Casemix funding in rural NSW: Exploring the effects of isolation and size

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Abstract

The New South Wales Department of Health (NSW Health) wishes to make appropriate use of casemix data as inputs to the determination of funding levels for small rural hospitals. However, other factors such as hospital size and degree of isolation might need to be taken into account.

The study reported here involved correlation of actual expenditures with those predicted by use of a casemix model alone, across 105 small public hospitals in the State. We then explored the extent to which the correlation could be increased by the addition of distance and isolation variables.

It was found that actual costs were highly correlated with those predicted from the casemix data alone, and that the correlation increased when both the distance and the size variables were introduced. However, contrary to expectations, reduced size was associated with reduced costs, and reduced isolation was associated with increased costs.

It was concluded that, while the predicted relationships may be present, they are likely to be relatively weak and are probably being masked by other factors not present in the model. In particular, it seems likely that there are variations in severity within the acute admitted patient category which are not fully explained by the casemix instrument used in this study (the DRG classification). We suggest that other terms be introduced to control for this possibility before any further attempt is made to test whether size and distance factors can be identified which work in the expected direction.

The context

The New South Wales Government introduced a revised funding strategy for the State's health system in October 1995. Its key features are needs-based funding to areas and districts under an extended resource allocation formula (re-named the Resource Distribution Formula), casemix-based funding of services within areas and districts, and payment according to predetermined prices for cross-boundary flows.

The strategy recognises the special needs of rural areas (NSW Health 1995). For example, the Minister noted that there were '... inequities in health care' for people living in '... rural and remote areas', and an internal report to the Health Economic Reform Committee in February 1996 recommended that particular attention should be paid to '... hospitals with less than 50 beds' when developing casemix funding formulas.

The idea of casemix-based funding is fundamentally sound. A key feature is that all hospitals (and other health care providers) should be paid the same amount for the same product. Inter alia, this creates the incentive to identify and then manage differences in production costs across sites.

However, there may be cost differences that are uncontrollable no matter how effectively the hospital is managed. In the context of this paper, it is often suggested that small hospitals have unavoidable additional costs which are a direct consequence of their size. There is the related concern that remoteness also contributes to unavoidable additional costs.

The effects of size are widely understood in principle. For any single product type, there may be significant diseconomies associated with low volumes. One might expect this to apply to hospital production, although the magnitude of the cost penalties (and the level of volume at which they begin to apply) might vary according to case type. Most obvious, any case type for which there are step-wise costs associated with investments in staff or facilities is most likely to exhibit increased unit costs as the volume falls.

The effects are likely to vary according to the ratio of case types to total volume. Thus a small hospital which is expected to meet a wide range of requirements for a large and sparsely populated area would be more likely to experience unit cost problems than a small but highly specialised hospital in a metropolitan area.

Remoteness may be an important factor regardless of size. One might expect higher input costs for consumables, staff and patient transport, staff recruitment, and so on. It is particularly common to argue that remote hospitals have difficulties in recruiting and retaining staff, and this means they must either accept more generalist or less well-qualified employees in some circumstances or recruit at higher levels of payment.

In fact, there is relatively little literature which presents controlled evidence of the effects of size and isolation on hospital performance. While there are satisfactory studies of individual correlates (such as cost or quality of care), covariates are seldom adequately controlled.

For these and other reasons, the evidence of financial penalties is mixed. Shride (1997) summarised the popular view: that rural hospitals have greater financial difficulties as a consequence of such factors as declining population, corporate mergers and downsizing, transportation, cost of technology, and health manpower shortages. Yellowlees (1992) described the particular difficulties of providing psychiatric services in a remote part of New South Wales. Cleverley and Harvey (1992) noted that there were many United States rural hospitals in financial difficulties, and argued that they had to achieve relatively higher levels of labour productivity in order to counterbalance the many risk factors.

However, many studies suggest that the difficulties are overestimated in some circumstances. For example, Lillie-Blanton et al. (1992) and Succi, Lee and Alexander (1997) were unable to confirm the assertion that rural hospitals were particularly disadvantaged by the United States Federal Government's casemix-based funding model (the Medicare prospective payment system). Williams, Hadley and Pettengill (1992) obtained similar results: rurality and size were not themselves associated with financial difficulties, but hospitals in areas with small or declining populations had higher than average risks. Rogers et al. (1997) examined trauma care, which has been widely shown to be unprofitable in urban areas under the prospective payment system. They found, however, that there were fewer financial difficulties in rural areas, in most circumstances (and especially with low injury severity). Stajduhar et al. (1996) concluded that, where Veterans' Affairs beneficiaries were transferred from their rural homes to specialised Veterans' Affairs facilities in urban areas, the costs of care were much higher than if they were provided with the same care in the local community hospital located in the immediate vicinity. Culler, Holmes and Gutierrez (1995) analysed hospital costs of knee replacement for rural residents by location of service. They found that predicted cost per case was lower in rural rather than urban hospitals across all patient types. Lave et al. (1996) studied hospitalised patients with community-acquired pneumonia and concluded that treatment costs were lower for rural patients than for urban patients, but outcomes were not different.

The literature is relatively consistent with regard to the relationship between size and quality of care: it is strong at the low end of volumes, but not so after a particular threshold is reached (which differs according to the complexity of the intervention). For example, Culler, Holmes and Gutierrez (1995) noted that complications of knee procedures were significantly correlated with volume at the extreme (below 10 procedures per year), but that there were otherwise no major differences between rural and urban hospitals.

There are fewer patterns with respect to the effects of isolation on quality of care. For example, Nesbitt et al. (1990) found that women from isolated communities had a greater proportion of complicated deliveries, higher rates of prematurity, and higher costs of neonatal care than women from communities where most patients delivered in the local hospital. However, Welch et al. (1992) analysed readmissions in rural hospitals in Washington State and found no evidence of lower quality.

The costs might not be higher, but workforce problems are generally judged to be greater in remote rural areas. These appear to affect all types of professions including nursing (Fuszard, Slocum and Wiggers 1990; Stratton et al. 1991; Huntley 1994), medicine (Mills 1997) and social work (Egan and Kadushin 1997).

In general, it is reasonable to conclude that results of analyses of the effects of size and isolation are inconsistent because of the typically small number of data points and the high number of factors which affect performance. For example, hospital performance is affected by the nature of primary care services, and availability varies considerably from place to place (Dor and Holahan 1990). The serviced populations can be quite different. Typical results are those obtained by Anderson and Dugdale (1997), who found significant differences in the morbidity patterns of two rural Queensland communities. Many studies have shown that ethnicity (and in particular Aboriginality) may have significant effects on small and isolated hospitals. Other causes of casemix differences include acute transfers, which not only affect small hospitals but also many others (including tertiary referral hospitals). Goodman et al. (1997) studied the influence of distance from home to the nearest hospital on the likelihood of hospitalisation and mortality. They found that rural dwellers were significantly less likely to be hospitalised as a consequence of distance.

In view of the conflicting evidence, it is not surprising that payment models vary considerably with respect to adjustments for size and remoteness. Several useful examples are provided by the United States Medicare prospective payment system, where adjustments have seldom been well received by care providers and have been regularly modified. There has always been a payment differential according to the estimated variations in a labour price index between regions (and which has therefore typically resulted in lower payment rates for rural areas). With minor exceptions, there have not been equivalent adjustments for variations in input prices for goods and services. Incidentally, there is reason to believe that, in Australia, there are smaller variations in labour costs by geographic location but more significant variations in non-labour costs compared with the United States. The main factor is that governments have exercised a high degree of control over labour prices, and one assumed consequence is that ease of recruitment varies by location.

The United States Medicare prospective payment system has also used a direct measurement of remoteness, in addition to taking account of observed variations in input prices. The most obvious example is the additional payment for 'sole community hospitals'. A sole community hospital is a hospital which is important to a small community because it is relatively isolated and no other hospital facilities are easily accessible. It is defined by a set of isolation measures, such as distance from another similar hospital, and barriers of topography or weather. In the initial years of the prospective payment system, each sole community hospital was paid largely on the basis of its own costs rather than national average costs.

In Australia, health authorities in all States and Territories except the ACT recognise differences in cost and casemix for small and remote hospitals in one way or another. This is true, regardless of the general structure of the funding model: whether cost reimbursement is the predominant approach, needs-based funding is applied, or the core is output-based funding.

Victoria made only minor adjustments in its first casemix funding model (1993–94). It increased the differentials in several ways in subsequent years (including the use of rural distance, transportation, and rural specialty grants). The changes were partly a consequence of an evaluation report prepared by Health Solutions which identified many benefits but also raised some concerns, including the tendency of the new model to disadvantage small rural hospitals. It has been argued that distance is of less concern in Victoria than in other States, but there have been problems even at the extreme.

The experiences in Queensland are more relevant in some ways, given its similar distribution of population to that of New South Wales. When it introduced its casemix-based funding model in 1995, Queensland Health argued that some hospitals would be inappropriately funded by use of the existing set of casemix classifications. It therefore determined that several types of hospitals would be excluded in Phase 1 (and the rules have been little changed since that date). Excluded hospitals comprised those which provided mainly primary and limited secondary services, had fewer than 750 discharges per year, and were located in communities with a population below 3500. They would continue to be funded according to a global budget based primarily on expenditure in the previous year.

The South Australian Health Commission's first statewide casemix-based funding model, introduced in 1994–95, included an additional funding component, termed the rural access grant, which was intended to cover some unavoidable additional costs associated with remoteness. There were two main components, depending on the size. Extremely small and remote hospitals would continue to be funded by a direct grant based on their historical expenditures.

Other small hospitals would be funded according to their casemix-adjusted volumes, but with transitional arrangements. The process involved computation of a minimum budget based on estimated costs of specific inputs (such as the appropriate staff mix for its activity levels). Where the casemix-based budget was below the minimum budget, the latter would apply (and the difference termed the rural access grant). Where actual expenditures in the previous year exceeded the minimum budget, the difference might be provided as a transition grant. The hospital would therefore be expected to reconfigure its operations within a reasonable period of time so that it could manage within the minimum budget.

The minimum budget took account of the costs of salaries and wages which were appropriate to its activity levels and functions, including nursing, clerical, hotel services, maintenance, superannuation, and workers' compensation. It also took account of the costs of goods and services, including drugs, medical and paramedical supplies, and building services.

A similar approach has been investigated in the Midwest and Gascoyne region of Western Australia. Again, the approach involves estimation of the minimum staffing and mix for the hospital's volume and function. The focus, however, has been on definition of a model which involves the employment of two nursing staff for three shifts per day, and the staffing of 8 acute beds or 16 nursing home beds. This configuration is based on a service population of up to 3500, no capacity for surgical procedures requiring an operating theatre, maternity services for low-risk births, and the equating of two nursing home type patients to one acute patient.

Some statistics for New South Wales public hospitals are presented in Table 1. Hospitals are assigned to peer groups for the purposes of comparison, and the small rural hospitals discussed in this paper are largely placed into one of two peer groups: community acute hospitals and community non-acute hospitals. Community hospitals are those with fewer than 2000 separations and fewer than 2000 casemix-weighted separations per year (NSW Health 1998). Non-acute and acute hospitals are distinguished on the basis of the sum of non-acute bed-days and outlier bed-days as a proportion of total bed-days. Community acute hospitals are those with less than 40% of their bed-days related to non-acute or outlier bed-days, and community non-acute hospitals comprise the remainder.

Table 1: Basic hospital statistics, public hospitals, 1996–97

	Community		Other acute	All
	Non-acute	Acute		
Number	53	34	81	168
Beds	1 367	931	14 988	17 286
Expenses ($mil)	123.79	124.11	4 296.89	4 544.79
Separations	27 945	41 593	1 127 775	1 197 313
Bed-days	330 476	185 271	4 540 813	5 056 560
ALOS (all separations)	11.8	4.5	4.0	4.2
ALOS (overnight only)	14.1	5.4	6.1	6.2

In mid-1996 it was decided that experiences should be pooled with a view to establishing a common strategy for the use of casemix measures in the funding of small and remote hospitals. This paper summarises one of the analytical studies which has supported that goal.

The main objective was to develop a casemix-based budgeting model, with extensions as considered necessary (such as size and remoteness) to take account of cost factors not reflected in the available casemix measures. The model would be provided to area health service managers to use as they considered appropriate in the next budget round.

It was recognised from the outset that no model could be constructed in the short term, and with available data, which could be expected to be sufficiently precise for budget setting by itself. A component of the study would therefore be the establishment of a process whereby the model would be progressively improved so that it might become the dominant basis for budget setting in due course.

Method of study

The first stage involved defining the scope of the analysis, in terms of the participating hospitals and the data to be sought. It was decided that the analyses would be applied to data for the complete 1994–95 financial year, since equivalent data for 1995–96 would not be available for some time for every site. The original intention was to include only the 78 free-standing hospitals with fewer than 50 beds, but the scope was subsequently widened to cover 110 sites. Five were eliminated because of data problems. Therefore, the results shown in this report relate to 105 hospitals with bed sizes as shown in Table 2.

Table 2: Participating hospitals by number of beds

Number of beds	Number of hospitals
9 or fewer	5
10 to 19	29
20 to 29	31
30 to 39	24
40 to 49	11
50 to 59	3
60 and over	2
Total	**105**

In selecting the data elements, it was necessary to compromise between relevance and feasibility of retrieval from existing computerised data systems. The required information comprised cost and volume data for the 15 components of production listed in Table 3. Where a site was unable to obtain outpatient data at the indicated component levels, it was permitted to provide only total cost and volumes. Similarly, it could choose to provide only totals for community services.

Data were then extracted from statewide databases by staff of the Central Office where possible. The remainder were obtained by use of a questionnaire sent to all participating sites in October 1996.

Several adjustments were made to the methods of data compilation after an initial appraisal of the available data. For example, one problem related to long-stay patients who were discharged during 1994–95, having accrued days before 1 July 1994: or who were not discharged during 1994–95. The most obvious source of admitted patient data was the New South Wales morbidity collection. However, at that time, it was unsuitable because days were recorded according to the year in which separation occurred and it was therefore necessary to use an alternative database.

In the second stage, data submitted by participating sites were assembled in a single study database in a format suitable for the intended analysis. In outline, we required volumes and total costs for each of the 15 component products, from which cost per unit of production could be determined. In the case of acute admitted patients, volume was defined to be the casemix-weighted number of separations. National cost weights were used for convenience, because updated State weights were not available at the time. It would be advisable to repeat the analyses with a different set of cost weights, although brief investigation suggested that there would be little effect on the key results. In the case of all other component products, volume was defined to be crude bed-days or occasions of service in the absence of any suitable within-product casemix classifications.

Table 3: Level of completeness of cost and volume reporting after adjustment

Component	Share of total costs (%)	Mean cost per unit of production ($)
Acute		
Acute admitted patients (episodes)	62.59	2575
Acute non-admitted patient services (OoS)	13.16	44
Doctor, in A&E	1.65	45
Doctor, not in A&E	0.46	45
Nurse	1.50	45
Allied health profession	0.46	21
Other A&E	2.35	42
Diagnostic services only	1.27	43
Other non-admitted	5.47	40
Not acute		
Non-acute admitted patients (days)	16.74	146
Non-acute non-admitted patients (OoS)	1.36	29
Total community health (OoS)	6.16	26
Hospital admitted patient	0.11	33
Nursing home type	0.16	114
Home care	2.04	25
Outreach	0.64	22
Other community health	3.20	33

The submitted data were then subjected to a series of predefined edits. Many questionable values were identified, which was not unexpected given that there had been no significant incentives for compilation of data according to the full range of products. In most cases, the source of the errors was obvious. For example, a hospital might have failed to separate a cost total into its component parts. In other cases it was impossible, with the available data, to reconcile total and sub-total expenditures and volumes with component data. An edit report was therefore prepared, and some of the errors and omissions were subsequently corrected, either from the statewide data systems or by direct enquiry to the participating sites.

In the third stage, the re-submitted data were subjected to more thorough analysis for the purpose of correcting errors and imputing missing values. It was decided that a conservative approach would be used: data would be imputed where either cost or volume data were available, and pro rata adjustments would be made to ensure internal consistency. However, no other revisions would be made in the source data, even where the reported values were seemingly implausible. At the extreme, where the data for a particular site were seriously deficient in terms of plausibility or completeness, it would be removed entirely from the study. Five sites were excluded on these grounds.

The revisions were initially undertaken using a mathematical routine written for application to an Access database. However, it was decided that the same process would be replicated by way of formulas in an Excel spreadsheet. The latter approach was chosen because of the degree of ease with which it might be repeated or enhanced by the department or individual hospitals at a later date.

In outline, the modelling process comprised five steps. First, we derived the average cost per unit of production for each component product for which there were both expenditure and volume data, and then used these values to compute the average cost across all hospitals with both volume and cost data (AvCPU).

Second, we imputed total expenditure for each component product where the reported value was zero but the volume was non-zero by multiplying its volume by AvCPU. In a similar way, we imputed volume for each component product where the reported value was zero but the expenditure was non-zero by dividing its expenditure by AvCPU. Thus, by this stage, there were volume and expenditure values in all cells.

The total reported expenditure across all hospitals was $258 million, whereas the total of the expenditure components (after imputation as described above) was $263 million. In step 3, we adjusted the imputed values on a pro rata basis so they summed to the reported total of $258 million.

Fourth, we re-computed mean costs per unit of production, and applied them to the volume data to determine the predicted costs for each hospital. These values were then used in the correlation analyses.

The imputed costs are simply an attempt to make the best possible estimates of actual costs with the available data. The process used here tends to produce overstated correlations. It will also introduce some bias, especially at the component product level. However, no changes were made during the imputation process which would affect the relative performance of the various models described below.

In summary, the processes described above led to imputation of costs for component elements of each hospital's production, where either cost or volume had been reported but not both. After imputation in this way, mean costs per product were determined for each product type, and used as the basis for predicting costs for particular levels of reported production.

The fifth step involved the development of a set of linear regression models. The dependent variable in each case was actual total expenditure. The predictor variables were cost predicted by use of the casemix data, three measures of isolation in kilometres (distance to nearest hospital of any size, distance to nearest hospital of 50 or more beds, and distance to nearest hospital with an intensive care unit), and four measures of size (number of beds, number of staff of all types, number of nursing staff, and number of medical staff).

The first type of model made use of only the casemix data. The results are summarised in Table 4. As noted above, the casemix model predicts costs by use of DRG costs weights for acute admitted patients and mean costs per product for all other products.

The results are presented in the standard manner of Microsoft Excel. We chose to display results in this way because of the relatively wide familiarity of Excel, and in order to facilitate repetition of the computations with modified source data. More precise and detailed results can be obtained from specialised logistic regression packages, but there is no effect on the relative performance of the models under test.

This model simply defines the best linear fit between the actual and the predicted costs. Performance is relatively satisfactory, as indicated by the adjusted R^2 (R Square) value of 0.8363 on the third row of the results.

The coefficients are 383194 for the intercept and 0.8441 for the X variable (which is predicted total cost in this case). Great care needs to be taken when interpreting a simple model of this type. However, one might reasonably depict the model to represent a cost structure where there is a fixed component of $383 194 associated with a hospital's operation.

Table 4: Regression of imputed costs against expected costs, casemix model

Regression statistics	
Multiple R	0.9154
R Square	0.8379
Adjusted R Square	0.8363
Std Error	609622
Observations	105

ANOVA

	df	*SS*	*MS*	*F*	*Signif F*
Regression	1	1.97842E+14	1.97842E+14	532	1.72979E-42
Residual	103	3.82788E+13	3.71639E+11		
Total	*104*	*2.36121E+14*			

	Coefficients	*Std Error*	*t Stat*	*P-value*	*Lower 95%*
Intercept	383194	107828	3.5537	0.0006	169342
X Variable 1	0.8441	0.0366	23.0727	0.0000	0.7716

	Upper 95%	*Lower 95.0%*	*Upper 95.0%*
Intercept	597046	169342	597046
X Variable 1	0.9167	0.7716	0.9167

Many other models were then developed, making use of both the casemix variable and one or more of the isolation and size variables. Eight are summarised in Table 5. The first is the pure casemix model, as described above. Model 2 involves the use of the casemix variable and all seven other variables representing distance and size factors. Thus the aim here is to assess the extent to which the differences between actual and casemix-based predicted costs can be reduced by taking account of other factors.

As before, the model defines the best linear fit between the actual and the predicted costs. Performance is improved relative to the casemix-only model, as indicated by the adjusted R^2 value of 0.9405 (compared with 0.8363). This value is of interest to the extent that it suggests the likely upper bound on performance with the available predictor variables. However, Model 2 is not useful in this form, if only because of the high degree of correlation between the individual predictor variables (and especially between the measures of distance, and between the measures of size). In these circumstances, it is largely arbitrary which of multiple highly correlated variables will take positive and negative values.

Table 5: Performance of eight linear regression models

	Variables employed	Adj R^2	Coefficients of added terms
1	Casemix-based cost (CM) only	0.8363	
2	CM plus all 7 distance and size variables	0.9405	
3	CM plus distance to nearest hospital of any size, in km	0.8388	–1783
4	CM plus distance to nearest hospital of 50 or more beds, in km	0.8436	–2051
5	CM plus distance to nearest hospital with an ICU, in km	0.8416	–1071
6	CM plus mean distance (average of previous 3 distance measures)	0.8429	–1878
7	CM plus number of beds	0.8525	+29393
8	CM plus total number of FTE staff	0.9414	+41869

Models 3, 4 and 5 use each of the three distance measures in turn. Model 6 was produced to illustrate the point that combinations of variables can be used, which might be simple or weighted averages (or some more complicated function). In this case, it was the mean of the three distance measures used in Models 3, 4 and 5.

Models 7 and 8 use size variables. The latter uses total full-time equivalent (FTE) staff. Almost identical results were obtained when each of total nursing FTE staff and total medical FTE staff were used.

Models 3 to 8 all provide improvements over the pure casemix model in terms of adjusted R^2. This is much as expected: the addition of any other variable with some degree of association with the dependent variable would tend to improve predictive power. However, the gains are surprisingly small, with the exception of Model 8.

This model uses total staff (FTE). The higher correlation between predicted and actual costs is to be expected, given the strong logical association between cost and number of staff. There is no practical significance, however, since inclusion of this kind of variable is not logical in the context of output-based funding.

Finally, note the coefficients of the additional variables (that is, those added to the casemix term). For the distance terms in Models 3 to 6, the coefficients are all negative (–1783, –2051, –1071 and –1878 respectively). This indicates that costs tend to decline with increasing distance, which is inconsistent with the hypothesis that remoteness results in additional uncontrollable costs of care.

For the size terms in Models 7 and 8, the coefficients are both positive (29393 and 41869 respectively). This indicates that costs tend to increase with increasing size, which is inconsistent with the hypothesis that small size carries penalties such as loss of economies of scale.

Discussion

All eight models are similar in their predictive powers. Several other variants were tested, and different approaches to modelling were explored, but with little effect on the results (and none on relative performance).

The casemix term is by far the most powerful of the available predictor variables. The size and isolation variables contribute to a small degree. However, their effects are in opposite directions to those which were anticipated. Costs decrease with reductions in size and with increased isolation.

These results are difficult to interpret, but it is often the case in regression analysis of complicated systems with sparse and imprecise data that causal relationships are masked by another factor not represented in the model which acts in a contrary direction. In this case, one possible explanation is that the effects of distance and size are as hypothesised, but cannot be observed in the available data because of the effects of sensible referral practices which are not adequately represented by the casemix term.

This interpretation is supported by recent work by Hindle et al. (1997) which showed that within-DRG lengths of stay were correlated with the number of diagnoses and procedures per discharge, and that larger hospitals tended to have greater numbers of diagnoses and procedures per discharge. This is a clinical plausible result. One might expect the more complicated cases to be referred to hospitals with more sophisticated resources. The association between length of stay and number of diagnoses and procedures applied after the removal of all patients spending one or more days in intensive care. In the South Australian casemix funding model, intensive care unit episodes and associated costs constitute a separate funding item.

It is likely that there are some provider effects, such as the tendency for teaching hospitals to make greater use of sophisticated diagnostic capabilities not present lower in the referral chain (simply because they are available). It might also be the case that teaching and research costs are not being fully separated from the costs of patient care. However, the evidence of patient differences is strong in both clinical and empirical terms.

There might be similar relationships with respect to other hospital products such as outpatient clinics and rehabilitation. However, it is sufficient at this stage to note the plausibility of the relationships in respect of acute admitted patients. Their costs dominate the expenditures of the hospitals in this study. It is entirely reasonable to hypothesise that within-DRG severity variations have a contrary effect which entirely masks the effects of distance and size.

The results of this study do not reduce the argument for using a casemix-based funding model for small hospitals. It has identifiable weaknesses, but it is better than any other available option in terms of cost prediction (with the exception of expenditure-based models which are undesirable for obvious reasons). However, there should be protection against any real changes in funding for the first period of use. In other words, a notional budget should be computed, to give hospitals the opportunity to make changes in operation (and to improve their data so that a better model might be developed for the next budget period).

There appears to be no equivalent argument for including size and distance factors (at least, not in the general funding model although they might be considered at the local level). It is reasonable to assume that any effects they might have are more than compensated by the variations in severity and consequent costs within DRGs which are associated in the other direction.

The casemix model should make use of the best available DRG cost relativities. We used national cost weights in the analyses reported here, but also tested the sensitivity of the regression results to the use of other data sets including New South Wales cost weights from the 1992–93 national costing study. The conclusions were hardly affected by the change, although there were variations at the level of individual hospitals. It may be that better results can be obtained from use of later data (such as from the 1996–97 costing survey).

At the same time, it would be sensible to consider the use of a similar within-DRG severity adjustment to that developed in South Australia (and more recently in Tasmania). Depending on the results of investigation of severity differences, it might be possible to repeat the investigation of effects of size and distance after controlling for unexplained casemix effects. The method of analysis should be much as described here, but with refined measures of casemix. We expect that distance and size factors will have the effects suggested by logic. This will, however, only be able to be demonstrated when improvements have been made to the dominant casemix terms in the model.

Other factors will need to be considered, including the use of a funding model which has both volume-dependent and fixed terms to reduce the budget instability consequent on short-term variations in volume which are harder to manage by small and isolated hospitals. It would also make sense to incorporate the flexibility to adjust the model over time. Whatever the current patterns may be, they are likely to change over the next few years. One factor is communications technology. The possibilities include mobile computed tomography (Hartley, Moscovice and Christianson 1996), teleradiology (Caldwell, Miles and Barrington 1996), and telemedicine (Preston, Brown and Hartley 1992). This and other factors may be expected to affect the referral patterns themselves – which are apparently a major cause of within-DRG severity variations.

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