# Classifying sub-acute and non-acute patients: Results of the New South Wales Casemix Area Network study

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## Abstract

*In 1994 the New South Wales Casemix Area Network initiated a study to develop a classification and funding model for sub-acute and non-acute care. Thirty-five rehabilitation, geriatric, psychogeriatric and palliative care services were recruited into the study throughout eight area health services. The aim of the first phase, summarised here, was to capture and analyse a sufficiently large quantity of data to select those variables most likely to predict resource utilisation, for subsequent use in a detailed costing study.*

*It is known that acute care diagnosis related groups are not predictive of costs in sub-acute care. This phase of the project confirmed that, in New South Wales, the most predictive variables were case type, functional status measures, impairment type for rehabilitation, phase for palliative care and severity of symptoms for palliative care.*

*The resultant Phase 1 casemix classification, which has built on recent United States experience and studies in other Australian States, has been termed the New South Wales Sub-Acute and Non-Acute Patient (SNAP) Version 1 classification.*

## Introduction

The classification of the outputs of the health system is recognised as being necessary for its effective management. This has led to the development and use of the AN-DRG (Australian national diagnosis related group) casemix classification system which is designed to classify acute inpatient hospital episodes. However, sub-acute and non-acute episodes are not adequately classified by DRGs (Batavia & DeJong 1988; Eagar & Innes 1992) and it is now accepted that sub-acute and non-acute care requires a different classification approach.

Development has been occurring in the United States since 1983 (Hindle & Laffey 1989; Fries et al. 1994; Stineman et al. 1994) and in Australia since 1990 (Commonwealth Department of Health, Housing and Community Services 1992; Roberts et al. 1993; Smith 1993; Smith & Firms 1994; Duckett et al. 1995a, 1995b) to refine a classification system for this form of care. Common to each has been the incorporation of measures of functional status, as this has shown to be more predictive of resource consumption than diagnosis (Hosek et al. 1986), although it is not the sole predictor of cost (McGinnis et al. 1987; Oczkowski & Barreca 1993; Lee et al. 1994). However, no measure has been used consistently across all settings and in all studies.

Existing classification systems for sub-acute and non-acute episodes of care were reviewed for use in this project. Resource Utilisation Groups (RUGs) comprise a classification system in use, predominantly in United States nursing homes (Fries et al. 1994). It is a system which is based on grouping patients with special needs who require special procedures (including allied health therapy), and considering a nursing dependency level called the RUG-ADL (Resource Utilisation Groups Activities of Daily Living) score. The Australian Resident Classification Instrument (RCI) for nursing homes uses similar concepts (Commonwealth Department of Health, Housing and Community Services 1992).

The Non-Acute Inpatient Project (NAIP) classification was developed in Australia (Roberts et al. 1993) to classify both sub-acute and non-acute inpatient days of care, but did not include palliative care. A *per diem* classification with 19 major functional categories was established, with six major classes (orthopaedic, spinal, pain, psychiatric, nervous system and medical) split using the RUG-ADL score. The study concluded that a daily classification may be necessary for this form of care as length of stay was not predictable. This was confirmed in another small study in the Illawarra (Lee, Kennedy & Aitken 1996).

For rehabilitation medicine, the most important existing classification is the FIM-Function Related Group (FIM-FRG). It uses the Functional Independence Measure (FIM) and classifies medical rehabilitation *episodes* of inpatient care into 54 groups split by Functional Impairment Category, FIM scores (or subsets) and age (Stineman et al. 1994).

The Victorian Rehabilitation Casemix Project (Coopers and Lybrand Consultants 1995) subsequently developed a classification system with up to 17 classes, similar to the Functional Impairment Categories used by the FIM-FRG. Change in functional status between admission and discharge, as measured by the Barthel Index (Mahoney & Barthel 1965), was predictive of variance in length of stay. Like FIM-FRG, length of stay was used as a proxy for cost.

In palliative care, clinicians developed a draft Palliative Care Casemix Classification (PCCC) (Smith 1993). It classified patients by five 'phases of care', defined as acute, stable, deteriorating, terminal and bereavement, and included a severity index and a measure of function (the RUG-ADL). A study of episodes from a small sample of sites in Western Australia confirmed that the PCCC was predictive of resource use in both inpatient and community settings (Smith & Firms 1994). A Victorian study obtained similar results, though the sample of hospitals was again small (Calder et al. 1995). The dependent variable in both cases was cost per day.

In summary, these studies have identified a number of functional and other measures that explained variation in the dependent variables used as a proxy for resource consumption. However, because the dependent variable was not the same across each study, the relative power of the different measures is unclear. It is also unknown whether other measures would be better predictors of resource use across sub-acute and non-acute settings. A study was therefore undertaken to assess the ability of commonly used patient measures to predict the resource consumption of sub-acute and non-acute patients. The study was designed to include previously assessed, and untested, measures of functional status. The measure of resource consumption was based on direct patient care costs. The study was designed to be Phase 1 of a larger project (known as SACAN) to develop a classification and funding model for sub-acute and non-acute care.

## Method

The study was designed to include patients defined by the New South Wales Health Department episode of care categories that were not classified as acute. These were nursing home type, convalescent care, respite care, rehabilitation, palliative care and psychogeriatric.

The data to be collected across these patient types were defined in collaboration with clinicians and staff at the participating sites before the study began. This enabled data definitions to be agreed and training needs to be established. The outcome of this process was the selection of some 100 data items. Data would be collected at the level of a patient episode for all episode types. In addition, data were collected per phase of palliative care for patients of this type.

The data items can be grouped into four categories. The first category were core data items and were to be collected at all sites for all patients. They included all items in the current New South Wales inpatient discharge data set (HOSPAS) and the RUG-ADL as the core measure of functional status.

The second category were specialty-specific data items and were to be collected only for specific case types. For example, the PCCC data items Phase of Palliative Care and Severity Score were collected for palliative care episodes but not for others; Folstein's Mini-Mental State Examination (MMSE) (Folstein et al. 1975) was collected in all psychogeriatric units, but not in all palliative care units.

The third category were optional data items which sites could elect to collect. The most important of these were additional instruments for the measurement of function, namely, the FIM, the RCI, the Barthel Index (Mahoney & Barthel 1965) and the Australian Activities Index (AAI), now known as the Adelaide Activities Profile (Clark & Bond 1995).

The fourth category were cost data items, necessary to establish cost relativities between patients. These included measures of staff time and expensive or atypical goods and services consumed by individual patients. Clinical interventions of exceptional cost were also recorded per patient. Actual cost data were collected by cost centre at the end of the data collection period, and were attributed to patients based on the recorded staff time and use of goods and services. Sites were only required to provide costs associated with patient care, not information on overhead costs.

Staff time was collected for all categories of staff, with the exception of nursing in non-palliative care services. During the consultation process, the participating sites argued that they did not have sufficient resources to capture nursing costs per patient per day. As a result, an alternative (albeit less satisfactory) methodology for determining nursing time was developed. Nursing time would be imputed using a regression model derived from nursing time and RUG-ADL scores collected during the NAIP. The RUG-ADL was a reasonable proxy as it is a direct measure of carer burden and, therefore, a measure of nursing resource intensity. However, as the NAIP did not include palliative care patients, these sites were requested to collect nursing time data.

A total of 35 New South Wales services were selected by the project team in conjunction with the New South Wales Casemix Area Network as being a representative sample of services in the participating area health services. Project officers were appointed at each site, and training was provided in the definitions of the data as well as in any assessment tools that were to be used. This included FIM training to sites intending to collect the FIM as a standard measure of function. A study handbook was also distributed to all participating staff.

Data were captured on all patients receiving sub-acute and non-acute care in these services over the six-month period from 1 March 1994 to 31 August 1994. As noted previously, some data were collected by staff, while other data were downloaded from HOSPAS and hospital accounting systems. Patient data collected from HOSPAS and staff were linked to create a single patient data file. The success of the linking process varied between facilities, with a number of factors causing problems. The study report contains a complete description of this process (Eagar, Cromwell & Kennedy 1995).

The cost centre expenditure data were then combined with the data on staff times and resource consumption to derive a cost for each patient. Costs were derived for both episode and palliative phase data sets, using the same methodology each time. As noted previously, nursing costs were allocated on the basis of the average RUG-ADL scores collected on admission and discharge. Medical and allied health costs were distributed in proportion to the minutes of care reported, with unaccounted staff costs being allocated in proportion to length of stay. Lastly, costs of atypical and expensive services were allocated to the identified patients, again with any remaining costs being allocated in proportion to length of stay. Once more, full details can be found in the study report (Eagar, Cromwell & Kennedy 1995).

The final outcome was an episode-based data set of 5684 records, and a palliative care phase data set of 3104 records. The overall level of data completeness was satisfactory. The response rate for the core data items varied from between 80 per cent and 90 per cent for variables such as age, principal diagnosis and the RUG-ADL to 100 per cent for items such as sex, marital status and episode type. The response rate was satisfactory for all the specialty-specific items except the MMSE. Only 45 per cent of cases had an MMSE score and the completion rate varied by episode type, from 15 per cent for palliative care to 72 per cent for rehabilitation. In contrast, there was 100 per cent completion for the palliative care phase and severity score. The level of completion of the optional measures of function varied, with 40 per cent of all rehabilitation cases having a FIM score but just 1.3 per cent having a Barthel score.

Each data set was then analysed using the PC-group software. This analytical method partitions patients into mutually exclusive groups and is based on an analysis of variance (ANOVA) model. Splits were made on the basis of a specified independent variable being able to explain the variation in values of the dependent variable (in this case, cost per day or cost per episode).

## Results

### Nursing home, convalescence, respite and psychogeriatric episodes

The predictive power of the variables was tested for the four episode types: nursing home, convalescence, respite and psychogeriatric. Their power was tested with respect to both *cost per day* and *cost per episode*. However, the sample sizes for each type were limited: 317 cases for nursing home types, 305 cases for both convalescence and respite, and 148 cases for psychogeriatric.

For *cost per day*, the functional dependency measures (excluding RUG-ADL) had only limited ability to explain resource use. Most notable was the AAI with respect to convalescence and respite patients. It explained 37 per cent and 20 per cent respectively. However, it was based on a small sample (66 records, as not all facilities collected it), and so classes split on this variable could not be recommended. Folstein's MMSE was also notable for its ability to explain cost variation between psychogeriatric patients. However, the number of observations within each partition was again small, and the same reservation applies.

On the whole, the performance of the variables was reduced when tested on the mean cost per episode. Where improvement was observed, it was only slight, and not sufficient to conclude that the variable could be used as the basis for a split.

### Palliative care

Data on palliative care were collected in two formats: by episode of care and by phase. Each episode could contain one or more of the five phase categories. The episode and phase data sets contained 1206 and 3014 cases respectively.

Within the episode data set, the best predictor of variation in *cost per day* was the score on Folstein's MMSE, explaining 15 per cent of variation when recorded on admission. However, the number of cases with an MMSE score was small. It was expected that the *phase* data would predict variation in cost better than the episode data because it contained variables specific to palliative care. This proved to be the case.

Table 1 shows the results when cost per day is the dependent variable. As can be seen, two variables apart from the RUG-ADL measure give a significant reduction in variance. The first is the phase type itself. The other is the combined score of the severity index.

**Table 1: Cost per day variation explained, palliative care**

| Variable | Sample size (number of cases) | Variance explained (%) | Number of classes |
|---|---|---|---|
| Phase | All | 25.3 | 3 |
| Number of problems, occurrence | All | 4.9 | 2 |
| Severity, pain | All | 8.7 | 2 |
| Severity, family/culture problems | All | 9.8 | 3 |
| Severity, psychological/spiritual problems | All | 12.8 | 3 |
| Severity, symptoms | All | 20.5 | 3 |
| Severity, all | All | 27.9 | 5 |
| RUG ADL, admission | All | 38.9 | 4 |
| RUG ADL, discharge | All | 37.5 | 3 |

Based on these results, phase would be the preferred choice as a splitting variable. Although severity of symptoms explains cost variation equally well, phase has greater clinical meaning. It is also more intuitive to create further splits within phase, for example, by severity, than to do so the other way around. The explanatory power of the severity variables within the phases was then investigated. The total measure again explained significant degrees of variation in the acute, stable, deteriorating and terminal phases, 13 per cent, 20 per cent, 14 per cent and 10 per cent respectively.

Given the perceived advantages of a per episode classification, it was decided to test variation in cost per episode. Data on severity were not collected by episode and so were excluded from analysis. As expected, none of the variables performed well, except the RUG-ADL, which achieved 26.4 per cent of variance. The next best performing variable was number of problems, which achieved 9.1 per cent variance explanation.

The explanatory power of the variables was also tested against the *mean cost per phase.* Phase explained 12 per cent of variation, but the performance of the other variables dropped significantly. This would suggest that any classification for palliative care might need to be based on cost per diem.

## Rehabilitation

The 2862 patients classified as rehabilitation formed the largest subset of the sub-acute episode types, and therefore it was important to identify suitable variables for a classification. To this end, several rehabilitation-only variables had been collected and their explanatory power was tested along with the standard variables.

Initially, each variable was analysed for its ability to explain variation in the mean cost per day. Table 2 shows the results.

The explanatory power of both the rehabilitation-only functional dependency measures was good, better than the general measures. The FIM, its motor component, and the Barthel measure all explained more than 20 per cent of cost variation when measured on admission. However, the small number of records with the Barthel measure means that the robustness of its variation statistic is not known, although it is worth noting that the 38 values were strongly correlated with the motor component of the FIM.

The other rehabilitation-specific measure collected was the Functional Impairment Category (FIC). It was tested at three levels of detail. The first used only the major impairment categories. The second included information up to one decimal place within each impairment group. This, for example, differentiated between traumatic and non-traumatic brain dysfunction. The last level of detail used all coded information. The explanatory power of the Functional Impairment Category increased at each level of detail used. The overall power was reasonable, although not as good as the FIM. However, an advantage of this variable is its clinical meaning. Thus it makes sense to have it as the root of any rehabilitation tree.

To this end, the predictive power of the FIM was tested on two functional impairment categories, stroke and orthopaedics. It would have been preferable to test it on all the categories, but only these two had sufficient records to ensure the strength of any resulting classes. The sample sizes of the orthopaedic and stroke impairment categories were 420 and 228 respectively. As before, the FIM scores recorded on admission explained a significant amount of variation in the mean cost per day. Within the stroke sample, the FIM motor component explained 33 per cent, while the total FIM explained 34 per cent. For orthopaedic patients, the total FIM and its motor component both explained 20 per cent.

**Table 2: Cost per day variation explained, rehabilitation**

| Variable | Sample size | Variance explained (%) | Number of classes |
|---|---|---|---|
| Age | 2530 | 9.0 | 4 |
| Principal diagnosis, excluding V-codes | 2470 | 6.3 | 5 |
| Behaviour scale, admission | 52 | 6.1 | 3 |
| Behaviour scale, discharge | 522 | 5.9 | 3 |
| Mini-mental, admission | 1813 | 4.6 | 3 |
| Mini-mental, discharge | 1813 | 2.6 | 2 |
| Australian Activity Index (total) | 450 | 3.2 | 2 |
| RUG-ADL, admission | 2510 | 19.9 | 3 |
| RUG-ADL, discharge | 2510 | 17.7 | 3 |
| Major Functional Impairment Categories | 2553 | 9.5 | 3 |
| FIC, plus 1st decimal place | 2516 | 13.9 | 4 |
| FIC, all detail | 2516 | 16.4 | 4 |
| FIM motor, admission | 1158 | 21.3 | 3 |
| FIM motor, discharge | 1158 | 20.0 | 3 |
| FIM cognitive, admission | 1158 | 10.2 | 4 |
| FIM cognitive, discharge | 1158 | 10.3 | 3 |
| FIM total, admission | 1158 | 22.5 | 3 |
| FIM total, discharge | 1158 | 21.6 | 4 |
| Barthel, admission | 38 | 29.4 | 3 |
| Barthel, discharge | 38 | 16.1 | 3 |

Several studies (Stineman et al. 1994) have indicated that variation in resource use can be explained at the level of an episode for rehabilitation patients. Thus this scenario was investigated. The results suggest that variation in episode cost can be explained. The variables identified in the preceding analysis again proved to be the most powerful. However, the power of all except one measure was reduced. The exception was the Function Impairment Category, with each level tested improving by around 4 per cent.

As before, the ability of the FIM to explain cost variation was tested within the orthopaedic and stroke impairment categories. Again, the best predictors were the values recorded on admission. For stroke patients, the total FIM and its motor component explained 23 per cent and 22 per cent respectively, a decrease on its cost per day performance. For orthopaedic patients, both explained 25.5 per cent of the cost variation.

## The proposed classification

From the above analysis, the following five variables were identified as being predictive of resource use:

- episode type
- phase (palliative care)
- severity of illness (palliative care)
- the Functional Impairment Categories (rehabilitation)
- the FIM (rehabilitation).

These were then used to devise a *per diem* classification. From this analysis, it would appear that an episode-based classification is not feasible for sub-acute and non-acute care, with the probable exception of rehabilitation. The challenge in developing a classification is to find a balance between empirical results, clinical meaning and ease of use. More explicitly, it should satisfy the following criteria (Roberts et al. 1993):

- classes should have meaning to clinical staff, and group patients with similar clinical characteristics
- classes should be resource-homogeneous
- there should be a manageable number of classes
- the variables used should describe patients' need instead of the services actually provided, and should not be easily gamed.

Table 3 shows the classification tree developed from the data. The initial split is based on episode type which, although not an effective single variable, is a clinically sensible starting point.

The overall per diem costs of the seven episode types used in Phase 1 are quite similar. Table 3 shows the costs for each of the seven episode types as cost relativities or cost weights, with all SNAP bed-days being given a value of 1.00. The cost weights range from 0.82 for convalescent episodes to 1.05 for psychogeriatric episodes.

**Table 3: The NSW SNAP Phase 1 classification tree**

| Cases | Cost weight | Class name |
|---|---|---|
| 6760 | 1.00 | All patients |
| 317 | 0.96 | Nursing home type |
| 305 | 0.82 | Convalescent |
| 305 | 0.87 | Respite |
| 2130 | 1.02 | All rehabilitation care |
| 69 | 1.48 | Stroke *Low FIM motor* |
| 43 | 1.16 | Stroke *Medium FIM motor* |
| 116 | 0.83 | Stroke *High FIM motor* |
| 48 | 1.45 | Non-traumatic brain dysfunction |
| 47 | 2.13 | Traumatic brain dysfunction |
| 129 | 1.13 | Neurological conditions |
| 64 | 1.29 | Non-traumatic spinal dysfunction |
| 35 | 1.70 | Traumatic spinal dysfunction |
| 92 | 0.94 | Amputation |
| 91 | 1.07 | Arthritis |
| 188 | 0.94 | Pain |
| 33 | 1.19 | Orthopaedic disorders *Low FIM motor* |
| 161 | 0.81 | Orthopaedic disorders *Medium FIM motor* |
| 226 | 0.59 | Orthopaedic disorders *High FIM motor* |
| 227 | 0.87 | Cardiac pulmonary |
| 561 | 1.06 | Other rehabilitation |
| 3014 | 1.01 | All palliative care |
| 126 | 0.82 | Acute *Low severity* |
| 311 | 1.05 | Acute *Medium severity* |
| 40 | 1.41 | Acute *High severity* |
| 412 | 0.81 | Stable *Low severity* |
| 394 | 1.12 | Stable*Medium severity* |
| 26 | 1.61 | Stable *High Severity* |
| 139 | 1.02 | Deteriorating *Low severity* |
| 502 | 1.23 | Deteriorating *Medium severity* |
| 52 | 1.66 | Deteriorating *High Severity* |
| 138 | 1.13 | Terminal *Low severity* |
| 326 | 1.32 | Terminal *Medium severity* |
| 41 | 1.72 | Terminal *High Severity* |
| 507 | 0.50 | Bereaved |
| 148 | 1.05 | Psychogeriatric |
| 541 | 1.04 | Other |

Only two of the episode types are split further: palliative care and rehabilitation. Splits within the other episode types are not proposed from this study because, given the sample size, the predictive power of the variables tested was not sufficient to warrant further splits. The one variable that could subsequently be a splitting variable, the RUG-ADL, was ruled out of this phase because of its use to estimate nursing costs for all but palliative care. Nevertheless, given the high correlation between the RUG-ADL and nursing costs found in previous studies, this variable needs to be considered in the next study.

## Palliative care

The palliative care branch is split at two levels, first by phase and then by the total severity in all phases except bereavement. Within the palliative branch, the split by phase achieves a variance reduction of 25.6 per cent. Splitting each phase (except bereavement) by total severity/problem score increased the variance reduction to 34.1 per cent.

An alternative second split would be to partition each phase based on the RUG-ADL functional dependency score. This has several advantages, the most important of which is that it is a rigorous variable and is less open to gaming. The variance reduction achieved by splitting each phase by functional dependency level in this study was 39.4 per cent. However, given the use of the RUG-ADL to impute nursing costs, this option cannot be recommended as the preferred model from this current study.

The cost weights for palliative care in this study range from 0.50 for the bereavement class to 1.72 for the high severity terminal class.

## Rehabilitation

The rehabilitation subgroup is split at the first level by the Functional Impairment Category, using information up to the first decimal place. This variable proved to be a reasonable predictor of resource use. Equally important, however, is that it makes clinical sense. The variance explained by this sub-branch is 16.2 per cent.

This figure could have been enhanced by creating a group for multiple trauma, and splitting the amputation class into two: double amputations and single amputations. However, the number of cases of multiple trauma and of double amputations was small. Therefore, the robustness of this enlarged tree was open to question, although such splits are intuitive.

The stroke and orthopaedic Functional Impairment Categories were then split by the FIM motor score as recorded on admission. The motor component was chosen because, like the total FIM, it produced good statistical results. Standardised classes were defined, although this reduced the level of variance explained. The effect of these splits was to increase the overall level of variance explained within the sub-branch to 23.58 per cent.

The cost weights for rehabilitation in this study range from 0.59 for the high function orthopaedic class to 2.13 for the traumatic brain dysfunction class.

## The influence of cost differences between facilities

The variable 'facility code' proved to be a powerful predictor of cost and explained 57.8 per cent of cost variance. This figure could imply that the costs provided by the facilities differed in their construction and completeness. However, it might be that different treatment protocols exist for relatively similar patient types. Another possibility is that each of the facilities treats a different mix of cases and the variable facility code is simply a reflection of differences in casemix. The critical issue is the degree to which facility code predicts costs after standardisation for casemix.

The high explanatory power of facility code was therefore subjected to further analysis (Cromwell & Eagar 1996). This demonstrated that, whilst the variable facility code influenced the cost estimates of the final classes to some degree, in all but one case (rehabilitation for arthritis) the cost relativities between the defined classes remained sufficiently large to justify the splits made and the splitting variables used.

## The classification

In total, the 34 classes outlined in Table 3 explain 25.1 per cent of the variation in the mean cost per day. This is a satisfactory statistical performance, given that the overall per diem costs of the seven episode types are quite similar and that most of these 34 classes will be further split in the next study based on a standard measure of function. This SACAN classification has been termed the New South Wales SNAP Version 1 classification. More detailed analysis of costs, particularly nursing, in the next phase can be expected to increase the statistical performance of the overall classification.

## Conclusion

Phase 1 of the New South Wales Casemix Area Network project on sub-acute and non-acute care has achieved what it set out to do. It captured a sufficiently large quantity of data to allow for the identification of a subset of the most promising variables which could then be refined and used as the basis of the final phase of a sub-acute classification study. The study did not establish the actual costs of each casemix class (nor did it aim to do so), but simply established the cost relativities between preliminary classes.

The study has demonstrated results which are, for the most part, consistent with the international literature. Specifically, the key variables used in DRG assignment seem unlikely to be of use, regardless of the quality and quantity of data, except in very limited circumstances. Age, diagnoses, number of diagnoses, source of referral, and destination after discharge have all performed poorly in the most recent Australian studies.

Based on consistent findings reported in the literature, the final classes in the preliminary classification now need to be split by an agreed ADL measure. Both the RUG-ADL and the FIM remain as possible measurement tools.

## The next step

A national SNAP casemix classification study has subsequently been initiated to develop the first version of a national casemix classification for sub-acute and non-acute care. This national study is collecting data during 1996 and will report in 1997.

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