HPA
HEALTH POLICY ANALYSIS

Independent Hospital Pricing Authority

Development of the Australian Emergency care classification

Public consultation paper

Revision history

Version	Date	Modifications
0.1	12 September 2017	Initial report.
0.2	15 September 2017	Incorporation comments/ edits from IHPA.
0.3	19 September 2017	Incorporation further comments/ edits from IHPA.
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Executive summary

The Independent Hospital Pricing Authority (IHPA) commissioned a project to develop a new classification system for emergency care[1] for Australia, for the purposes of Activity Based Funding (ABF). This *public consultation paper* seeks stakeholders' views on the proposed draft classification. The consultation paper also describes the work undertaken to design the classification, provides details of the statistical data analysis undertaken, and the consultation processes used.

IHPA has undertaken a significant work program leading to the development of the draft Australian Emergency Care Classification (AECC).

In 2013, IHPA commissioned an *Investigative review of classification systems for emergency care* (Health Policy Analysis, 2014). The *Investigative review* assessed the suitability of the current classification systems used for ABF for emergency care in Australia – Urgency Related Groups (URGs) and Urgency Disposition Groups (UDGs) - as well as other classification systems used abroad. It concluded that the classifications were not suitable for funding emergency care in the medium to long term. This was mainly due to the reliance on triage, and the strong interest in moving to a more diagnosis-based classification. The review recommended that IHPA support a staged development of a classification system to replace URGs and UDGs. The final report of the *Investigative review* is available from the IHPA website.

In 2015, IHPA commissioned a project led by Health Policy Analysis to develop a new classification system for emergency care services for ABF purposes. The project included a costing study of emergency care to explore a range of patient and stay characteristics as drivers of cost. The costing study has been completed and the results have been presented in a separate report - the *Emergency care costing study final report* (Health Policy Analysis, 2017) – available from the IHPA website. The outcomes of the costing study have been used to inform the classification development.

The proposed AECC follows the structure recommended in the *Investigative review*. An overview is shown in Figure 1. The draft AECC has 145 end classes:

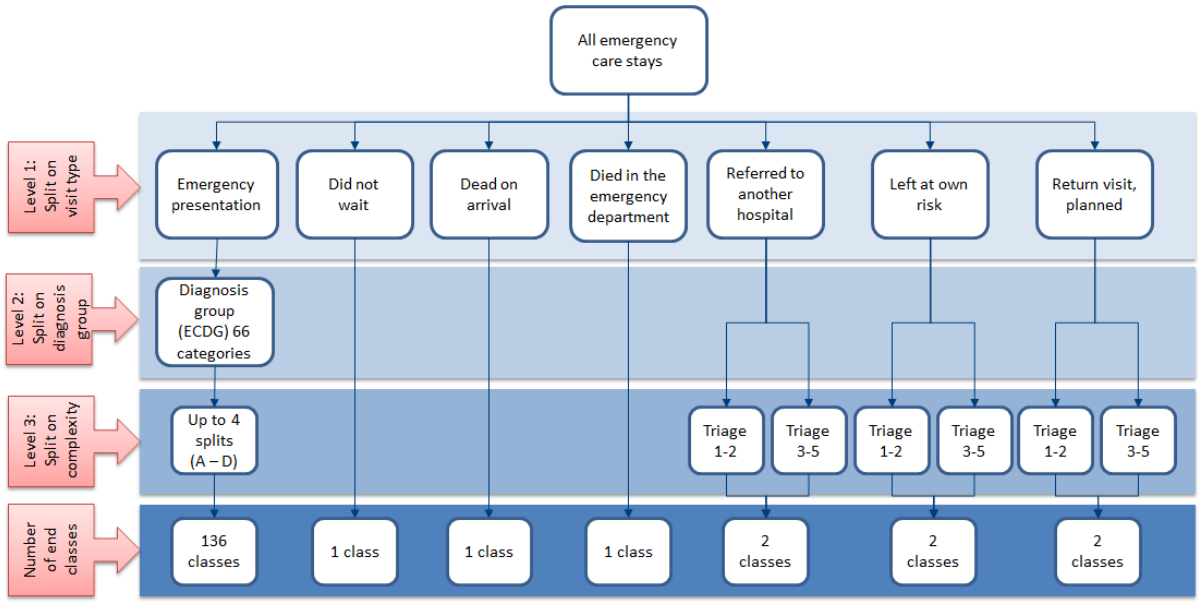
- The first level groups emergency stays into those requiring emergency care and a small set of other classes, some with no further splits.
- The second level groups emergency stays into clinically meaningful groups using emergency department diagnosis. The groupings of emergency department diagnoses are referred to as 'emergency care diagnosis groups' (ECDGs)[2].
- Where required, the third level splits the ECDGSs to reflect different levels of severity and/or complexity (consequently also reflecting resource use).

[1] This document uses the phrase 'emergency care' to refer to emergency departments and emergency services.

[2] The terminology and the numbering that has been used for ECDGs draws on conventions used in the Australian Refined Diagnosis Related Groups (AR-DRGs). However, although it may be desirable to have links between the emergency and admitted patient care classification, it may not be practical to retain these links as the classifications are refined over time. Therefore, the labelling and the numbering used in this document are interim, and will be revisited when the classification is fully developed.

The classification presented in this document has been developed for the short-term (i.e. immediate implementation), and uses variables that are presently collected and reported uniformly nationally. A future version of the classification will also be considered using new variables collected in the *Emergency care costing study*. It is proposed for this future version to be aimed for implementation in the medium to long term, given that the variables are not currently collected or reported in a standardised way across Australia.

Figure 1 – Overview of AECC



Consultation questions

Feedback is being sought on the following areas:

1. Are there any categories for level 1 that can be grouped together while remaining clinically meaningful?
2. Are there any ECDGs that can be grouped together while remaining clinically meaningful?
3. Are the variables included in the draft AECC relevant to clinicians, health service managers and other stakeholders?
4. Are the end classes included in the draft AECC relevant to clinicians, health service managers and other stakeholders?
5. Are the proposed data items for the future version(s) of the AECC feasible to collect and report nationally?
6. What is the feasibility for emergency services to collect an aggregated list of diagnosis codes? If feasible, what level would be appropriate?
7. What other issues should be considered in the development of the AECC?

Submissions

Submissions should be sent as an accessible Word document to submissions.ihpa@ihpa.gov.au or posted to "Submissions" PO BOX 483 Darlinghurst NSW 1300. Submissions close at 5pm (AEST) Friday 8 December 2017.

More information

The IHPA website provides up to date information on the development of the AECC, including links to key documents referred to in this public consultation paper: www.ihpa.gov.au.

This document assumes some knowledge of classification development. IHPA recognises the importance of a broader audience engaging in this consultation process. Should your organisation require further resources to assist in explaining the classification development process, please contact IHPA at enquiries.ihpa@health.gov.au.

Acknowledgments

Thank you to members of the IHPA Emergency Care Advisory Working Group (ECAWG) for their advice and support and to the numerous health professionals involved in the targeted consultation process to develop the draft AECC. Thank you to the staff and management from the 10 hospitals that participated in the *Emergency care costing study*.

Context

1

IHPA

The Independent Hospital Pricing Authority (IHPA) is an independent government agency established by the Commonwealth as part of the implementation of the National Health Reform Agreement (NHRA). IHPA has a number of determinative functions as specified by the NHRA. IHPA's primary role is to determine the National Efficient Price and the National Efficient Cost for public hospital services. IHPA's functions also include determining data requirements, and developing and specifying the classifications for services provided by public hospitals. IHPA undertakes reviews and updates of existing classifications and is also responsible for introducing new classifications.

IHPA is governed by the Pricing Authority. Members of the Pricing Authority bring significant expertise and skills to the role, including substantial experience and knowledge of the health care needs and the provision of health care services for people living in regional and rural areas.

Classification systems

Classification systems aim to provide the health care sector with nationally consistent methods for classifying patient level activity and other services to provide better management, measurement and funding of high quality and efficient health care services.

Classifications are comprised of end classes (groups) that provide clinically meaningful ways of relating the types of hospital activities to the resources required. They enable hospital and health service provider performance to be measured by creating a link between hospital activities and the resources consumed for undertaking these activities.

Current classification systems for funding emergency care in Australia

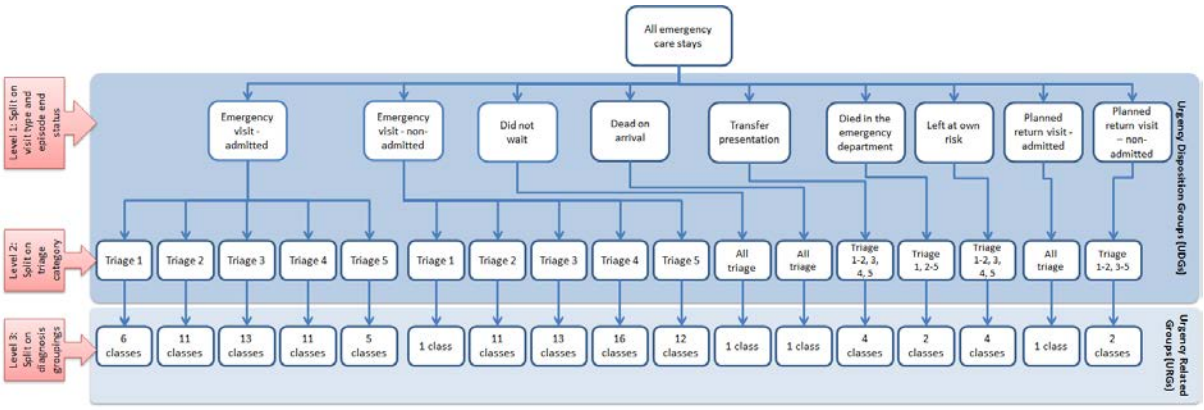
In 2012, at the commencement of national ABF in Australia, Urgency Related Group (URG) and Urgency Disposition Group (UDG) were implemented as the classification systems for funding emergency care.

URGs classify patients combining four data elements: type of visit (emergency or non-emergency presentation), episode end status (admitted/ transferred to another hospital, discharged, did not wait and dead on arrival), triage (categories 1-5)[3], and emergency department diagnosis (grouped to 28 'Major Diagnostic Blocks' - MDBs). There are 114 end classes. UDGs follow the same logic, but do not incorporate emergency department

[3] Triage categories are as follows: 1 Resuscitation (patient must be seen immediately, within seconds); 2 Emergency (patient must be seen within 10 minutes); 3 Urgent (patient must be seen within 30 minutes); 4 Semi-urgent (patient must be seen within 60 minutes); and 5 Non-urgent (patient must be seen within 120 minutes).

diagnosis (and thus there are much fewer classes). UDGs have 17 end classes. An overview of the URG and UDG classifications is shown at Figure 2.

Figure 2 – Overview of the Urgency Related Group (URG) and Urgency Disposition Group (UDG) classifications



URGs are used for funding of emergency departments, and UDGs for emergency services[4]. This is because emergency services do not collect data at a level that would allow grouping to URGs, and may not have the variety of cases presenting for a diagnosis-based system to be meaningful or useful.

Purposes and key features

The development of a new classification for Australian emergency care services is being undertaken for the purposes of ABF. This is consistent with IHPA's responsibilities mentioned previously, that is, to develop classifications for services funded on an activity basis and determine the National Efficient Price. In this context, a classification is one of the essential inputs to a pricing model for emergency care; in addition to counting, costing and determining price weights for emergency care. For IHPA, an emergency care classification requires the grouping together of patients that have similar costs or resource use.

However, a new emergency care classification should serve multiple purposes, meeting the needs of other stakeholders who will have different values and uses for an emergency care classification over and above its contribution to ABF. This objective was a recommendation from the *Investigative review.*

For patients, a new classification for emergency care should contribute to better outcomes. This will be achieved through providing clinicians with better information about the care that they provide, and enabling them to identify and action improvements. It will also be achieved through a better understanding and allocation of resources to reflect the complexity of patients. These factors will help drive higher quality patient care and outcomes.

[4] **Emergency services** range from those providing first aid and treatment prior to referral to a higher level of service, to those with 24-hour nursing staff but medical staff available on call within 20 mins, 24 hours a day. **Emergency departments** range from those that have medical staff available in the hospital 24 hours a day to those that can manage all emergencies, with some with a state-wide referral role and/or major trauma centre.

For clinicians, an emergency care classification should align with their approach to the clinical management of patients. It should group together patients that have similar clinical characteristics and/or patients that will have similar diagnostic and treatment pathways. The individual variables used in the emergency care classification should be clinically meaningful and make sense to clinicians. The data underpinning the classification should, as much as possible, be relevant to how clinicians make decisions about the provision of emergency care. Clinicians will also value an emergency care classification that is based on data that are readily able to be collected.

For hospital managers, an emergency care classification should support analyses of patterns in the utilisation of emergency care services, and the resource implications of changes in the types of presenting patients. Hospital managers may also seek information on whether existing models for the provision of emergency care are clinically effective and efficient. To the extent possible, this requires that an emergency care classification should not be locked into a single model of care, but should be flexible to support improvements in models of care. For hospital managers, a new emergency care classification should be able to be implemented across the range of different settings, hospital types and locations in which emergency care is provided in Australia.

The *Investigative review* made several recommendations on key features of the new classification system. The first key feature is that the new classification should have a strengthened reliance on patient-based variables (potentially including measures of complexity, severity, co-morbidities and patient dependency), reducing the reliance on triage and episode end status, which can vary within and across hospitals, and not always reflect patient needs. This key feature aligns with IHPA's principle of pricing based on differences in the costs of care that are patient-related, in preference to pricing based on hospital or administrative factors.

The second closely related key feature is that the classification should incorporate clinically meaningful classes that accurately represent the clinical management of patients. The number of classes should be extensive enough to cover the broad range of conditions with which patients present, and the other factors that impact on the care they will receive. One of the important implications of this key feature is that there may be differences between the breadth and depth of a classification for its use by clinicians / hospital managers compared with its use by IHPA as part of a pricing model. It is highly likely that IHPA will group together classes with similar resource use for simplicity, and to reduce administrative burden. This key feature suggests that it will be helpful to distinguish what should be included in an emergency care classification versus what should be incorporated in a pricing model for emergency care services.

The next key feature underpinning the development of a new emergency care classification is that there should be separate (and non-overlapping) classifications for emergency care, admitted care and non-admitted care. One of the reasons for this recommendation in the *Investigative review* was that it aligns with IHPA's pricing approach which involves six patient service categories (admitted acute care; subacute and non-acute care; non-admitted care; emergency care; mental health care; and teaching, training and research) that are counted, costed and priced separately. In recommending this key feature, the *Investigative review* noted that while classifications may be separate, there should be as much alignment as possible between the data elements and definitions across classifications.

The fourth key feature is that a new emergency care classification should be able to be applied across all Australian emergency departments and emergency services. The *Investigative review* recommended this broad application, subject only to keeping the data burden and reporting requirements manageable for emergency services. This concept aligns with the first key feature of a patient-based classification as it assumes that the data variables relating to patients' clinical conditions and management should be the same across all types of hospitals. This does not mean that different types of hospitals will not manage patients with different complexity, only that patients should be able to be classified using the same variables. Further, it is recognised that emergency services and emergency departments have different data reporting capabilities which may impact if/ how a classification can be applied to both.

The draft classification presented in Chapter 4 of this document should be assessed against the above purposes and features.

Governance

IHPA's Emergency Care Advisory Working Group (ECAWG) oversees the development work program of the AECC and reports up through the Jurisdictional Advisory Committee's and IHPA's Chief Executive Officer to the Pricing Authority. ECAWG advises IHPA on matters relevant to emergency care and includes representatives from all jurisdictions, and the IHPA Clinical Advisory Committee.

The project is also advised by subject matter experts, classification system development experts and data analysis experts in the Health Policy Analysis consortium.

Work undertaken to date

2

Drivers of cost in emergency care

In 2013, IHPA commissioned an *Investigative review of classification systems for emergency care* (the *Investigative review*) (Health Policy Analysis, 2014). The *Investigative review* explored a range of factors that had the tendency to result in a higher cost for a patient. Some of these (such as diagnosis) are already reported in national minimum data sets. Others are collected at a hospital or state/ territory level, but not reported nationally. The remainder are either not collected, or collected only by a few hospitals.

The *Investigative review* concluded that URGs and UDGs are not suitable for classifying emergency care for funding purposes in the medium to long term. This is mainly due to the reliance on triage, and the strong interest in moving to a more diagnosis-based classification. The *Investigative review* recommended that IHPA support a staged development of a classification system to replace URGs and UDGs, which included undertaking a targeted costing study to support the classification development.

Further information on the key recommendations are documented in the *Investigative review of classification systems for emergency care services in Australia final report* (Health Policy Analysis, 2014), available from the IHPA website: https://www.ihpa.gov.au/sites/g/files/net636/f/publications/classification-systems-emergency-care-v4.0.pdf

Emergency care costing study

The *Emergency care costing study* was conducted in a sample of emergency departments across Australia. The study also involved the collection of patient characteristics not included in the *Non-Admitted Patient Emergency Department* Care (NAPEDC) National Minimum Data Set (NMDS).

States and territories were asked to nominate hospitals to participate in the study. The final sample was made up of 10 sites representative of the different sizes and roles of emergency departments, as shown in Table 1 below. The Table also shows the strata used within the sampling frame for the study. In some strata, only one hospital participated. No emergency services were nominated to participate in the study.

Table 1 – Hospitals by study strata and location

Hospital name	State	Strata	Location
Sydney Children's	New South Wales	Specialist paediatric	Major city
Royal Prince Alfred	New South Wales	Major city: large	Major city
Sir Charles Gairdner	Western Australia	Major city: large	Major city
Armadale Kelmscott	Western Australia	Major city: large	Major city
Lyell McEwin	South Australia	Major city: large	Major city

Hospital name	State	Strata	Location
Royal Darwin	Northern Territory	Regional: large	Regional/remote
Blacktown	South Australia	Major city: other	Major city
Port Macquarie	New South Wales	Regional: other	Regional/remote
Mount Gambier	New South Wales	Regional: other	Regional/remote
Alice Springs	Northern Territory	Remote (Rem)	Regional/remote

A one-month pilot study at Nepean Hospital (New South Wales) was undertaken during November and December 2015. Based on the outcomes of the pilot study, further refinements to the study methodology and supporting infrastructure were made.

The costing study involved a four-week data collection period within April to June 2016. Within this, two weeks involved the collection of the time associated with patient care, procedures provided and patient characteristics which were believed to impact complexity and resource use (termed 'diagnosis modifiers'). For the other two weeks, relevant data was collected on patient characteristics, additional to the data routinely collected through emergency department information systems. Participating hospitals were also required to submit routinely collected data for the remainder of the 2015-16 financial year, so that a whole-of-year analysis could be undertaken.

Following the collection and submission of the additional patient and stay[5] characteristics and clinician time data, a whole-of-hospital costing study was undertaken by each hospital for the entire 2015-16 financial year. This was important so that all costs relating to the financial year could be allocated, and costs specifically relating to the emergency department were not over- or under-estimated. As part of the costing methodology, Health Policy Analysis developed relative value units using the clinician time data for sites to allocate clinical staff costs to patients. Relative value units specify, in relative terms, the costs (in this case nursing and medical salaries and wages) that should be allocated to each patient.

A total of 43,175 presentations were captured by hospitals during the four-week data collection period, with 21,765 of these attributed to the two weeks in which clinician time associated with patient care and procedures was collected. The analysis showed that:

- Several of the variables collected through the study are correlated with higher costs, such as: greater urgency (triage); increasing age; admission to hospital, referred to another hospital or died in the emergency department; Indigenous status; confusion/agitation; unconsciousness; and involuntary mental health patient.
- Injuries (23% of total sample), respiratory system disorders (11%), digestive system disorders (11%), and circulatory system disorders (10%), were the four categories with the most commonly reported emergency department diagnoses.
- Medical and nursing costs were by far the largest components of the overall cost. On average, they contributed 26% and 24% of the direct costs respectively, accounting for 50% of the total costs.

[5] 'Stay' is the unit of measure for presentations to emergency departments, defined as the period between when a patient presents at an emergency department and when that person is recorded as having physically departed the emergency department.

- The cost distributions varied between hospitals, but generally, hospitals had similar average costs, and similarly distributed costs across patient stays.

The results of the costing study were presented to participating sites as part of a review and validation process. Overall, clinicians supported the study results. Where there were shifts in costs compared with results based on previous routine costing of emergency care, clinicians commented that the shifts seemed reasonable and appropriate.

As part of the validation process, 177 clinicians (57% nursing and 39% medical) were surveyed seeking feedback on their experience with the study and any additional input regarding factors that impacted patient complexity/ resource utilisation. Responses noted:

- Support for the diagnosis modifiers captured in the study.
- Complexity increases when the emergency department clinicians attempt to resolve a patient's issues to send them home versus admitting them. This is contrary to the higher weights for subsequently admitted patients in the current URG classification, and is a theme that has been consistent in the consultations with clinicians in relation to this project.
- The National Emergency Access Target (NEAT) target for 90% of patients to leave the emergency department within four hours of presentation has impacted on resources that are allocated to treating patients.
- Where a patient is a resident of an aged care facility, there may sometimes be a reduced level of resource use, as the setting into which the patient is discharged is more likely to have nursing support compared with community settings.

Based on the analysis, and feedback from clinicians and other hospital staff involved in the costing study, the conclusion is that the data obtained from the costing study is good quality, and sufficient to support further analysis to develop a classification for emergency care.

Further information on the costing study and results are documented in the *Emergency care costing study final report* (Health Policy Analysis, 2017), available from the IHPA website: https://www.ihpa.gov.au/sites/g/files/net636/f/emergency_care_costing_study_final_report.docx

Emergency care clinician time consensus study

In addition to the costing study data collection, a consensus study of time that clinicians take to carry out investigations, procedures and other patient-related activities, was undertaken as part of the project. The consensus study used the same set of activities/ procedures collected in the costing study, and asked for time estimations for the different categories of patients receiving those activities/ procedures (e.g. simple or complex). The purpose of the consensus study was to validate the results of the costing study, and fill any gaps in data.

A Delphi process involving 292 clinicians was used to obtain the estimates. The estimates were validated by the Australasian College for Emergency Medicine, the College of Emergency Nursing Australasia and various allied health groups. The results were endorsed with minimal alteration.

A comparison of the times from the two sources was undertaken. There was alignment, but also differences. Generally, the times recorded in the costing study tended to be lower. Reasonable explanations were provided by clinicians where the times differed.

The results were also used to supplement times for a small number of procedures with low volumes in the costing study, such as pacing wire insertion, oesophagoscopy/ gastroscopy, laryngoscopy, and pleural aspiration.

Further information on the consensus study and results are documented in the *Emergency care clinician time consensus study report* (Health Policy Analysis, 2017), available from the IHPA website:
https://www.ihpa.gov.au/sites/g/files/net636/f/emergency_care_clinician_time_consensus_study_report.docx

3 Development of the AECC

Classification development

Classification development principles

The development of the AECC has been guided by the principles for classification development, which were developed as part of the *Investigative review*. They are:

1. comprehensive, mutually exclusive and consistent
2. clinically meaningful
3. resource homogenous
4. patient-based
5. simple and transparent
6. minimises undesirable and inadvertent consequences
7. capacity to be improved over time
8. utility beyond ABF
9. administratively and operationally feasible.

Modelling approach

Predictive performance was assessed using two performance measures, root mean square error (RMSE) and predictive R-squared:

- *Root mean square error (RMSE).* Compares a predicted value and the actual observed or known value to provide an indication of how accurate a model is in its prediction. To calculate RMSE, the predictive error is first calculated by taking the difference between the predicted value using the model arising from the training data applied to the test data, and the actual value from the test data. The error is then squared (to ensure negative errors do not cancel positive errors) and a mean of this squared error is calculated. The square root of this value is then taken to re-scale the metric in a value similar to the predicted value. Models that result in better predictions will have lower RMSE values.

- *Predictive R-squared*. In explanatory analyses, the R-squared statistic can be interpreted as the proportion of variation that is explained by a model. In predictive analyses, the predictive R-squared is an estimate of the proportion of variation that a model will predict when applied to new data. The predictive R-squared is calculated using the test (out-of-sample data), rather the data used to estimate the model. Because it is calculated on out-of-sample data, predictive R-squared statistics can be outside the range of 0-1, although the interpretation is similar to the traditionally calculated R-squared statistic. Models that result in better predictions will have a higher predictive R-squared statistic. Predictive R-squared statistics are typically lower than R-squared statistics calculated on in-sample data.

Training and validation of models

To assess the predictive performance of models generated, the study data was randomly partitioned into 'training' and 'validation' data sets representing 75% and 25% of the data. Models were developed using one partition of data (i.e. the training data), and then assessed using other partitions (i.e. the validation data). This was repeated 10 times, each time with a different partition of the data. The predictive performance of alternative models was assessed using the results of applying the model to the validation data.

Initial analysis of candidate classification variables

Initial analysis using the *Emergency care costing study* data was undertaken to examine the predictive performance of individual candidate classification variables and the correlations between variables. Cross-validation was used to estimate the predictive performance of the variables on data that was not used to estimate (train) the models. This gives a more realistic estimate of how well the predictors perform when applied to new data, which is important for a classification. The analysis of individual predictor variables is shown in Table 2.

Table 2 – Predictive performance of individual variables

Candidate predictors	RMSE	R^2
Emergency department principal diagnosis (grouped to ECDGs)	465.8	0.176
Episode end status	467.2	0.178
Triage	468.2	0.172
Investigations	469.0	0.170
Transport mode	472.6	0.158
Age group	485.2	0.113
Presenting problem	489.4	0.096
Visit type	514.0	0.004

The conclusions from the analysis are that singularly, emergency department diagnosis has the best predictive performance in terms of cost. Episode end status is the next best predictor, followed by triage and investigations, which have similar levels of predictive performance. Transport mode and age group also have reasonable predictive performance.

Presenting problem yields moderate predictive performance metrics. However, this was ruled out as a classification variable. This is because there is wide variation amongst hospitals in the reporting of presenting problem, and that non-descriptive problems rank amongst the most frequently recorded problems, which does not provide adequate differentiation of cases from a clinical perspective. On a range of measures, it is inferior to emergency department diagnosis.

Visit type yields very low predictive performance metrics, largely because the majority of stays (close to 98%) have a visit type of *Emergency presentation*.

Individually, the diagnoses modifiers had relatively low predictive performance. This was expected, as they apply to a small proportion of cases. Nevertheless, they can be important in differentiating higher-cost stays amongst others with a similar diagnosis. The most predictive of the diagnosis modifiers is *Distress and confusion*.

Analysis of the correlations between variables was also undertaken. The level of correlation provides some insight into the extent to which individual candidate variables are independent of each other, specifically, where one variable may be used to capture variation explained by another. This analysis showed that triage, episode end status, visit type, transport mode and age group are relatively independent. This means that they could be used as independent predictor variables in the classification. However, there was a moderate association between each of these predictor variables and diagnosis, which means that to an extent, diagnosis predicts triage, episode end status, visit type, transport mode, and age group. Therefore, for some diagnosis groupings, it is not necessary to further subdivide into classes based on these variables.

The above analysis was presented to IHPA's advisory committees, as well as jurisdictional stakeholders through the ECAWG. Following feedback from stakeholders, further work on the classification was undertaken.

AECC structure

Level 1

In the first level of the proposed classification, stays are grouped into those requiring emergency care and a small set of other classes reflecting specific visit type, episode end status and triage categories.

Level 2

Aligning with the principle of clinical meaning, for level 2, emergency department diagnoses were grouped into clinically coherent clusters, which, have been labelled 'emergency care diagnosis groups' (ECDGs) in the interim, until more suitable terminology has been settled. The groups differentiate where possible diagnoses that lead to specific pathways and/ or are likely to be associated with a specific model of care in the emergency department. Examples of the latter are fractured neck of femur and chest pain.

Initial ECDGs were developed by clinicians and a health information manager who are part of the Health Policy Analysis consortium. This initial grouping resulted in 84 ECDGs. These were considered by ECAWG, and following feedback from members and further analysis undertaken by Health Policy Analysis, they were collapsed to 66 ECDGs.

The numbering that has been used for both the ECDGs draws on Australian Refined Diagnosis Related Group (AR-DRG) numbering, aligning the ECDGs with Adjacent DRGs (ADRGs) and major diagnosis categories (MDCs). The numbering has been modified to reflect the cases more likely to be encountered in emergency care versus admitted settings.

Nevertheless, although it may be desirable to have links between the emergency and admitted patient care classification, it may not be practical to retain these links as the classifications are refined over time. Therefore, the numbering is also interim, and will be revisited when the classification is fully developed.

Level 3

Level 3 introduces complexity splits within ECDGs where relevant. Initially, these splits have been developed using variables that are currently available. These include triage, episode end status, arrival mode and age group. In the medium to long term, variables that could be available in future iterations of the NAPEDC NMDS (such as additional diagnoses, diagnosis modifiers, investigations and procedures) could be considered.

Three of the categories created at level 1 (referred to another hospital, left at own risk, and planned return visit), are split by triage category. Each is split by two categories of triage (1 and 2, and 3-5), creating six end classes.

For the ECDGs, complexity splits were developed based on recursive partitioning. In recursive partitioning, the objective is to split the data into sub-groups within each ECDG using specified predictor variables to identify the best set of sub-groups that predicts the value of the response variable. The algorithm repeatedly assesses and selects variables and variable values that best reflect the variation in the response variable. Each step of the algorithm can be represented as a tree. The resulting tree can then be applied to new data, and the predicted value for each sub-group applied for each observation. The response variable was cost. Predictor variables included:

- triage category (all 5 categories were used)
- episode end status (categories 1, 3 and 6 were collapsed into a single category, effectively admitted care, and category 2, departed, represented a second group)
- selected age groups (0-4,5-9,10-14,15-69,70-74,75-79,80-84,85+)
- arrival mode (ambulance and air/helicopter represented one category, and all others assigned to a second).

For selected larger ECDGs (specifically, mental health and minor injury), sub-groups of diagnoses were also included as potential predictors.

For these regression tree models, the predictors were all categorical variables. This resulted in predicted values that formed a limited number of discrete values. In some instances, the number of discrete values was larger than what was considered appropriate, and a method to apply limits to the number of splits within each ECDG was used. The number of splits considered appropriate for any ECDG was between one (no split) and four splits. Where the model had predicted more than four splits, a clustering algorithm was applied to combine splits into four groups.

The complexity splits have been labelled from A to D; with A representing the highest cost/ complexity, and D representing the lowest. Where there is only one resulting end class, this has been labelled A, in the interim, despite there being no differentiation in complexity for the ECDG.

Number of end classes

The next step involved considering which combination of splits across the whole data would yield an appropriate number of end classes in the classification. Targets of 110, 120, 130, 140 and 150 end classes were considered. To achieve these numbers of end classes, trade-offs between splitting different ECDGs into one (no splits), two, three or four sub-groups needed to be considered. A method to minimise the sum of squares for each of these constraints was applied. This resulted in a classification that included an appropriate number of end classes, and in which different ECDGs would not be split, or split by two to four sub-groups.

The recommended AECC, presented in the next Chapter, contains 145 end classes. The predictive performance values of the recommended classification and the alternative models are shown in Table 3. The use of training and validation data to assess the predictive performance is explained above under 'Training and validation of models'.

Table 3 – Predictive performance of preferred model and alternatives

Models generated	Number of classes	RMSE		R^2	
		Training	Validation	Training	Validation
Restricted to 110 classes	110	438.94	444.19	0.2643	0.2406
Restricted to 120 classes	120	435.23	441.61	0.2765	0.2499
Restricted to 130 classes	130	431.77	438.89	0.2883	0.2590
Restricted to 140 classes	140	428.74	437.86	0.2982	0.2627
Restricted to 150 classes	150	427.07	436.60	0.3037	0.2672
Preferred model	145	427.72	437.06	0.3017	0.2656
URG v1.4	114	444.38	439.33	0.2573	0.2587

At first glance, the R-squared values reported here appear generally lower than reported in previous Australian studies of emergency care classifications. However, a few points worth noting are:

- The predictive R-squared values reported for this study are based on cross-validation methods. These give a more realistic estimate of the variation explained by the classification when it is applied to new data.
- The R-squared values have been estimated without excluding outlier observations. Other studies have tended to exclude outliers in the reporting of a classification's performance. Excluding outliers usually yields much better performance. However, as with the point made about cross-validation above, including outliers gives a more realistic estimate of the values that would apply when the classification is applied to actual data.
- The *Emergency care costing study*, on which the classification is based, used more precise methods for costing. This resulted in higher, but realistic, levels of variation in costs. Other studies of emergency care classifications have used key elements of the classifications being assessed (e.g. URGs and UDGs), such as episode end status or triage, in the costing process. This yields higher, but unrealistic, R-squared values when assessing performance.

- The studies of the development of URGs (Jelinek, 1992) and UDGs (Bond, Erwich-Nijhout, Phillips, & Baggoley, 1998) were based on small samples of emergency department stays from a small number of hospitals (three hospitals and one hospital respectively), which is likely to have contributed to a lower level of variation in cost overall compared with the current study.

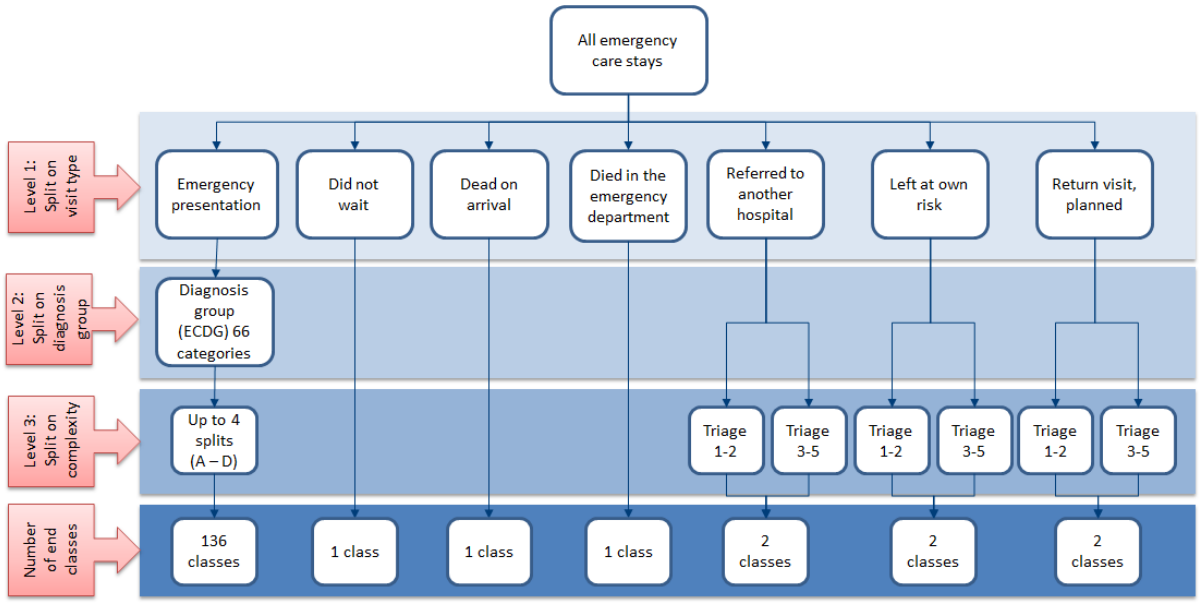
Overall, the predictive performance of the draft AECC is within the range expected for classification systems. By comparison, when analysed in the same way as the draft AECC, the current URG v1.4 classification system demonstrates less predictive performance (as noted in Table 3).

Draft AECC

4

The draft AECC presented in this document has been developed for the short-term (i.e. immediate implementation), and uses variables that are collected uniformly nationally. The draft AECC structure is shown in Figure 3.

Figure 3 – Overview of AECC



The draft AECC has 145 end classes. The classes are shown at Appendix 1. The statistics within the table at Appendix 1 are based on data from the *Emergency care costing study*. Further information on the draft AECC end classes is provided in the supplementary technical attachment to this Public consultation paper. This includes the logic/process map for each end class shown both diagrammatically and in a tabular form.

Consultation questions

1. Are there any categories for level 1 that can be grouped together while remaining clinically meaningful?
2. Are there any ECDGs that can be grouped together while remaining clinically meaningful?
3. Are the variables included in the draft AECC relevant to clinicians, health service managers and other stakeholders?
4. Are the end classes included in the draft AECC relevant to clinicians, health service managers and other stakeholders?

Next steps

5

Consultation process and further refinement of draft AECC

Following the consultation period, the responses from stakeholders will be collated. Where possible, suggestions will be further analysed. Consideration of the suggestions and accompanying analysis will be presented at a national workshop of key stakeholders, including state and territory health authorities, clinical experts, and key national groups such as the Australasian College for Emergency Medicine, the College of Emergency Nursing Australasia. The workshop is planned for February 2018.

Health Policy Analysis and IHPA will jointly consider the recommendations from the workshop. Health Policy Analysis will then finalise the classification, incorporating recommendations that are immediately feasible, and documenting others for future consideration.

Health Policy Analysis will present the final recommended classification to IHPA, for consideration by the Pricing Authority and Ministers. The classification is expected to be finalised by June 2018.

Ongoing development of the AECC

A version of the classification has been developed using variables collected in the *Emergency care costing study* that are not currently collected or reported in a standardised way across Australia. It achieves better predictive performance than the short-term classification presented in this document. The variables that have been used are the diagnosis modifiers, investigations, and procedures. Additional diagnoses may also be considered in future versions.

The classification using the new variables is proposed for implementation in the medium to long term, when the variables are collected in a consistent way across hospitals, and incorporated into national minimum data sets. It will also be refined following feedback on the classification presented in this document.

Consultation questions

5. Are the proposed data items for the future version(s) of the AECC feasible to collect and report nationally?

Applicability to emergency services

The application of the new emergency care classification to emergency services primarily relates to the feasibility of collecting the relevant diagnosis codes and measures that comprise the complexity tier of the classification. The collection of an aggregated list of diagnosis codes (e.g. the IHPA ED ICD-10-AM principal diagnosis short list (further information available from the IHPA website) or ECDGs) may provide a more feasible option for emergency services.

No emergency services were included in the emergency care costing study, and as a result, no specific data was captured for these services. However, initial analysis of the median cost per emergency stay across the 'large' and 'other' hospitals demonstrated very little variance, indicating that size of an emergency service may not be material. However, stakeholders have fed back that there are differences in cost related to the size of a hospital, specifically, staffing and range of services provided.

Consultation questions

6. What is the feasibility for emergency services to collect an aggregated list of diagnosis codes? If feasible, what level would be appropriate?

Data development

The *Emergency care costing and classification project* includes undertaking data development work to support future version of the classification system. Health Policy Analysis will provide recommendations to enhance or modify existing data items, as well as new data items that should be considered for national reporting. This will be undertaken based on feedback from stakeholders in relation to the proposed short-term classification, and further analysis for the future version of the classification.

Consultation questions

7. What other issues should be considered in the development of the AECC?

References

Bond, M., Erwich-Nijhout, M., Phillips, D., & Baggoley, C. (1998). Urgency, disposition and age groups: a casemix model for emergency medicine. *Emergency Medicine, 10*, 103-110.

Health Policy Analysis. (2014). Investigative review of classification systems for emergency care – Final report. Sydney: Independent Hospital Pricing Authority.

Health Policy Analysis. (2017). Emergency care costing and classification project – Cost report. Sydney: Independent Hospital Pricing Authority.

Jelinek, G.A. (1992). A Casemix Information System for Australian Hospital Emergency Departments Report to the Commissioner of Health. Perth.

Appendix 1: AECC end classes

The Table below shows the mean cost and cost dispersion for each AECC end class. The data is from the *Emergency care costing study*. The Technical Compendium provides indicative volumes within each class when applied to the national data.

Table 4 – AECC end class mean costs and cost dispersion

AECC end class	Statistics from the *Emergency care costing study*			
	n	Cost – mean	Cost – standard deviation	Cost – co-efficient of variation
A01 Did not wait				
A01_A	1,758	$247	$324	1.31
A02A Return Visit, planned, planned Triage=1,2				
A02A_A	8	$1,126	$607	0.54
A02B Return Visit, planned, planned Triage=3,4,5				
A02B_A	256	$450	$287	0.64
A03 Dead on arrival				
A03_A	91	$173	$226	1.31
A04A Referred to another hospital, planned Triage=1,2				
A04A_A	243	$1,352	$1,034	0.76
A04B Referred to another hospital, planned Triage=3,4,5				
A04B_A	453	$971	$673	0.69
A05 Died in ED				
A05_A	24	$1,885	$2,049	1.09
A06A Left at own risk, planned Triage=1,2				
A06A_A	84	$867	$490	0.56
A06B Left at own risk, planned Triage=3,4,5				
A06B_A	448	$526	$400	0.76
B63 Dementia/ chronic brain syndrome				
B63_A	10	$1,535	$905	0.59
B63_B	14	$1,035	$508	0.49
B63_C	11	$756	$392	0.52
B64 Delirium/ confusion/ acute encephalopathy				
B64_A	168	$1,359	$558	0.41
B69 TIA and precerebral occlusion				
B69_A	110	$1,153	$502	0.44
B70 Stroke & other cerebrovascular disorders				
B70_A	108	$1,680	$1,260	0.75
B70_B	35	$1,119	$506	0.45
B72 CNS infection/ inflammation				
B72_A	12	$1,599	$738	0.46
B81 Disorders of the nervous system, other				
B81_A	32	$1,609	$507	0.32
B81_B	349	$1,180	$595	0.5
B81_C	980	$742	$509	0.69
C633 Eye disorder, other				
C633_A	52	$1,003	$695	0.69
C633_B	465	$414	$246	0.6
D66 Ear, nose, mouth and throat disorders, other				
D66_A	39	$880	$478	0.54
D66_B	88	$639	$248	0.39
D66_C	369	$381	$191	0.5
D671 Teeth and supporting structures disorders, other				
D671_A	30	$899	$381	0.42
D671_B	217	$355	$170	0.48

AECC end class	Statistics from the *Emergency care costing study*			
	n	Cost – mean	Cost – standard deviation	Cost – co-efficient of variation
E61 Major respiratory diagnosis				
E61_A	31	$1,490	$615	0.41
E61_B	37	$1,139	$568	0.5
E623 Upper respiratory tract infection (URTI), other				
E623_A	315	$691	$373	0.54
E623_B	721	$384	$204	0.53
E65 Chronic obstructive airways disease				
E65_A	268	$1,140	$708	0.62
E69 Asthma/ wheeze/ croup/ airway infection				
E69_A	536	$809	$388	0.48
E69_B	619	$484	$216	0.45
E753 Respiratory disorder, other				
E753_A	831	$1,120	$531	0.47
E753_B	775	$638	$343	0.54
F60 Acute coronary syndrome				
F60_A	309	$1,028	$608	0.59
F62 Heart failure and shock				
F62_A	86	$1,438	$561	0.39
F62_B	147	$1,115	$531	0.48
F74 Chest pain				
F74_A	496	$1,072	$481	0.45
F74_B	1,275	$779	$362	0.46
F75 Circulatory disorder, other				
F75_A	146	$1,486	$1,020	0.69
F75_B	525	$906	$507	0.56
F75_C	432	$669	$334	0.5
F76 Arrhythmia and cardiac arrest				
F76_A	152	$1,178	$527	0.45
F76_B	210	$828	$353	0.43
G61 Gastrointestinal haemorrhage				
G61_A	92	$1,268	$626	0.49
G61_B	129	$687	$382	0.56
G65 Gastrointestinal obstruction				
G65_A	110	$1,149	$518	0.45
G661 Gastrointestinal peritonitism/ perforation				
G661_A	103	$1,213	$691	0.57
G661_B	317	$822	$400	0.49
G662 Abdominal pain				
G662_A	889	$972	$499	0.51
G662_B	1,106	$661	$320	0.48
G67 Oesophagitis and gastroenteritis				
G67_A	305	$841	$493	0.59
G67_B	354	$483	$253	0.52
G702 Digestive system disorders, other				
G702_A	186	$1,023	$545	0.53
G702_B	426	$751	$389	0.52
G702_C	615	$519	$284	0.55
H63 Disorders of liver				
H63_A	8	$2,009	$762	0.38
H63_B	56	$1,043	$419	0.4
H63_C	19	$577	$250	0.43
H64 Disorder of the biliary tract				
H64_A	27	$1,362	$552	0.4
H64_B	199	$774	$381	0.49
I01 Major injury				
I01_A	256	$1,219	$783	0.64
I01_B	681	$461	$394	0.86
I02 Fractures of neck of femur				
I02_A	58	$1,512	$507	0.34
I02_B	67	$1,235	$379	0.31
I02_C	41	$889	$370	0.42
I03 Fracture of shoulder and lower leg, dislocation, sprain and strain				

AECC end class	Statistics from the *Emergency care costing study*			
	n	Cost – mean	Cost – standard deviation	Cost – co-efficient of variation
I03_A	180	$1,206	$599	0.5
I03_B	266	$873	$556	0.64
I03_C	792	$496	$238	0.48
I04 Injuries, fractures (forearm, wrist, ankle, foot), and other injuries				
I04_A	301	$911	$596	0.65
I04_B	2,116	$482	$214	0.44
I05 Injury, other				
I05_A	171	$1,343	$678	0.5
I05_B	329	$776	$437	0.56
I05_C	693	$456	$259	0.57
I06 Minor injury				
I06_A	16	$1,179	$860	0.73
I06_B	416	$891	$517	0.58
I06_C	1772	$427	$214	0.5
I71 Musculotendinous disorders, other				
I71_A	761	$915	$601	0.66
I71_B	1,241	$484	$331	0.68
I85 Complications of surgical and medical care				
I85_A	105	$801	$356	0.44
I85_B	211	$528	$268	0.51
I85_C	45	$323	$170	0.53
J64 Cellulitis/ skin infection				
J64_A	112	$1,163	$544	0.47
J64_B	946	$554	$293	0.53
J67 Skin disorders, other				
J67_A	144	$748	$404	0.54
J67_B	511	$417	$260	0.62
K60 Diabetes				
K60_A	54	$1,371	$856	0.62
K60_B	46	$708	$375	0.53
K62 Miscellaneous metabolic disorders				
K62_A	181	$1,143	$447	0.39
K62_B	191	$685	$358	0.52
L60 Renal failure				
L60_A	50	$1,316	$678	0.52
L60_B	36	$856	$456	0.53
L672 Kidney and urinary tract disorder, other				
L672_A	645	$915	$447	0.49
L672_B	430	$604	$329	0.54
M64 Male reproductive system disorders				
M64_A	168	$623	$343	0.55
N62 Menstrual and other female reproductive system disorders				
N62_A	390	$702	$319	0.45
O61 Postpartum and post abortion				
O61_A	106	$701	$368	0.52
O66 Antenatal and other obstetric presentation				
O66_A	320	$596	$279	0.47
P68 Perinatal disorders				
P68_A	17	$827	$357	0.43
P68_B	18	$452	$145	0.32
Q60 Reticuloendothelial and immunity disorder				
Q60_A	51	$951	$391	0.41
Q60_B	29	$444	$156	0.35
Q61 Red blood cell disorders				
Q61_A	110	$1,167	$571	0.49
Q61_B	12	$632	$222	0.35
Q62 Haemostasis				
Q62_A	12	$969	$448	0.46
Q62_B	14	$831	$452	0.54
Q62_C	7	$471	$150	0.32
R62 Neoplastic disorders				
R62_A	22	$1,565	$2,007	1.28

AECC end class	Statistics from the *Emergency care costing study*			
	n	Cost – mean	Cost – standard deviation	Cost – co-efficient of variation
R62_B	104	$900	$486	0.54
T60 Septicaemia				
T60_A	72	$1,542	$660	0.43
T60_B	15	$1,222	$453	0.37
T62 Fever of unknown origin				
T62_A	132	$1,190	$609	0.51
T62_B	226	$677	$591	0.87
T63 Viral illness				
T63_A	268	$711	$292	0.41
T63_B	637	$419	$195	0.47
T64 Infectious and parasitic disease, other				
T64_A	57	$840	$433	0.52
T64_B	52	$478	$239	0.5
U62 Psychosis				
U62_A	15	$1,433	$714	0.5
U62_B	140	$819	$493	0.6
U69 Mental and behavioural disorder, other				
U69_A	145	$1,076	$602	0.56
U69_B*	261	$803	$486	0.6
U69_C*	420	$711	$491	0.69
U69_D	140	$517	$313	0.61
V69 Alcohol and/ or drug related mental and behavioural disorders				
V69_A	69	$1,211	$543	0.45
V69_B	353	$796	$416	0.52
V69_C	105	$428	$229	0.53
X61 Allergic reactions				
X61_A	92	$656	$288	0.44
X61_B	96	$379	$186	0.49
X62 Poisoning				
X62_A	13	$1,933	$781	0.4
X62_B	236	$992	$482	0.49
X62_C	120	$494	$242	0.49
X64 Abuse and neglect				
X64_A	55	$1,153	$429	0.37
X64_B	68	$477	$302	0.63
Y62 Burns				
Y62_A	9	$985	$132	0.13
Y62_B*	35	$639	$253	0.4
Y62_C*	16	$593	$244	0.41
Y62_D	125	$380	$161	0.42
Z611 Falls risk				
Z611_A	308	$868	$634	0.73
Z612 Pain syndrome				
Z612_A	159	$696	$379	0.54
Z613 Signs and symptoms, other				
Z613_A	480	$783	$495	0.63
Z63 Forensic examination				
Z63_A	365	$974	$620	0.64
Z64 Other factors influencing health status				
Z64_A	271	$876	$442	0.51
Z64_B	800	$377	$264	0.7

** Although the average costs between the end classes marked are similar, they are being retained as separate classes due to the differences in the dispersion of costs combined with very high volumes represented by these classes when applied to national data. The volumes of activity and dispersion of costs are shown in the Technical Compendium to this Public Consultation Paper.*