community hospitals in the proportions of medical remuneration costs. In Manitoba, medical remuneration, exclusive of benefits, accounted for about 5-6 percent of overall costs.

[142] Medical remuneration is excluded from the weights used to develop CMGs and RDRGs. Hence the approaches in these two provinces are inconsistent with the weighting method.

We think that the resulting analysis is useful and worthwhile in the context of its use here, but caution the reader to bear in mind the caveats before using the data for other purposes.

The 1991/92 Alberta data, obtained from Alberta Health, excluded hospitals with less than 1,000 discharges in two consecutive years.[143] In fact, some hospitals with as few as 930 discharges in 1991/92 fulfilled this criterion. For consistency, all Ontario and Manitoba hospitals with fewer than 930 cases were excluded from the analysis as well. The Alberta funding approach measures case mix with RDRGs and uses its own unique method of calculating the marginal costs of outlier days by RDRG. Most long-term care unit cases are excluded from the Alberta case cost dataset. Exceptions occur in a few hospitals whose long-term care unit does not have a separate facility number. Alberta applies no special weights to long-term care unit days remaining in the dataset. Only hospitals in Edmonton and Calgary are included in the major urban community category used in this section. These hospitals, like Seven Oaks Hospital in Winnipeg, have small amounts of medical training activity, but not enough to justify true teaching hospital status.

Alberta includes in its list of teaching hospitals some which have small amounts of teaching activity. We classified Foothills, University of Alberta Hospitals, Royal Alexandra and Caritas as teaching hospitals. The remaining major urban general hospitals had interns and residents to bed ratios lower than that of Seven Oaks in Winnipeg. These hospitals - Holy Cross - Rockyview, Calgary General and Charles Camsell were, like Seven Oaks, classified as urban major hospitals in this study.

The Ontario Ministry of Health provided 1993/94 information on its hospitals including weighted cases based on CMGs. Other things being constant, one would expect that the use of CMGs would result in gaps in costs per weighted case between teaching hospitals and community

[143] These hospitals are excluded from the Alberta Acute Care Funding System's case mix based approach.

hospitals that are larger than those that would have been observed if an RDRG system had been used. This is because CMGs do not capture the acuity dimension of case mix to the same extent as the RDRGs and therefore weights assigned to teaching hospitals will generally be underestimated inasmuch as these hospitals commonly have patient loads with higher acuity levels than community hospitals do. Ontario has six Peer Group 2 teaching hospitals that create classification ambiguities. The Ministry classified teaching hospitals as Peer 1 or Peer 2 on the basis of their RIW indices. Those with the higher indices are in the Peer 1 Group.[144] Peer Group 2 hospitals, though classed by the province as teaching institutions, generally have comparatively smaller amounts of teaching activity and tend to have few tertiary services.[145] They tend to be the second or third teaching hospitals in smaller markets such as London, Hamilton and Kingston although two are from Toronto. Tertiariness seemed to supersede teachingness in Ontario's classification system because Hamilton Civic was classed in Peer Group 1 whereas Chedoke-McMaster was classed as a Peer 2 member. Based on our assessments, the minor teaching hospitals seem to fit best in the teaching group.[146] Since we did not have time to study the issue in depth, we provide two reclassifications, one which classifies them as teaching hospitals and the other which includes them with the major urban community hospitals. Table 12 also contains a version with the two classes of Ontario teaching hospitals shown. The written text will refer only the results of grouping them with the teaching hospitals.

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[144] Peer Group Membership for option 2c in Appendix 4 of OHA/OCOTH/MOH Peer Group Committee Report, For the First Phase of Transitional Funding (February 20, 1990).

[145] Michael Loyd & Associates (1991), op. cit., pp 23-29.

[146] If cost per weighted case were the sole criterion, four seem to fit with the Peer 1 teaching hospitals and two with the Urban Majors.

Table 12

	N	Avg Cases	Avg Ccost	Avg Ccost Index	Avg CWC Index
Manitoba					
Teaching	2	30,620	4,371	208.3	141.0
Urban Major	5	8,342	3,538	168.6	100.9
Other Community	22	2,398	2,098	100.0	100.0
Alberta					
Teaching	4	32,320	4,011	200.1	127.0
Urban Major	3	25,436	3,258	162.6	120.2
Other Community	63	2,711	2,004	100.0	100.0
Ontario Version 1					
Teaching	10	23,328	5,694	229.0	148.0
Urban Major	27	15,377	3,017	121.3	116.7
Intermediate Community	42	10,912	2,815	113.2	107.9
Minor Community	81	2,550	2,487	100.0	100.0
Ontario Version 2					
Teaching	16	21,543	5,016	201.7	145.5
Urban Major	21	14,465	2,769	111.3	109.6
Intermediate Community	42	10,912	2,815	113.2	107.9
Minor Community	81	2,550	2,487	100.0	100.0
Ontario Version 3					
Teaching	10	23,328	5,694	229.0	148.0
Teaching II	6	18,567	3,886	156.3	141.3
Urban Major	21	14,465	2,769	111.3	109.2
Intermediate Community	42	10,912	2,815	113.2	107.9
Minor Community	81	2,550	2,487	100.0	100.0

We include in the Ontario major urban community hospital group only hospitals that are located in Toronto, Hamilton or Ottawa, the major urban centres larger or similar in size to Calgary, Edmonton and Winnipeg. The average size of the remaining Ontario community hospitals with more than 930 discharges was much bigger than the averages in Alberta and Manitoba. To hold size differences constant in the group of smallest rural community hospitals, we split the Ontario data from community hospitals outside of the major cities into two groups: Intermediate Community Hospitals and Minor Community Hospitals.[147] The lower level group has about the same average number of discharges as the Manitoba and Alberta hospitals outside the urban areas. We use the lower group in the Ontario teaching-non urban hospital comparisons. Thus, Ontario's Minor Community Hospitals are equivalent in our analysis to the Other Community category in Alberta and Manitoba.

The classification of the Manitoba hospitals was straightforward. However, we did depart from the usual Manitoba Health denotation of Brandon as a major community hospital. For interprovincial consistency in the approach, we included Brandon with the "Other Community Hospital" group.

Manitoba and Alberta's differences in raw costs per case between categories were similar. In each province, the case costs of Teaching Hospitals were slightly more than twice those of Other Community Hospitals; Urban Majors were more than 60% more costly. In Ontario, the relationship between raw Teaching Hospital costs per case and those of the Minor Urban Hospitals (Version 2) was similar to those in the western provinces (201.7). The gap between the Urban Majors and the Teaching hospitals was much greater in Ontario. The raw case costs of the Urban Majors were only 11.3% higher than those of the Minor Community Hospitals.

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[147] We are holding size constant to be conservative in the event that size, at this level, had an important bearing on cost. By holding size constant, we achieve more homogeneity in the activities of the lowest group of community hospitals in the three provinces. In the absence of the size distinction in Ontario, its other community hospital class would have contained many hospitals of the same size and market area as Brandon General in Manitoba.

Now consider the effect on the ratios when costs have been calculated in relation to weighted cases. If scale, location and funding traditions were irrelevant, one would have expected that weighting would eliminate the differences observed in raw case costs between classes of community hospitals. In Manitoba, the weighted results met these expectations, essentially eliminating the initial difference between Urban Major Community and Other Community Hospitals, reducing it from 68.6 to 0.9%. In Alberta, weighting reduced the gap substantially from 62.6 to 20.2%, but the remaining difference was the largest of the three provinces.[148] Weighting for case mix caused little change in the ratio of Urban Major case costs relative to those of Minor Community Hospitals in Ontario. The indices of the Major Urbans were 9.6% higher after weighting, only a slight drop from the initial 11.3% difference.

Weighting substantially lowered the gaps in raw costs per case between Teaching Hospitals and the Other Community/Minor Community Hospitals as well. The Alberta gap was the smallest, a difference of only 27.0%. The gaps in Manitoba and Ontario, by contrast, were 41.0% and 45.5% respectively. From this comparison, it would appear that the Alberta costs of "teaching" are comparatively less than those in the other two provinces.[149] The difference in Alberta costs per weighted case between Urban Majors and Teaching Hospitals also supports this conclusion. It was only 5.7%.

The most likely reason for the different configurations of the intergroup costs per weighted case is different historical funding criteria. For example, Ontario originally found, when planning its case-mix based funding approach, that costs per weighted case varied in the province by bed size

[148] The difference in the average numbers of cases was greatest in Alberta as well.

[149] It does not appear that extraordinarily high Other Community Hospital costs per weighted case are the cause because the gap between them and the Urban Majors is the highest of the three provinces. Moreover the initial configurations of absolute raw cost and the indices were almost exactly the same as in Manitoba. The higher relative average weights of the Alberta Teaching Hospitals caused the greater narrowing of the gaps. Note that the size differences, as measured by cases, between the Alberta Teaching and lowest level of Other Community Hospitals are similar to those in Manitoba and much larger than those of the Ontario hospitals irrespective of the version of the classification. Thus scale is not a factor that explains the narrower gaps in Alberta.

of hospitals and teaching status, with the tiers of teaching hospitals originally defined by RIW indices. Ontario took these relationships to be technical and developed its case mix approach to fund on the basis of peer groups differentiated on bed size and two tiers of teaching status. By setting higher cost per weighted case baselines for each of the peer groups as one moved up the hierarchy, Ontario might have merely sustained previous historical and unscientific funding practices under the pretext of scientific case-mix based funding. If costs do not vary technically by bed size when other factors are controlled for, as the Manitoba regressions suggest, and the adjustment required for teachingness is much smaller than those allowed in Ontario, as the Alberta and American experience suggests, then Ontario's funding approach is inimical both to efficiency and equity. If one analyzes the relationship between size and cost per weighted case within the Ontario classes used in Table 12, one finds that cost per case is not related to size within any of the four groups.[150] Within the Peer 1 group of teaching hospitals, tertiariness does not seem to explain differences in costs per weighted case either. The costs per weighted case of The Toronto Hospital and University Hospital London, the high technology hospitals, were only 3.8% higher than those of the entire group.

The Alberta relationship between Urban Major and Teaching Hospital costs also seems most likely to have resulted from funding differences. The less likely alternative explanations are that the classification of hospitals is incorrect or there is some factor other than teachingness influencing the Alberta results. If we compare only Foothills and the University of Alberta hospitals - the hospitals with intern and resident to bed ratios comparable to the Manitoba teaching hospitals - to the Urban Major and Other Community hospitals, the gaps rise to 7.8 and 29.6%.[151] The small increase in the differentials is owing to the extraordinarily high costs of

[150] We used a univariate regression model with cases as the independent variable and cost per weighted case as the dependent variable. Cases were used to measure scale because the numbers of beds were not readily available.

[151] Foothills and the University of Alberta hospitals both had ratios of 20.7 per 100 beds in 1991/92, according to Alberta Health.

University of Alberta Hospitals. Foothills' differentials are less than the average of all Alberta teaching hospitals.[152]

In analysing hospital costs in Canada's uncompetitive and single payer systems, one must bear in mind that the observed patterns may result from behavioural activities of the funding agencies and hospitals rather than from technical factors. Given that jurisdictions tend to imitate each other, this admonition is valid even when one observes similar patterns in different provinces.

Manitoba's spread in the ratios of cost per weighted case (CWC) indices between Teaching and Major Urbans of 39.6% is the largest, higher than the 32.7% spread in Ontario. By contrast, the Alberta spread is only 5.7%.

Manitoba's 40.9% spread between the Other Community Hospitals and Teaching Hospitals in the table is much higher than the 27.0% spread in Alberta but it is less than the range of 45.5% in Ontario using the Minor Community Hospitals in the comparison.

Absolute costs per case can be misleading because of interprovincial differences in wage rates and the presence of long-term care days in the Manitoba and, to a lesser extent, the Alberta datasets.[153] Of the other mix differences, the presence of high proportions of obstetrics cases can have a particularly marked affect on raw case costs.[154] It is interesting that the raw costs

[152] Foothills differentials are 2.2% and 22.8%.

[153] Of course, the effects of interprovincial wage differences would be removed in a refinement of this approach. We avoid the problem in the analysis of this section by focusing on within-province relativities between classes of hospitals.

[154] Length of stay is a key determinant of raw cost per case. The presence of long-term care cases tends to increase the raw cost per case; the obstetrical cases, which tend to have shorter lengths of stay, have the opposite effect.

of Ontario teaching hospitals, under either classification version 1 or 2, are much higher than those of their Manitoba counterparts, in spite of the fact that for the latter the hospitals' case loads contained an average proportion of 22.7% long-term care days. The high proportions of obstetrics in the Manitoba hospitals only partially offset the effect of the long-term stays on raw case costs because the average Ontario teaching hospital had considerable obstetrical activity as well. Eight of the ten Peer 1 Teaching Hospitals and five of the six Peer 2 Teaching Hospitals had obstetrics/gynaecology units ranging in size from 27 to 82 beds. The raw case costs of the Minor Community hospitals are much higher in Ontario than those of Manitoba's Other Community Hospitals as well, again despite the presence of long-term cases in the Manitoba dataset. Conversely, the raw costs of Manitoba's Urban Major Community hospitals are higher than those of their counterparts in Ontario (irrespective of the classification of Peer 2 hospitals). Seemingly the 16.9% of long-term days in the Manitoba hospitals was partly responsible for this result. The factors driving the Manitoba urban major community costs have superseded the effect of the higher Ontario wage rates.

The raw average case costs of the Manitoba and Alberta Teaching Hospitals are similar, the Manitoba Urban Major costs are higher, as they were when compared to Ontario counterparts, and the Other Community Hospital costs are similar. All four of the Alberta teaching hospitals had large obstetrics and gynaecology units, ranging from 56 to 143 beds. Thus the large obstetric components of the Manitoba Teaching hospitals do not bias the comparisons of Alberta and Manitoba raw teaching hospital case costs.

The analysis of raw costs per case and ratios of case weighted costs shows that weighting substantially closes the nominal gaps between Teaching and the various classes of non teaching hospitals in Alberta and Ontario. In Manitoba, the weighting decreases the gap between the nominal costs of Teaching Hospitals and Other Community Hospitals, but widens the gap between the former and Urban Major Community Hospitals. The findings suggest that the Manitoba teaching hospitals receive funding per raw case similar to those in Alberta and less than those in

Ontario. But their weighted case loads may not justify levels of funding comparable to those received by tertiary teaching hospitals in the other provinces. In the other provinces, the high relative case weights substantially narrow the gaps in nominal case costs between Teaching Hospitals and Major Urban Community Hospitals.

The Manitoba spreads in costs per weighted case between Urban Majors and Teaching Hospitals are the largest of the three provinces. We know from the analyses of case mix in the main body of this study that the Health Sciences Centre and St. Boniface have case mixes that are not that dissimilar in expected costliness from those of the Winnipeg community hospitals, except for a few tertiary services that comprise a small portion of activity. We also know that the raw case costs are not dissimilar from those in Alberta. This implies that the two Manitoba hospitals may be funded similarly to teaching hospitals in the other two provinces, however they do not have the case mix acuity needed to justify this funding. This is supported by results from a comparison of expected costliness of patient mixes across provinces using the same yardstick. HMRI data from 1991 support the conclusion that the per diem expected costs of the Health Sciences Centre and St. Boniface are considerably lower than those of other major teaching hospitals in Canada. The average daily typical and atypical RIW weights of a peer group of high order major teaching hospitals was 25% higher than those of the local hospitals. The per diem RIWs of a second echelon Canadian teaching hospital peer group was over 18% higher.[155]

The differences in costs per weighted case between Alberta Teaching and Major Urban hospitals are by far the lowest of the three provinces. Alberta's difference between Teaching and Other Community Hospitals is also the lowest in the three provinces. Further research is warranted to determine the causes and effects of the funding patterns that have led to these results.

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[155] Michael Loyd & Associates, Supplement to the Comparative Cost of Manitoba's Major Teaching Hospitals (June 26, 1992), pp 25-28.

Manitoba Regression Results

The regression models based on Manitoba community hospital data showed that numbers of beds and cases were not significant determinants of interhospital cost differences in the province when case mix differences were properly taken into account. Location only had a minor effect on costs, with Northern hospitals having higher costs. By contrast, in American studies, various gradations of location and size have been found to be significant. This may be on account of competitive hospital wage differences that do not exist within a Canadian province, except for northern allowances, or they may stem from imperfect adjustments for case mix differences.[156,157]

The Manitoba regression models showed that RDRG-based case weighting indices did not fully quantify the interhospital case mix differences in expected costliness. The proportion of intensive care unit cases was a significant supplementary indicator of expected case costliness. But this variable seemingly would do little to explain the differences in costs between teaching and community hospitals. The Health Sciences Centre's proportion of intensive care unit cases in 1991/92 was about 0.8% higher, whereas St. Boniface is about 0.6% lower than the average for the Winnipeg community hospitals.

American Experience

The differences between teaching and community hospital costs has been studied in great depth in the United States where the magnitude of the teaching hospital adjustment factor for Medicare patients has been a controversial topic. Recent studies suggest that the adjustments for the two

[156] Wage differences will not be a factor in the American studies that adjust for them.
[157] City size and beds are likely to be correlates of the costliness of case mix. They may quantify factors not captured by the explicit case mix measures.

local hospitals' amounts of teaching activity, amounts which are not large by American standards, would not explain much of the excess costs identified at the beginning of this section.

In the literature, the indirect costs of teaching are usually quantified using regression models. We could not directly perform this kind of analysis on a dataset comprising only Manitoba hospitals because the number of teaching hospitals is too few to produce reliable results. Furthermore, suitable Canadian studies were unavailable. Consequently, we will draw indirect inferences from the American data, an approach that parallels our use of Maryland data for the case weights.

Much of the debate over the required teaching hospital adjustment for Medicare payments has been technical, focusing mainly on the other variables, besides teachingness, that are also adjusted for. Some of the candidates for inclusion are bed size, rural-urban location, city size and extraordinary proportion of poor patients. The problem in the analysis is that many of the other candidate variables correlate positively with the level of teaching activity. Hence, if one omits some of these other correlates from the equation, the coefficient of the teachingness variable will tend to be artificially high because it is capturing the effects on costs not only of teaching activity but also some of the effects of these other cost drivers. In other words, a misspecification that omits important explanatory variables will tend to overestimate the adjustment required for the teaching factor alone.

In this analysis, we will focus on the results of the more recent models that have been developed to deal with past methodological shortcomings. We can remove all effects of rural-urban locational differences and city size differences by comparing Manitoba's two teaching hospitals only to the Winnipeg community hospitals. Consideration of this subset of Manitoba hospitals also lessens the differences in bed size between the hospitals under consideration. It is debatable whether these variables would be important in this analysis anyway because the RDRG's acuity dimension should take into account, at least in part, one of the reasons why the bed size variable might have been significant in DRG-based work and also one of the reasons why case costs of the poor are systematically higher in American analyses.[158] Of course, we have also seen in the Manitoba community hospitals RDRG-based regression that bed size is not a statistically significant determinant of costs when case mix is measured more fully.

Thorpe's re-estimation of the original HCFA double log econometric model, in which he included the case mix index, wage and city size as independent variables, calculated that teachingness and its correlates would add an extra 7.16%, approximately, for each increase of 10% in (1 + IRB), where IRB is the ratio of interns and residents to beds.[159] This indirect teaching effect is artificially high, but since we are running no models of our own for teaching hospitals and our comparisons explicitly hold constant only the variables in this Thorpe model plus acuity (as measured by RDRGs), one could argue that this might give us a rough estimate of the upper bound of expected teaching, bed size, acuity and other correlates contributing to the observed Manitoba differences in teaching and Winnipeg community hospital costs. The Health Sciences Centre's interns and residents to bed ratio of .226 (223/986) attributes 15.7% of costs to "the teachingness catchall" using the Thorpe high estimate.[160] Similarly, St. Boniface's ratio of .197 justifies a 13.7% add-on to base costs. This leaves unexplained excess costs of 14.7% at the Health Sciences Centre and 21.1% at St. Boniface.[161]

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[158] It is possible that Canadian Medicare's universal access without direct cost would render a disproportionate share of poor variable insignificant in a Canadian model.
[159] K. E. Thorpe, The Use of Regression Analysis to Determine Hospital Payment: The Case of Medicare's Indirect Teaching Adjustment. ***Inquiry*** 25 (Summer 1988) pp 219-231.
[160] $(1.226)^{0.716} = 1.157$.
[161] This comparison uses benchmark 1. If we use the $1922 urban community hospital benchmark (and simplify the discussion somewhat) this means that teachingness has justified costs per weighted case of approximately 1.157 x 1922 or $2,224 at the Health Sciences Centre. The remaining excess costs would be 14.7% at the Health Sciences Centre based on its cost per weighted case of $2,550.

The foregoing Thorpe model does not adjust for acuity or bed size, a correlate of acuity. Since the Manitoba case mix study does adjust for acuity (and might, in consequence, render the bed-size variable nonsignificant if we had a sufficient number of teaching hospitals to conduct a proper test) we think that the estimates derived from the above model are likely to overstate the costs of the "teachingness catchall" in the Manitoba context.[162] Also note that we excluded newborn bassinets from the calculations of (1 + IRB) because no information was available on whether these were included in the American models. If they should have been included, then the estimates of the Manitoba costs of teaching above and those that follow would be lower.

Rogowski employs another specification that held the same factors constant but better differentiated the city size from teachingness cost determinants. This is a version of the original Pettengill-Vertees double log specification which she modified, however, to test the effect of eliminating the bed size variable. HCFA adapted the Pettengill-Vertees model, dropping the beds variable, to originally quantify the effects of teaching for American Medicare. The coefficient of Rogowski's revision was .864, which means that each 10% increase in (1 + IRB) would be associated with approximately an 8.6% of teaching and other correlated costs. This coefficient would justify a 19.2% add-on at the Health Sciences Centre and a 16.8% add-on at St. Boniface.[163] This is another upper bound estimate.

Thorpe developed two additional models of interest here. One was a double log model which retained (1+IRB) as an independent variable but more fully specified other independent variables such that he obtained a truer estimate of the effects of teaching, as distinct from its other correlates such as bed size. This model estimated a coefficient of 0.362 for true teachingness,

[162] This conclusion would not hold if the omitted bed size coefficients were significant, very large and provided a non-behavioural explanation for the higher costs of St. Boniface and the Health Sciences Centre. Of course, bed size would not account for St. Boniface's cost per weighted case being higher than those of the Health Science Centre because the latter is substantially larger.

[163] Jeannette A. Rogowski and J. P. Newhouse, Estimating the Indirect Costs of Teaching, ***Journal of Health Economics*** (1992), Vol. II, p.153 - 171.

considerably lower than the earlier estimates. The inference from these equations is that teachingness explains 7.7% of the Health Sciences Centre's costs and 6.7% of those of St. Boniface. This model employed DRGs for taking case mix into account, thus it contained no acuity measure, except the beds variable, which is, at least in part, a proxy.

Thorpe's final model is similar to the foregoing one except that it is a semi-log model that uses spline dummy variables for teaching instead of the continuous variable (1 + IRB). He wanted to test the contingency that the relationship of teachingness and cost may differ over different threshold ranges.[164] The Health Sciences Centre and St. Boniface both fall into the second lowest size category, that is, teaching hospitals with ratios of interns and residents of 1-2.5 per ten beds. The coefficient of this dummy variable was .09, which means that true teachingness would justify 9.4% add-ons at each hospital.[165]

The final model that we will consider is Rogowski's most inclusive specification that also employs a spline function to quantify the effect of teaching. She started with a dummy variable to estimate the fixed costs of teaching and splines, each representing one sixth of the teaching hospitals as determined by the intern and residents to bed ratio distribution. Testing led to the following simplification of the model: one spline that represented the bottom five-sixths of the distribution and another representing the top sixth. The fixed cost coefficient proved to be nonsignificant and was therefore dropped. The coefficient of the spline into which the Health Sciences Centre's and St. Boniface's ratios would have fallen was .012. Under this model, the teachingness variable would explain about 1.2% of each hospital's costs.

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[164] The spline specification allows for different quantitative effects for different levels or thresholds of teaching activity.

[165] Thorpe's highest level of teaching activity is 4.0+ interns and residents per 10 beds, almost double the ratios of the two Manitoba teaching hospitals.

These analyses strongly suggest that true teachingness would explain little of the difference in costs per weighted case between Manitoba's teaching and urban community hospitals if the findings of the American models were relevant in the Canadian context. Based on American data, teachingness would explain 1.2 to 16.8-19.2% of teaching hospital excess costs in Manitoba. The true figures are likely to be at the low end of the range, perhaps as little as 1.2% or as much as 9.4%.[166] These add-ons would be consistent with the differences in the costs per weighted case between teaching and urban community hospitals in Alberta.

Some concluding remarks about the bed size variable are warranted. The bed size variable has been found to be significant in some studies. If it were a significant variable, then seemingly it could "explain" some of the two local teaching hospitals' excess costs because these hospitals are comparatively large. As mentioned earlier, the most plausible explanations for the significance of the bed size variable are that it proxies unobserved case mix and/or acuity differences between hospitals and/or reflects the higher order servicing mixes available in larger hospitals.

The Manitoba regression model supports this explanation, because the bed size variable was significant when the RDRG case mix index was the only expected case costliness indicator, but was no longer significant when the proportion of intensive care unit cases was added as an independent variable. If we could get a good reading on Manitoba teaching hospital costs with a regression model, it is quite possible that the inclusion of an RDRG case mix index, the proportion of intensive care unit cases and teachingness as independent variables would render a beds variable nonsignificant.

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[166] Note that the differences between the alternative Thorpe models were small as were the differences between the Rogowski models.

If, however, the beds variable in such a model were significant it is unlikely that its impact would be commensurate with the bed sizes of St. Boniface and especially the Health Sciences Centre unless the relationship is structural. We will consider that possibility below. Meanwhile, note that the bed size variable certainly cannot explain the differences in cost per weighted case between the Manitoba teaching hospitals. The cost per weighted case is higher at St. Boniface, even though St. Boniface is substantially smaller than the Health Sciences Centre -- and St. Boniface has less teaching activity.

The relationship between bed size and the costs in the two local teaching hospitals are unlikely to be linear for two reasons. First, if there is a relationship between bed size and acuity, undetected case mix differences and/or servicing capacity, this relationship could only apply over some limited range of bed size; it certainly could not apply indefinitely. Moreover, after a certain point, one would expect that in a market as limited as that of Winnipeg/Manitoba, as hospital size increases, the acuity and case mix levels would have to decline. Second, both of the local teaching hospitals had large portions of beds devoted to the care of long-term patients. The presence of these beds could not logically be associated with the cost factors discussed in this paragraph, except inversely.[167]

If the significance of the bed size variable were indicative of a structural relationship between costs and scale, this would not justify the continuation of funding these high cost facilities. Instead, the proper public policy would be to reduce the size of such hospitals until their costs decreased to a reasonable level.

[167] Note that the American hospital datasets that have been used in many of the models that showed the significance of a bed size variable usually do not have many hospitals the size of the Health Sciences Centre and St. Boniface, and also seldom have general hospitals with large long-term care components.

There is no evidence to suggest that there is a quantitatively consequential structural relationship between large size and high costs. Several Alberta hospitals have merged in recent years for the purpose of reducing costs. Similarly, competitive pressures have led American hospitals to merge to reduce costs. Finally, the literature on hospital cost functions supports the notion that hospital long-run average cost curves are either horizontal or gently increasing at the high extreme of the bed size range.[168]

Hence bed size is not a likely candidate for justifying the excess costs of the Manitoba teaching hospitals. The remaining a priori possibilities are that the hospitals are inefficient and/or that there are systematic unobserved case mix or acuity differences between the teaching hospitals and the urban community hospitals. Additional research, beyond the scope of this study, could be undertaken into these possibilities when the model is re-run on 1993/94 data.

Conclusions

In 1991/92, the costs of care at Manitoba teaching hospitals was high relative to that delivered at other hospitals in Manitoba. Budget cuts and bed closures at these hospitals since 1991/92 may have changed this picture. However, because teaching hospitals deliver such a high proportion of hospital care in the province, it is important to critically assess why their costs might have been so high.

Our analyses suggest that if the differential costs had been solely attributable to teaching, each intern and resident would have cost the province and extra $200,000 to $300,000 per year, an

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[168] T.G. Cowing, A.G. Holtmann and S. Powers, Hospital Cost Analysis: A Survey and Evaluation of Recent Studies, ***Advances in Health Services Research*** (Vol. 4, 1983) pp 257-299.

extraordinary burden on a publicly-funded system. It is unlikely that this explains all of the additional costs of the teaching hospitals. Comparisons of the excess costs of teaching hospitals based on American analyses suggest that an expected range of excess costs arising from teaching activities would be 1.2 to 9.4%, considerably lower than that what we found in Manitoba. When we make comparisons with other provinces, we do find that Alberta teaching hospitals are only 5.6% more expensive than Edmonton and Calgary major community hospitals, while Ontario teaching hospital are 32.8% more expensive than major urban hospitals in the province. In Manitoba, the difference is 39.7% between the teaching and Winnipeg community hospital costs per weighted case. Our analyses suggest that historical funding policies and practice patterns at the individual institutions are likely at least as important as case mix or teachingness in explaining these differences.

Because so much care is delivered at Manitoba teaching hospitals, and, at least in 1991/92, this care was so relatively expensive, careful ongoing scrutiny of the cost efficiency of these institutions must be maintained.

The results of the analysis suggest that the costs of teaching probably do not explain more than 1.2 to 9.4% of the teaching hospitals' excess costs, which average 35.2% (Brandon now included), using the urban community hospital average as the benchmark, or 56.3%, using the two least expensive urban community hospitals.[169] It is likely that the actual costs of teachingness would be at the lower end of the 1.2 to 9.4% range because the studies that generated the estimates did not take acuity into account. Acuity would, therefore, tend to be subsumed in the coefficients of the teachingness variables. There seem to be substantial unexplained excess costs, especially at St. Boniface.

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[169] This is despite the fact that the Maryland-based weights include the costs of interns and residents, which should create a bias in favour of the teaching hospitals because their types of cases would tend to be most affected.

APPENDIX K: FEATURES OF MARYLAND DATASET

Regulatory Environment

The Maryland Health Services Cost Review Commission (HSCRC) has four main areas of responsibility:[170]

- Ensuring public disclosure of hospitals' financial positions;
- Determining whether hospitals have adequate financial resources and helping them to maintain financial viability;
- Requiring hospital trustees to disclose conflicts of interest; and
- Conducting rate reviews and approving hospital rates,

The Commission's three basic regulatory goals are that:[171]

- Costs should be reasonably related to services;
- Charges should be reasonably related to costs; and
- All payers should be treated equally.

The Maryland regulatory system produces hospital charge data which are very suitable for the development of case cost and marginal cost weights. First, charges must reflect the costs of providing the service. Thus regulations prevent hospitals from charging different margins for different product lines or establishing some services as loss leaders to attract business to more

[170] Guide to Rate Review in Maryland Hospitals, Volume I, An Overview, (page unnumbered). The Trustees of the Educational Institute, Version 2.0. 1989.
[171] Ibid

profitable lines. This eliminates one common cause of weights that are inaccurate and unreflective of costs.

Second, the mark-ups that a hospital is permitted to build into its charges are essentially constant, irrespective of the source of payment. The only exception is that hospitals allow large third party payers (Medicare, Medicaid, qualifying HMOs and Blue Cross) 4-6% discounts that are said to represent the lower administrative costs attained with high volume billing.[172]

Third, the dataset includes the case costs of all inpatients treated in Maryland acute general hospitals. By contrast, the American Medicare DRG-based case cost dataset excludes most patients under the age of 65 years. Similarly, datasets of states without all payer systems often exclude portions of the population. Such exclusions engender the possibility that case costs will be biased.

The use of two years of Maryland data in the study to develop the initial weights expanded the number of cases to 1,260,000. The larger sample size increased the number and stability of weights in low volume RDRGs.[173] Even with over one million cases, there were many low volume RDRGs.

The Maryland dataset of hospitals consisted of 52 acute general hospitals. The dataset included hospitals with strong complements of psychiatric, paediatrics and acute rehabilitation patients. One hospital had a specialty paediatrics inpatient service similar in size to that of Children's Hospital at the Health Sciences Centre. In general, there was a good representation in the

[172] Ibid, p11

[173] There was a trade off between the currentness of data and the benefits of increasing the number of cases.

Maryland dataset of the kinds of services that are provided in Manitoba's general hospitals. If the Maryland delivery system had placed more emphasis of free-standing specialty hospitals, then some of the above listed types of cases might have been underrepresented or absent from the costing dataset.

Maryland average lengths of stay were generally shorter than the Manitoba averages for corresponding RDRGs, even when the Manitoba dataset was purged of cases from the poor coding hospitals and the non-acute cases of the good coders. The costliness of the Maryland case mix was somewhat higher than that of the Manitoba hospitals.

To put Maryland in the American context, its average lengths of stay were equal to the American average in 1988 and its average mix adjusted cost per case was 6% lower.[174] Prior to the establishment of its current regulatory system, its performance was much worse than average. In 1976, it ranked 47th among states with average case costs 24% above the American average.[175]

MCHPE performed various analyses on the Maryland data to test aspects of the data including the quality. Comparisons of Maryland RDRG lengths of stay with the Manitoba averages and analyses of the patterns of daily costs over the stays of Maryland long stay cases strongly suggest that the Maryland dataset is composed almost entirely of acute care patients, as expected because of the incentives for quick discharge in the American system.

Comparisons of RDRG average case costs in 1991 and 1992 showed reasonable stability, abstracting from the general trend of increasing costs, when the volumes of cases were sufficient

[174] *Guide to Rate Review in Maryland Hospitals*, Volume II, Version 2, 1989, Chart 4
[175] Ibid, Chart 4.

to make such a determination. The data also showed reasonable consistency in tests to determine whether the reported total case costs equalled the sum of their parts.

APPENDIX L: GLOSSARY OF TERMS

ADRG	Adjacent DRG (Collapsed RDRG)
ALC	Alternative Level of Care
ALOS	Average Length of Stay
Atypical	Patients with abnormal LOS, transfer, death, or non-acute days
CCs	Comorbidities and Complications
CIHI	Canadian Institute for Health Information
CMG	Case Mix Group
CTS	Central Therapy Services
CWC	Cost per Weighted Case
D&T	Diagnostics and Therapy
Daily Marginal Cost	Incremental cost of an additional day
DRG	Diagnosis Related Group
FIS	Financial Information Systems Data
Good Coding Hospital	Hospital the consistently uses service codes to identify non-acute cases
HCAM	Hospital Costs Allocation Methodology. A methodology developed by MCHPE
HCFA	Health Care Financing Administration (U.S.)
HMRI	Hospital Medical Records Institute* see CIHI
HSCRC	Maryland Health Services Cost Review Commission
ICD-9-CM	International Classification of Diseases, 9th Revision, Clinical Modification
LIS	Laboratory and Imaging Services
LOS	Length of Stay in Hospital
LTC	Long Term Care
M&S	Medical and Surgical Supplies
MCHPE	Manitoba Centre for Health Policy and Evaluation
MDC	Major Diagnostic Category

Non-acute days	
Notch	Period between ALOS and Trim
Outlier	A case which stays much longer than expected for a given RDRG
Poor Coding Hospital	Hospitals that do not use service codes consistently to identify non-acute cases
RA	Routine and Ancillary Charges, used by HMRI
RCW	Relative Case Weight
RDRG	Refined Diagnosis Related Group
Service Codes	Codes indicating patient services, for example: Geriatrics
Subservice	Codes indicating patient subservices, for example: panelled patients
Trim point	The point after which any additional days are classified as outlier days
Typical	Patients whose hospitalizations had a normal LOS, no transfer, death or non-acute days
WTALOS	The average length of stay with case mix held constant - used in deaths and transfers

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