A new clinical complexity model for the Australian Refined Diagnosis Related Groups

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ABSTRACT

Background: The Australian Refined Diagnosis Related Groups (AR-DRG) underwent a major review in 2014 with changes implemented in Version 8.0 of the classification. The core to the changes was the development of a new methodology to estimate the Diagnosis Complexity Level (DCL) and to aggregate the complexity level of individual diagnoses to the complexity of an entire episode, resulting in an Episode Clinical Complexity Score (ECCS). This paper provides an overview of the new methodology and its application in Version 8.0.

Method: The AR-DRG V8.0 refinement project was overseen by a Classifications Clinical Advisory Group and a Diagnosis Related Groups (DRG) Technical Group. Admitted Patient Care National Minimum Dataset and the National Hospital Cost Data Collection were used for complexity modelling and analysis.

Result: In total, Version 8.0 comprised 807 DRGs, including 3 error DRGs. Of the 321 Adjacent DRGs (ADRGs) that had a split, 315 ADRGs used ECCS as the only splitting variable while the remaining 6 ADRGs used splitting variables other than ECCS: 2 used age and 4 used transfer.

Discussion and conclusion: A new episode clinical complexity (ECC) model was developed and introduced in AR-DRG V8.0, replacing the original model introduced in the 1990s. Clear AR-DRG structure principles were established for revising the system. The new complexity model is conceptually based and statistically derived, and results in an improved relationship with actual variations in resource use due to episode complexity.

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1. Introduction

The aim of this paper is to present the method adopted in Australia from 2016 to allow for patient complexity in the Australian Refined Diagnosis Related Groups (AR-DRG) classification. Up to then, an Australian adaptation of the original Yale method of allowing for complexity had been used [3]. Increasingly this had been questioned, following a series of unconnected changes over the years, including the introduction of non-clinical complexity factors, and doubts about some of the relative weights that applied for different co-morbidities.

Australia's public hospitals are funded primarily through an Activity Based Funding (ABF) model, using the AR-DRG classification. Hospital in-patient episodes in public hospitals cost approximately $AUD 33 billion in 2017-18 [1]. AR-DRGs are also widely used by private health insurance funds in case payment models for Australia's private hospitals.

The AR-DRG classification, which has been Australia's casemix system since its release in 1998, classifies individual episodes of patient care based on patient, administrative and clinical characteristics. The classification first assigns each episode of care to a Major Diagnostic Category (MDC), based on the episode's principal diagnosis (PDx). High cost episodes such as organ transplants

bypass this MDC assignment and are instead assigned directly to so-called pre-MDC Adjacent DRGs (ADRGs) with an average cost of $AUD 119,000 [2]. It then partitions MDCs into clinically coherent groups of episodes known as ADRGs. Episodes are assigned to ADRGs primarily according to their PDx and interventions performed during the episode.

The Diagnosis Related Group (DRG) is the end class of the classification, with each ADRG split into one or more DRGs according to clinical complexity and/or a limited range of other factors. Clinical complexity of an episode, typically indicated by the presence of specific additional diagnoses, can result in increased care needs, and therefore costs.

Up to AR-DRG Version 7.0, clinical complexity had been assessed using a system of Complications and Comorbidities (CCs). The CC structure used as the basis of clinical complexity processing within the original Australian National Diagnosis Related Groups (AN-DRG) was developed by Yale University in the late 1980s [3]. The structure included a diagnosis exclusion list, which was used to disregard diagnoses associated with, or related to, other diagnoses already recognised as CCs. For example, some diagnoses which provide further information about coexisting CCs were excluded from being considered additional CCs.

In developing AN-DRG V3.0, the Australian Government enhanced the Yale CC structure by specifying integers 0,. . .,4 for each CC, known as CC levels (CCLs), which were intended to quantify relative levels of complexity among CCs. In the year 2000, AR-DRG V4.0 saw the introduction of the Patient Clinical Complexity Level (PCCL), which combined the CCLs of each episode to quantify the effects of multiple CCs on resource use [4,5].

In July 2013, the Independent Hospital Pricing Authority (IHPA) contracted the University of Sydney as lead of the Australian Consortium for Classification Development (ACCD), which included partners at Western Sydney University and KPMG, to maintain and refine the AR-DRG Classification System. The AR-DRG Classification System comprises two components: the AR-DRG classification itself; and the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM), together with the Australian Classification of Health Interventions (ACHI) and the Australian Coding Standards (ACS).

A systematic review of the AR-DRG clinical complexity structure had not been undertaken since the introduction of PCCLs in AR-DRG V4.0. The development of Version 8.0 therefore included a complete review of the episode clinical complexity structure. The consortium's reports to IHPA on Version 8.0 were released by IHPA [6,7], and Version 8.0 manuals published [8] and implemented from 1 July 2016.

The AR-DRG V8.0 refinement project was overseen and advised by a Classifications Clinical Advisory Group (CCAG) and a DRG Technical Group (DTG), which included key stakeholder representatives. Both groups met regularly throughout the review and endorsed the approach taken. After the AR-DRG V8.0 refinement project had been completed, IHPA commissioned a major consulting firm to undertake an independent review of the project outcomes.

Since the clinical complexity system was introduced in Australia, the quality of documentation and coding of diagnoses and interventions in patient data has improved substantially. This improvement has been noted in other countries that have adopted DRG systems and have introduced a range of complexity adjustment processes, such as France, Canada and the UK [5]. As well, patient level cost data are now available, and have been progressively improved, for the large majority of public hospital episodes. At the same time, these large data sets can now be analysed quickly and efficiently using much improved information technology systems and statistical software packages.

The performance of the AR-DRG V7.0 clinical complexity system was evaluated at the outset of the review. The results showed

that CCLs did not correlate well with cost variations within ADRGs. In particular, diagnoses with greater (ie. more complex) CCLs (so-called catastrophic and severe) showed no greater link with higher episode costs than diagnoses with lower CCLs. Similarly, many diagnoses not recognised as CCs showed significantly greater correlation with cost variation than some CCs.

On the basis of the poor performance of the existing Australian clinical complexity system, and after review of various approaches in other countries, it was decided that the complexity system should be revised, based on actual cost data and clinical classification of episodes, avoiding as far as possible a priori judgments about the relative importance of different co-morbidities either singly or in combination, and minimising the use of non-clinical, or administrative, variables.

Principles for splitting ADRGs into DRGs, and more generally to inform the development of the AR-DRG classification, were developed and agreed by the oversight committees, and were included in the Version 8.0 manuals [8]. Broadly, these principles required that: the AR-DRG classification should be clinically coherent; DRGs should be reasonably homogeneous in resource use; the classification should be statistically robust, balanced, stable over time, understandable and acceptable to stakeholders; and, importantly, the implementation of the classification should not encourage inappropriate behaviours in patient treatment and management practices within the health system. A key governance principle was that the AR-DRG classification should adapt to developments in the underpinning statistical classifications (ICD-10-AM and ACHI), but the reverse should not apply. ICD-10-AM and ACHI have many uses other than their role in the AR-DRG system.

2. Methods

Patient data from the Admitted Patient Care (APC) National Minimum Dataset (NMDS) and the National Hospital Cost Data Collection (NHCDC) were linked for the AR-DRG review. Modelling and analysis were undertaken using all public hospital in-patient same day and overnight episodes from 2009-10, 2010-11 and 2011-12, with 2006-07, 2007-08 and 2008-09 data used for validity and sensitivity tests. The annual number of episodes rises annually over this period, averaging some 5,000,000. The diagnosis and intervention arrays of each year's APC data were mapped from the edition of ICD-10-AM/ACHI for that year forward to the current edition.

The new approach to complexity allows all diagnoses, including the principal diagnosis, to be considered in assessing clinical complexity. The previous system only allowed a set of pre-determined additional diagnoses to be considered for each ADRG.

In AR-DRG Version 8.0, complexity within a patient episode involves first an estimation of the Diagnosis Complexity Level (DCL) to be associated with each diagnosis x in each ADRG A. Second, the DCLs for the episode are combined to give an overall Episode Clinical Complexity Score (ECCS).

The first stage in the derivation of DCLs involved the profiling of ADRG episode costs and diagnoses by partitioning the episodes of each ADRG A into sets of episodes that contained precisely i diagnoses for $i = 1,2,. . .$. Episodes where i = 1 contain only a principal diagnosis, so complexity is not relevant. For each i greater than 1 and for each diagnosis x, the relative change in cost within ADRG A associated with diagnosis x among episodes with precisely i diagnoses was defined as the geometric mean cost of the subset of episodes in A with precisely i diagnoses and including diagnosis x, divided by the geometric mean cost of the set of episodes in A with precisely $(i$-1) diagnoses. The change in cost was measured in relative terms, reflecting the general nonlinear shape of the ADRG cost profile as the number of diagnoses increases; for instance, the

second diagnosis results in a relatively larger cost increase than the tenth.

It should be noted that the method does not distinguish between costs that may be caused by diagnosis x in isolation and other costs which may be present due to correlations among appearances of x with other diagnoses.

The next stage in the calculation of DCLs was to combine the relative costs across the various values of i; that is, to define the relative cost associated with diagnosis x in ADRG A as the sample-weighted geometric mean over i of the relative changes in costs associated with diagnosis x in ADRG A for the various values of i. As well, diagnostic codes which do not impact on cost (such as most signs and symptoms and factors influencing health status and contact with health services) were excluded from the complexity process.

The result was a matrix of some 400 ADRGs by 16,700 diagnoses. Many cells were empty. To prevent rare combinations having an undue affect, a cumulative aggregation of episodes into clinically coherent samples was undertaken to derive statistically robust estimates of relative change, with at least 100 episodes contributing to a cell [6]. Second, the relative change estimates for each ADRG were standardised. DCLs were then defined as the standardised relative change estimates rounded to integers between 0 and a cap of 5.

To pass from the complexity level of individual diagnoses to the complexity of an entire episode, the ECCS was calculated by taking a weighted sum of the DCLs of each recorded diagnosis. Specifically, the DCLs of an episode were first arranged from highest to lowest and a decaying weight was applied to each consecutive DCL before summing over the resulting weighted DCLs of the episode.

To incorporate the ECCS into the AR-DRG classification, a split for each ADRG was selected from all possible ECCS-based splitting models, generally resulting in nil, one or two splits (three in a few cases). The statistical criteria used to select the chosen split included minimum size (number, cost and percentage of episodes), minimum absolute or relative change in mean cost between categories, and reduction in deviance (RID) of at least 5% compared to a split with one less category (RID was used based on the assumption of a gamma distribution of episode cost).

If the statistical criteria were met using ECCS as the splitting variable, in most cases, the resulting split was adopted for AR-DRG Version 8.0. Exceptions are discussed in the Results below.

3. Results

AR-DRG Version 8.0 comprised 406 ADRGs, the same number as in Version 7.0. Changes in ADRGs were relatively minor, as this was not the focus of Version 8.0 development.

Of the 406 ADRGs:

- 85 had no split
- 246 had one split
- 70 had 2 splits
- 5 had 3 splits.

In total, Version 8.0 comprised 807 DRGs, up from 771 in Version 7.0.

Of the 321 ADRGs that had a split, 315 ADRGs used ECCS as the only splitting variable while the remaining 6 ADRGs used splitting variables other than ECCS: 2 used age and 4 used transfer.

Overall performance of the classification was assessed using RID. There was a decrease in the overall RID performance of the classification from Version 7.0 to Version 8.0 (from 71.6% to 69.7%). This was not surprising as length of stay (LOS) was almost entirely removed as a splitting variable in Version 8.0; LOS is highly correlated with cost and therefore should not be used as an explanatory

variable. Excluding the 59 ADRGs where LOS had been removed as a splitting variable, the overall RID performance of the AR-DRG classification increased from 74.3% in Version 7.0 to 75.2% in Version 8.0. While not a dramatic improvement, Version 8.0 splits relied almost entirely on a standardised use of diagnoses without use of other splitting variables.

Version 8.0 was approved by the Pricing Authority in November 2014 and independently reviewed by a major consulting firm in early 2015.

4. Discussion

The AR-DRG clinical complexity system previously had had a poor relationship with cost variations within ADRGs. As well, a wide and increasing range of variables had been introduced in recent versions, including urgency and mental health legal status; it is possible that some of these changes were part proxies for clinical complexity. Most significantly, there had been a rapid increase in the use of LOS, particularly same day, as an explanatory variable for episode cost, notwithstanding the well-known relationship between LOS and cost. In Australia, a large proportion of in-patient episodes are same day, rather than only overnight stays. Use of LOS opened the way for gaming of ABF: a patient could be held overnight rather than discharged in the evening, for substantial increase in revenue.

It was evident that the ongoing refinement of the classification would benefit from a clear set of underlying principles. The development and endorsement of AR-DRG structure principles as an early step in Version 8.0 refinement gave the development team a clear path forward. The principles adopted are not new, more a return to the earlier concepts of Fetter and their adaptation in Australia [9,4] where complexity was based on co-morbidities.

In light of the classification principles, use of diagnosis as the indicator of clinical complexity was favoured by ACCD's clinical advisors. They saw diagnoses as clear markers of clinical complexity. Diagnoses are coded expertly in the APC data set for each episode of care, using the long established ACS [10], and so are a readily available quality set of variables. The statistical robustness of the use of diagnoses as the base for the new ECC model supported the use of diagnoses alone, without the use of other administratively determined variables. This places renewed emphasis on the need for complete and accurate clinical documentation as the base for clinical coding which, in turn, will facilitate allocation of episodes to the most appropriate DRG.

The statistical criteria used were similar to those used in previous versions, with the addition of a prescribed minimum size for the lowest complexity split (25%). These criteria are necessarily somewhat arbitrary, and there were a small number of ADRGs where a split was adopted even though a criterion was not quite met: the cost difference (percentage or absolute) in particular could be close to meeting the relevant criterion and the RID criterion was met.. This pragmatic approach was more likely where the number of episodes involved was large. To reduce discontinuities with existing splits in Version 7.0, where the new approach resulted in no split and there had previously been a split, the split was maintained for Version 8.0 (but generally not for Version 9.0 which was developed two years after Version 8.0).

A particular feature of earlier AR-DRG versions was the treatment of complexity for neonates. A separate set of complexity variables based on diagnoses and interventions had been introduced, to counter the poor performance of the general approach to complexity in earlier versions. It was found that the ECC model gave comparable results for splitting neonatal ADRGs, without the need for a separate complexity system.

Age of the patient was maintained as an additional splitting variable for two ADRGs (A07 Allogeneic Bone Marrow Transplant, A09 Kidney Transplant) as it was considered a clinical marker for complexity in these 2 ADRGs.

Version 7.0 contained 8 ADRGs with a split based on acute transfer to another hospital or death, within 5 days of admission. Acute transfer was maintained for four of these ADRGs (B70 Stroke and Other Cerebrovascular Disorders, B78 Intracranial Injuries, F60 Circulatory Disorders, Admitted for Acute Myocardial Infarction without Invasive Cardiac Investigative Procedures, F62 Heart Failure and Shock) because complex cases are often transferred to a more appropriate hospital for necessary treatment and care. For these ADRGs, death was not an indicator of costs incurred once the ECC model was applied, and so death was eliminated as a splitting variable.

The new complexity system is responsive to changes in morbidity patterns. Clinical complexity will be recalculated in each new version of the AR-DRG classification. In line with the structure principles already described, it would be desirable to maintain stability in the complexity system now developed. However, the system will need to evolve in the light of experience as it is implemented and in line with clinical changes and changes in cost structures. The stability of the DCL calculations when data for later years are used will need to be investigated.

Already changes have been made. Most important, changes in clinical coding practice had been observed once Version 8.0 came into force. Relatively minor and transient problems arising during an in-patient episode were more likely to be coded as additional diagnoses, inconsistent with the intent of ACS 0002 *Additional diagnoses*. In response, there has been a tightening of the Eleventh Edition of ACS 0002 to minimise this form of overcoding [10].

5. Conclusion

Estimation of clinical complexity of Australian admitted episodes in AR-DRGs was completely reviewed in Version 8.0, and an improved system developed. A DCL was defined for each diagnosis in each ADRG, and a new method for quantifying the cumulative influence of the patient's diagnoses to give an ECCS was implemented. Almost all splitting variables not based on diagnosis were removed. Version 8.0 was implemented in Australian public hospitals on 1 July 2016.

Experience with the new Australian approach to complexity, and adaptations and responses to it, may be of interest to other countries in coming years. The principles adopted in the development of Version 8.0 of the AR-DRG classification may be of more immediate interest.

Contributors

Richard Madden and Vera Dimitropolous are co-directors of the NCCH that was responsible for the development of the AR-DRG Versions 8.0 and 9.0. Other authors were members of the DRG team. All authors have read and approved the final version of the manuscript.

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