CHILDREN'S HOSPITALS AUSTRALASIA

Costing Kid's Care

A Study of the Health Care Costs in Australian Specialist Paediatric Hospitals

LAETA

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Executive Summary

Key Findings

The key finding of this research study is that the AR-DRG system fails to account for a large number of complications and comorbidities that materially affect the cost of care of children, particularly of children cared for in Specialist Paediatric Hospitals.

This failure accounts for at least 77% of the difference between acute inpatient expenditure of Specialist Paediatric Hospitals and that expected given both their AR-DRG casemix and the average cost of these DRGs in other hospitals in their states.

The study identifies 1,497 ICD-10-AM diagnosis codes that are not part of the AR-DRG Patient Complication and Comorbidity Level (PCCL) structure but which can be used to identify groups of AR-DRGs where the cost relativities for Specialist Paediatric Hospitals are materially different from those of the rest of the health system. Hence AR-DRG evaluation (based on a single set of AR-DRG normative costs) is invalid if applied to a mix of general hospitals and Specialist Paediatric Hospitals.

The AR-DRG system does not recognise age effects on complication and comorbidity levels of diagnoses, however this project has demonstrated the existence of such effects.

This project has significantly clarified that differences in the cost of health care for children exist. It offers a basis for determining the appropriate uplift in funding/budget for Specialist Paediatric Hospitals compared with that of other hospitals. If a Specialist Paediatric Hospital is appropriately funded, that funding level can now be justified by an understanding of the structural reason for differences in costs of care for children. Where a Specialist Paediatric Hospital is not funded to cover the extra cost, this clearer understanding may be used to make a case for funding adjustment.

Research Issues

This research report addresses key evaluation, costing and funding issues pertaining to Specialist Paediatric Hospitals in Australia. The report examines:

- Are DRG based evaluations of Specialist Paediatric Hospitals appropriate?
- If not, why are they not appropriate?
- Are Specialist Paediatric Services too different for standard funding systems?
- What are the key ways these differences matter?
- What are the likely funding implications of the differences?
- What more can be done to address the appropriate funding of specialist paediatric inpatient services?

The research was commissioned by Children's Hospitals Australasia, and funded by a consortium of specialist paediatric hospitals from NSW, Victoria, Queensland, South Australia and Western Australia.

Summary of Findings

DRG based evaluation of Specialist Paediatric Hospitals' performance efficiency is not valid because of differences in cost relativities between Specialist Paediatric Hospitals and other public hospitals

- Comparison of Specialist Paediatric Hospitals' costs by DRG, with the average costs for all hospitals in the state/territory showed that in all instances Specialist Paediatric Hospitals having higher costs overall.
- Specialist Paediatric Hospitals are not uniformly more costly but have higher costs per case for some DRGs.
- The differences between costs in Specialist Paediatric Hospitals and general hospitals and in the pattern of DRG cost relativities are (statistically) persistent across time and jurisdiction.
- The findings show that these persistent and consistent differences are structural, relating to the cases treated rather than the administration of the hospitals.

"Pure" Casemix Funding of Specialist Paediatric Hospitals would have a major impact on Specialist Paediatric Hospitals' financial viability

- Analysis showed the differences between Specialist Paediatric Hospitals' costs and their states' costs are not uniform across all ranges of AR-DRG costs.

- There is no clear range of National AR-DRG cost weights where Specialist Paediatric Hospitals expenditure correlates with the cost expected based on state average costs.
- Notional casemix funding (based on State Average AR-DRG costs) of Specialist Paediatric Hospitals would have a material effect on the viability of each of the Specialist Paediatric Hospitals in this study.

Material cost relativity differences between Specialist Paediatric Hospitals and the broader system are indicated across all age ranges present in Specialist Paediatric Hospitals. The differences in AR-DRG cost relativities were greatest for neonates and children under 3 years.

Partitioning by medical, surgical and procedural case-type failed to remove the cost relativity differences between Specialist Paediatric Hospitals and the broader system

- No particular broad case-type appears to be specifically related to the reason for the interaction effect between hospital type and DRG case type cost.

The differences in DRG cost relativities were evident in a variety of components including ward (nursing), clinical (medical) and operating theatre costs.

With the small numbers of paediatric patients the additional cost due to complexity of care in Specialist Paediatric Hospitals cannot be exposed at the individual Diagnosis Related Group (DRG) level.

The analysis of cost impacts suggests some broad MDC (Major Diagnosis Category) case types that are more likely to have higher costs per separation.

- MDCs most commonly involving higher costs were:
  - Diseases and Disorders of Respiratory System - Medical Partition
  - Diseases and Disorders of Digestive System - Medical Partition
  - Diseases and Disorders of Hepatobiliary - Surgical Partition
  - Diseases and Disorders of Endocrine, Nutritional and Metabolic - Procedure Partition
  - Diseases and Disorders of Kidney and Urinary Tract - Medical Partition
  - Diseases and Disorders of Female Reproductive System - Surgical Partition
  - Newborns and Other Neonates - Medical Partition

Childhood Complications and Comorbidities (CCC) codes not taken into account by the AR-DRG system, have been found to provide strong prediction of higher AR-DRG costs in Specialist Paediatric Hospitals.

- Highly credible and empirically verified English studies have identified a list of 3,071disease codes that complicate care of paediatric cases (Childhood Complicating Conditions - CCC). Of these 1,495 are not recognised as complications by the Australian AR-DRG system.

- Medical record coders in Australia are recording these diagnoses suggesting a material affect on the care of children.

- 15% of the Paediatric cases have at least one of these codes, so up to 15% of episodes of care in our data have been materially affected by the presence of secondary diagnoses that the AR-DRG Classification has not taken into account.

- A list of DRGs was defined based on the frequency of occurrence of these codes in the AR-DRGs across the (NSW) public health system as a whole.

- AR-DRGs where these CCC codes are in higher frequency (when the frequency exceeds 1/5) account for the majority (at least 77%) of Specialist Paediatric Hospitals' shortfall difference between expenditure and expected expenditure.

AR-DRG design rather than Specialist Paediatric Hospital practice appears to account for discrepancy in the DRG cost relativities between Specialist Paediatric Hospitals and other hospitals

- The effect of the codes' presence on expenditure difference and AR-DRG cost relativities was consistent across all of the Specialist Paediatric Hospitals in the study.

- The codes' effect on the adult portion of the system as a whole was shown to be small.

- There is strong evidence of CCC that have reduced effect on adult cases in which they occur, indicating the need for AR-DRG redesign.

- Importantly, our identification of a group of codes affecting Specialist Paediatric Hospital AR-DRG costs shows the cost variation is about treatment population and not hospital practice. Therefore we have indirectly identified a group of DRGs that are candidates for funding uplift in Specialist Paediatric Hospitals.

- The codes that affect Specialist Paediatric Hospitals will also impact child cases with these codes, in other hospitals.

A net increase in ED attendances from 2002 to 2006 was indicated for Specialist Paediatric Hospitals.

- Some hospitals reported strong growth in the proportion of more serious triage categories in this period. All hospitals showed a decrease in the relative proportion of 'non-urgent' cases.

Specialist Paediatric Hospitals have a much higher level of Outpatient Occasions of Service relative to inpatient separations compared to the state system as a whole. Outpatient numbers are growing to minimise admissions for ongoing treatment such as chemotherapy.

- The historical funding basis for most hospitals outpatient services is not adequate to address the growth and rapidly changing nature of outpatient services.

Recommendations

This study has identified long, medium, and short term actions needed to achieve appropriate casemix based funding of Specialist Paediatric Hospitals and other paediatric units.

Long Term:

- Redesign the AR-DRG system to accommodate diagnosis codes with age affected comorbidity and complication levels (CCLs).

Medium Term:

- Calculate individual AR-DRG cost-weight uplifts based on the relative frequency of age-interacting childhood complexity codes not accounted for in the AR-DRG system.

Short Term:

- Communicate to State and Federal Authorities the cost pressures experienced by Specialist Paediatric Hospitals and Paediatric Units in treating a population with hidden complexity. State Authorities should review their paediatric funding adjustments in line with the magnitude of the discrepancy identified in this study.
- Base productivity assessments of Specialist Paediatric Hospitals and Paediatric Units on their performance on the unaffected (DRGs with low frequency of CCCs) portion of their caseload.
- Conduct further research on the list of age-interacting comorbidities to more precisely discriminate the AR-DRGs in need of an uplift for Specialist Paediatric Hospitals and Paediatric Units.
- Review the adequacy and funding basis of ED and outpatients' services to address the growth in services and the increased complexity of the services provided.

Chapter One: Introduction

Questions about appropriate funding of specialist paediatric inpatient services and related issues of relative cost efficiency and quality of care have been raised and investigated in Australia (Victorian Department of Human Services, 2004), (Aisbett & Blandford, 2001), (Hanson, 1998), and internationally (NACHRI, 2007).

The underlying motivation for these investigations in Australia and elsewhere is the perception that specialist paediatric hospitals have relatively higher cost per case-weighted separation. These perceptions are based on documented comparisons of the cost of providing specialist services against evaluations of the services' output. Paediatric hospital outputs are compared with the average cost of Diagnosis Related Groups (DRG) in the broad health systems. But are these DRG based evaluations fair? The fundamental issue in funding paediatric hospitals according to output is whether there is a method by which their output may be evaluated relative to other hospitals.

The research questions from which the research evolved were:

- Are specialist paediatric hospitals uniformly more expensive than other hospital types across their caseload?
- Where are specialist paediatric hospitals different in the costs and treatment of sub-populations compared with other hospital type groupings?
- Do Specialist Paediatric Hospitals have a higher level of expensive outlier cases and skewed within DRG cost distributions that may be attributable to community pressure to save a child's life at all costs?
- Examine whether a more comprehensive appraisal of the services supplied by specialist paediatric hospitals through ED and inpatients services suggests they provide a more appropriate comparative framework for assessing specialist paediatric hospitals expense in DRG terms.

This research report addresses key costing and funding issues pertaining to Specialist Paediatric Hospitals (Specialist Paediatric Hospitals) in Australia. The report examines:

- Are DRG based evaluations of Specialist Paediatric Hospitals fair?
- If not, why are they not fair?
- Are Specialist Paediatric Services too Different for DRG based Funding?
- What are the key ways these differences matter?
- What are the likely funding implications of the differences?
- What more can be done to address the appropriate funding of specialist paediatric inpatient services?

The research was commissioned by Children's Hospitals Australasia, and funded by a consortium of specialist paediatric hospitals from NSW, Victoria, Queensland, South Australia and Western Australia.

Report Outline

The next chapter investigates if the Specialist Paediatric Hospitals really are different as a class, and if so does it matter for AR-DRG based evaluation. Chapter 3 continues this investigation by looking at where and how they are different. Chapter 4 identifies why they are different and how it may be accommodated in AR-DRG terms. Chapter 5 provides a review of Emergency Department and Outpatient services with contrast between State level data sets and between Specialist Paediatric Hospitals. The final chapter, Chapter 6 presents conclusions and recommendations and includes considerations on how the findings affect other children's hospitals.

Background

Some basic concepts underpin the investigation and are critical to comprehension of the findings of the research.

Hospital Costing

Cases treated by a hospital can be described by their DRG case-mix, which is the combination of Diagnosis Related Groups (DRGs) that are present in the discharge dataset. Costs can be assigned retrospectively to each DRG seen by a hospital. Since a

DRG may consist of one or more separations, it is customary to express the cost of DRGs in two parts as follows:

1. As a cost per separation for the DRG; and
2. The number of separations making up that DRG.

The relativities between the cost of each DRG are predictable and can be used to model hospital costs through the application of a suitable base value. The schedule of cost relativities is commonly referred to as cost-weights.

AR-DRG Classification

The AR-DRG Classification system therefore underlies costing and evaluation of technical efficiency of hospitals. It is therefore critical to consider how the classification system works and any potential source of difficulties for Specialist Paediatric Hospitals. The system is based on hierarchies of diagnoses and procedures distributed between surgical, medical and other partitions. The grouping process includes the following tasks in order of presentation:

1. Demographic and clinical edits
2. Major Diagnostic Category (MDC) assignment
3. Pre-MDC processing
4. Adjacent DRG (ADRG) assignment
5. Complication and comorbidity level (CCL) and patient clinical complexity level (PCCL) assignment
6. DRG assignment [1]

The AR-DRG numbering reflects three elements including the broad group the DRG belongs, adjacent DRGs within the MDC and the partition to which the adjacent DRGs below and the split indicator that ranks DRGs within adjacent DRGs on the basis of their consumption of resources. The complications and comorbidity codes (CCs) are the key drivers in the determination of the split assignment. How this works has been described in previous publications:

[1] Source: AR-DRG v5.0 definitions Manual

> The complications and comorbidity codes (CCs) constitute the severity of illness adjustment applied within the AR-DRGs. Where these codes apply, they are considered likely to result in significantly greater resource consumption. Each diagnosis is assigned a rank, known as a "complication and comorbidity level" (CCL). The value of the rank is between 0-3 for medical episodes and 0-4 for surgical and neonatal episodes. A code of zero indicates that the diagnosis does not represent a complication or comorbidity, forms part of the definition of the Adjacent DRG, is already on the record, or that the complication or comorbidity is closely related to the principal diagnosis. A code of 1 indicates a minor complication or comorbidity, 2 moderate complication or comorbidity, 3 severe complication or comorbidity and 4 catastrophic complication or comorbidity. Each additional diagnosis thus has a complication or comorbidity level assigned to it. Various combinations of these levels can be combined together into a summary patient-level measure, the 'patient clinical complexity level' (PCCL) which takes into account all the additional diagnoses for that admission. In determining the PCCL, a CCL may be reassigned to zero if the complication or comorbidity is closely related to another higher or equivalent level complication or comorbidity on the record. For example, two unrelated diagnosis codes ranked at level 2 are summarised into a single overall PCCL measure of 3. These overall summary measures are then used as part of the splitting procedures for defining individual DRGs (Aisbett, Wiley, McCarty, & Mulligan, 2007).

Within most AR-DRGs the number of children is small. While previous studies have shown clinical differences between children and adults and the existence of highly specialised conditions, the small number of episodes does not allow for meaningful costing of such conditions because it is statistically impossible to control for all sources of variation to allow valid comparisons (Victorian Department of Human Services, 2004).

Public funding of Specialist Paediatric Hospitals

The public funding of hospital services in general and Specialist Paediatric Hospitals in particular, has evolved differently in the different states, and even for different institutions within the same state. It may be taken for granted that sufficient funding has been provided to allow the delivery of health services meeting at least the basic expectations of the community. The funding principles are very often not transparent, and may not be equitable, and indeed may not provide sufficient resources for the ongoing operation of quality care in some types of publicly funded hospitals. However, there will be a nexus between Specialist Paediatric Hospitals' costs and the funds provided, if for no other reason than the community's expectation that these health services exist in a viable form.

Methodology

Data

The principal source of data for this study was the data collection held by Children's Hospitals Australasia (CHA). It was important to draw on data that reflected the true cost of hospital inputs in Specialist Paediatric Services (SPS) since other costing methodologies potentially mask important differences. A selection of Specialist Paediatric Hospitals with advanced inpatient costing systems, were chosen to participate in the research. They were:

Children's Hospital at Westmead (CHW)
Sydney's Children's Hospital (SCH)
Royal Children's Hospital Melbourne (RCHM)
Children Youth and Women's Health Service (CYWHS)
Royal Children's Hospital, Brisbane (RCHB) and
Princess Margaret Hospital (PMH)

Hospital profiles of participating hospitals can be found at Appendix I.
The data supplied by these hospitals were five main types:

- Inpatient morbidity data
- Patient level cost data for inpatient episodes
- Survey data addressing issues of the hospitals' operations
- Summary data on Emergency Department attendances
- Summary data on Outpatient Visits

Reference data were sourced from the Australian Institute of Health and Welfare (AIHW) website. These were of a summary nature as there is only restricted assess to data identifying jurisdiction. Although not purposefully so, the effect of these access limitations is to seriously curtail rigorous scientific investigation of matters of national interest. For example, it was not possible to determine the frequency by State by AR-DRG by hospital type by age group of certain diagnosis codes.

The AIHW does publish extensive data for public sector inpatients at state level. Much of these comparative data were acquired from the AIHW and/or the National

Hospital Cost Data Collection in summarized form. These report AR-DRG LOS and cost statistics suitable for a range of comparisons with summarized CHA data. These comparisons were between each of the study hospitals and their states (NSW, SA, VIC, WA and QLD). The state-wide cost data were drawn from the National Hospital Cost Data Collections (NHCDC) for 2003/04, 2004/05and 2005/06 as count and average costs per case (by AR-DRG). The study hospitals' data were used to provide average costs by year and hospital for all available years. All costs were adjusted for inflation using the national CPI figures.

The questionnaire data was collected by a survey administered by Laeta Pty Ltd on behalf of CHA. It aimed to provide contextual information to assist in the interpretation of analyses and possible general effects expected within the data. Such information included:

- a brief description of the services provided, including any specialised referral services and their definitions;
- a summary of statutory requirements unique to children's services and estimated cost impact and affect on activity;
- a description of any significant identified differences in clinical practices between children and adult services;
- the costing systems used, particularly in respect to "modelling" versus patient level cost attribution;
- how the ED department is configured and costed;
- if any observation unit (EMU) was introduced and how activity is identified;
- a description of the transfer (in and out) practices with general and other hospitals;
- whether hospital-at-home activity is defined and recorded;
- data items collected for outpatient services and how multi-disciplinary contacts are recorded.

The central purpose of the survey was to understand how the hospitals may differ from each other and from other hospitals in their state. The other data referred to above, Emergency Department and Outpatients were collected for the same type of informal analysis and to cross reference responses in the surveys with relevant activity data.

Chapter Two: Specialist Paediatric Hospitals' Cost Relativities

Chapter Summary

The initial analysis compared Specialist Paediatric Hospitals' costs by DRG, with the average costs for all hospitals in the state/territory. The analysis showed that in all instances Specialist Paediatric Hospitals show higher costs overall. The analysis indicated that Specialist Paediatric Hospitals are not uniformly more expensive but more expensive for some DRGs and less expensive for others. The analysis shows difference in the pattern of DRG cost relativities in Specialist Paediatric Hospitals compared to other public hospitals in their state. Therefore, the fundamental requirements for casemix based technical efficiency comparisons do not apply to Specialist Paediatric Hospitals.

The differences between costs in Specialist Paediatric Hospitals and general hospitals and in the pattern of DRG cost relativities are (statistically) persistent across time and jurisdiction. The findings suggest that the persistent and consistent differences are structural, relating to the cases treated rather than the administration of the hospitals.

Analysis shows that the Specialist Paediatric Hospitals cost differentials are not uniform across all ranges of cost but no clear pattern has emerged as to the particular cost range where Specialist Paediatric Hospitals are most cost efficient. The impact of the cost differential in notional casemix funding were applied and showed major deficits for all the Specialist Paediatric Hospitals.

Differences in Clinical Practices at Specialist Paediatric Hospitals

The inherent differences between the clinical treatment of children compared to adults in hospitals have been acknowledged in both Australia (Hanson, 1998) and internationally (NACHRI, 2007). The report by the National Association of Children's Hospitals and Related Institutes (NACHRI) states that in the USA children require extra time, extra monitoring, specialized medications, specialised instrumentation and caregivers with the specialist skills and compassion to understand the needs of children. The report notes that hospitalised children under age 2 require

45 percent more routine nursing care. Similar, findings have been reported in Australian paediatric hospitals for children less than 3 years (Adelaide: Paediatric Nursing Study Consortium , 1996). There is wide recognition internationally that neonatal intensive care is expensive (Richardson, 2001).

In a report to the Victorian Department of Human Services (Victorian Department of Human Services, 2004), a number of factors related to the treatment of children were considered for their likely impact on Royal Children's Hospital Melbourne's (RCHM) costs. Analysis showed that 48% of RCHM separations had received a general anaesthetic compared with 21% state wide. The estimated cost impact was $2.9 million casemix adjusted. The disproportionate number of separations with congenital anomalies (14.3% separations versus 1.3% state-wide) and the higher number of transfer in separations (5.6% separations versus 2.7% state-wide) were also estimated to have an impact on costs. Further exploration of a select number of RCHM specialities involving clinical experts' inputs revealed clear differences between adults and children. Children received more specialised care than adults (Victorian Department of Human Services, 2004).

The survey of participating paediatric hospitals identified a number of differences in clinical practices between children and adult services. Differences include:

- Anaesthetic for simple procedures and IV administration of pharmaceutical agents and removal of venous catheter.
- Higher nurse dependency
- No student medical staff (interns) employed in Specialist Paediatric Hospitals
- Specialist nursing staff
- Education and support for families (including accommodation)
- Distraction and play therapy
- Entertainment and school facilities

Due to their specialist role Specialist Paediatric Hospitals also provide clinical services to children in other hospitals. In addition, some of the paediatric hospitals, RCHM, CYWHS, PMH (since 2006) and CHW (since July 2004) provide Hospital at Home Services.

All the Specialist Paediatric Hospitals in the survey reported an extensive range of outpatient and outreach services referred to in the profile of hospitals at Appendix I. Services related to requirements under child protection laws included:

- Review of children presenting with child protection issues
- Provision of a child protection consultation service
- Managing relationships with child protection departments
- CYWHS provides a forensic investigation service into reports of child abuse and has a staff advisory role.

The survey information provided details on each hospital's transfer arrangements within the wider hospital system. The table below presents the tertiary services requiring inbound transfers. It should be noted that CYWHS provides inbound transfer services for patients in SA and NT hospitals. Patients for cardiac, lung and heart transplants are transferred to RCHM for surgery after a workup at CYWHS.

Table 1: Tertiary services requiring inbound transfers.

SCH	RCHB	CYWHS	PMH
Trauma	Trauma	Paediatric Intensive Care	Neonate
Neonatal Surgery (incl Cardiac)	Burns	Paediatric surgery – specialties*	
Paed/ Neonate Intensive Care	PICU	Paediatric medicine – specialties*	
Emergency General Surgery		Paediatric Intensive Care	
Plastic Surgery			
Specialised paediatric consultation			

Note:* see Appendix I for specialist services

Previous work (Victorian Department of Human Services, 2004), indicates that although the rates of transfer in are higher in Specialist Paediatric Hospitals than state's hospitals generally, the rates remains low. The elevation in costs of transfers in are generally understood to be around 20% but given the low incidence these cases alone could not account for impact observed in earlier research (Victorian Department of Human Services, 2004), (Aisbett & Blandford, Costing Kid's Care: An Investigation into cost differentials for Paediatric Patients, 2001).

Cost Components Evaluation

As described above, differences in the role and inpatient population affect the inputs and services delivered by Specialist Paediatric Hospitals. The fundamental issue in funding Specialist Paediatric Hospitals according to output is whether there is a method by which their output may be evaluated relative to other hospitals.

The last 20 years has seen the rise of Diagnosis Related Group (DRG) case-mix as the most common cost evaluation methodology. The feature of DRG systems is that the classification divides the inpatient treatment population into clinically coherent and statistically homogeneous groups. In concept, the case-types are defined by their hospital inputs of goods and services, to the extent that any two cases in the same DRG are expected to consume the same amount of each good and service.

During the development of multi-institutional cost schedules, it emerged that the cost of the hospitals' differing production functions can be broadly modelled as a change in base cost (Aisbett & Rendalls, 2001). The notion of different base costs follows as a logical consequence of the assumption that the relativities between costs recorded in a hospital's AR-DRG cost schedule are predictable, even if the actual value for a particular AR-DRG is not. This model, referred to as the Hospital Casemix Cost Model (HCCM), assumes that these relativities remain constant across a broad sample of hospitals (including those being studied), and that they change only slowly over the years. The schedule of relative values is referred to as AR-DRG cost-weights. The base cost (for a cost-weight schedule) is the single value which, when multiplied by each of the cost-weights in turn, produces the original schedule of costs.

Previous research (Aisbett & Blandford, 2001) suggested that in practice the underlying assumption that relativities between DRG groupings are consistent across hospitals doesn't work when dissimilar hospitals are considered. The previous section shows that the goods and services used in the treatment of children are different from adults in the same case-mix grouping or children treated in different setting. The research therefore considered:

Are specialist paediatric hospitals too dissimilar to be evaluated using health system wide case-mix approaches?

It is important to ask this question as hospital funding models that use cost-weights assume the one set of relativities are relevant to all the hospitals being funded. If this assumption is wrong then the funding model is flawed and potentially unfair. The cost efficiency comparisons made on this basis will similarly be flawed and lead to inappropriate conclusions (Andrew, 2002).

An analysis was undertaken to investigate the costs of care (at DRG case-type level) in Specialist Paediatric Hospitals relative to the costs of this care in the state system as a whole. The analysis also considers the pattern of relative cost of AR-DRGs in the Specialist Paediatric Hospitals compared with the state system. The investigation of patterns is the study of the interaction effects between AR-DRG cost relativity and hospital type.

Cost Component Analysis

Hospital cost data from the Australian Institute of Health and Welfare (AIHW) for the years 2003/04, 2004/05 and 2005/06 and Children's Hospitals Australasia (CHA) supported a casemix cost analysis involving each of the study hospitals and their states (NSW, SA, VIC, WA and QLD). The data were restricted to AR-DRGs which occurred in the paediatric hospitals.

The Generalised Least Squares method (Aisbett C. , 1999) was used to derive the following statistics at State/Hospital-Year level:

- GLS Index of Costliness
- CMA Index of Costliness
- Ratio (compares GLS and CMA indices for the same State/Hospital-Year)

.

The GLS index assesses the relative costliness of the hospital/state based on a model that includes the casemix and the hospital/state effect. Using this model the costs of a DRG for that hospital/state is compared with a reference set that includes the other hospitals and states but exclude the costs of the entity. Values greater than one imply that the entity is more costly than the reference group and values less than one suggest the hospital/state entity is less costly than the reference set of hospitals/states at the DRG level.

Case-Mix Adjustment (CMA) Index is an Indirectly Standardised Index which is most often used in case-mix work. The defining feature of CMA is that it uses normative values from a broad system (generally averages across the whole data collection). CMA index similarly assesses the relative costliness but based on a model that includes casemix effects but not the individual hospital/state effect. For this model the entity costs per DRG are compared with the average costs for that DRG across all entities including the hospital/state being indexed. A key assumption that underlies the validity of this evaluation method is the absence of any interaction effect between hospital type and AR-DRG grouping. In other words relativities between AR-DRG (defined as bundles of goods and services) are consistent across hospitals. The use of indirect standardized measures in assessing hospital performance in the UK has been criticized because of its reliance on this assumption (Andrew, 2002).

The third statistic used in the analysis is the ratio of the two indices. This will be around 1 when the relative costs of DRGs for the given hospital is the same as the reference set for both indices. This is because the inclusion or exclusion of the hospital specific costs has not material bearing the cost relativities DRG to DRG. When the hospital cost relativities is not consistent with the reference set the ratio will be appreciably different from 1. The statistics were derived for each of the study years. The results for 2005/06 are presented in Table 2.

Table 2: Results for GLS and CMA ratios for states and Specialist Paediatric Hospitals 2005-2006.

Hospital/State	GLS Index	CMA Index	Ratio	Separations
QLD 05-06	0.95	0.95	1.00	699,113
VIC 05-06	0.91	0.92	1.00	1,211,920
NSW 05-06	1.03	1.03	1.00	1,324,119
WA 05-06	1.14	1.14	1.00	438,585
SA 05-06	0.97	0.97	1.00	366,771
PMH0506	1.50	1.38	1.09	21,112
RCHM0506	1.17	1.08	1.09	33,558
CHW0506	1.34	1.23	1.09	26,724
SCH0506	1.35	1.23	1.09	13,665
CYWHS0506	1.18	1.08	1.10	18,886
RCHB0506	1.09	0.99	1.10	15,781

The analysis shows considerable variation in both cost indices across datasets, but a marked tendency of the Specialist Paediatric Hospitals to have higher indices than their states (for the same year). Most evident, is the strong pattern in the ratio of indices, with the states' having value 1 and the hospitals value around 1.09 and 1.10, which is strong evidence that AR-DRG cost relativities are not the same in general data as in paediatric data (Aisbett & Rendalls, 2001). There is a multiplicative interaction between AR-DRG cost relativity and hospital type particularly affecting Specialist Paediatric Hospitals. That is, Specialist Paediatric Hospitals have a different AR-DRG relativities than the system as a whole.   This result invalidates standard interpretations of the main effect of Specialist Paediatric Hospitals as being uniformly more expensive than the general hospitals in their state. It is the hypothesis of this project that persistent and consistent differences are structural, relating to the cases treated rather than the administration of the hospitals. The results are consistent with international findings. NACHRI (NACHRI Case Mix Program, 2000) research showed that the relative cost weights for paediatric patients tend to be similar or a little lower than for an all age patient population for severity level 1, similar for severity level 2, but higher for severity levels 3 and 4 within the same APR-DRG. These findings are consistent with Specialist Paediatric Hospitals having different cost relativities.

Length of Stay - Distribution Analysis

Longer length of stay within AR-DRG generally implies extra costs. Analysis of the length of stay distribution for different case-types was undertaken by comparing the mean and the percentile points (25, 50, 75, and 95) for AR-DRGs with more than 20 valid cases in the Specialist Paediatric Hospitals. The mean and percentile cut-offs were compared with the National Data (AIHW) for public hospitals. The analysis tested the technical efficiency argument that if Specialist Paediatric Hospitals were uniformly more expensive then the distribution of the length of stay of cases for a given DRG would have the same form but different scale as the distribution for the state as a whole. In other words, we would expect the Specialist Paediatric Hospitals to show a more stretched out flatter distribution than the pattern of the overall state pattern for length of stay for a given DRG. The Goodness of Fit test between two distributions was conducted which showed that the shape of the distribution of the Specialist Paediatric Hospitals is fundamentally different than the national distribution of length of stay for a range of case-types.

The pattern of length of stay in Paediatric hospitals shows that for a range of DRGs the 95 percentile point is much higher than the national average even if the median length of stay is similar to the national average. This suggests for a small set of cases in certain AR-DRGs the length of stay increases substantially. Examples of such DRGs are given below.

Table 3: Comparison of LOS Distribution Statistics for Selected AR-DRGs

AR-DRG		A06Z	W01Z	Y01Z
Title		Tracheostomy Or Ventilation>95	Ventiln/Cranio Mult Sig Trauma	Severe Full Thick Burns
Mean length of stay (days)	Paed	44.2	39.7	56.1
	Pop	32.5	33.7	51.7
25th percentile for length of stay	Paed	12	13	25
	Pop	13	15	19
Median for length of stay (days)	Paed	21	24	38
	Pop	23	25	38
75th percentile for length of stay	Paed	41	41	60
	Pop	39	44	80
95th percentile for length of stay	Paed	138	148	186
	Pop	85	83	145
Episodes	Paed	1407	137	83
	Pop	8317	1126	126

A skewness measure was devised by calculating the ratio of a LOS distribution's 95 percentile to it median for the Specialist Paediatric Hospitals and the state. After removing all AR-DRGs with 1.00 as their 95 percentile, a statistically significant (log-log) regression was found relating the system-wide average cost of a DRG to the amount by which the paediatric LOS Ratio exceed the system-wide LOS Ratio. This means the more expensive the AR- DRG the more skewed to the right the Specialist Paediatric Hospitals LOS distribution is relative to the state distribution.

This finding is relevant to the research because it indicates that for case-types where clinical discretion is more likely to come into play, a small proportion of case receive markedly more care even in comparison to a similar selection of adult cases. This finding supports the hypothesis that societal expectations that a child's life is more valuable than an adult's. Other explanations could be there is a lack of suitable transfer arrangements for follow-up care of children.

Transfers back to Local Hospitals

In the survey of Specialist Paediatric Hospitals, SCH, RCHB, CHW and CYWHS all gave the following reasons for transfer back to local hospitals:

- Clinical needs of patients suitable
- Convenience and family
- Local hospital has sufficient infrastructure and beds

PMH transfers back for some secondary services such as recovery from bronchitis and some surgery such as tonsillectomy.

Only SCH and CYWHS reported formal transfer arrangements.

Review of the CHA morbidity data shows that across the board, and even for episodes with stays longer than the AR-DRG specific 95 percentile point in their state, more than 90% are discharged home, and no more than 4% are transferred to another acute facility. CYWHS is less likely to transfer patients to another acute setting even after a long stay than are the other Specialist Paediatric Hospitals. We note that for patients with long stay in their AR-DRG, death is a more likely outcome than for the usual cases but even at the 95 percentile of stay the frequency of death does not exceed 1%.

These findings do not added support to the hypothesis that longer stays come about through extreme efforts to save lives of children.

Financial Viability Under Notional Casemix Funding

This section looks at a notional funding model and explores the impact of cost differentials between average state AR-DRG costs and average AR-DRG costs for the Specialist Paediatric Hospitals. The notional funding model is very simple: Provide funds to the hospital that would allow it to cover the cost of its inpatient work, if the cost of that work was the state average cost for the same AR-DRG casemix and load.

An analysis was undertaken for each hospital using 2003/04 and 2004/05 data for states and hospitals. The analysis plots (as y) the cumulative difference between the hospital's costs and the notional cost (based on the state average calculated at an AR-DRG level) for AR-DRGs valued at or less than each cost (x) on the x-axis. The analysis seeks to also identify the AR-DRG cost ranges where the cost differential has the greatest impact on the hospitals' financial viability.

The graph below for RCHM shows the overall cost impact for RCHM was $44.88m (+16.10%) in the two years 2003/04 and 2004/05. The loss of profitability start to occur for the DRGs with a state average cost of around $900, with the cost difference being less pronounced and following an even rate from $2,000 to $44,000. The exception being a pronounced drop due to DRG Z64A *Other Factors Influencing Health Status* which had a state average cost of $5934 compared to $1096 (1153 cases) at the hospital resulting in a total potential gain of
$5,577,675.

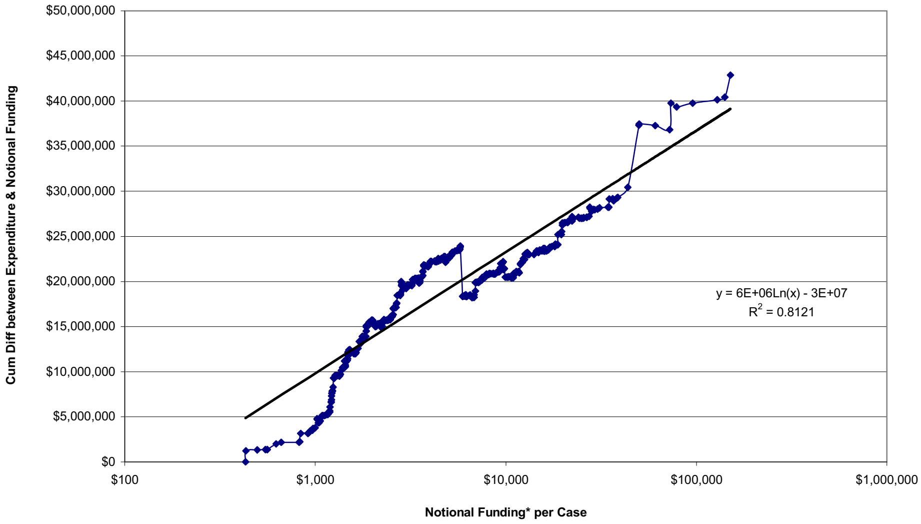

Figure 1: RCHM cumulative loss of profitability v AR-DRG State Cost

Similar analysis for each of the hospitals is provided at Appendix III. A general pattern emerges for each of the Specialist Paediatric Hospitals in the study. The Specialist Paediatric Hospitals all lose money under this model. If the swings and roundabouts in AR-DRG funding were even and the Specialist Paediatric Hospitals were managing well, then the cumulative difference would be zero. As the graphs at Appendix III show, each of the participating hospitals indicate significant deficits. No clear pattern related to the DRG value ranges impact on financial viability was discerned.

AR-DRGs that show high cost volumes in excess of the state average costs are shown in the table in Appendix IV with the shortfall difference.

Conclusion

The analysis showed the expected gap between the total costs of each the Specialist Paediatric Hospitals hospital and expected total cost based on average state DRG costs. The graphical analysis showed the Specialist Paediatric Hospitals cost differentials are not uniform across all ranges of cost but no clear pattern has emerged as to the particular cost ranges where Specialist Paediatric Hospitals are most cost efficient.

The next chapter elucidates the nature of the structural differences and examines why they increase the value of production of Specialist Paediatric Hospitals in a way that cannot be explained in simple AR-DRG terms. In particular the funding issues cannot be scientifically addressed by the elevation of the base rate in a funding formula. A better understanding is required to match funding with activity.

Chapter 3: Where Specialist Paediatric Hospitals Differ

Chapter Summary

The data was partitioned according to common age ranges, medical cases, surgical cases or procedural cases. Within the age partitions, the interaction between case-type and hospital type is greatest for neonates and children under 3 years but was also present for the older 15 and 16 year old patients. Similarly the partitioning by medical, surgical and procedural cases failed to remove the cost relativity differences between Specialist Paediatric Hospitals and the broader system. Casemix technical efficiency analysis is invalid if an interaction effect is present. Therefore it is not possible to draw conclusions about the technical efficiency of Specialist Paediatric Hospitals even after restricting attention to common age ranges, medical cases, surgical cases or procedural cases.

Exploration of the various cost components shows the interaction effect is evident in a variety of components including ward costs, clinical and operating theatre costs. Indeed the ward nursing cost component showed a high interaction effect suggesting children have distinctly different pattern in AR-DRG nursing requirements than adults.

The analysis of cost impacts suggests some broad MDC (Major Diagnosis Category) case types that are more likely to have higher costs per separation.

Broad Case Type as a Possible Driver of Costs

Previous studies (Aisbett & Blandford, 2001), (Aisbett C. , 2003) have similarly identified differences in the cost relativities between Specialist Paediatric Hospitals and other hospitals. A set of analysis was undertaken to try to identify the source of difference by excluding different case types. The analysis of cost indices discussed in the previous chapter, was undertaken with further restrictions applied (separately) to the case types considered: They were:

- Exclude MDC 14 (Obstetrics)
- Exclude Error AR-DRGs

- Exclude Surgical AR-DRGs
- Exclude Procedural AR-DRGs
- Exclude Medical AR-DRGs

Although there was greater variance in the indices (including some attributable to excluded type), the ratios for the Specialist Paediatric Hospitals were uniformly about 1.1 while those for the states were approximately 1.0, no matter what exclusions were applied. We conclude therefore that there are important interactions between Specialist Paediatric Hospitals type and AR-DRG cost relativities across the broad spectrum of case-types.

Another feature of the indices data that persisted even with the exclusions list above was that the both the GLS and CMA index value for Specialist Paediatric Hospitals (with very few exceptions) was larger than the values for the respective state. This suggested that Specialist Paediatric Hospitals are more costly in providing services across a broad spectrum of case-type, but this inference ignores the interaction discussed above.

Age Groups Impact Costs

Chapter 2 identified previous research in Australia (Hanson, 1998) and internationally (NACHRI, 2007) showing the cost differential between children and adults is not uniform across sub-populations of Specialist Paediatric Hospitals. These findings suggested that the cost differentials between participating Specialist Paediatric Hospitals and other hospitals reported in Chapter 2 may be driven by specific age groups of the hospitals patients' population. The data from each of the Specialist Paediatric Hospitals were split into age group categories for comparison with the general hospitals (without age-splits).

The age groups used were as follows:

- Neonates
- <3 years (excl neonates)
- 3-13 years
- >13 years

Problems of low case numbers and highly variable costs meant that data for a number of years had to be combined (after CPI adjustment). The decision was made to only include the two financial years 2003/04 and 2004/05 to reduce reliance on CPI adjustment and yet to have sufficient data.

The results can be seen in Table 4. The GLS index appeared very high in some instances however this is not unusual for such small numbers of separations (and skewed distributions). A few highly expensive cases at a particular Specialist Paediatric Hospitals could inflate the index considerably. Inspection of the index values for the different age groups showed no clear pattern. In some Specialist Paediatric Hospitals the highest index is for Neonates and for other Specialist Paediatric Hospitals the 15 &16 years age group recorded the highest index. The presence of extremely expensive isolated cases with such small numbers of separations makes it difficult to detect any systematic pattern in terms of the relative cost of different age groups adjusted for DRG.

The rows of Table 4 are sorted by the statistic “Ratio” (of GLS to CMA) and show a clear distinction between the states’ data and the Specialist Paediatric Hospitals age group specific data. Despite the lack of distinctive pattern in the index values the ratio scores are consistent across Specialist Paediatric Hospitals. The older children are closest to the model compliant ratio (i.e.1.0), and the under 3’s and neonate groups being most different (being over 1.10 indicating poor compliance with the HCCM).

The implication of the Ratio being greater than 1 not easy to interpret but it suggests that there is relatively common work in the broad hospital system that is not so common in Specialist Paediatric Hospitals and that this work has higher cost relativity in the Specialist Paediatric Hospitals than in the broader system.

Table 4: Paediatric hospitals with age groups, all data combined (inflation adjusted)

Hospital	Patient Grouping	GLS Index	CMA Index	Ratio	Number of Separations
RCHM	Neonates	1.47	1.29	1.14	1,549
CHW	Neonates	1.23	1.09	1.13	1,198
SCH	Neonates	1.18	1.06	1.11	760
CYWHS*	Neonates	1.64	1.48	1.11	466
CYWHS*	3-14 yrs	1.12	1.01	1.11	18,873
CYWHS*	< 3 yrs(excl. neonates)	1.22	1.10	1.10	11,974
PMH	< 3 yrs(excl. neonates)	1.52	1.39	1.10	6,026
PMH	Neonates	1.28	1.17	1.10	695
CHW	< 3 yrs(excl. neonates)	1.32	1.20	1.09	17,850
RCHM	< 3 yrs(excl. neonates)	1.10	1.01	1.08	21,533
PMH	3-14 yrs	1.49	1.38	1.08	11,197
SCH	3-14 yrs	1.21	1.12	1.08	14,465
CHW	3-14 yrs	1.28	1.18	1.08	27,466
SCH	< 3 yrs(excl. neonates)	1.22	1.13	1.08	9,956
RCHM	3-14 yrs	1.06	0.99	1.07	33,652
CHW	15&16 yrs	1.59	1.51	1.05	5,712
RCHM	15&16 yrs	1.26	1.20	1.05	10,103
PMH	15&16 yrs	1.99	1.89	1.05	2,574
SCH	15&16 yrs	1.29	1.23	1.05	2,773
CYWHS*	15&16 yrs	1.32	1.26	1.05	5,783
NSW Public Hospitals	All cases	1.01	1.01	1.00	2,236,526
WA Public Hospitals	All cases	1.13	1.13	1.00	770,652
SA Public Hospitals	All cases	0.93	0.93	1.00	620,305
Vic Public Hospitals	All cases	0.94	0.94	1.00	2,074,234
Qld Public Hospitals	All cases	0.89	0.89	0.99	1,255,022

*child cases only

The ratio (indicative of compliance to HCCM) is close to 1 for the states as expected, and then deviates away from 1 from oldest to youngest patient age groups, with neonates indicating a particular different type of cost structure – most interactive with Specialist Paediatric Hospitals versus standard care.

There are no surprises in the finding that neonatal patients are different in paediatric hospitals, but the ratio is also very high for the under 3's and this forms a large part of the caseload. Bearing in mind the age specificity of many AR-DRGs, these findings clearly suggest consistent differences between state and Specialist Paediatric Hospitals cost structure that is much more pronounced than those between the states.

While the actual indices vary between Specialist Paediatric Hospitals the ratio for the different age groups is fairly stable suggesting there is a strong structural explanation for the difference between Specialist Paediatric Hospitals and other hospital populations.

Differences in Cost Components in Specialist Paediatric Hospitals

Another potential source of the interaction effect is a difference in the nature of various cost components of an AR-DRG's costs. The source of the interaction could be a particular set of inputs in a patients care in Specialist Paediatric Hospitals that makes them different from other hospitals. For instance, in the survey of Specialist Paediatric Hospitals identified higher nursing dependency with more specialised skills as a source of higher costs. Of interest is whether nursing costs are uniformly higher in Specialist Paediatric Hospitals or whether they exhibit a different pattern of cost relativities for nursing than other hospitals in the state. Specialist Paediatric Hospitals also identified anaesthetics costs as a possible source of difference between children and adult populations' treatment. Clinical costs would also be expected to be different in Specialist Paediatric Hospitals because of the higher level of specialisation required.

A cost indices analysis was undertaken for a number of cost components including:

- Ward costs[2] (nursing costs makeup the bulk of this cost component)
- Clinical (medical) costs
- Operating Theatre costs

[2] Nursing costs could not be separated out from ward costs for one of the Specialist Paediatric Hospitals

Table 5: Ward Cost Component Indices Comparing Specialist Paediatric Hospitals and States (2005/06)

Hospital/State	GLS Index	CMA Index	Ratio	Separations
NSW 05-06	0.854	0.860	0.993	1,324,262
VIC 05-06	1.113	1.117	0.997	1,212,063
QLD 05-06	0.921	0.924	0.997	699,256
SA 05-06	1.004	1.002	1.001	367,001
WA 05-06	1.196	1.192	1.003	438,784
PM0506	1.097	0.994	1.104	21,128
RCHM0506	1.308	1.182	1.107	33,586
RCHB0506	1.190	1.072	1.110	15,752
SCH0506	1.401	1.260	1.112	13,669
CYWHS0506	1.481	1.326	1.117	18,861
CHW0506	1.558	1.392	1.120	26,554

Based on CMA index, ward costs appear generally higher in VIC and WA and lower for QLD and NSW. With the exception of PMH ward costs are higher at the Specialist Paediatric Hospitals compared to their respective state costs for all public hospitals. The magnitude of Specialist Paediatric Hospitals' CMA indices varied from hospital to hospital.

Ratio scores for each of the states are around 1 for this cost component but Specialist Paediatric Hospitals exhibit ratios around 1.10 and 1.11. A strong interaction effects for ward costs is indicated. Nursing costs relativities then for Specialist Paediatric Hospitals differs from nursing cost relativities by AR-DRGs for other public hospitals.

The cost indices for clinical (medical) cost (see Appendix V) vary substantially between states and hospitals. Despite the variance in the indices, ratio figures indicated that cost relativities for clinical costs for paediatric hospitals are different and consistently different across Specialist Paediatric Hospitals.

Cost indices for theatre costs again varied between states and across Specialist Paediatric Hospitals (see Appendix V), however, ratio figures for the Specialist Paediatric Hospitals vary more than other cost components ratio score but all are sufficiently different from 1 to indicate that cost relativities for operating theatre costs for Specialist Paediatric Hospitals are different to the system as a whole.

Case-type Impacts on Costs

The second phase of the analysis examined the case-types that show the highest cost relative to the state wide cost. Children's hospital costs by DRG for two years were compared with the average costs for all hospitals in the state/territory. For 63% of DRGs the average cost at a Specialist Paediatric Hospitals was higher than the state average. Discerning patterns in hospital average cost at the DRG level proved difficult because of the high variability in costs with a low number of episodes within many DRGs.

To identify some broad case categories associated with higher costs at Specialist Paediatric Hospitals, DRG's were grouped by the first two items in the code – part of body and type of treatment (0=Surgical, 1=Procedural, 2=Medical). Each group was scored for the number of DRG's within that broad category that cost more than the state average. A binomial test was conducted to find broader case types that were more likely to be more or less expensive at Specialist Paediatric Hospitals.

Specialist Paediatric Hospitals were significantly more expensive for around half the broader case-types (MDC) than their respective state average cost (DRG adjusted). These are shown in Table 6 below.

Table 6: Case types more expensive at Specialist Paediatric Hospitals compared to respective state cost

MDC Groups and Partition
Major Procedures not Associated with a Particular MDC - Surgical Partition
Major Procedures not Associated with a Particular MDC-Procedure Partition
Diseases & Disorders of the Nervous System - Surgical Partition
Diseases & Disorders of the Nervous System- Medical Partition
Diseases and Disorders of Ear, Nose, Mouth and Throat- Medical Partition
Diseases and Disorders of Respiratory System - Procedure Partition
Diseases and Disorders of Respiratory System- Medical Partition
Diseases and Disorders of Circulatory System - Surgical Partition
Diseases and Disorders of Circulatory System - Procedure Partition
Diseases and Disorders of Circulatory System- Medical Partition
Diseases and Disorders of Digestive System - Surgical Partition
Diseases and Disorders of Digestive System Procedure Partition
Diseases and Disorders of Digestive System- Medical Partition
Diseases and Disorders of Hepatobiliary - Surgical Partition
Diseases and Disorders of Hepatobiliary - Procedure Partition
Diseases and Disorders of Endocrine, Nutritional and Metabolic - Procedure Partition
Diseases and Disorders of Endocrine, Nutritional and Metabolic- Medical Partition
Diseases and Disorders of Kidney and Urinary Tract - Surgical Partition
Diseases and Disorders of Kidney and Urinary Tract- Medical Partition
Diseases and Disorders of Male Reproductive System - Procedure Partition
Diseases and Disorders of Female Reproductive System - Surgical Partition
Diseases and Disorders of Female Reproductive System- Medical Partition
Newborns and Other Neonates- Medical Partition
Diseases & Disorders of Blood, Blood Forming Organs, Immunological Disorders- Medical Partition
Neoplastic Disorders (Haematological & Solid Neoplasms) - Surgical Partition
Infectious & Parasitic Diseases, Systemic or Unspecified Sites - Surgical Partition
Infectious & Parasitic Diseases, Systemic or Unspecified Sites- Medical Partition
Mental Diseases and Disorders- Medical Partition
Multiple Trauma- Medical Partition
Injuries, Poisoning and Toxic Effects of Drugs- Medical Partition

Not all these broad case types were more expensive at all the participating Specialist Paediatric Hospitals. The case types that were consistently more expensive at all participating Specialist Paediatric Hospitals are listed in Table 7 below.

Table 7: Case types consistently more expensive at Specialist Paediatric Hospitals compared to state.

MDC Groups and Partition
Diseases and Disorders of Respiratory System - Medical Partition
Diseases and Disorders of Digestive System - Medical Partition
Diseases and Disorders of Hepatobiliary - Surgical Partition
Diseases and Disorders of Endocrine, Nutritional and Metabolic - Procedure Partition
Diseases and Disorders of Kidney and Urinary Tract - Medical Partition
Diseases and Disorders of Female Reproductive System - Surgical Partition
Newborns and Other Neonates - Medical Partition

In other instances, 5 out of 6 of the paediatric hospitals were more expensive (AR-DRG adjusted) in comparison with state costs.

Table 8: Case types significantly more expensive at Specialist Paediatric Hospitals than respective states at 5 out of 6 Specialist Paediatric Hospitals.

MDC Groups and Partition
Diseases and Disorders of Male Reproductive System - Procedure Partition
Nervous System Disorders - Medical Partition
Diseases and Disorders of Circulatory System - Medical Partition
Diseases and Disorders of Digestive System - Procedural Partition
Diseases and Disorders of Hepatobiliary - Procedural Partition
Mental Diseases and Disorders - Medical Partition
Diseases and Disorders of Male Reproductive System - Procedure Partition
Factors Influencing Health Status and Other Contact with Health Services - Procedural Partition

'Diseases and Disorders of the Male Reproductive System' (Medical and Surgical partitions) were the only broad case types where the participating Specialist Paediatric Hospitals were significantly less expensive.

Conclusion

This chapter has sought to identify a clear case type or cost component that varies in a systematic way at Specialist Paediatric Hospitals compared other hospitals. Broad case type partitioning, by medical, surgical or procedural cases did not remove the interaction effect between DRGs and hospital type suggesting the differences in the DRG cost relativities at Specialist Paediatric Hospitals to the broader system occurs for each others' broad case types. The analysis by age groups suggests younger cases, in particular, neonates and children under 3 years is where the distortion of relativities is greatest.

Exploration of the various cost components shows the interaction effect is evident in a variety of components including ward costs, clinical and operating theatre costs. Therefore, known clinical practices, such as the higher use of anaesthetics in invasive procedures and more specialist nursing in the treatment of children, does not account for the extent of observed differences in cost relativities. We conclude that treatment population requirement drives the observed differences in cost.

A number of broad MDC case types have been identified as the most likely to impact on Specialist Paediatric Hospitals' profitability.

The question remains however, 'What makes this broad array of case types more expensive at Specialist Paediatric Hospitals?' This is the subject of the next chapter.

Chapter 4: Potential Reasons for Inpatient Cost Differences

Chapter Summary

Highly credible and empirically verified English studies have identified a list of diagnoses not occurring in the AR-DRG Definitions as childhood complications. Fifteen percent of the paediatric cases have at least one of these codes so about 15% of episodes of care in our data where care has been materially affected by the presence of secondary diagnoses that the AR-DRG Classification does not take into account.

A list of AR-DRGs that include this extra complication is defined without selective reference to the Specialist Paediatric Hospitals data. The importance of Specialist Paediatric Hospitals' independence from the list is that it identifies the observed effects as a consequence of AR-DRG design rather than Specialist Paediatric Hospitals practice.

AR-DRGs where these CCC codes are in higher frequency (when the frequency exceeds 1/5) account for the majority (at least 77%) of Specialist Paediatric Hospitals' shortfall, difference between expenditure and expected expenditure.

The importance of the effect being found in each Specialist Paediatric Hospitals in the study is that such constancy shows the variation is about treatment population and not hospital practice. Therefore we have identified a group of DRGs that are candidates for funding uplift in Specialist Paediatric Hospitals.

International Development of Casemix Coding Systems

UK Version HRG4

Healthcare Resource Groups (HRG) are the UK equivalent of the Australian DRG classification system. They are described as standard groupings of clinically similar treatments that consume similar levels of healthcare resource (The Information Centre, Casemix Service, National Health Service UK, 2007). The HRG system is refined every 3 to 4 years with the latest version HRG4 released in 2007. In this version the significance of complications and comorbidities and of differences in age has been further recognised and enhanced. The groups have been split in every case where a variation in resource use could be demonstrated to be due to these factors. Groups specifically for Paediatric patients were also extended both within the childhood conditions chapter (92 HRGs) and paediatric splits in other chapters (86 HRGs).

Defining CC Splits and Refinement

The purpose of the complication and comorbidity splits is to allow 'HRGs to better reflect varying degrees of clinical complexity and severity' (The Information Centre, Casemix Service, National Health Service UK, 2007). One clear difference between HRGs and AR-DRGs is that its chapter structure (matching MDC in AR-DRG) includes a Paediatrics while the AR-DRG does not.

Each chapters of the current HRG version has its own complication and comorbidity list (CC list) which identifies diagnoses that result in additional resources being used by patients. The CC lists are used to split HRGs into three levels rather than simply 'with' and 'without CC' as in earlier HRG versions:

Level 1 – Not a significant complication
Level 2 – Intermediate complication
Level 3 – Major complication

The HRG design group (The Information Centre, Casemix Service, National Health Service UK, 2007) point out that a particular diagnosis may be a major complication for some procedures yet not be a relevant complication for others. 'The relevance and ranking of complications and comorbidities was assessed at chapter level by specialty groups to ensure that CCs are appropriately allocated and ranked.' Therefore, the CC list developed for the Paediatric chapter have been specifically devised to reflect the impact on resources when treating children. The lack of a "Paediatric" MDC in AR-DRG means such a focussed approach was not possible.

Rigorous Process for Compiling the CC List

The Design Team responsible for refining the HRG system consisted of representatives from the Department of Health and from the clinical and managerial professions, IT, the independent sector, the academic sector, hospital Chief Executives and key members of the Casemix Programme. The team was organised into 33 Expert Working Groups (EWG), consisting of 284 clinicians and finance professionals supported by a team of casemix experts and statisticians from the Information Centre. Fifty one professional associations and Royal Colleges provided representatives, including a Clinical Lead for each of the working groups. The role of each EWG was to define chapter/sub-chapter specific CC lists and decide which HRGs should have a CC split applied based on statistical analysis. The large datasets available from the NHS meant that the statistical precision of this work was well beyond any level possible in Australia.

Design issues affecting multiple clinical areas, were considered by four Expert Reference Panels (ERPs) to ensure that a uniform and consistent approach was applied across the portfolio (The Information Centre, Casemix Service, National Health Service UK, 2007).
The ERPs were:

- Paediatrics
- Cancer Services
- Chronic Disabling Diseases
- Specialised Services.

Where again the issued concerned with the provision of Paediatric services were given particular emphasis and systematically examined. The current payment system using the previous version of HRGs for NHS treatments in English hospitals (Department of Health , 2006), provides for a payment uplift of 11% for paediatric admissions unless classified to a paediatric specific HRG. A further payment uplift of 69% is made for specialised paediatric service admissions, defined as having a specified diagnosis or procedure from a published list.

Credibility of Statistical Analysis

A breadth of data from the NHS was used to analyse the effectiveness of the CC splits. It should be noted that databases from the UK are much larger than Australian data sources because of population volume (the English inpatient admission MDS contains in excess of 12 million records per year). This provides a more reliable basis for deriving cost estimates and statistical power to detect real differences in costs within diagnostic related groups

The design process included baseline analysis of existing v3.5 HRGs - by length of stay, cost, finished consultant episode count, age distribution and contribution to unexplained variation - leading to identifying those failing HRG4 Design Framework rules. From analysing this data the EWG were able to select the HRG3 groups that required refinement and define chapter/sub-chapter specific CC lists and decide which HRG should have a CC split. See Appendix VI for further information on the methodologies used.

US Version of DRG's

In 2000 NACHRI (NACHRI Case Mix Program, 2000) examined the benefits of using a system referred to as All Patient Refined Diagnosis Related Groups (APR-DRGs) compared to the previous HCFA-DRG. APR-DRG were more accurate at determining case mix indexes for children's hospitals. A key reason for this was a clearer definition severity levels. There are four subclass levels: 1 = minor, 2 = moderate, 3 = major, 4 = extreme.

The end result is an updated set of subclass level assignments that more clearly distinguish patient resource use (severity of illness) and mortality rates (risk of mortality). Compared to the previous version of APR-DRG, there are somewhat fewer Level 3 and 4 patients, but the cost differences between each severity level and mortality differences between each risk of mortality level are generally larger and more distinctive.

Relative cost weights for paediatric patients compared to an all age patient population tend to be similar or a little lower for severity level 1, similar for severity level 2, but higher for severity levels 3 and 4 within the same APR-DRG. This pattern, especially the higher weights for severity levels 3 and 4, is particularly pronounced for a Specialist Paediatric Hospitals population as in the cases of Septicaemia and Simple Pneumonia (NACHRI, 2000). It should be noted that much of the overall pattern for Specialist Paediatric Hospitals for severity levels 3 and 4 is driven by the paediatric populations at children's hospital and other major teaching general hospitals.

To illustrate possible effects on children's hospitals the NACHRI report (NACHRI Case Mix Program, 2000) showed alternative cost weights for children's hospitals classified the costs to the differing severity levels (similar to the AR-DRG PCCL).

Patient's admitted for Septicaemia with Major severity level, the cost weight for paediatrics was 9.3% higher than that for all hospitals, whilst children's hospitals were 32.2% and for patients with an extreme severity the figures were 14.8% and 29.3% higher respectively.

In England there were separate costs produced for children's Allogenic Bone Marrow Transplant[3], these were approximately 66% higher at an average cost of £80,500, and this cost difference is reflected in a higher set of cost weights.

For chemotherapy the propensity of children's cases are dominated by Leukaemia where the costs of drugs are normally expected to be higher.

Understandings of the potential for cost differences driven by clinical differences (such as in Chemotherapy) on its own provides an argument that the case-type relativities applying to Specialist Paediatric Hospitals are different than those in the general hospital. A further "commonsense" step is thinking that the existing relativity should therefore be uplifted. However this is not necessarily the position of a statistician or a casemix system designer. The statistical background is that the casemix approach relies on swings and roundabouts and selecting a case-type for an uplift just on the basis it may be more expensive should, at very least, be balanced through a process of selecting case-types for a down weighting in Specialist Paediatric

[3] Reference Costs 2005-06, Department of Health, 2006.

Hospitals. In more detail, the designer would see the need to find a MDC wide process for selecting weight changes that was not biased towards uplifts and one in which the basis of the uplift was not treating hospital type but features of the cases themselves. This divergence between commonsense at the case-type by treating hospital type level and good sense at the classification system design level is a theme we will return to often.

AR-DRG Developments

The AR-DRG system, in common with most advanced casemix systems [HRG v4, APR-DRG], has developed towards the use of comorbidity rather than age as a classification variable. That is, the presence of coded diseases, other than those occasioning admission to hospital[4], can be used to determine if the patient would be expected to require more complex care.

The Australian Coding Convention is a formal document from the National Centre for Classification in Health and explains that secondary diagnoses (that are not logically related to the Principal Diagnosis) should only be recorded if their presence materially affected the care of the patient during this particular episode of care. Therefore if two records are the same other than for the presence of a particular co-morbidity then the record with the co-morbidity is expected to have consumed more resources than the other.

The AR-DRG system has been constructed in a relatively information poor environment and so has relied on swings and roundabouts in a considered way. For example, if a known complication of care is extremely common in some AR-DRGs and rare in all others, it could well be ignored. As a general principle, a complicating diagnosis is only worthy of special attention if there is at least one proto AR-DRG in which its rate of occurrence varies markedly between hospitals. If this is not the case, then the known clinical complication can be ignored for classification purposes. An issue arises if the distribution of such a complication is affected by patient age, particularly in Specialist Paediatric Hospitals. Another feature of the relative paucity of data for the study of CCs during the development of AR-DRG is that statistical power was lacking in some tests, especially for uncommon codes. Since children form

[4] AR-DRG considers the complexity of some primary diagnoses in MDC 14

such a small proportion of inpatients, complications of their care were more difficult to test, and interactions between age and the added complexity of a code were essentially untested.

Recent developments in England described above have provided information that assists. The current English case-mix system (HRG V4) uses co-morbidity in its classification in much the same way as AR-DRG V5.1. The CC list from the UK 'Paediatric' chapter was compared with total CC lists recognised in the current AR-DRG coding system. The English casemix system recognises 3,071disease codes that complicate care of paediatric cases (Childhood Complicating Conditions - CCC). Of these CCCs, 1,495 are not recognised as complications by the Australian AR-DRG system.

There are a number of reasons why the omission of these codes (or their ICD-10-AM maps) from the Australian classification may have material impact on paediatric funding. The Australian Classification defines AR-DRG. Such considerations include:

- whether the omitted codes really impact care
- the Australian Classification lacks age based conditioning of complexity
- the materiality of the impact on care of these codes has been establishment for HRG using the huge English dataset.

The construction of HRG4 includes chapters, one of which is 'Childhood Disorders'. This meant that conditions that specifically complicate the care of paediatric aged cases could be studied in a focussed way. It led to the supposition that a condition may be a material complication in the care of children while not being one in the care of adults. The Australian classification has limited capacity to handle such a situation - there is no built in age based modification of the degree of complication of secondary codes. Even if the Australian classification was designed to handle age by complication level interactions, it would be difficult to establish reliable rules based on Australian morbidity data – estimating interaction effects that involve categorical variables with many different values require massive datasets. There are no suitable Australian datasets however the English data could be used to test length of stay effects.

It is clearly worth testing whether the presence of CCC codes not recognised in the AR-DRG system has some relationship to the difference between state and Specialist Paediatric Hospitals costs. The data access restrictions limited direct testing of this feature; however a testing process was derived.

Testing the Impact of HRG4 Childhood Complicating Conditions on Specialist Paediatric Hospitals Costs

Data

The unit level morbidity data were available for the study hospitals, as were reliable DRG level cost data (no data on variation within the cost data). The AIHW data, based on the NHCDC gave reliable estimates for the state-wide average costs of the care of each AR-DRG and also the number of episodes. Using these datasets, it was possible to extract the effects of the study hospitals on the state average DRG costs and so contrast the AR-DRG costs for each study hospitals with its state average net of the hospital(s) itself. This meant that statistically independent contrasts between a study hospital and its state system could be performed. There was no within AR-DRG variation data available, which made the analysis potentially problematic[5]. Earlier we referred to the divergence between commonsense at the case-type and good sense at the classification system design level. It is important to understand that an evaluation based on identifying CCC codes missed by AR-DRG design but with relatively high frequency in Specialist Paediatric Hospitals would lead to a biased assessment of CC code impact. So selection of an AR-DRG for comparison between Specialist Paediatric Hospitals and the more general system needs to be based on the frequency of these codes in the AR-DRG across the whole system. Next, AR-DRG development looked for CCs that impacted materially across case-types, so simultaneously restricting attention to a small number of AR-DRGs and a small number of CCCs is unlikely to show anything. Therefore the testing process needs to consider many of each in any contrast (between Specialist Paediatric Hospitals and the rest of the system). It is also appropriate to improve statistical independence by forming the state system average data without including the Specialist Paediatric Hospitals.

[5] The usual test of statistically significant differences between populations requires estimates of variance.

We now need to consider the hypotheses to test and how our data (with its limitations) may be used to provided evidence about these hypotheses. In outline we feel that the AR-DRG system has missed CCCs that materially impact the cost of care in Specialist Paediatric Hospitals but not so in the system outside the Specialist Paediatric Hospitals. If this is correct then we would not expect the codes to impact anything when attention was restricted to AR-DRGs where they were in low frequencies, but for an escalating impact to occur as their frequencies increase. Amongst the areas of hypothetical impact are the average cost of treating the cases (after adjusting for AR-DRGs included) and the compliance of the data with our model for casemix costs. Our measure of this compliance is the ratio between the hospitals' GLS index and their CMA index. A ratio materially different from unity is evidence that the hospital follows a different pattern of AR-DRG cost relativities than does the comparison set. If all the Specialist Paediatric Hospitals have similar ratios markedly different from 1 then our hypothesis that the cost relativities between Specialist Paediatric Hospitals and the remainder of the health system result from treatment population rather than hospital practice is supported. The data involved in this study are sufficiently extensive to mean that material differences observed may generally be taken to be statistically significant.

Process used to Identify DRGs Impacting on Appropriate Evaluation of Specialist Paediatric Hospitals

We now outline the process of selecting the AR-DRGs to form our list of case-types that are likely to be inherently more expensive (in relative and absolute terms) in SPS than in the rest of the system. The steps were:

- Obtain an independently derived list of diagnosis codes that impact on the care of children
    - This was sourced from the Paediatric Chapter of HRG redesign
    - The list does not exclude codes that occur in some general (adult) Chapter of HRG
- Map the diagnosis codes in the independent list to those used in Australia
    - This was done using the NCCH mapping tables available on the Web
- Compare the mapped list with the secondary codes recognised as potentially complicating in any Adjacent AR-DRG (ADRG) of the Australian system

    - This was done by flagging all codes that had an AR-DRG system Neonatal CCL score and all other codes that were assigned a CCL score in at least one ADRG

- Remove flagged codes from the CC list as being (approximately) covered by AR-DRG logic

    - This is a very cursory method of refining the CC list (to reflect CC codes underutilized in AR-DRG). It may well be that a removed code influences the care of only a handful of adult cases but most paediatric cases it occurs in. Also we may be stripping codes that are much more significant complications for children but only modest in adults.

- Use an available public hospital morbidity dataset to determine the relative frequency (within AR-DRG) of records with at least one of the codes retained from the mapped English list.

    - Again this is a very cursory approach, since multiple occurrences of these codes would normally be associated with higher severity of complication.

    - We only had permission to access one year (2005/06) of NSW public hospital morbidity data from which to calculate the AR-DRG frequencies.

- Identify complementary groups of AR-DRGs based on the relative frequency of CCCs. For example AR-DRGs where less than 10% of the NSW records for that AR-DRG contain at least one of codes and the complement set of AR-DRGs where at least 10% of records have such a code.

    - Complementary sets of AR-DRG were found for the threshold levels, 10%, 20%, 25% and 50%.

Learning, Testing and Evaluation Process

A formal learning, testing and evaluation process for testing the impact of these thresholds was executed as follows:

- We chose to use the years 2003/04 and 2004/05 as the independent learning set and the 2005/06 data as the testing set and then the combined data to see if material changes occurred between the first two and the final years.

- We adopted the Hospital Costing Casemix Model to test for the changes in main effect of hospital type and interaction between type and AR-DRG across the complementary sets of AR-DRGs

- We extracted the contribution of each the study hospital-year to its AR-DRG specific State-Year count of episodes and average to make the contrasts statistically independent. Results of Partitioning Data Based on CCC lists are below.

Findings from Partition Analyses

Childhood CC Partitions

Table 9: Partition Effects of CC Codes

20%Partition	NSW DRGs with less than 20% of records affected			NSW DRGs with at least 20% of records affected		
Hospital/State	CMA Index	Ratio	Separations	CMA Index	Ratio	Separations
CYWHS 03/04	0.95	1.02	12,968	1.08	1.06	6,358
CYWHS 04/05	0.99	1.02	11,697	1.16	1.06	5,866
CYWHS 05/06	1.05	1.02	12,029	1.15	1.05	6,854
RCHB 03/04	0.84	1.02	10,182	1.00	1.06	5,140
RCHB 04/05	0.81	1.02	9,844	1.01	1.06	4,972
RCHB 05/06	0.95	1.02	9,620	1.08	1.06	6,164
CHW 03/04	1.02	1.02	16,203	1.29	1.06	9,277
CHW 04/05	1.06	1.02	16,654	1.36	1.06	10,036
CHW 05/06	1.07	1.02	16,520	1.36	1.06	10,178
PMH 03/04	1.21	1.02	12,362	1.46	1.06	7,788
PMH 05/06	1.34	1.02	12,510	1.47	1.06	8,571
RCHM 03/04	0.98	1.03	19,320	1.03	1.07	13,247
RCHM 04/05	1.04	1.02	19,890	1.09	1.07	13,715
RCHM 05/06	1.11	1.03	18,901	1.13	1.07	14,730
SCH 03/04	1.01	1.02	8,018	1.12	1.07	6,329
SCH 04/05	1.10	1.02	8,197	1.27	1.07	5,654
SCH 05/06	1.20	1.02	7,563	1.27	1.07	6,040
NSW 0304	1.09	1.00	532,855	1.02	1.00	485,235
NSW 0405	1.05	1.00	542,365	0.99	1.00	477,259
NSW 0506	1.06	1.00	642,744	1.06	1.00	521,928
QLD 0304	0.83	1.00	203,195	0.89	0.99	183,152
QLD 0405	0.90	1.00	207,202	0.92	0.99	203,233
QLD 0506	1.00	1.00	356,527	0.98	1.00	257,523
SA 0304	0.88	1.00	163,364	0.90	0.99	117,962
SA 0405	0.95	1.00	150,060	0.95	0.99	113,924
SA 0506	0.99	1.01	172,339	1.00	1.01	143,370
VIC 0304	0.95	1.00	583,532	0.96	0.99	366,990
VIC 0405	0.93	1.00	605,991	0.94	0.99	384,392
VIC 0506	0.94	1.00	651,924	0.93	0.99	428,567
WA 0304	1.08	1.00	177,768	1.15	1.00	104,722
WA 0506	1.20	1.00	234,807	1.12	1.01	148,328

Table 9 shows that partitioning on the AR-DRGs in which the selected complications less common (threshold 20% of records) improves the compliance ratio, reduces the Costliness index and selects the majority of episodes when contrasted with the complementary set of AR-DRGs(with at least 20%). The partition effects noted above are nowhere near as pronounced on the state data. It should also be noted that as the compliance ratio tends towards 1 then the validity and reliability of the costliness index is improved.

These results would be more pronounced with the development of a refined list from England and by using State-Year specific AR-DRG frequency based partitions rather than NSW 200506 data. The strength of the result given the current limitations is testimony to the importance of this process.

A graphical presentation in the change in the casemix compliance ratio when different thresholds are placed on the presence of CCCs in the AR-DRG partitioning shows that the usually poor compliance ratios for Specialist Paediatric Hospitals are rapidly improved when the presence of the CCCs in the DRG is reduced. These partitioning changes however, have little impact on the state level data. This emphasises the importance of these codes to the Specialist Paediatric Hospitals population specifically.

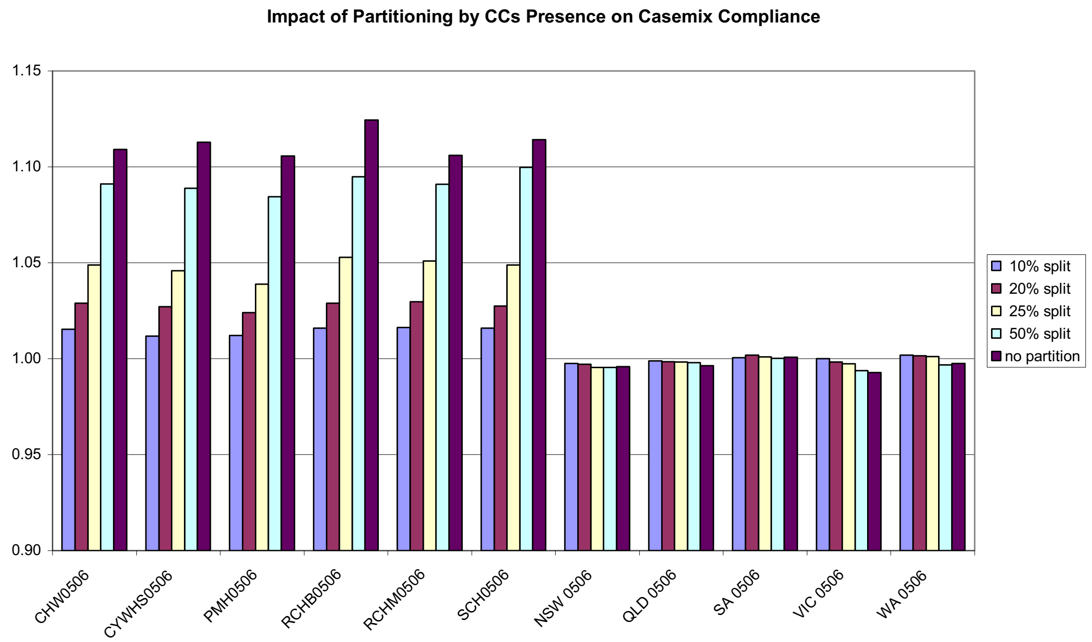

Figure 2: Impact of Different levels of CC codes on Casemix Compliance

The CMA costliness index also shows a strong reduction. An analysis of the hospitals' shortfall for the partition sets of AR-DRGs was estimated by calculating the shortfall between the hospitals expenditure for a given AR-DRG for a particular year and the expected expenditure given the state average cost for that AR-DRG. Similar to the profitability analysis presented in Chapter 2. The table below demonstrates the impact on profitability when partitioning the data according to the 20% threshold.

Table 10: Impact of CCC codes on shortfall

AR-DRGs where Rate of Records with unmanaged CC Code Less than 20% in NSW 2005/06									
Hospital / State	Episodes	Expend $	Expect Expend $	Fund ShortFall $	Expense Ratio	% of Short Fall	% of Expend	% of Expect Expend	% of Episodes
CYWHS	36,696	77,923,483	75,084,806	2,838,677	1.04	13%	38%	41%	66%
RCHB	29,663	54,625,917	56,207,125	- 1,581,208	0.97	-17%	38%	42%	65%
CHW	49,225	120,405,721	124,153,705	- 3,747,985	0.97	-7%	33%	40%	63%
PMH	24,872	68,880,143	65,489,721	3,390,422	1.05	9%	32%	37%	60%
RCHM	58,130	135,986,400	121,225,356	14,761,043	1.12	23%	31%	32%	58%
SCH	23,753	58,439,759	58,370,782	68,977	1.00	0%	30%	34%	57%
AR-DRGs where Rate of Records with unmanaged CC Code at Least than 20% in NSW 2005/06									
CYWHS	19,086	125,588,119	106,713,148	18,874,971	1.18	87%	62%	59%	34%
RCHB	16,288	88,809,780	77,704,958	11,104,822	1.14	117%	62%	58%	35%
CHW	29,282	248,020,810	187,735,650	60,285,161	1.32	107%	67%	60%	37%
PMH	16,461	143,517,169	109,905,668	33,611,501	1.31	91%	68%	63%	40%
RCHM	41,707	309,096,870	258,649,318	50,447,552	1.20	77%	69%	68%	42%
SCH	17,954	134,904,266	114,733,194	20,171,072	1.18	100%	70%	66%	43%

The AR-DRGs where there are 20% or less of the episodes have at least one of the CCCs accounts for around two thirds (66%) of episodes in some of the Specialist Paediatric Hospitals and 57% of episodes in other Specialist Paediatric Hospitals. While accounting for the majority of episodes these AR-DRGs only account for around a third (33%) of the hospitals' expenditure. As the Expense Ratio figure suggests for most hospitals the expense is roughly in line with the state average (around 1) for this group of AR-DRGs. This group of AR-DRGs have a small adverse impact on the hospitals profitability accounting for a small proportion of the shortfall in some case and representing a profitable sector (with a negative shortfall) for some hospitals. In contrast the AR-DRGs where the CCCs are more common (at least 20% of records with a CCC) account for a third of the hospitals caseload, two thirds of the hospitals' expenditure and most of the shortfall.

The findings of this chapter provide strong support for the hypotheses that the HRG CCC list (restricted to those not dealt with by AR-DRG) is the origin of the unusual CMA costliness finding related to Specialist Paediatric Hospitals.

Competing Partitions

Although the statistical argument above is well supported, it does not eliminate the potential argument that the results simply reflect a split between complicated and uncomplicated episodes as already accounted for in AR-DRGs. This alternate model was analysed by dividing the data according to AR-DRGs complicating grading in terms of the final digit of the AR-DRG (A,B,C,D). AR-DRGs ending in A were compared with the lowest complexity AR-DRG split. The results in (Table 11) show no clear relationship.

Table 11: Comparison of the Percent of Shortfall accounted for by Low and High Complexity AR-DRGs

Hospital/State	% of Shortfall Low Complexity AR-DRGs	% of Shortfall High Complexity AR-DRGs
CYWHS 03/04	33%	-6%
CYWHS 04/05	39%	32%
CYWHS 05/06	14%	30%
RCHB 03/04	65%	19%
RCHB 04/05	35%	73%
RCHB 05/06	30%	-36%
CHW 03/04	49%	86%
CHW 04/05	53%	32%
CHW 05/06	41%	38%
PMH 03/04	34%	8%
PMH 05/06	40%	29%
RCHM 03/04	85%	15%
RCHM 04/05	42%	23%
RCHM 05/06	28%	17%
SCH 03/04	33%	-155%
SCH 04/05	30%	51%
SCH 05/06	19%	52%

There is no consistent pattern across Specialist Paediatric Hospitals in the impact of high or low complexity AR-DRGs on the hospitals' percentage shortfalls. If we consider the compliance ratios for data split on this basis, we find that the mean ratio for the Specialist Paediatric Hospitals is 1.03 (StDev .003) for the low complexity group and 1.07 (StDev 1.010) for the A Split. The corresponding results for the 0.2 partition is 1.02 (StDev .003) for the low rate and 1.06 (StDev .006) for the high. This suggests complexity as currently captured by the AR-DRG system is not the most plausible explanation of Specialist Paediatric Hospitals CMA results.

A further test that the CCC list results were not shadowing some underlying relationship between Specialist Paediatric Hospitals' funding shortfall and AR-DRG cost ranges was undertaken. The DRG sets were split according to their average state costs.

Table 12: Comparison of Funding Shortfall of Specialist Paediatric Hospitals for episodes divided by the average cost of the AR-DRG (above and below $5,000)

	Less than $5,000			At least $5,000		
Hospital/State	Expense Ratio	% of Short Fall	% of Episodes	Expense Ratio	% of Short Fall	% of Episodes
CYWHS	1.107	48%	88%	1.134	52%	12%
RCHB	1.076	61%	88%	1.064	39%	12%
CHW	1.347	88%	86%	1.039	12%	14%
PMH	1.249	58%	83%	1.174	42%	17%
RCHM	1.159	42%	86%	1.183	58%	14%
SCH	1.230	87%	85%	1.026	13%	15%

The table above shows no consistent pattern in the percent of shortfall attributed to higher cost AR-DRGs across the different Specialist Paediatric Hospitals. The same analysis was undertaken at different AR- DRG cost points with no consistent pattern emerging.

These analyses serve to emphasise the strength of the results with the CCC codes partitioning. Models based on AR-DRG complexity and costs are less consistent than the model based on unmanaged CCCs. However there are clear connections between these features of the data.

Recognising genuinely unrecognised CC diagnoses

The findings from the partition analyses above show the existence of a set of genuine age interacting complications and comorbidities. In Appendix VII, we consider why AR-DRG Development did not identify this important set of complicating codes as part of the Classification. We also present a case to show that the disjunction between the English Childhood CC list and the AR-DRG list is further evidence of age interacting CCL. In addition we provide guidance on how revision of AR-DRG may occur.

Conclusion

This chapter explains how it is possible for the AR-DRG system to have a bias that adversely effects the evaluation of Specialist Paediatric Hospitals and tests this hypothesis against available data. The findings clearly support the hypothesis that a specified list of ICD-10-AM diagnosis codes complicates the care delivered in Specialist Paediatric Hospitals more than care delivered in the remainder of the acute inpatient hospital system.

We propose that the list of codes be used to identify AR-DRGs that should have uplift funding (increased AR-DRG cost relativities) for Specialist Paediatric Hospitals but argue for refinement of the list before these uplifts are determined.

We have demonstrated a method to refine the list by removing 76 of the candidate codes through the use of our technology and believe this approach will be of future use.

The further refinement of the list of CCs in question is a complex task that requires the Australian Government resources. It is well outside the scope of the current project. Further, the age interaction feature of these codes can only be accommodated if the AR-DRG system is modified so as to allow this concept.

The imminent finalization of AR-DRG version 6.0 specifications does not allow for age interacting CCL and hence is not going to resolve the issue. Indeed review of the Australian Government recommendations shows that even the work-a-rounds (for interaction) included in earlier versions are being removed for the sake of a cleaner logical structure.

Chapter 5: Emergency Department and Outpatients

Emergency Department

The purpose of the analysis of ED data was to examine whether a more comprehensive appraisal of the services supplied by specialist paediatric hospitals through ED and outpatients services will affect DRG costs and hence provide a more appropriate comparative framework for assessing specialist paediatric hospitals' expense in DRG terms. The Chapter examines whether the types of services provided in ED and Outpatients affect the thresholds for hospital admissions in children's and adult services and therefore affect the DRG costs.

Emergency Department Triage Categories

As part of the study, participating paediatric hospitals forwarded data on Emergency Department (ED) attendances and Outpatient Occasions of Service (OOS) from 2002 to 2006. Data was provided in the Australian Institute of Health and Welfare (AIHW) reporting format to allow for comparison between individual hospitals and state totals. The trend in ED attendances by triage category over 2002-2006 for each paediatric hospital, are presented at Appendix VIII.

Some fluctuation observed may have been an artefact of the triage process rather than change in treatment population. "While it is desirable to attempt to maximise inter-rater reliability for reasons of inter-departmental comparisons and for casemix purposes, it must be recognised that no clinical coding system achieves perfect reproducibility." [6]

All hospitals experienced a net increase in ED attendances from 2002 to 2006. CHW and RCHM also reported strong growth in the proportion of more serious triage categories in this period. All hospitals showed a decrease in the proportion of 'non-urgent' cases.

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[6] http://www.ruraldoc.com.au/xinha/plugins/ExtendedFileManager/demo_images/ATS_Scale.pdf

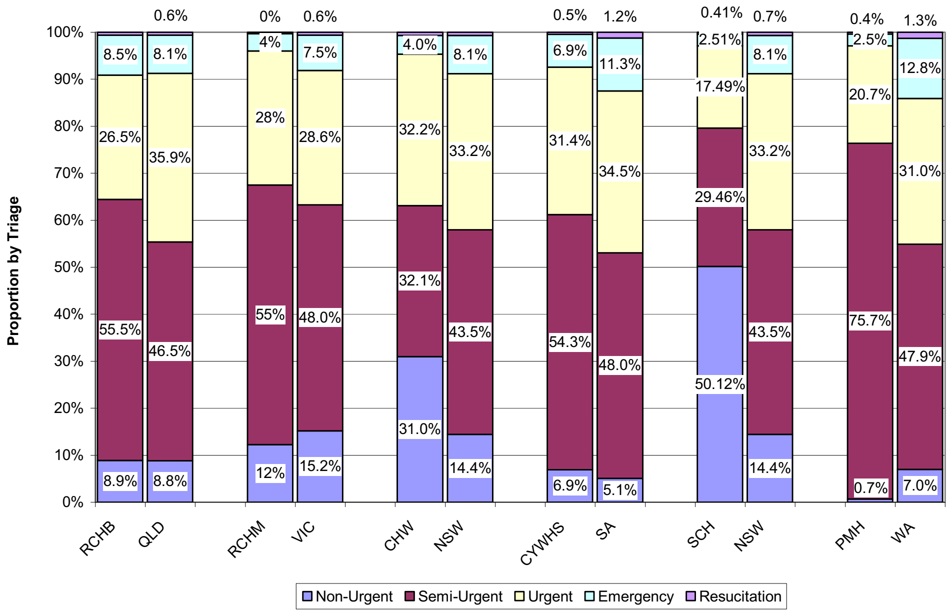

Figure 3: ED Attendances by triage category for each hospital and state for 2005-2006.

Figure 3 compares each hospital and the respective state for the year 2005-2006 only. All Specialist Paediatric Hospitals had a lower proportion of 'urgent', 'emergency' and 'resuscitation' cases when compared to their respective states. The two NSW Specialist Paediatric Hospitals have large proportions of non-urgent cases. SCH have explained the difference as follows:

> "Triage consistency project was undertaken with 7 other centres. It was discovered that SCH was "down triaging" categories 4 and 5. Staff were educated and now practice is more consistent with that of other centres in Australiasia."

Emergency Department Cases Ending in Admissions

Each Specialist Paediatric Hospitals submitted data on the percentage of ED patients admitted by triage category, as per the format collected by AIHW. Each triage category was weighted to give an average percentage of admissions for each hospital overall. The results for each hospital[7] are compared with state average provided by AIHW for 2005-2006 in figure 4. Results are outlined below.

[7] Some definitional differences in how to count attendances ending admission resulted in non-comparable data for some hospitals. These hospitals are excluded from the graph.

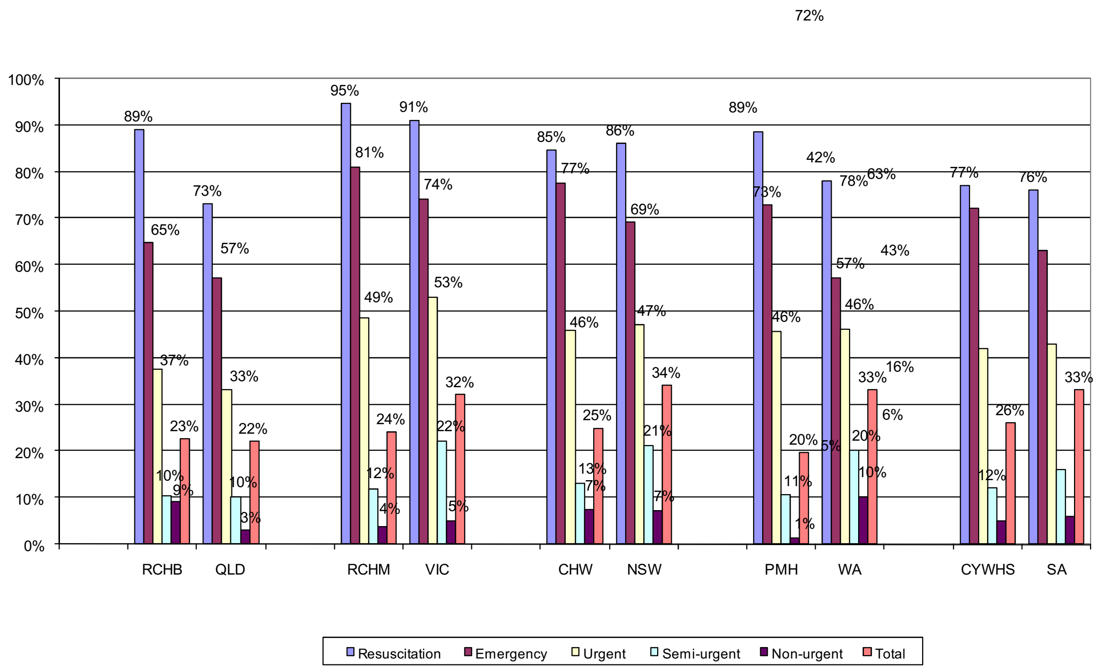

Figure 4: Proportion of ED attendances ending in admission by triage category for paediatric hospitals and states for 2005-2006.

In general terms, the Specialist Paediatric Hospitals rates (relative to their state rates) are similar for urgent cases, higher for resuscitation and emergency but lower for semi-urgent and non-urgent. The exceptions are commented on below.

A similar proportion (around 25%) of attendances at CHW, RCHM and CYWHS were admitted to hospital compared to around 30% for the state averages. PMH admission rate at 20% was much lower than WA state average (33%).

Only RCHB has a slightly higher average proportion of admissions compared to its state. All other hospitals have a lower average. RCHB and QLD have similar proportions for attendance in each category but a higher number of admissions in ‘Resuscitation’ and ‘Emergency’ and ‘Non-Urgent’.

The most obvious difference when comparing admissions by triage category is that, the Specialist Paediatric Hospitals are more likely to admit ‘Resuscitation’ and ‘Emergency’ cases than the state’s hospitals on average. Some resuscitation and emergency cases are transferred to operating rooms on arrival.

RCHM, CHW, PMH and CYWHS were less likely to admit 'Semi-Urgent' cases than the average for the state. RCHB was about equal with QLD. RCHB admits a similar proportion of this category as the other Specialist Paediatric Hospitals however QLD hospitals as a whole have lower rates of admission for cases in this category.

A general sense from these data is that the Specialist Paediatric Hospitals provide the inpatient care of the more urgent cases presenting to ED (perhaps with a lower threshold for admission) but tend to care for the less urgent cases within the ED itself (suggesting a higher admission threshold for these cases). Admission practices are of course determined by criteria. Appendix IX provides details on the criteria for Admission via Emergency Department for participating hospitals.

Proportion Seen on Time

Participating Specialist Paediatric Hospitals submitted data on the proportion of patients seen on time in the ED by triage category. This data was given in the same format as AIHW for comparison to state figures, as shown graphically in the figures below. The trend for each Specialist Paediatric Hospital from 2002-2003 is shown separately and discussed in Appendix X.

When comparing hospitals:

- 'semi-urgent' is the least likely to be seen on time at all hospitals.
- 'Resuscitation' is seen on time 100% of the time, except for PMH from 2002-2004.
- Performance is relatively stable across the years for most Specialist Paediatric Hospitals, with CHW having a decrease in proportions seen on time in 2003-2004.

Table 13 Proportion Seen on Time for States and Specialist Paediatric Hospitals by Triage 2005-2006

Proportion seen on time (%)	RCHB	RCHM	CHW	SCH	PMH	CYWHS
Resuscitation	100.0%	100%	100%	100%	100%	99%
Emergency	100.0%	89%	100%	87%	88%	83%
Urgent	67.1%	76%	52%	85%	86%	64%
Semi-urgent	71.8%	48%	44%	61%	61%	81%
Non-urgent	95.5%	79%	70%	80%	91%	98%
Total	75%	62%	57%	68%	68%	77%
	QLD	VIC	NSW		WA	SA
Resuscitation	100%	100%	100%		98%	99.0%
Emergency	66%	83%	81%		70%	69.0%
Urgent	55%	79%	61%		61%	57.0%
Semi-urgent	58%	71%	66%		54%	61.0%
Non-urgent	86%	89%	87%		79%	84.0%
Total	60%	77%	69%		60%	62.0%

Table 13 compares the proportion of ED attendances seen on time at each hospital with the average for the state.

- RCHB performs better than the state average in proportion seen on time in all triage categories. In particular 'emergency' cases were seen on time 100% of the time at RCHB compared to 58% for all QLD public hospitals.
- RCHM performs better than state average for 'emergency' cases and is equal for 'resuscitation' (100%) but overall shows a lower proportion seen on time than the state average. 'Semi-urgent' episodes in particular are less likely to be seen on time.
- CHW is also better than the NSW average for seeing 'emergency' episodes on time and equal for 'resuscitation' (100%). In all other triage categories its performance is lower than the state average. Average proportion 'seen on time' for CHW is lower than NSW.
- SCH has a higher portion 'seen on time' for 'resuscitation', 'emergency' and 'urgent' than the NSW average. It is only slightly lower for 'semi-urgent' and 'non-urgent'. As these are the two categories with the highest proportion the average 'seen on time' is slightly lower than NSW. The triage category issues noted earlier may be a factor in the observed results.
- PMH has a higher portion of cases 'seen on time' compared to all WA public hospitals in all categories and a higher overall average. The difference in proportions is substantial in each triage category.

- CYWHS has a higher proportion of cases seen on time than the state average in all triage categories. The main differences in proportions are for "emergency" and "semi-urgent" cases.

Service Event Duration

CHW, RCHM, CYWHS and PMH hospitals provided data on the average and median duration of service for ED attendances by triage. This data is compared to some state figures presented by AIHW in Hospital Statistics 2005/06 (Table 14 below). Victorian and South Australian data, however, was not reported as the practices in recording admitted patients time of admission results in over estimates for occasion of service event.

Table 14: Average and median duration of service (in minutes) for ED attendances by triage category for hospitals and state 2005-2006.

	RCHM	CHW	NSW	PMH	WA	CYWHS
Resuscitation						
Average duration of service event	244	336	219	227	160	186
Median duration of service event	190	241	158	150	124	144
Emergency						
Average duration of service event	286	428	260	239	182	207
Median duration of service event	230	310	201	159	147	159
Urgent						
Average duration of service event	205	320	219	219	151	197
Median duration of service event	158	182	165	135	119	123
Semi-urgent						
Average duration of service event	84	169	129	90	96	118
Median duration of service event	54	55	71	52	65	74
Non-urgent						
Average duration of service event	46	121	64	23	66	62
Median duration of service event	34	35	30	10	43	40
Total						
Average duration of service event	122	219	164	121	118	145
Median duration of service event	78	79	102	67	84	91

Comparison of the average statistics with the median statistic for service duration indicated a generally higher figure for the average than median. This suggests a small proportion of events at the top end taking considerably longer than the bulk of the attendances. Considering the total attendances, CHW average time spent is much higher than the NSW average, RCHM and PMH. CHW median service duration however is on par with both RCHM and PMH and lower than the NSW average. This again suggests a small proportion of episodes have much longer service duration.

CWH spends longer generally on 'resuscitation' and 'emergency' episodes with much higher average and median statistics than RCHM, CYWHS, PMH and the NSW and WA state averages. CHW is also higher on both statistics for urgent cases but not to the degree as with the higher triage categories. CHW average service duration is longer than the RCHM, CYWHS and PMH in all categories but has a similar median service time for semi-urgent and non-urgent episodes.

PMH has higher average and median times for the higher triage categories than WA state average for public hospitals, but lower times in the other categories. The overall average service time for PMH is very similar to the WA state average.

Conclusion on Emergency Departments

The data quality issues has not led to a clear picture of Specialist Paediatric Hospitals managing less urgent cases within ED and thereby filtering the cases seen as inpatients to be the more complex part of the DRG as seen elsewhere. The data are confusing. Perhaps their quality, especially relating to duration of service, is so poor as to mask the effects implied (and commented on) in the patterns of admission by triage category. For example, the statistics for service duration do not follow the pattern anticipated from the admission percentages. Compared to the state data, the more urgent groups receive more care in the Specialist Paediatric Hospitals as do the less urgent categories. If additional "filtering" care was being delivered in the EDs of Specialist Paediatric Hospitals then we would expect to see a bigger effect in the triage groups where admission could be more easily avoided.

The footnotes in the AIHW publication on service duration, and the fact these data do not have wide spread use mean we are unable to support or reject the filtering hypothesis.

Ambulatory

Outpatient Occasions of Service

As part of this study participating Specialist Paediatric Hospitals provided data on outpatient occasions of service (OOS) through:

- Survey questions about the type of OOS, how they are recorded and funded. Most hospitals also forwarded a breakdown of services by clinic type and level of care (0506 and 0607 data received).
- Tables similar in format to Australian Hospital Statistics (AIHW) reported outpatient tables recording total OOS by clinic type for 2005/06.

Due to the variation in how each hospital classifies OOS by clinic type, the analysis by clinic type against AIHW tables for respective states was not helpful. The overall number of OOS was considered in relation to patient contacts through inpatients and emergency attendances to identify differences at the macro level between Specialist Paediatric Hospitals and other public hospitals.

The table below was generated by taking the total number of inpatient separations, emergency department attendances and outpatient occasions of service for 2005/06. Each type of care was totalled and the relative proportions calculated to compare outpatient to inpatient ratios. The final two columns compare the number of emergency attendances for every inpatient and the number of OOS for every inpatient.

A clear overall pattern is that Specialist Paediatric Hospitals appear to have much higher levels of OOS than inpatient separations relative to states. In particular SCH has 11.24 OOS for each inpatient and CHW has 13.93 OOS for each inpatient recorded. This is in contrast to the ratio for NSW hospitals as a whole (3.12). In all cases Specialist Paediatric Hospitals have a much higher ratio of outpatients to inpatients overall.

Table 15: The proportion of outpatients to inpatient and outpatients to emergency attendances expressed as a percentage and as a ratio for paediatric hospitals and all hospitals combined in each state (2005-2005).

	Inpatient Separations*	Emergency Attendances *	Outpatient OOS*	Ratio Emergency/ Inpatient	Ratio OSS/ Inpatients
Specialist Paediatric Hospitals					
SCH	7%	16%	77%	2.32	11.24
CHW	6%	10%	84%	1.71	13.93
RCHM	12%	21%	67%	1.71	5.46
RCHB	15%	25%	60%	1.66	3.96
PMH	13%	28%	59%	2.22	4.69
CYWHS	11%	22%	67%	2.05	6.34
State					
NSW	19%	23%	58%	1.21	3.12
VIC	27%	26%	47%	0.98	1.78
QLD	19%	22%	59%	1.12	3.03
WA	24%	26%	50%	1.08	2.05
SA	23%	21%	56%	0.89	2.42

*All paediatric data was provided in AIHW proformas completed by participating hospitals. State data was taken from AIHW data in the same format.

The survey responses were analysed to provide an explanation for the higher proportion of outpatient cases in Specialist Paediatric Hospitals. The concern is that more outpatient OOS cases than inpatients would discount children's hospitals' funding estimates when estimates are based on inpatient figures. All hospitals reported that outpatient activity was historically funded, except for RCHM which receives grants and CYWHS which receives activity based funding. This would suggest that specific negotiations need to be made as outpatient services evolve to compensate historic funding levels.

It should be noted that most survey questions were open ended and omission of information does not necessarily mean that particular services do not exist at given hospitals. For example chemotherapy was noted as an outpatient service at SCH and CHW, but not included in the lists from other Specialist Paediatric Hospitals which were not exhaustive.

Another caveat when viewing this data is that Specialist Paediatric Hospitals vary in methods for recording outpatient data. For example, RCHB changed from manual to electronic records for outpatient between 2005/06 and 2006/07 and found a 50% increase in records. SCH reported in the survey that they electronically record their outpatient OOS. Other Specialist Paediatric Hospitals had not updated their recording method over the last 5 years.

Specialist Paediatric Hospitals in major metropolitan areas are likely to run clinics for childhood development specialties that require ongoing appointments such as speech pathology. This would account for a higher number of outpatients.

Another important point is that only some paediatric hospitals record OOS as one per consultation. Therefore multidisciplinary cases may include visits to several specialists or nurses for one patient, as in the case of SCH, RCB and CHW. This is the standard for the NSW Department of Health. RCHM explained that visits to multidisciplinary clinics are not recorded as single appointments and are therefore less accurate. CYWHS records multi disciplinary cases as "group OOS". This could partially explain why SCH and CHW have much higher outpatient to inpatient ratios than other Specialist Paediatric Hospitals.

SCH and CHW reported a recent change in chemotherapy from an inpatient treatment to an outpatient treatment. Specifically SCH reported that 70% of chemotherapy treatments are provided as outpatient OOS. This change began at SCH in 2002. Senior staff from the SCH Oncology Ward also provide outreach services to Newcastle, Campbelltown and Canberra[8]. This is significant because chemotherapy involves expensive drugs that cannot be ordered at the same scale as general hospitals and often cost more due to modifications for children. Further, blood transfusions also changed in 2000 from 100% inpatient to 100% outpatient OOS at SCH.

Another argument for why Specialist Paediatric Hospitals could have a greater number of outpatient OOS is a policy of reducing the need for admissions to minimise

[8] SCH Children's Hospital website, cited Jan 2008
http://www.sch.edu.au/departments/nursing/inpatient_services.asp

disruption to family life. Innovations such as Hospital in the Home (HITH) have been introduced at CHW, CYWHS, PMH and RCHM to allow certain patients to be treated at home. However, only CHW counts HITH patients as outpatients. It should also be noted that PMH only began HITH in 2006. This would partially explain the much higher ratio of outpatients to inpatients relative to other paediatric hospitals (just under 14:1). CHW provides a range of HITH and "post acute care" services for the following conditions:

- Asthma review and education
- Bronchiolitis / Pneumonia review
- Cellulitis
- Constipation - short term management
- Dental surgery follow up & education
- Enteral Feeding home transition support
- Febrile Convulsions
- Gastroenteritis
- Intravenous Antibiotics
- Osteomyelitis
- Oncology Support
- Subcutaneous & Intramuscular Injections
- Wound Dressings (including minor burns)[9]

The trend for reducing admissions and length of stay for inpatients is affirmed on the CHW website:

> "At The Children's Hospital at CHW, we try to reduce the anxiety and disruption to our children and their families by keeping their stay in hospital as short as possible. We do this by providing day-only surgery and a range of innovative programs where as much care as possible is provided on an outpatient basis." www.chw.edu.au/about

The trend in hospital admission avoidance is increasing. CYWHS has introduced hospital avoidance and early discharge programs to enable patients to receive treatment at home rather than within the hospital. PMH introduced HITH in 2006 and an Ambulatory Care Service in 2007. RCHM, CHW and CYWHS likewise developed HITH in the last few years. RCHB has introduced telemedicine and increased outreach clinics. Short Stay Wards, Emergency Medical Units and Day Only Wards

[9] *Children's Hospital CHW* website, cited Jan 2008 http://www.chw.edu.au/prof/kols/

have also been recently introduced to most hospitals but all hospitals in the study count admissions to these wards as inpatients. The introduction of these programs supports a trend in reducing the need for full admissions.

All Specialist Paediatric Hospitals responded that patients receiving diagnostic tests are counted as outpatients. More tests could be ordered by interns at paediatric teaching hospitals such as SCH and CHW to verify initial diagnosis. However, children are more often admitted for diagnostic tests than adults because they require an anaesthetic for some tests (SCH, RCHB, CYWHS). The insertion of a PICC line (PMH) requires admission at some paediatric hospitals.

SCH provided a list with their survey response of services provided to outpatients, most of which were at the tertiary level of care. This list demonstrated the extensive list of outpatient services available at Specialist Paediatric Hospitals. Hospitals again vary in how they distinguish outpatients.

Outreach Services

SCH and CHW provide extensive outreach programs. Importantly SCH and CHW reported that they counted some of the activity in outreach clinics in outpatient data. SCH counted nurse run clinics and Allied Health outreach services as outpatients. CHW reported that outreach services were counted as outpatients. Currently CHW has specialist staff visiting 26 regional centres that host outreach clinics from 18 departments in the hospital[10].

Conclusion on Ambulatory Service

In conclusion there appears to be a shift toward more outpatient services in order to better meet the needs of regional area patients through outreach programs. Outpatient numbers are also growing to minimise admissions for ongoing treatment such as chemotherapy. This trend is reflected in changes to reduce the number of full admissions and length of stay (eg EMU, SSW). This is reflected in the high outpatient figures for SCH and CHW who have extensive outreach clinics and count some of

[10] www.chw.edu.au/about/outreach

these as outpatients. An important factor is also the practice of recording multidisciplinary cases as one per consultation and one per diagnosis at SCH and CHW which further accounts for their much higher ratio of outpatient to inpatients compared to NSW as a whole and other paediatric hospitals (Table 16).

There were no patterns exposed that have a direct bearing on the central research questions, other than the geographically extensive and highly specialised nature of the outpatient services. These features must have bearings on the inpatient catchment populations of the Specialist Paediatric Hospitals. We would expect increased acuity within AR-DRG.

Chapter 6: Conclusions and Recommendations

In response to the original research questions we concluded:

- Specialist paediatric hospitals are *not* uniformly more costly than other hospital types across their caseload.
- Specialist paediatric hospitals differ in the costs and treatment of sub-populations (compared with other hospital type groupings) in a number of ways, but an important driver of the AR-DRG cost differences is the presence of complicating diagnoses not appropriately dealt with by AR-DRG.
- Specialist Paediatric Hospitals do tend to have higher 95 percentiles in their LOS distributions (for more costly AR-DRGs) and this would tend to skew within-DRG cost distributions, however it is difficult to attribute this to community pressure to save a child's life at all costs. The presence of complicating diagnoses not appropriately dealt with by AR-DRG offers a simpler explanation.
- Review of the services supplied by Specialist Paediatric Hospitals through ED and outpatients services does not clarify whether inpatients as result of these secondary and community contacts are affecting within-AR-DRG severity levels.

While conducting the research we became aware that comorbidities that differentially affected the care of patients of different age-groups existed in sufficient number to impact on hospitals that had treatment populations with select age profiles (such as children's hospitals). Further we are aware that the existing versions of AR-DRG and the version under development (version 6) do not accommodate the concept of an age-interacting comorbidity. The CCL level is fixed by the Adjacent AR-DRG, other than for possible gender differences and absconding. It is not directly influenced by patient age. We therefore conclude *that all children's hospitals and paediatric services will be affected* by this feature.

Further research should be done on the list of age-interacting comorbidities. Possibly this should also be extended to include age-interacting interventions. Such research would also help in the development of lists of codes to be considered by DRG Development in the Australian Government.

During this project we reached the conclusion that the technical approach to evaluation and the Classification underlying it were unintentionally biased towards undervaluing the acute inpatient work of Specialist Paediatric Hospitals. Further we concluded the bias was substantial and left Specialist Paediatric Hospitals and the children in their care exposed to unacceptable risk. Adequate funding needs to be based on a casemix system which is cognisant of the added complexity in the care of some children. A lack of response by funding authorities may put the quality of care of these complex cases at risk.

We also reached the conclusion that to rigorously address the problems at the AR-DRG classification level would require a sizable national input. What is required is a redesign of the AR-DRG system to take into account age dependent CCCs. This involves:

- Identifying the codes where comorbidity & complication level (CCL) changes with age
- Determining the CCL by age category that should be applied
- Changing the logic of the classification algorithm

In the medium term, an evidence based set of AR-DRG uplifts for children's cases needs to be developed. This also requires a significant body of work in identifying the most materially impacted AR-DRGs. This involves:

- Filtering the list of CCC to those that have different impacts on different age groups
- Using the refined CCC list to identify the AR-DRGs according to the frequency of occurrence of these CCs in Specialist Paediatric Hospitals
- Determine the uplift value for Specialist Paediatric Hospitals
- Determine the uplift value for children in other hospitals according to the relative frequency of the CCCs compared to Specialist Paediatric Hospitals. For example, if CCCs are twice as frequent in a given DRG in a Specialist Paediatric Hospital than for children's cases in other hospitals then the uplift

for children's cases in that DRG in other hospitals would be half that for Specialist Paediatric Hospitals.

In the short term, benchmarking of Specialist Paediatric Hospitals against their state should be focused on a set of AR-DRGs that were not badly affected by the biasing elements of the Classification. This should reduce the need for children's hospitals to defend their current budgets and allow them to focus on rectification of any historical underfunding.

Our recommendations are that the effort to redesign AR-DRG be put on the National Agenda, that a project be started to more precisely discriminate the AR-DRG in need of a Children's uplift (and the amount there of) and finally that the short term solution (based on prorated performance) be advanced to the responsible health departments.

The message to the Australian Government is that further AR-DRG development is required. For the state health departments the message is that the Specialist Paediatric Hospitals are more costly for some segments of their caseload. The changes in AR-DRG relativities in Specialist Paediatric Hospitals are both up and down, but the net effect is to make the care more costly. The cumulative impact for Specialist Paediatric Hospitals in dealing with this unrecognised complexity without funding redress is untenable. It is imperative that funding reflect the extra resources required in treating these children or quality of care of these complex cases will suffer.

Children's hospitals and paediatric units need to have a better understanding of their costs and the complexity of care of their treatment population so that they can make their case for appropriate funding from a stronger evidence base. In particular they need to be aware of the bias arising from funding systems that ignore age affected complication & comorbidity levels.

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Appendix I: Profiles of Participating Specialist Paediatric Hospitals

Sydney Children's Hospital, SCH

SCH admitted 13,672 patients and treated another 289,351 children through its emergency, outpatient, regional outreach services and 11 early childhood health centres. This included 31,688 emergency attendances for 2005-2006[11].

SCH is a state wide referral centre for the following services: Renal Transplant Unit, Interventional Neuroradiology, Paediatric ICU, Neonatal ICU, Epilepsy and Telemetry Services, Allogeneic Bone Marrow Transplantation, Cochlear Implant, Paediatric Trauma, Adolescent Mental Health, Foetal Surgical Unit.

Patients are transferred to SCH for the following services in particular: Trauma, Neonatal Surgery, Paediatric/ Neonate Intensive Care, Emergency General Surgery, Plastic Surgery and when specialised paediatric consultation is required.

SCH has made changes to the model of care over the past 5 years. These include chemotherapy moving to be 70% outpatient and blood transfusion has become 100% outpatient when both were previously 100% inpatient.

SCH is subject to the NSW system of hospital funding that combines historic, population and activity based funding. Outpatient departments are funded using a historic budget.

The Children's Hospital at Westmead, CHW

CHW had 26,775 inpatient separations in 2005-2006 was 26,775, and 665, 357 occasions of service, including 45, 818 emergency attendances[12].

The majority of patients come from Sydney West (48 percent) and Sydney South West (23 per cent) areas. Outreach services cater to children living outside the city. Specialist doctors travel to regional centres for consultations with regular, past or new patients. Currently there are 26 regional centres that will host outreach clinics from 18 departments in the hospital. CHW provides a range of outreach services free of charge including Aboriginal, adolescent, allergy and asthma education.

The hospital provides state referral services for the liver transplant program, newborn screening, burns and poisons information. A comprehensive epilepsy service has state-wide recognition with referral of patients for epilepsy monitoring and review.

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[11] *South East Sydney Illawarra Health Annual Report 2005-06*

[12] *The Children's Hospital at Westmead Annual Report 2006* www.chw.edu.au

Models of care that have undergone change over the last 5 years include the establishment of a an Emergency Medicine Unit(EMU), a short stay ward, a fast track (ED) system and long term ventilation unit.

CHW is similarly funded by the NSW hospital funding system. CHW uses patient levels in funding models (theatre, diagnostics, AH and pharmacy). CHW is reimbursed indirectly for out of area services from the area budget.

Royal Children's Hospital Brisbane, RCHB

RCHB had 15,787 inpatient separations in 2005/06 and 26,170 emergency attendances and 62,495 outpatient clinic occasions of service.

RCHB provides a state referral service for Cerebral Palsy / Rehabilitation Clinical Genetics Oncology. The hospital runs Community Child Health services. ENT, General Surgery, Respiratory Medicine all supply outreach services activity recorded to RCH with no charge to other hospital and free to patient. Telemedicine has similar approach with around 100 occasions of service per month across most services.

The only significant changes to models of care in the last 5 years have been Telemedicine and the provision of more outreach clinics.

Funding is currently in transition from historic to activity based.

Royal Children's Hospital Melbourne, RCHM

RCHM, recorded 33,631 inpatient separations in 2005/06 and 57,471 emergency attendances and 183,672 outpatient occasions of service.

The Royal Children's Hospital Melbourne provides a full range of clinical services, tertiary care and health promotion and prevention programs for children and adolescents. The hospital is the major specialist paediatric hospital in Victoria, and also cares for children from Tasmania and southern New South Wales and other states around Australia and overseas. RCHM provides referral service for all paediatric specialist services. It receives specific funding for heart and liver transplants, cystic fibrosis, orthopaedic surgery, gait laboratory and rehabilitation. RCHM is the Australian National Centre for cardiac transplantation. RCHM is the leading centre for bone marrow and cord blood transplantation. Adelaide transfers liver transplant patients to RCHM for surgery after work up

The hospital has changed its short stay unit and hospital in the home models of care in the last 5 years.

RCHM receives capped activity funding and special grants as its funding basis. All outreach services provided by RCHM are covered by Medicare and ED funding is based on attendance, but does receive some activity funding.

Children's Youth and Women's Health Services (Adelaide), CYWHS

In 2005/06 paediatric and neonatal patients treated at CYWHS included 18,930 inpatients and 38,860 Emergency Department patients.

The Children, Youth and Women's Health Service (CYWHS) is South Australia's leading provider of health services for children, young people and women. CYWHS provides a state wide referral service for Paediatric: Gastroenterology, Cardiology, Pulmonary Medicine, Infectious Diseases, Metabolic Clinic, Renal, Endocrinology, Sleep unit, Rehabilitation, Psychiatry, Intensive Care Unit, Retrieval, Oncology & Haematology, Neurosurgery, Craniofacial Unit, Burns, Orthopaedics and Plastics. Other state wide services include: Clinical Genetics, Metabolic Clinic, Foetal Echo Cardiology, Perinatal Autopsy Service, Newborn Screening, Cytogenetics, National Referral Lab and Anatomical Pathology.

Changes to models of care in the past 5 years include the introduction of an Emergency Department short stay ward and an increase in early discharge, hospital avoidance and family home visiting programs.

CYWHS funding is a combination of activity based and historic. Paediatric cost weights are used for inpatient activity based funding.

Princess Margaret Hospital (Perth)

In 200506, PMH had 21,141 inpatient separations and 47,011 emergency attendances.

PMH provides inbound transfer services for neonates. It has outreach services in Rural Paediatrics, Cardiology Service, Diabetes service and Respiratory medicine as well as clinics for diabetes and rheumatology at other facilities.

In the last 5 years changes to models of care include hospital in the home and establishment of an adolescent oncology wing.

PMH receives historic funding only and receives funding for out of area treatments based on the number of medical sessions provided or staff hours.

Appendix II –GLS, CMA, Compliance Indices and Correlated Index Methods- Technical

Introduction

In Statistics, indices are calculations based on the data generated about the state of a multifaceted process that generates events that can be counted or valued. For example Consumer Price Indices attempt to determine the change in value of a unit of money through the change in cost of basket of goods and services. Also, Standardised Mortality Ratios are indices used to compare counts of events (deaths) across differing populations.

In this work, extensive use is made of two index methodologies. The forms of calculations used are constrained quadratic programming and indirect method standardisation. The variants of each of these used are the Generalised Regression Index and the Indirectly Standardised Event Rate Index.

The Origin of GLS and CMA

The form of Generalised Regression Index selected is Generalised Least Squares (GLS) in which a two way model without interaction terms is used. The effects of the unit of study (hospital/state) are taken to be multiplicative and the values (DRG costs, ALOS) of elements in a partition of the study unit (AR-DRG) are taken to follow a fixed but unknown schedule of relativities. The version of the Indirectly Standardised Index adopted is most often used in case-mix work and hence is referred to as the Case-Mix Adjustment (CMA) Index in this work. The defining feature of CMA is that it uses normative values from a broad system (generally averages across the whole data collection) rather than "Base Year" values.

The Mathematical Formulation of GLS and CMA

The Constrained Quadratic Programming Problem -

Minimise $\sum_{i=1}^{s}\left(\beta_i \mathbf{C}_i - \mathbf{N}_i\boldsymbol{\rho}\right)' \mathbf{N}_i^{-1}\left(\beta_i \mathbf{C}_i - \mathbf{N}_i\boldsymbol{\rho}\right)$ with respect to $\boldsymbol{\beta}$ and $\boldsymbol{\rho}$ subject to

$$*)\quad \boldsymbol{\rho}'\left(\sum_{i=1}^{s}\frac{\mathbf{C}_i\mathbf{C}_i'}{\mathbf{C}_i'\mathbf{N}_i^{-1}\mathbf{C}_i}\right)\boldsymbol{\rho} = \sum_{i=1}^{s}\mathbf{C}_i'\mathbf{N}_i^{-1}\mathbf{C}_i\,;\ \boldsymbol{\rho}\ \text{non-negative}$$

where $\mathbf{C}_i$ is the vector of total utilisation for small area i, $i = 1,2,\ldots,s$.

$\mathbf{N}_i = Diag\left(n_{ij}\right)$ is the diagonal matrix of counts of populations occurring in small area *i*.

- has as solution the vector of GLS indices of utilisation for each small area in the study.

The GLS indices are calculated using the recursion:

$$\mathbf{r}_{(n+1)} = \left(\sum_{i=1}^{s} \mathbf{N}_i \right)^{-1} \left(\sum_{i=1}^{s} \frac{\mathbf{C}_i \mathbf{C}_i^{'}}{\mathbf{C}_i^{'} \mathbf{N}_i^{-1} \mathbf{C}_i} \right) \mathbf{r}_{(n)}$$

- and then the constraint * is applied to recover ρ.

The CMA Index is defined using the formula for indirect standardisation well known to demographers. It is the ratio between the number of events that occur in the study unit to the number of events that would be expected to occur in the study unit if the elements in its partitions followed the system wide average for elements of their partition:

Let n_{jk} be the number of elements in the intersection of partition j and unit k.

Let m_{jk} be the count of events occurring to elements in the intersection of partition j and unit k divided by n_{jk}

Let N_j be the number of elements in partition j in the data as a whole.

Let M_j be the count of events occurring to elements in partition j in the data as a whole divided by N_j .

Then the CMA Index for the kth study unit is:

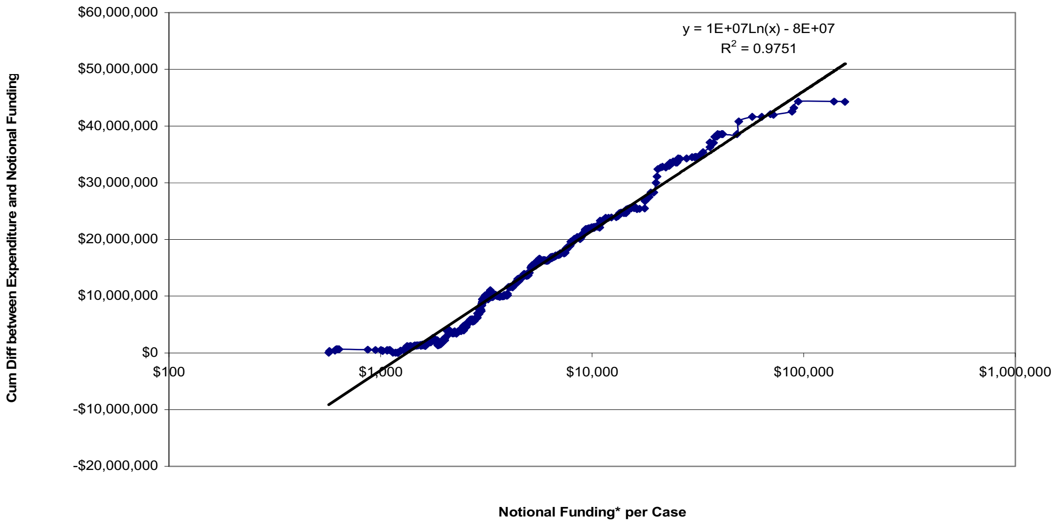
$$i_k = \sum_{j=1}^{p} \mathrm{n}_{jk} \mathrm{m}_{jk} \Big/ \sum_{j=1}^{p} \mathrm{n}_{jk} \mathrm{M}_j$$

where p is the number partitions present in the data for unit k .

Appendix III: Financial Viability Analysis Under Notional Casemix Funding Graphs

CHW

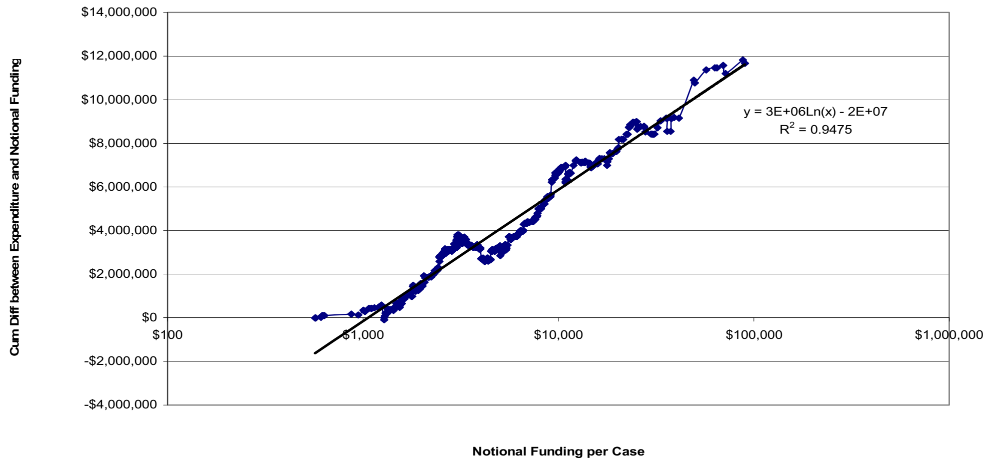
Similar analysis was undertaken for each of the participating hospitals. The graph below shows the cumulative difference between the CHW's costs and those of NSW calculated at a DRG level. The total difference for CHW over 2 years was $44.28m (+21.41%).



CHW cumulative loss of profitability v AR-DRG State Cost

SCH

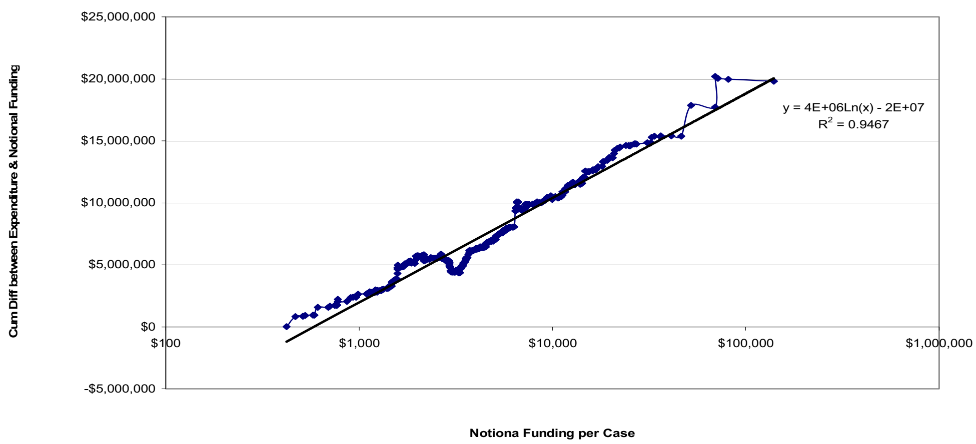
The results for SCH compared with NSW average over the two years are not as extreme. Overall for SCH the total difference was $11.67m over the two years 2003/04 and 2004/05. To some extent the difference between the Specialist Paediatric Hospitals' costs and state average costs is masked by the inclusion of the Specialist Paediatric Hospitals in the state average costs. For DRGs that have greater costs at Specialist Paediatric Hospitals than other hospitals, average state costs will be higher. Similarly for DRGs where Specialist Paediatric Hospitals are less costly the state average costs will appear lower.



SCH cumulative loss of profitability v AR-DRG State Cost

CYWHS

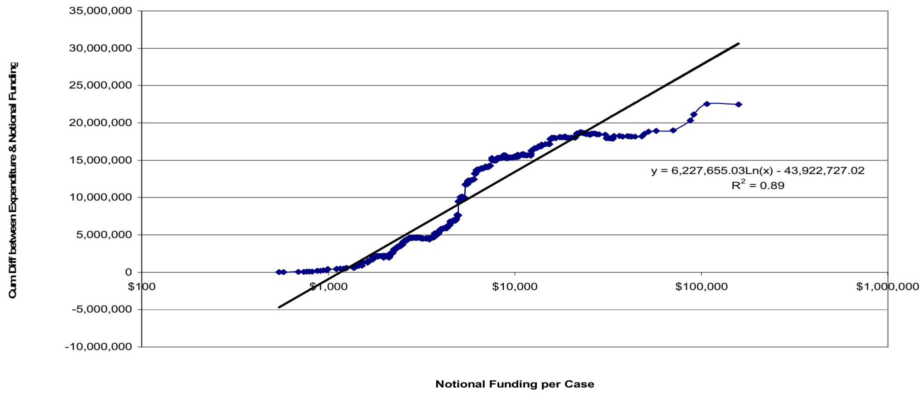
In SA, funding for CYWHS is based on paediatric cost weights. When CYWHS paediatric costs are compared with average state costs at DRG level the total difference was $19.80m over the two years 2003/04 and 2004/05.



CYWHS cumulative loss of profitability v AR-DRG State Cost

PMH

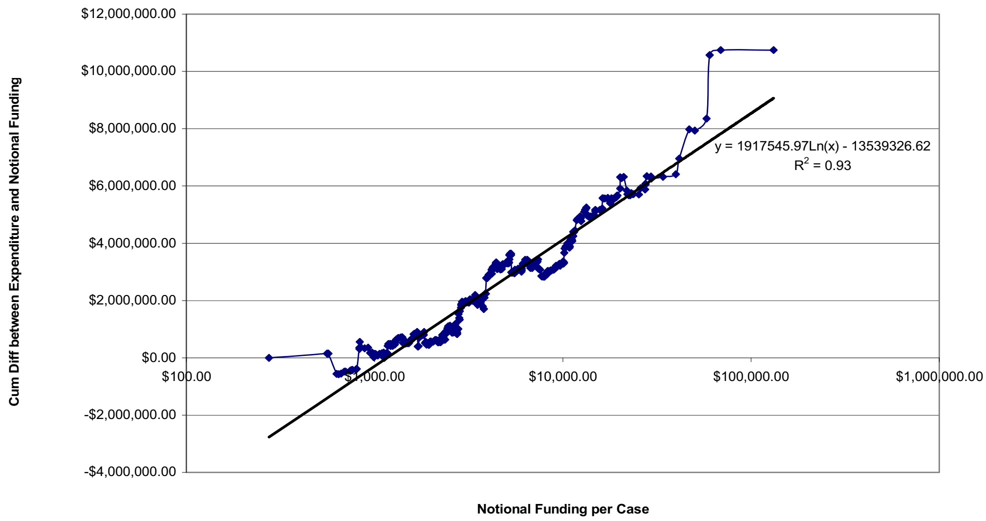
The graph below shows the cumulative difference between the hospital's costs and those of the state calculated at a DRG level. Overall for PMH the total difference was $22.48m over the two years 2003/04 and 2004/05.



PMH cumulative loss of profitability v AR-DRG State Cost

RCHB

The graph shows the cumulative difference between the hospital's costs and those of the state calculated at a DRG level. Overall for Brisbane the total difference was $10.74m over the two years 2003/04 and 2004/05.



RCHB cumulative loss of profitability v AR-DRG State Cost

Appendix IV: DRGs with the Biggest Difference between State Average Cost and Hospital Cost 2003/04 and 2004/05

RCHM

AR-DRG	Description	State Average Cost	Hospital cases	Hospital Average Cost	Cost Difference /case	Total Cost Impact
P06A	Neonate, > 2499 g W Sig O.R. Proc W Multi Major Problems	$49,866	265	$75,860	$25,994	$6,888,380
P02Z	Cardiothoracic/Vascular Procedures for Neonates	$73,554	129	$96,460	$22,906	$2,954,827
A40Z	ECMO W/O Cardiac Surgery	$151,156	36	$219,117	$67,961	$2,446,583
R60C	Acute Leukaemia W/O Catastrophic or Severe CC	$2,820	645	$4,750	$1,930	$1,244,950
L61Z	Admit for Renal Dialysis	$432	1102	$1,535	$1,102	$1,214,830
P06B	Neonate, > 2499 g W Sig O.R. Proc W/O Multi Major Prob	$18,795	105	$29,571	$10,776	$1,131,526
F07A	Other Cardiothoracic/Vascular Proc W CPB Pump W Cat CC	$43,717	143	$51,452	$7,736	$1,106,180
R63Z	Chemotherapy	$1,023	819	$2,274	$1,251	$1,024,701
P67A	Neonate, > 2499 g W/O Sig O.R. Proc W Multi Major Probs	$11,930	136	$19,464	$7,534	$1,024,609
B02A	Craniotomy W Catastrophic CC	$27,603	45	$50,065	$22,462	$1,010,779
K62C	Miscellaneous Metabolic Disorders Age <75 W/O Catastrophic or Severe CC	$1,246	544	$3,102	$1,856	$1,009,665
P67B	Neonate, > 2499 g W/O Sig O.R. Procedure W Major Problem	$6,919	268	$10,472	$3,553	$952,319
F04A	Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W Cat CC	$34,896	112	$42,984	$8,088	$905,864
G45B	Other Gastroscopy for Non-Major Digestive Disease, Sameday	$837	1097	$1,652	$815	$894,384
K60B	Diabetes W/O Catastrophic or Severe CC	$2,697	514	$4,320	$1,624	$834,627
B76B	Seizure W/O Catastrophic or Severe CC	$1,699	783	$2,679	$979	$766,872
F09A	Other Cardiothoracic Procedures W/O CPB Pump W Cat CC	$19,801	40	$37,798	$17,997	$719,875
F75C	Other Circulatory System Diagnoses W/O Cat or Severe CC	$2,563	240	$5,528	$2,965	$711,655
D40Z	Dental Extractions and Restorations	$1,425	1116	$2,009	$584	$651,217
P67C	Neonate, > 2499 g W/O Sig O.R. Proc W Other Problem	$3,708	216	$6,638	$2,929	$632,734

CHW

AR-DRG	Description	State Average Cost	Hospital cases	Hospital Average Cost	Cost Difference	Total Cost Impact
P06A	Neonate, > 2499 g W Sig O.R. Proc W Multi Major Problems	$49,337	101	$71,507	$22,170	$2,239,122
F07B	Other Cardiothoracic/Vascular Procedures W CPB Pump W/O Catastrophic CC	$20,033	260	$26,557	$6,523	$1,696,033
U66Z	Eating and Obsessive-Compulsive Disorders	$17,776	97	$31,088	$13,312	$1,291,302
A41A	Intubation Age<16 W CC	$20,410	105	$32,641	$12,231	$1,284,237
B76B	Seizure W/O Catastrophic or Severe CC	$2,050	771	$3,563	$1,513	$1,166,534
U64Z	Other Affective and Somatoform Disorders	$3,005	66	$20,507	$17,502	$1,155,137
P06B	Neonate, > 2499 g W Sig O.R. Proc W/O Multi Major Probs	$20,281	169	$26,979	$6,698	$1,131,911
R60C	Acute Leukaemia W/O Catastrophic or Severe CC	$4,028	715	$5,608	$1,580	$1,129,611
A01Z	Liver Transplant	$94,071	24	$140,949	$46,878	$1,125,061
F07A	Other Cardiothoracic/Vascular Procs W CPB Pump W Cat CC	$37,925	47	$61,238	$23,313	$1,095,712
E62B	Respiratory Infections/Inflammations W Sev or Moderate CC	$5,127	159	$10,577	$5,449	$866,450
A08A	Autologous Bone Marrow Transplant W Catastrophic CC	$57,042	16	$110,286	$53,244	$851,904
U62B	Paranoia & Acute Psych Disorder W/O Cat/Sev CC W/O Mental Health Legal Status	$2,488	26	$35,140	$32,652	$848,949
T01A	O.R. Procs for Infectious and Parasitic Diseases W Cat CC	$36,001	9	$130,105	$94,104	$846,939
R60A	Acute Leukaemia W Catastrophic CC	$36,005	35	$60,052	$24,047	$841,648
D01Z	Cochlear Implant	$18,960	73	$30,298	$11,338	$827,673
R60B	Acute Leukaemia W Severe CC	$7,524	62	$19,405	$11,881	$736,629
U65Z	Anxiety Disorders	$3,267	89	$11,028	$7,761	$690,721
U63B	Major Affective Disorders Age <70 W/O Catastrophic or Severe CC	$2,926	31	$24,707	$21,780	$675,191
A41B	Intubation Age<16 W/O CC	$7,932	86	$15,752	$7,820	$672,546

SCH

AR-DRG	Description	State Average Cost	Hospital cases	Hospital Average Cost	Cost Difference	Total Cost Impact
P06A	Neonate, AdmWt > 2499 g W Significant O.R. Procedure W Multi Major Problems	$49,337	63	$76,828	$27,491	$1,731,912
A06Z	Tracheostomy or Ventilation >95 hours	$88,108	108	$93,871	$5,763	$622,380
A08A	Autologous Bone Marrow Transplant W Catastrophic CC	$57,042	11	$110,531	$53,489	$588,384
T60A	Septicaemia W Catastrophic or Severe CC	$9,259	250	$11,573	$2,314	$578,559
F07A	Other Cardiothoracic/Vascular Procedures W CPB Pump W Catastrophic CC	$37,925	27	$59,066	$21,141	$570,804
P60B	Neonate Died/Transf <5 Days of Adm, W/O Significant O.R. Proc, Not Newborn	$2,454	59	$10,654	$8,200	$483,786
K60B	Diabetes W/O Catastrophic or Severe CC	$3,033	145	$6,245	$3,212	$465,728
Z63A	Other Aftercare W Catastrophic or Severe CC	$5,584	10	$44,647	$39,063	$390,626
A41A	Intubation Age<16 W CC	$20,410	46	$28,765	$8,355	$384,316
W61Z	Multiple Trauma Without Significant Procedures	$11,952	18	$32,193	$20,242	$364,348
G07B	Appendicectomy W/O Catastrophic or Severe CC	$4,523	188	$6,458	$1,935	$363,725
B76B	Seizure W/O Catastrophic or Severe CC	$2,050	433	$2,809	$759	$328,759
B02A	Craniotomy W Catastrophic CC	$33,424	30	$44,109	$10,685	$320,547
F04A	Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W Cat CC	$32,212	9	$64,834	$32,621	$293,592
B02B	Craniotomy W Severe or Moderate CC	$18,310	42	$24,985	$6,675	$280,349
E01B	Major Chest Procedures W/O Catastrophic CC	$11,205	31	$20,202	$8,997	$278,902
L04C	Kidney, Ureter and Major Bladder Procedures for Non-Neoplasm W/O CC	$6,654	88	$9,812	$3,158	$277,941
D40Z	Dental Extractions and Restorations	$1,803	223	$2,951	$1,148	$255,966
G03B	Stomach, Oesophageal and Duodenal Procedures W/O Malignancy W Cat or Sev CC	$22,304	38	$28,702	$6,397	$243,104

CYWHS

AR-DRG	Description	State Average Cost	Hospital cases	Hospital Average Cost	Cost Difference	Total Cost Impact
A06Z	Tracheostomy or Ventilation >95 hours	$69,472	110	$92,001	$22,529	$2,478,192
P06A	Neonate, AdmWt > 2499 g W Significant O.R. Procedure W Multi Major Problems	$52,036	32	$129,384	$77,348	$2,475,144
U61B	Schizophrenia Disorders W/O Mental Health Legal Status	$6,413	53	$30,740	$24,326	$1,289,303
L61Z	Admit for Renal Dialysis	$469	1,140	$1,191	$722	$822,610
R63Z	Chemotherapy	$612	1,187	$1,138	$527	$625,004
901Z	Extensive O.R. Procedure Unrelated to Principal Diagnosis	$14,745	44	$26,034	$11,289	$496,705
G45B	Other Gastroscopy for Non-Major Digestive Disease, Sameday	$775	547	$1,627	$853	$466,396
D40Z	Dental Extractions and Restorations	$1,579	1,085	$1,996	$417	$452,552
I06Z	Spinal Fusion W Deformity	$32,654	41	$43,127	$10,473	$429,413
U63B	Major Affective Disorders Age <70 W/O Catastrophic or Severe CC	$6,548	40	$16,391	$9,843	$393,725
P06B	Neonate, Adm Wt > 2499 g W Significant O.R. Proc W/O Multi Major Problems	$18,231	54	$25,062	$6,830	$368,847
B67C	Degenerative Nervous System Disorders Age <60 W/O Cat or Sev CC	$3,327	39	$12,430	$9,103	$355,017
L67C	Other Kidney and Urinary Tract Diagnoses W/O Catastrophic or Severe CC	$1,580	118	$4,523	$2,943	$347,279
Z63A	Other Aftercare W Catastrophic or Severe CC	$7,243	21	$23,737	$16,494	$346,377
B76B	Seizure W/O Catastrophic or Severe CC	$1,970	369	$2,875	$905	$334,004
U64Z	Other Affective and Somatoform Disorders	$4,547	100	$7,670	$3,123	$312,320
X62B	Poisoning/Toxic Effects of Drugs & Other Substances Age <60 W/O CC	$1,475	364	$2,327	$852	$310,044
Q60C	Reticuloendothelial and Immunity Disorders W/O Cat or Sev CC W/O Malignancy	$904	522	$1,448	$544	$284,085

PMH

AR-DRG	Description	State Average Cost	Hospital cases	Hospital Average Cost	Cost Difference	Total Cost Impact
U67Z	Personality Disorders and Acute Reactions	$4,985	128	$19,537	$14,553	$1,862,776
K60B	Diabetes W/O Catastrophic or Severe CC	$5,425	278	$11,915	$6,490	$1,804,297
A07Z	Allogeneic Bone Marrow Transplant	$87,332	11	$208,530	$121,198	$1,333,177
963Z	Neonatal Diagnosis Not Consistent W Age/Weight	$7,535	20	$59,221	$51,686	$1,033,714
A06Z	Tracheostomy or Ventilation >95 hours	$91,269	39	$111,830	$20,560	$801,853
K62B	Miscellaneous Metabolic Disorders Age >74 or W Severe CC	$6,088	24	$37,997	$31,908	$765,799
901Z	Extensive O.R. Procedure Unrelated to Principal Diagnosis	$15,484	58	$26,687	$11,203	$649,771
U66Z	Eating and Obsessive-Compulsive Disorders	$21,452	57	$30,631	$9,180	$523,239
K62C	Miscellaneous Metabolic Disorders Age <75 W/O Catastrophic or Severe CC	$3,719	134	$7,580	$3,861	$517,341
P67C	Neonate, AdmWt > 2499 g W/O Significant O.R. Procedure W Other Problem	$4,494	100	$9,190	$4,696	$469,571
E75B	Other Respiratory System Diagnosis Age >64 or W CC	$4,912	64	$12,182	$7,271	$465,324
E69C	Bronchitis and Asthma Age <50 W/O CC	$2,243	695	$2,905	$662	$460,211
U65Z	Anxiety Disorders	$6,208	31	$20,811	$14,603	$452,703
U64Z	Other Affective and Somatoform Disorders	$5,106	24	$23,131	$18,025	$432,595
Q60C	Reticuloendothelial and Immunity Disorders W/O Cat or Sev CC W/O Malignancy	$1,535	492	$2,356	$822	$404,211
K61Z	Severe Nutritional Disturbance	$12,248	16	$34,008	$21,759	$348,151
F04A	Cardiac Valve Proc W CPB Pump W/O Invasive Cardiac Inves W Cat CC	$49,545	8	$92,325	$42,780	$342,236
K64B	Endocrine Disorders W/O Catastrophic or Severe CC	$3,925	116	$6,800	$2,875	$333,521

RCHB

AR-DRG	Description	State Average Cost	Hospital cases	Hospital Average Cost	Cost Difference	Total Cost Impact
A06Z	Tracheostomy or Ventilation >95 hours	$60,121	55	$100,485	$40,364	$2,220,036
A07Z	Allogeneic Bone Marrow Transplant	$46,893	23	$91,739	$44,845	$1,031,441
G45B	Other Gastroscopy for Non-Major Digestive Disease, Sameday	$829	963	$1,547	$718	$691,106
P06A	Neonate, AdmWt > 2499 g W Significant O.R. Procedure W Multi Major Problems	$41,573	16	$75,666	$34,093	$545,489
U67Z	Personality Disorders and Acute Reactions	$3,911	95	$9,617	$5,706	$542,049
R60C	Acute Leukaemia W/O Catastrophic or Severe CC	$2,787	597	$3,657	$870	$519,197
A01Z	Liver Transplant	$58,000	7	$117,618	$59,618	$417,325
U65Z	Anxiety Disorders	$3,814	43	$13,268	$9,455	$406,547
A41A	Intubation Age<16 W CC	$20,161	45	$28,848	$8,688	$390,945
901Z	Extensive O.R. Procedure Unrelated to Principal Diagnosis	$11,851	98	$15,539	$3,689	$361,476
U68Z	Childhood Mental Disorders	$10,152	130	$12,699	$2,547	$331,152
E60A	Cystic Fibrosis W Catastrophic or Severe CC	$12,992	157	$15,005	$2,013	$316,028
G69Z	Oesophagitis and Misc Digestive System Disorders Age<10	$1,727	311	$2,714	$987	$307,000
K60B	Diabetes W/O Catastrophic or Severe CC	$2,827	97	$5,966	$3,139	$304,521
Y02A	Other Burns W Skin Graft Age >64 or W (Cat or Sev CC) or W Complicating Proc	$27,928	9	$58,041	$30,113	$271,013
K62C	Miscellaneous Metabolic Disorders Age <75 W/O Catastrophic or Severe CC	$2,368	187	$3,792	$1,424	$266,320
I74C	Injury to Forearm, Wrist, Hand or Foot Age <75 W/O CC	$1,173	413	$1,790	$617	$254,778
E70B	Whooping Cough and Acute Bronchiolitis W/O CC	$2,285	334	$3,045	$759	$253,660
G02A	Major Small and Large Bowel Procedures W Catastrophic CC	$20,156	12	$40,817	$20,662	$247,940

Appendix V: Cost Indices – Clinical and Theatre Cost Component Compared between Specialist Paediatric Hospitals and State for 2005-2006.

Cost Indices – Clinical Costs Component Compared between Specialist Paediatric Hospitals and State for 2005-2006.

Hospital/State	GLS Index	CMA Index	Ratio	Separations
NSW 05-06	0.845	0.855	0.988	1,324,262
SA 05-06	0.749	0.755	0.992	367,001
QLD 05-06	0.943	0.947	0.995	699,284
VIC 05-06	1.139	1.135	1.004	1,212,063
WA 05-06	1.342	1.333	1.007	438,784
RCHM0506	1.736	1.560	1.112	33,577
CHW0506	1.473	1.323	1.114	26,422
SCH0506	0.962	0.861	1.117	13,671
PMH0506	1.617	1.446	1.118	21,115
CYWHS0506	0.828	0.740	1.120	18,886
RCHB0506	1.312	1.147	1.144	15,787

Cost Indices – Operating Theatre Costs Component Compared between Specialist Paediatric Hospitals and State for 2005-2006.

Hospital/State	GLS Index	CMA Index	Ratio	Separations
SA 05-06	0.915	0.927	0.987	367,001
QLD 05-06	0.952	0.962	0.989	699,284
NSW 05-06	0.911	0.918	0.992	1,324,262
WA 05-06	0.958	0.962	0.996	438,569
CHW0506	0.673	0.665	1.012	26,743
VIC 05-06	1.183	1.160	1.020	1,212,063
PMH0506	1.221	1.195	1.021	21,134
SCH0506	1.362	1.324	1.029	13,650
RCHM0506	1.078	1.046	1.031	33,621
RCHB0506	1.087	1.053	1.033	15,708
CYWHS0506	1.209	1.159	1.043	18,459

Appendix VI: Statistical Analysis Used in Development of HRG 4

Other data sources used to inform HRG4 include:

- The National Schedule of Reference Costs
- Data from Expert Reference Panels (ERPs)
- Other pilot data from trust departmental systems (Theatre, Pathology etc)
- Data from outpatient studies.

NHS National Reference Cost data were collected from a large number of trusts who could supply these data at the patient or procedure level. These data were analysed and used to inform HRG development, ensuring that varying resource use was taken into account in HRG development and not just data relating to length of stay.

The principal data sources from which HRG4 groupings have been derived are:

- Admitted Patient Care Commissioning Data Set (CDS)
- Outpatient Attendance CDS
- Accident and Emergency CDS (for Emergency and Urgent Care HRGs)
- Critical Care Minimum Data Sets (MDS)

The most common statistical methods were:

1. Basic summary statistics - mean, mode, minimum, maximum, inter-quartile range

2. Measurements of Variability - including the Coefficient of Variation (or CV which equals the standard deviation/mean). An aim in the design of HRGs is to minimise the cost variation within an HRG and so minimise the CV

3. Reduction in Variance (RIV) – a measure of how much variation is explained by the HRGs. An aim with HRGs design is to maximise the RIV

4. Classification and Regression Trees (CART) – an analysis technique used to suggest possible HRGs. Essentially, given a resource variable (for example Total Episode Cost), CART will identify groupings that best differentiate between high and low cost cases.

Appendix VII: Recognising genuinely unrecognised CC diagnoses

The English HRGv4 groups identify a set of CC diagnoses specific to the HRG Childhood Diseases chapter. There are a total of 3,071 diagnoses in the CC list of which 1,495 codes are not included in the AR-DRG CC list.

The diagnoses can be described as being in three groups (not mutually exclusive):

- Paediatric Diagnoses, including congenital disorders
- Age affected general diagnoses
- General diagnoses

The fact that the English Paediatric Chapter identified each of the codes in its CC list as being of consequence to the care of children means a more detailed investigation of the implication of these codes for the AR-DRG system is required. The objective is to identify unrecognised CCs that describe the additional resources attributed to children within existing AR-DRGs.

We need to consider, once again, how an important complicating code may escape inclusion in the AR-DRG definition. This presupposes that these codes have a differential impact on care after the codes already in the classification are taken into account. From the statistical point of view, such an assessment would be very difficult to perform. Although the Australian data collections used in AR-DRG development are quite large, a simple reflection on combinatory theory shows it is highly segmented by the features of the Classification System. There will be more combinations than there are data points.

Given that there is no real possibility of empirically discovering all complicating diagnoses, clinical lead needs to be followed and tested as best it can against the limited data. As written above, the English had less limited data and so had the potential to discover/verify impacts of codes beyond those in the Australian Classification.

What we now must consider is what would make a significant complicating code more likely to be discovered in HRG development but not in AR-DRG development. Relatively low frequency of occurrence would be an obvious selector. We may suppose that in aggregate the codes that were missed by AR-DRG development but included in HRG could have material effect, of the type we observed above. A particular subclass of these low frequency codes is those that are not so infrequent in Specialist Paediatric Hospitals but scarce in the adult cases. We may also have relatively frequent codes that occur across the whole treatment population but are only a material cost driver in children. The Australian Classification does not allow age interaction in complication level (CCL) so such a code could be ruled out by the bulk of its occurrences in adult cases, or simply have its effect masked by these cases during AR-DRG development discovery/verification. Again, the effect of each of these codes may be negligible (part of swings and round-a-bouts) but important in aggregate. Again the net effect of these codes would show up in our analyses but not in conventional approaches.

When we come to consider the 1,495 codes in question we must also take into account that CCs are identified by a screening process and these processes are subject to both false positive and false negative findings. Although the larger English data set reduced false positives (code that appears to be a significant complication when not), false negatives (missing a real complication) would occur, and our selection process (CC codes not used in AR-DRG) would tend to concentrate these codes. Further, if there were no false negatives in the Australian screening process, we could safely argue that any of the 1,495 codes that were not false positives in the English process would be age interacting, and much more complex in children. But we know there are false negatives from the Australian process, so there will be codes amongst our 1,495 that affect adults at least as much as children. Clearly there will be noise amongst our 1,495 codes, noise that must be removed before bias correction (uplifts) are instigated on the basis of these codes. On the other hand, amongst the 1,495 codes there are many codes for which both the English and Australian screening process were error free and these codes will be age interacting with higher CCL levels in children.

We now consider some examples that illustrate the discussion above and, that besides the genuinely statistical limitations faced in reducing the 1,495 codes to a better list, there is a need for focussed clinical review cognisant of the design of the AR-DRG Classification and healthy service referral and transfer practices.

Preliminary investigation of the 1,495 codes found the 76 codes (see table below) that are primarily found in children. These codes were most commonly associated with a Paediatric DRG. It may be there is a resource impact built into those AR-DRG costs according to the swings and roundabouts argument. As an example, diagnosis *R62.8 Other lack of expected normal physiological development* which indicates “failure to thrive” and represents a good indicator of more complex patients, is current recorded on about 5% of Specialist Paediatric Hospitals episodes.

The testing process used to assess the impact of the 1,495 codes was followed just with the 76 codes listed. Because these codes were uncommon, the analysis used partition thresholds of 0.25%, 0.5%, 1.0% and 5.0%. The lowest average compliance ratio (on either side of the partition) for Specialist Paediatric Hospitals was 1.06, and there was no evidence of consistency in the CMA indices. Indeed even the state compliance indices became unstable at the 5% threshold. These 76 codes do not drive the effect of the 1,495 codes. As a further check the original analysis was run using the list of 1,419 codes obtained by removing the 76 higher Specialist Paediatric Hospitals codes and the results were marginally better (on both sides of the partition) than the original.

Congenital problems are expected to be more relevant to Specialist Paediatric Hospitals by implication, but will also be relevant to adults. *Q25.0 Patent ductus arteriosus* (PDA) is a congenital heart defect which can lead to poor weight gain, and can lead later in life to congestive heart failure. This secondary diagnosis is associated with cases with a higher than expected length of stay for children’s hospitals but is lower than expected for children in other hospitals. This may indicate that the patients are being transferred to the specialist services provided by children’s hospitals. This is an example of a diagnosis that while currently concentrated in the Specialist Paediatric Hospitals’ population, could become a more significant diagnosis for other hospitals with the increasing life expectancy of patients with congenital diseases. It also exemplifies the need to clinically assess age effects on CCL in the absence of extensive data for older patients.

We cannot ignore the possibility that the English list contains "false positives" in the form of adult diagnoses not prevalent in the paediatric population and or not showing a significant increase in length of stay or cost over and above that expected within the DRG. The latter type are typified by minor CCs that occur in relatively high volumes in the adult population rather than children e.g. Hypertension which is a frequent adult secondary diagnosis but is rarely described for children, where other more specific diagnoses should be recorded e.g. *P29.2 Neonatal hypertension*. Another example is *E03.9 Hypothyroidism* is a diagnosis common for adults but it does occur on 2.44% of children's hospital age 19+ records. This may also be a less specific recording of *E03.0 or E03.1 Congenital hypothyroidism*.

E86 Volume depletion is a common complication of illnesses in paediatric patients presenting, and has been observed in studies for children presenting to Emergency Departments (England AG, 2006). It could indicate the need to treat the patient to prevent shock and cardiovascular problems. This problem is also associated with adults and is associated with a higher than expected length of stay. This complication appears to be relevant for the AR-DRG system as whole and not necessarily of particular significance for paediatric population. This would fit in the category of CCs as a general diagnosis relevant for both adult and children's populations but without age interactions.

E83.3 Disorders of phosphorus metabolism, which includes Vitamin-D-resistant osteomalacia, whilst the adult form of Osteomalacia is coded to M83. This coding would normally only be associated with children. For Specialist Paediatric Hospitals, cases with this secondary diagnosis have a longer length of stay than expected.

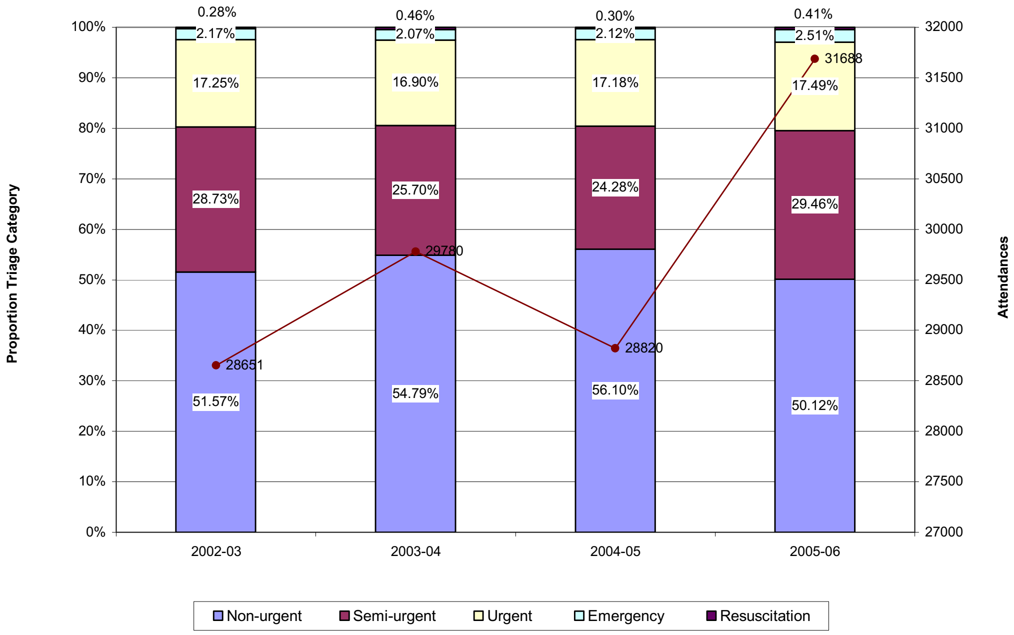
B96.2 Escherichia coli (as cause of classified to other chapters), is an example of an infection for which children and the elderly are susceptible to complications, and therefore an age effect may be associated. For the 0-18 population in Irish Specialist Paediatric Hospitals these patients have a length of stay 1.63 times the expected whilst the adults also have a higher than expected length of stay also with an index of 1.40. We could not review this in the Australian dataset but assume that it holds.

CC codes Relatively Frequent in Specialist Paediatric Hospitals Only

Dx	Specialist Paediatric Hospitals Diagnosis Description
A082	Adenoviral enteritis
B978	Oth viral agents as cause of dis classified to other chaps
C4101	Mal.neop-Bones of skull and face
E550	Rickets active
E748	Other specified disorders of carbohydrate metabolism
E833	Disorders of phosphorus metabolism
F721	Sev mental retard sign impairm behav req attent /treatment
F900	Disturbance of activity and attention
G4011	Locl-rel(foc)part)symp epilep/ epilptic syn simpe part seiz
G4040	Other generalized epilepsy and epileptic syndromes
G4080	Other epilepsy
G8226	Paraplegia unspecified
H351	Retinopathy of prematurity
I158	Other secondary hypertension
M303	Mucocutaneous lymph node syndrome [Kawasaki]
M4109	Infantile idiopathic scoliosis-Site unspe
M4110	Juvenile idiopathic scoliosis-Mult site
M4119	Juvenile idiopathic scoliosis-Site unspe
M4134	Thoracogenic scoliosis-Thoracic
N031	Focal and segmental glomerular lesions
N259	Disorder result from impaired renal tubular function unspec
P051	Small for gestational age
P0702	Extremely low birth weight
P0703	Extremely low birth weight
P0711	Other low birth weight
P0712	Other low birth weight
P0713	Other low birth weight
P0722	Extreme immaturity
P2841	Other apnoea of newborn
P285	Respiratory failure of newborn
P2889	Other specified respiratory conditions of newborn
P290	Neonatal cardiac failure
P293	Persistent fetal circulation
P2981	Oth cardiovascular disorders origin in the perinatal period
P2982	Oth cardiovascular disorders origin in the perinatal period
P2989	Oth cardiovascular disorders origin in the perinatal period
P524	Intracerebral (nontraumatic) haemorrhage of fet and newborn
P590	Neonatal jaundice associated with preterm delivery
P598	Neonatal jaundice from other specified causes
P612	Anaemia of prematurity
P614	Other congenital anaemias not elsewhere classified
P748	Other transitory metabolic disturbances of newborn
P808	Other hypothermia of newborn
P809	Hypothermia of newborn unspecified
P810	Environmental hyperthermia of newborn
P831	Neonatal erythema toxicum
P833	Other and unspecified oedema specific to fetus and newborn

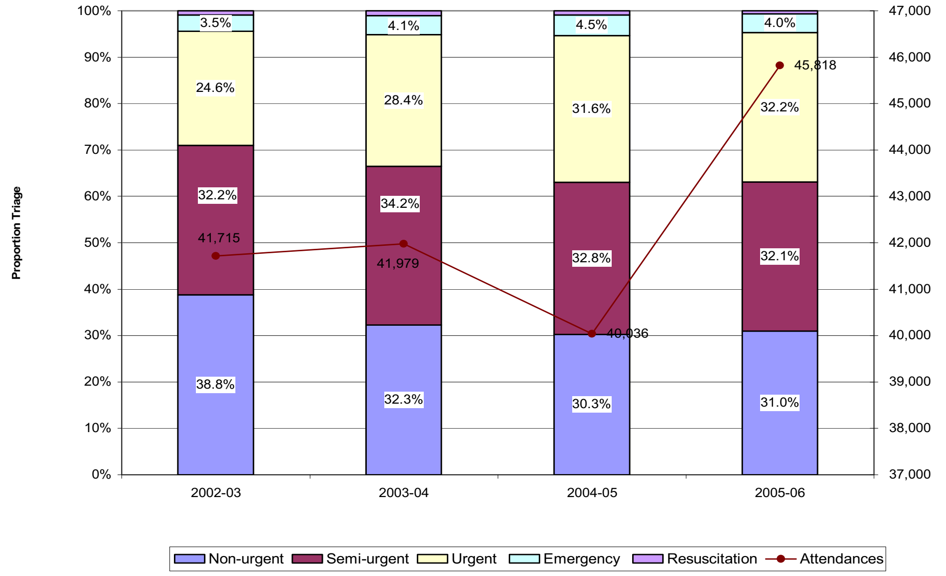
P835	Congenital hydrocele
P912	Neonatal cerebral leukomalacia
P9181	Other specified disturbances of cerebral status of newborn
P942	Congenital hypotonia
P960	Congenital renal failure
Q02	Microcephaly
Q049	Congenital malformation of brain unspecified
Q0782	Other specified congenital malformations of nervous system
Q206	Isomerism of atrial appendages
Q208	Other cong malforms of cardiac chambers and connections
Q240	Dextrocardia
Q250	Patent ductus arteriosus
Q254	Other congenital malformations of aorta
Q255	Atresia of pulmonary artery
Q256	Stenosis of pulmonary artery
Q257	Other congenital malformations of pulmonary artery
Q268	Other congenital malformations of great veins
Q278	Other spec cong malformations of peripheral vasc system
Q445	Other congenital malformations of bile ducts
Q658	Other congenital deformities of hip
Q660	Talipes equinovarus
Q7409	Oth cong malformation of upper limb(s) inc shoulder girdle
Q742	Other cong malformation of lower limb(s) incl pelvic girdle
Q743	Arthrogryposis multiplex congenita
Q7482	Other specified congenital malformations of limb(s)
Q7485	Other specified congenital malformations of limb(s)
Q7489	Other specified congenital malformations of limb(s)
Q798	Other congenital malformations of musculoskeletal system
R628	Other lack of expected normal physiological development

Appendix VIII: Trends in ED Attendances 2002-2006



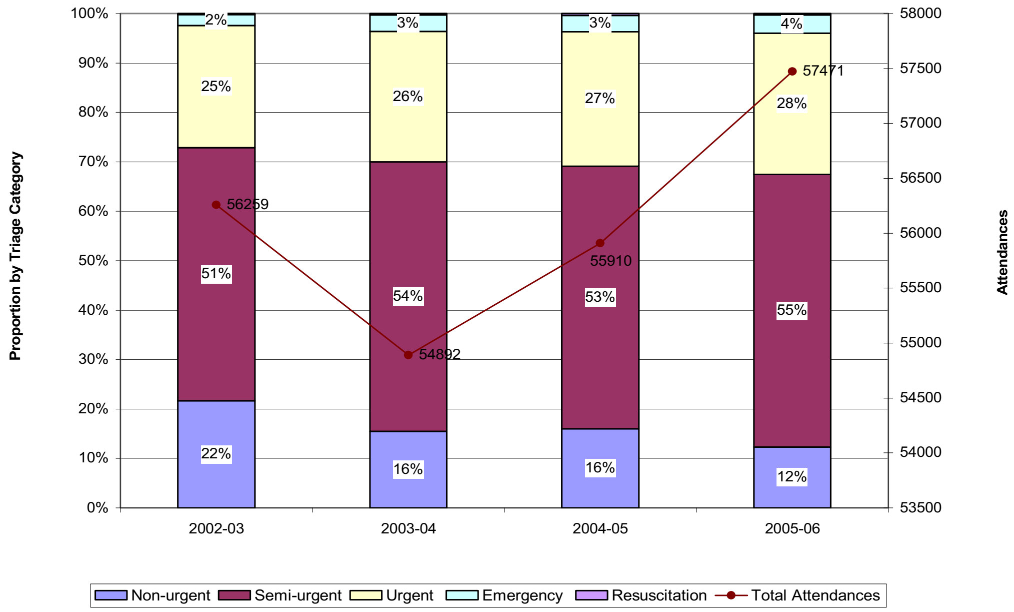
Trend in ED attendances at SCH from 2002 to 2006.

ED attendances at SCH increased by a total of 10.5% from 2002 to 2006. The proportion of each triage category was similar from 2002 to 2006 except for a change in the balance of non-urgent and semi-urgent attendances in the middle years. This fluctuation may have been an artefact of the triage process rather than change in treatment population.



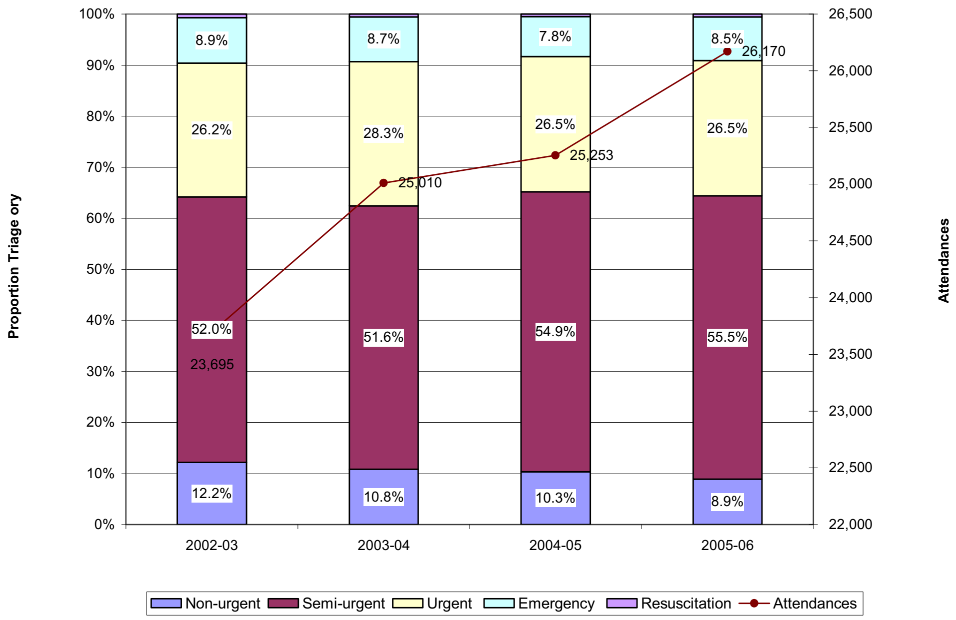
Trend in ED attendances for CHW from 2002 to 2006.

CHW showed a drop in ED attendances of around 5% in 2004/05 followed by a 13% rise the following year. There has been a proportional increase in ‘urgent’ cases and a proportion decrease in non-urgent cases in the last four years. Other triage categories have remained at a similar proportional level.



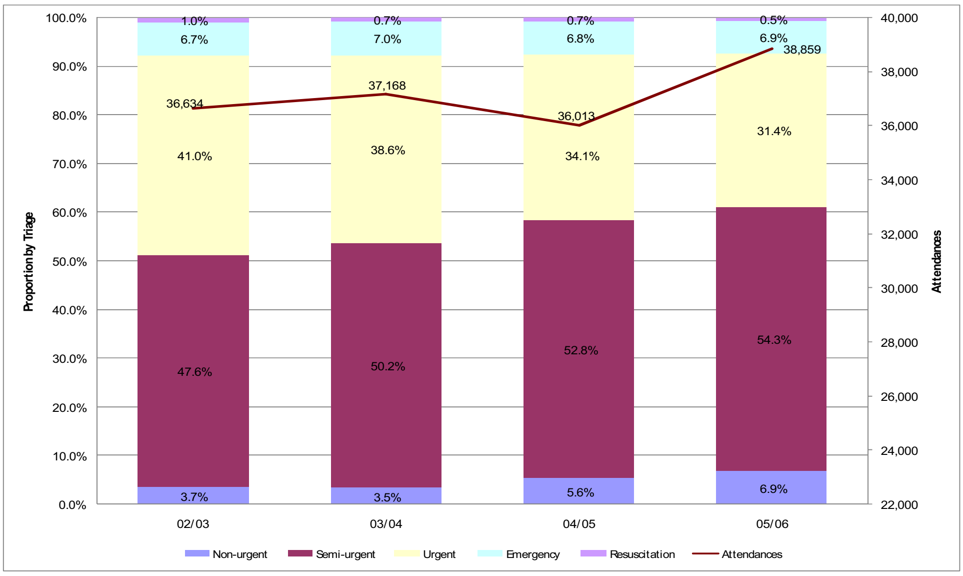
Trend in ED attendances for RCHM from 2002 to 2006.

RCHM had a drop in ED attendances of around 2.5% in 2003/04 but has seen a rise of nearly 2% in 2004/05 and a further rise of around 3% in 2005/06. The proportion of non-urgent occasions of service has dropped from 22% in 2002/03 to 12% in 2005/06 with a proportional rise in ‘urgent’ and ‘semi-urgent’ cases.



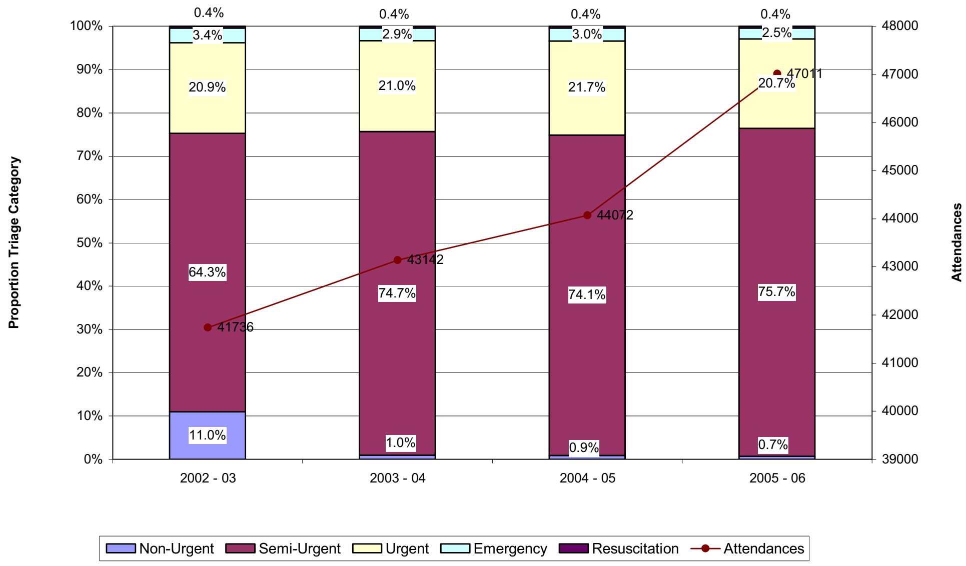
Trend in ED attendances for RCHB from 2002-2006.

RCHB has experienced a steady increase in the ED attendance in the last four years with an increase of 6% in 2003/04 and a further 4% increase in 2005/06. Proportional representation of triage categories has remained fairly stable with a slight drop in the proportion of ‘non-urgent’ and a slight increase in ‘semi-urgent’ cases.



Trend in ED attendances for CYWHS from 2002-2006.

ED attendances at CYWHS increased between 2004/05 and 2005/06. There has been some shift from urgent to semi-urgent attendances presenting in recent years.



Trend in ED attendances for PMH from 2002-2006.

PMH had a steady increase in ED attendances from 2002 to 2006 of 12.6%. Proportions of each triage category remained the same except for an apparent shift of 'non-urgent' to 'semi-urgent' cases in 2003-2004, which remained permanent to 2006. This accounted for a decrease of over 90% of 'non-urgent' cases or 10% of total cases since 2002-2003. The change has been explained as a change in triage process rather than change in treatment population.

Appendix IX: Criteria for Admission via Emergency Department

The criteria for admission provided in survey replies from Specialist Paediatric Hospitals may go some of the way to explaining the trends in ED submissions described above.

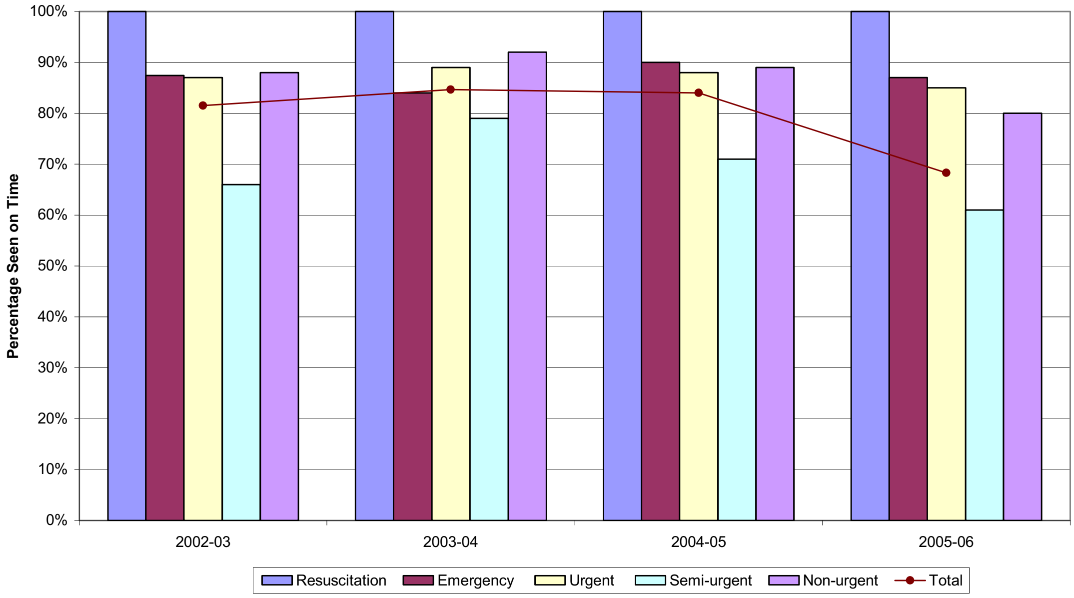
SCH admits patients from the ED in two groups; observation and acute. Admissions are determined by senior medical staff. Patients admitted as observation are planned to be discharged within 12 hours although some may ultimately be determined to require full admission. Patients requiring longer periods of observation are given full admission. These practices could impact by reducing admission rate for emergency and some resuscitation cases, if some EMU admissions are not recorded as full hospital admissions.

RCHB admits patients requiring 2-6 hours of observation and acute patients requiring less than 24 hours treatment. RCHM and CYWHS admit all patients after 4 hours of care in the ED under medical discretion. PMH admissions depend on clinical judgement. CHW refers to a Department of Health policy that ED patients cannot be admitted to the ED and are admitted as inpatients to the hospital only.

All hospitals have Short Stay Units (SSU) or Emergency Medical Units (EMU) managed by the ED, except for CHW which only admits direct to hospital inpatients. The time since establishment varies: SCH for over 10 years, CYWHS for over 5 years and RCHM for 2 years. Admission is based on clinical criteria:

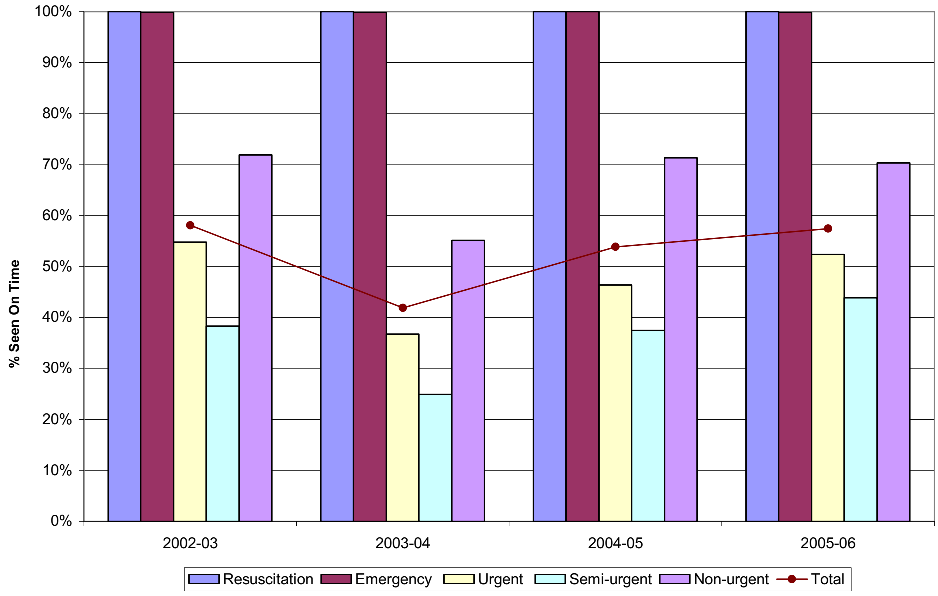
- SCH admits patients requiring 4-12 hours of observation before being discharged home or full admission.
- RCHM specified that short stays are for patients requiring less than 36 hours observation with treatment starting in the ED as assessed. All patients in the SSU are counted as inpatients at RCHM.
- PMH keeps patients here for less than 24 hours for observation or overnight.
- CYWHS admits patients to the short stay ward when technical requirements are met.

Appendix X: Proportion Seen on Time Analysis for Participating Hospitals



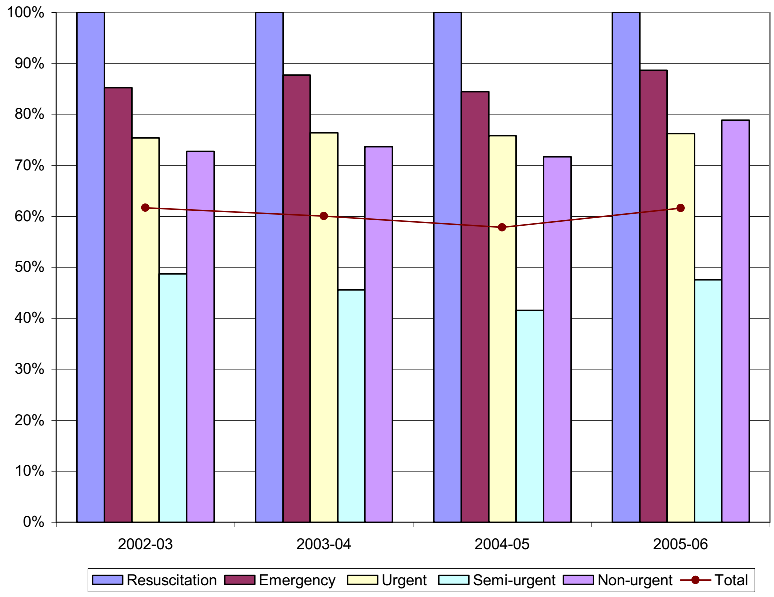
SCH proportion of ED attendances seen on time from 2002-2006.

SCH figures suggest a dip in the proportion seen on time in 2005/06. This drop in the total seen on time occurred in the year when the hospital saw a large increase in the overall number of ED attendances. Triage categories 1-3 show little change from 2002 to 2006. ‘Non-urgent’ varies slightly and ‘semi-urgent’ has the greatest variation with a large drop in the proportion seen on time in 2005/06.



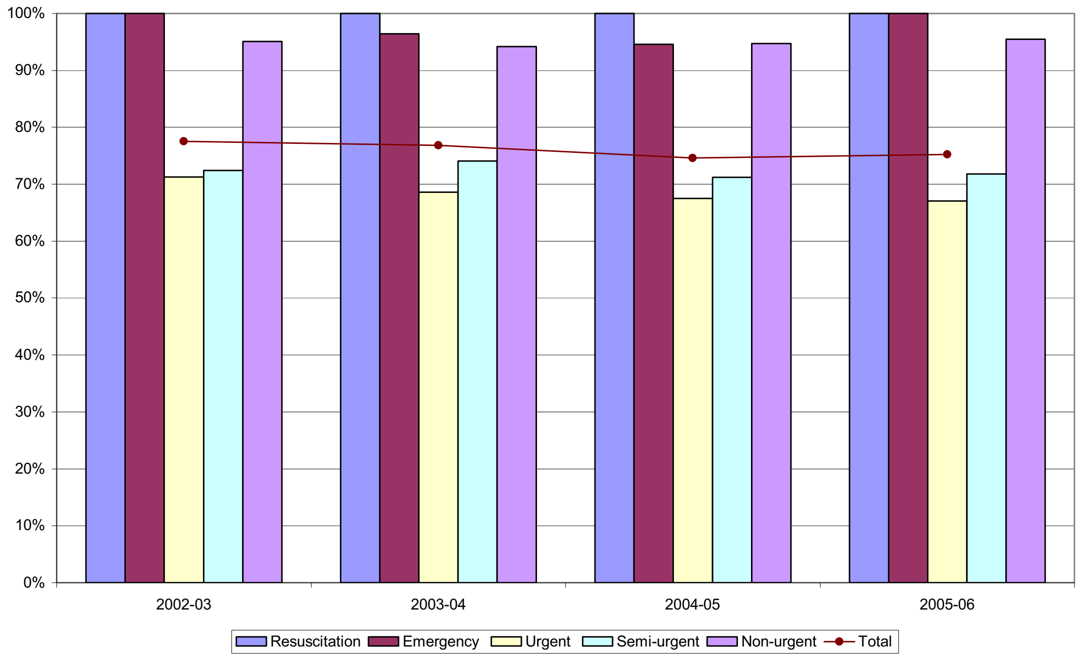
CHW proportion of ED attendances seen on time from 2002-2006

Triage categories 1 and 2 remain at 100% from 2002-2006 for CHW. Categories 3 to 5 have reduced proportion seen on time during 2003 to 2004 and increase to 2002 levels from 2004 to 2006. 2003-2004 appears to be an unusual year.



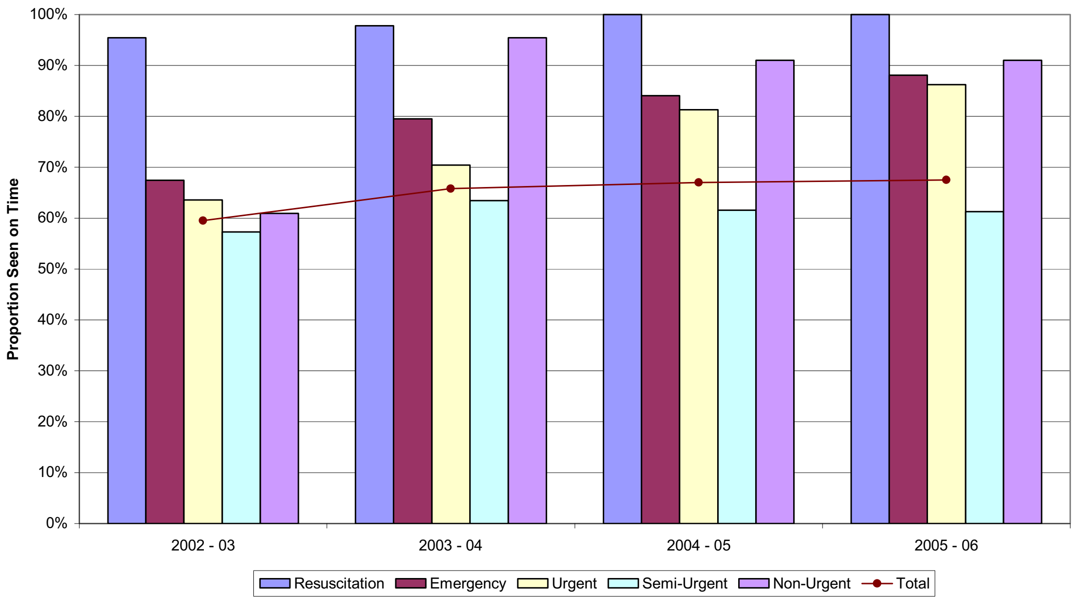
RCHM proportion of ED attendances seen on time from 2002-2006.

Proportion of ED admissions seen on time is very consistent at RCHM between 2002 and 2006.



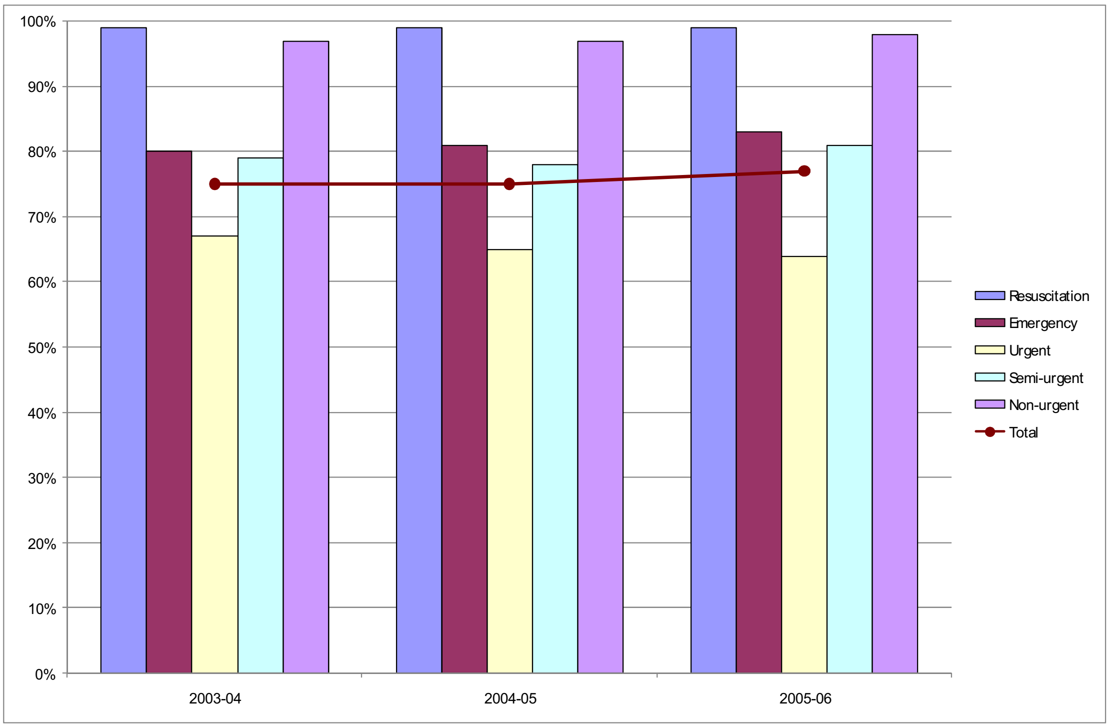
RCHB proportion of ED attendances seen on time from 2002-2006

RCHB has a stable performance for all triage categories from 2002 to 2006.



PMH proportion of ED attendances seen on time from 2002-2006.

At PMH all triage categories have shown an increase since 2002 in the proportion 'seen on time'. 'Resuscitation', 'emergency' and 'urgent' has increased substantially. 'Non-urgent' cases were almost always seen on time from 2003 onwards, however, the numbers categorised as non-urgent have been negligible since 2003.



CYWHS proportion of ED attendances seen on time from 2003-2006.

CYWHS has a stable performance for all triage categories from 2003-2006. Comparable data set was not available for 2002-03.