An assessment of the effects of casemix funding on hospital utilisation: A Northern Territory perspective

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Abstract

This article is concerned with the methodological issues of assessing the effects of casemix funding on hospital utilisation. Time-series analysis and intervention analysis are proposed to ascertain the effects. It was found there had been a decline in average length of stay and number of bed-days, an increase in weighted separations for teaching and non-teaching hospitals, and no apparent increase of costliness in terms of a comprehensive casemix index. No evidence of decline in quality of care can be established in terms of readmission rates. The long-term effects of casemix funding, and specific issues in terms of the funding model used, patients and cost shifting between hospital services and community health services, remain to be studied.

Introduction

For some years, the Commonwealth Government has pursued improvement in the way it funds State health systems, including public hospitals. Its purpose has been to reduce inequities and inefficiencies among hospitals and seek maximum returns for the health dollar. The Commonwealth Government's strategy has been to encourage States and Territories to develop equitable funding systems, and prepare for the introduction of a system of casemix funding at both State and Commonwealth levels (Commonwealth Department of Health and Family Services 1996).

Under the 1993–98 Medicare Agreements, the State, Territory and Commonwealth governments agreed to establish a nationally consistent casemix-based management and information system that could serve as the foundation for alternative hospital funding models (Eagar & Hindle 1994a, 1994b; Commonwealth Department of Health and Family Services 1996).

In March 1995, the Department Executive of Territory Health Services approved the staged development and implementation of an output- or casemix-based funding model for the Northern Territory's public hospitals. From March to July 1995 a basic model would be developed. From June to July 1996 the model would be run in parallel with current financial appropriations, and evaluated and refined. From July 1996 the model would be implemented as a basis of funding (Territory Health Services 1996, 1997). The Department adopted the following implementation strategies (Beaver 1995). It:

- developed policy statements and strategic frameworks to reflect broader services strategies and resource allocation methodologies
- reviewed the existing hospital financial information system and associated feeder systems
- reviewed and modified hospital management infrastructures to allow the development of internal hospital budgets on an output basis
- reviewed the process involved in documenting and classifying the morbidity profiles of hospitals
- implemented the modifications to information systems and work practices along with a marketing and education program for managers and hospital services staff
- implemented essential infrastructure to provide managers and clinicians with timely, accurate and valid information to assist with decision support, resource management, performance measurement and service planning, and
- identified and implemented initiatives to ensure the appropriateness and quality of care.

Evaluation methods

After one year of casemix funding it was necessary to assess its effects on hospital utilisation in the Northern Territory's public hospitals. This article summarises the methods and results.

The pattern of changes of hospital utilisation measures from July 1991 to the end of June 1997 for five public hospitals in the Northern Territory are summarised. The effects of casemix funding on these measures are then evaluated. Evaluation is based on three criteria: output, quality of care and efficiency. Two measures of output, weighted separations and number of bed-days, are used. 'Weighted separations' is defined as the sum of numbers of separations multiplied by the cost weights for all Australian National Diagnosis Related Groups (AN-DRGs). 'Number of bed-days' is the product of average length of stay (ALOS) and number of separations. Quality is examined in terms of 'readmission rates', defined as the number of emergency patient readmissions within 28 days of separation divided by the total number of admissions excluding deaths during the periods calculated. Finally, efficiency of provision of care is assessed through ALOS and a casemix index (CI). ALOS is defined as the total length of stay for all admitted patients divided by the number of patients. CI, defined below, is a comprehensive indicator reflecting the average costliness per separation. The higher the CI, the higher the average case reimbursement and the relatively lower the efficiency.

A formula for calculating the CI is constructed by modifying the methods proposed by Bentes, Mateus and Gonsalves (1996), and Steinum (1997) to enable incorporation of same-day cost weights.

$$CI = \frac{\Sigma(NSD_i * SCW_i + NNSD_i * NSCW_i)}{\Sigma \text{ Number of separations for } DRG_i}$$

where the summation is for all diagnosis related groups (DRGs) and where:

NSD_i = number of same-day discharges for DRG_i

$NNSD_i$ = number of non-same-day discharges for DRG_i

SCW_i = same-day cost weights for DRG_i

$NSCW_i$ = non-same-day cost weights for DRG_i.

Other criteria, such as accessibility to the hospital care, may be formulated to measure hospital utilisation. Similarly, patient satisfaction and hospital-acquired infection rate are potential indicators of quality of care (DesHarnais et al. 1987; Health Solutions 1994). Due to resource constraints, data on such indicators are not readily available for all five hospitals at the time of evaluation. Thus, we limit the scope of investigation to the aforementioned measures.

In the literature, descriptive and qualitative evaluations of output-based funding are widely reported (Maddox & Gliddon 1995; Bentes, Mateus & Gonsalves 1996; Jacobs et al. 1996). The major shortcoming of such evaluations is that they lack quantitative analysis of the sequential changes over time. Time-series modelling, coupled with intervention analysis, is adopted in this study as an effective and efficient analysis tool for appropriate evaluation. It departs in several aspects from previous approaches. First, the analysis uses extended time series of monthly data before and after the implementation of casemix funding. The use of seasonal data rather than annual data increases the statistical power of identifying regulatory intervention effects. More importantly, the larger number of observations allows for dynamic modelling of the underlying time-series process. Since most time series encountered in the social sciences tend to exhibit considerable stochastic behaviour (McCleary & Hay 1980; Maddala 1988), temporary drifts in the level of the time series coinciding with the onset of the regulation might initially be mistaken for intervention effects. Previous evaluations in the literature rely on the unrealistic assumption that change in time-series values before the intervention will continue after the implementation of casemix funding in the form of a linear trend.

Auto-regressive integrated moving average models

Time-series analysis is concerned with data that consist of time-ordered sequences of measurements. Its applications can be found in various areas of health services research (Muller 1993; Tandberg & Qualls 1994; Rutledge et al. 1996). Within the class of time-series models, auto-regressive integrated moving average (ARIMA) models are the most popular. Three types of process are involved: auto-regression, differencing and moving average. An auto-regressive process with order p is one in which each term of the series is regressed on the preceding lag p terms. A moving average is the average of a series value with adjacent lag q values. Moving averages are taken to smooth a time series (that is, reduce fluctuation in the series). Prior to expressing a time series in terms of its auto-regressive and moving average components, the series must first be rendered stationary. This is achieved by differencing the series between successive values. The general model, neglecting seasonality, is written as ARIMA (p, d, q) where p is the order of auto-regression, d the degree of differencing and q the order of moving average involved (see, for example, Bowerman & O'Connell 1987 and Diggle 1990 for more details).

The autocorrelation function (ACF) and partial autocorrelation function (PACF) are typically used to identify the order of the underlying process. The ACF gives the autocorrelations calculated at lags 1, 2, and so on; the PACF gives the corresponding partial correlations, controlling for autocorrelations at intervening lags. The underlying process, as well as seasonality in the time series, may be determined by a cross-examination of these two functions. Details can be found in standard texts such as Diggle (1990, pp 34–9).

Intervention analysis

ARIMA models can be used to analyse the stochastic behaviour of a time series. On the other hand, intervention analysis concentrates on a disruption in the normal behaviour of a series (for example, McCleary & Hay 1980). Since casemix funding can be considered as a macro intervention, it is appropriate to apply intervention analysis in conjunction with ARIMA models to assess the effects of casemix funding on hospital utilisation.

ARIMA models with intervention indicator variables are used to ascertain the effects of casemix intervention. With respect to the timing of the intervention, two indicators (NOTION and IMPLEMEN) are set up. They denote, respectively, the potential effects due to the notional period of casemix funding (July 1995 to June 1996) and the actual implementation period (July 1996 to June 1997). To establish whether there is any significant monthly effect in the series, 11 indicator variables (JAN to NOV) are created, with December as the reference level. To investigate any apparent trend of the series, a TREND variable is obtained by dividing observation number by 12.

As a consequence of the extra functions of teaching hospitals, additional costs are associated with patient treatment which are not evident in non-teaching hospitals.

Teaching status of a hospital is taken into account by paying additional funds to teaching hospitals. In the Hospital Budgeting Model Generation 2 of the Northern Territory (Territory Health Services 1997), teaching grants have been allocated to teaching hospitals for lost clinical time whilst assisting students (thus ensuring patient care is not compromised by the teaching responsibilities). The five public hospitals in the Northern Territory are classified into teaching (Royal Darwin Hospital and Alice Springs Hospital) and non-teaching categories (Katherine Hospital, Tennant Creek Hospital and Gove District Hospital). The data for these two groups are analysed and contrasted.

Results

Data

The data were obtained from the Northern Territory aggregated Hospital Morbidity Databases. Renal dialysis patients were removed from the calculation of ALOS since the majority are same-day patients. Inclusion of such patients will adversely mask the actual overall level of ALOS (Territory Health Services 1996).

The data are available from July 1991 to June 1997 for teaching hospitals and from July 1992 to June 1997 for non-teaching hospitals. Table 1 provides average levels of the five measures for the study period. Table 2 summarises the ARIMA models fitted to both groups. Only the significant variables are listed. Details of the fits are available upon request.

Table 1: Hospital utilisation measures for teaching and non-teaching hospitals

Fiscal year	1991–92	1992–93	1993–94	1994–95	1995–96	1996–97
ALOS (days)						
Teaching	6.03	5.78	5.40	4.79	5.06	4.86
Non-teaching	–	4.75	4.35	4.28	4.10	3.73
Weighted separations*						
Teaching	1 805.08	2 553.75	2 820.42	3 483.08	3 344.67	3 409.00
Non-teaching	–	569.42	624.58	631.25	699.92	739.42
Number of bed-days*						
Teaching	10 840.75	14 744.58	15 209.42	16 470.75	16 933.83	16 546.17
Non-teaching	–	2 703.58	2 702.42	2 807.08	3 087.17	2 758.25
Readmission rate (percentage)						
Teaching	6.25	6.89	6.41	6.70	5.37	5.16
Non-teaching	–	6.81	6.69	7.20	6.41	5.89
Casemix index						
Teaching	0.36	0.37	0.36	0.43	0.38	0.38
Non-teaching	–	0.37	0.35	0.33	0.34	0.38

* Monthly average

Table 2: Summary of ARIMA model fits for teaching and non-teaching hospitals[†]

Measures	Teaching hospitals	Non-teaching hospitals
ALOS	MA1[*] NOTION[#] TREND[#]	AR1 IMPLEMEN[#]
Weighted separations	AR1[*] NOTION TREND MAR NOV	AR1 NOTION TREND MAR APR MAY JUN AUG
Number of bed-days	AR1[*] IMPLEMEN[#] MAR TREND	AR1 IMPLEMEN[#] MAR APR
Readmission rate	AR1[*#] FEB[#] JUN[#]	AR1 APR[#]
Casemix index	AR1[#] TREND MAY	AR1 APR[#]

[†] Only significant variables are listed
[*] With differencing of 1 lag
[#] With a negative coefficient

Average length of stay

Figure 1 shows the general trends of ALOS for teaching and non-teaching hospitals. It can be seen that there are declining but non-stationary tendencies in ALOS for teaching hospitals but more stable trends for non-teaching hospitals. ALOS of teaching hospitals is consistently longer than that of non-teaching hospitals. For teaching hospitals, the effect of notional period of casemix funding on ALOS is marginally significant, while for non-teaching hospitals the effect of the implementation is significant. Trend of significant declining ALOS is also found for teaching hospitals. No seasonal effects have been identified in both groups. MA(1) and AR(1) processes are identified for teaching and non-teaching hospitals, respectively.

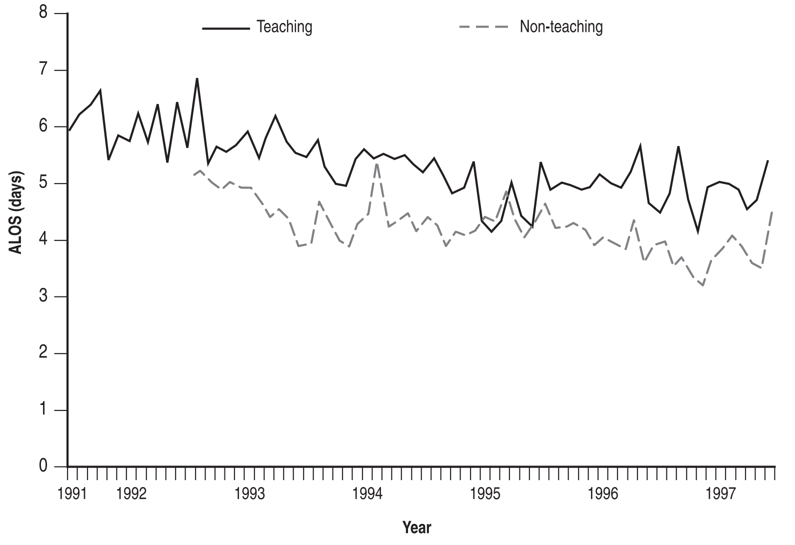

Figure 1: ALOS, July 1991 to June 1997, teaching and non-teaching hospitals

Weighted separations

Figure 2 shows the general trends of weighted separations for teaching and non-teaching hospitals. There are increasing but non-stationary tendencies for teaching hospitals but stable trends for non-teaching hospitals. ARIMA (1,1,0) and (1,0,0) models without apparent seasonality patterns are identified for teaching and non-teaching hospitals, respectively. The notional period of casemix funding has a positive effect on weighted separations and increasing trends are evident for both groups.

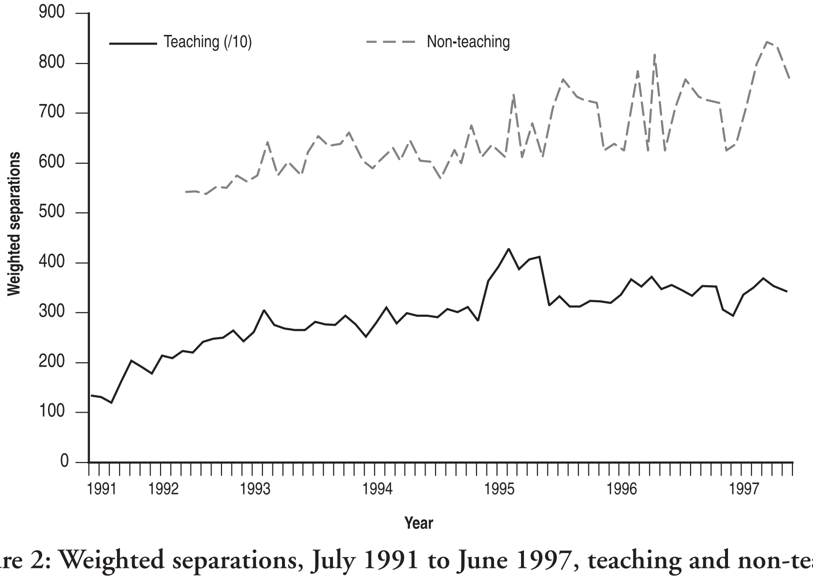

Figure 2: Weighted separations, July 1991 to June 1997, teaching and non-teaching hospitals

Number of bed-days

Figure 3 indicates that there are increasing but non-stationary tendencies in number of bed-days for teaching hospitals but stable trends for non-teaching hospitals. ARIMA (1,1,0) and (1,0,0) models without apparent seasonality patterns are identified for teaching and non-teaching hospitals, respectively. The effect of the implementation of casemix funding on number of bed-days is statistically significant and negative for both groups. However, there is still a general upward trend in number of bed-days for teaching hospitals.

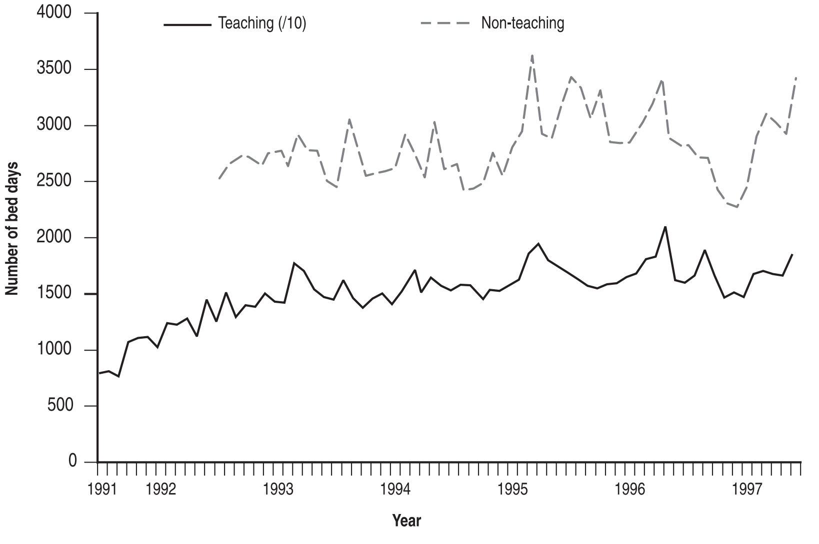

Figure 3: Number of bed-days, July 1991 to June 1997, teaching and non-teaching hospitals

Readmission rates

The time series of readmission rates, which serve as a proxy for quality of care, are plotted in Figure 4. There are similar declining but non-stationary tendencies for both groups, and the rates are generally higher for non-teaching hospitals. ARIMA (1,1,0) and (1,0,0) models without apparent seasonality patterns are determined for teaching and non-teaching hospital groups, respectively. Neither the notional nor actual implementation has an impact on readmission rates.

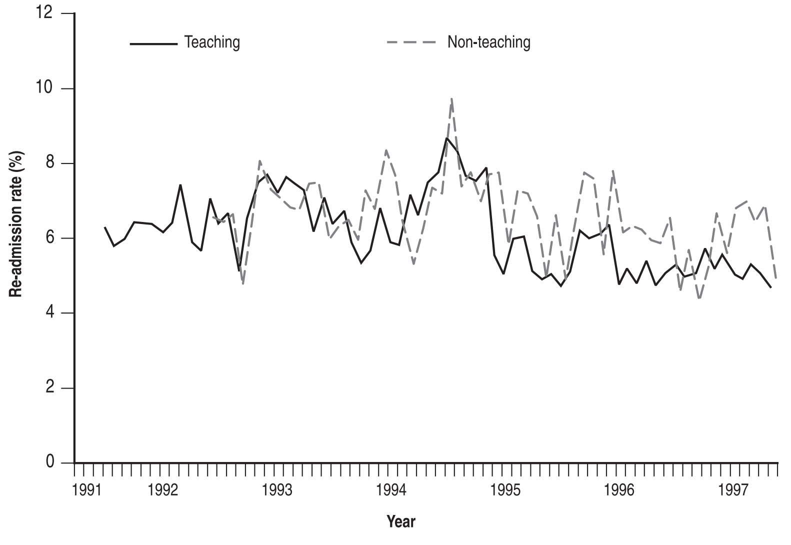

Figure 4: Readmission rates, July 1991 to June 1997, teaching and non-teaching hospitals

Casemix index

The CI time series are displayed in Figure 5, showing non-stationary tendencies. The CI levels of teaching and non-teaching hospitals are similar, except the period between October 1994 and April 1995. ARIMA (1,0,0) models without apparent seasonality patterns are fitted for both hospital groups. No apparent effects of notional and actual implementation of casemix funding are evident.

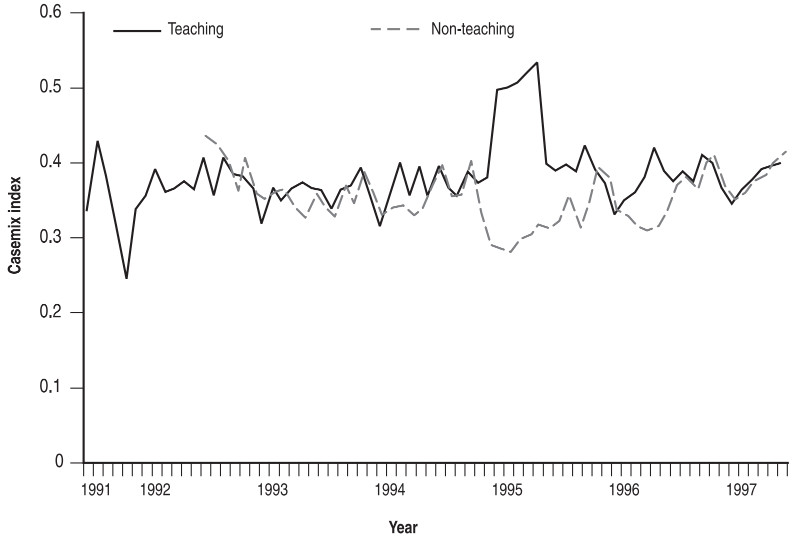

Figure 5: Casemix index, July 1991 to June 1997, teaching and non-teaching hospitals

Discussion

The introduction of casemix funding has stimulated debates among health authorities, hospital managers, clinicians and health professionals in terms of its effects on cost efficiency and standards of clinical effectiveness (Duggan 1994; Hickie 1994; Phelan 1994; Phillips 1994; Stoelwinder 1994). Casemix funding may be expected to lead to shorter length of stay, earlier discharges, more same-day surgery, and lower per case cost possibly offset by higher admission rates (Scotton & Owens 1990). As reported by the Victorian Auditor-General's Office (1998), casemix is clearly a superior mechanism to the previous historically-based budgeting process in that it is a driver of improved efficiency, and it provides a fairer means of funding health networks and hospitals. Its influences on the efficiency, output and quality of care in the Northern Territory context are discussed below.

Efficiency

The expected impact of casemix funding on length of stay is reduction in length of stay through better scheduling of tests, discharge planning and review of need for hospitalisation. For example, in the United States' Medicare prospective payment system (PPS), researchers found the short-term impacts were that ALOS for all hospital inpatients decreased by 8.34–8.45% (Prospective Payment Assessment Commission 1988; United States Department of Health and Human Services 1989) compared to a fall of 2.9% prior to the introduction of casemix funding. In South Australia, the decline in ALOS during the implementation of casemix funding in 1994–95 was due to an increase in the number of same-day patients and reduced lengths of stay amongst overnight patients compared to the previous two years (Commonwealth Department of Health and Family Services & South Australian Health Commission 1997). A similar phenomenon has been found in Victoria (Health Solutions 1994; Victorian Auditor-General's Office 1998) and in other studies (Maddox & Gliddon 1995; Bentes, Mateus & Gonsalves 1996), although Jacobs et al. (1996) argued there was no significant change in ALOS after casemix funding.

In this study, the decreasing trends in ALOS are observed for both teaching and non-teaching hospitals. It is also interesting to find that there is a significant effect on ALOS during the notional introduction of casemix funding (July 1995 to June 1996) for teaching hospitals but for non-teaching hospitals the effect did not appear until the actual implementation (during July 1996 to June 1997). Unlike other studies in the literature (Bentes, Mateus & Gonsalves 1996; Jacobs et al. 1996), the modified CI, reflecting the costliness of a hospital, has not deviated markedly from previous levels. We may tentatively conclude that efficiency in the provision of care has not been reduced due to casemix funding.

Output

In Victoria the number of inpatients to be treated has been found to be increasing, and the number of bed-days to be decreasing since the introduction of casemix funding (Health Solutions 1994). In South Australia, increases in total separations and total casemix-weighted separations have been observed (Commonwealth Department of Health and Family Services & South Australian Health Commission 1997). Maddox and Gliddon (1995) observed in a comparison of pre- and post-casemix years that after the implementation of casemix funding, the output increased 16% in terms of admissions.

In this study, the notional period of casemix funding has a substantial impact in lifting total casemix-weighted separations for both teaching and non-teaching hospitals. Meanwhile, the implementation has actually decreased the total number of bed-days for both hospital groups. This demonstrates the positive consequences of casemix funding in terms of hospital output.

Quality

In American prospective payments systems, reduced quality in terms of premature discharges leading to higher readmission rates was expected. However, researchers found there is no systematic evidence of decline in quality. Moreover, readmission rates have not changed substantially from pre-PPS levels (DesHarnais et al. 1987; DesHarnais, Chesney & Fleming 1988; Lave 1989; Prospective Payment Assessment Commission 1989), although Morrisey, Sloan and Valvona (1988) found that Medicare patients were transferred sooner and in a higher state of dependency. Similar results are evident in Victoria and South Australia where the quality of in-hospital care remained largely the same on a system-wide basis during the year that casemix funding was introduced (Owens 1993; Health Solutions 1994; Commonwealth Department of Health and Family Services & South Australian Health Commission 1997). However, although readmission rates were unaltered in Victoria, there was some evidence of an increase in discharge of patients in an unstable state and more were transferred to nursing homes (Duggan 1994). As reported by the Victorian Auditor-General's Office (1998), the majority of senior clinicians perceived a deteriorated quality and in particular, certain vulnerable patient groups (such as the chronically ill) might be at risk as a result of practices introduced in response to casemix.

In this study, no apparent influences of the implementation on readmission rates have been observed for both teaching and non-teaching hospitals. Based on this indicator, it can be established that there is no real decline in quality due to casemix funding. It should be acknowledged that other measures need to be taken into consideration to confirm the quality of care aspect. Unfortunately, data on measures such as patient satisfaction and hospital-acquired infection are currently not available.

Complicating factors

One of the related issues when evaluating casemix funding is to assess the potential confounding effect of budget cuts on those measurements. For example, in Victoria there was a budget cut of 1.5% per annum from the financial year 1990–91 to 1991–92, a 4% cut in 1992–93, followed by a 10% cut over the period 1993–94 (pre-casemix) and 1994–95 (first casemix year) (Health Solutions 1994). However, the final budget allocation for the Northern Territory public hospitals had increased from 1994–95 to 1996–97 (Territory Health Services 1998). Compared to the previous financial year, the percentages of budget increase for 1995–96 (notional period of casemix funding) and 1996–97 (actual implementation period) were 9.28% and 14.78% per annum, respectively. Therefore, no confounding effect of budget cut is evident in the Northern Territory.

Like other States, the Northern Territory has a number of small, remote facilities for which casemix funding in its current state of development may not be entirely suited. This relates primarily to the fact that their fixed costs are high relative to their patient utilisation. These hospitals (non-teaching) may be unable to achieve the efficiencies on which the benchmark price of the casemix funding model is based. Hindle, Frances and Pearse (1998) also demonstrated the importance of the effects of isolation and size on casemix funding in rural New South Wales. Thus, the differences in utilisation between teaching and non-teaching hospitals in the Northern Territory context are of significance in the funding model.

Another specific issue in the Northern Territory is that there is a large proportion of Aboriginal patients. As the utilisation of hospital services between Aboriginal and non-Aboriginal patients are quite different (Beaver et al. 1998), it is important to consider this aspect in the future funding model.

Due to the limitations of the data, only short-term effects of casemix funding have been observed in this study. It is desirable to continue monitoring the changes of the measurements and indicators. Studies in the United States (United States Department of Health and Human Services 1989; Muller 1993) showed that the reimbursement reforms in America's Medicare PPS had reduced hospital admissions, ALOS and number of bed-days in the early stage of the implementation but significant readjustments occurred for all three measurements two years later. The United States Medicare reimbursement reforms appeared to remain effective in reducing hospital utilisation, but at a reduced rate. Whether casemix funding will remain effective in the long term remains to be studied.

The anticipated reduction in hospital length of stay was expected to be partly achieved by greater use of outpatient 'after-care' services such as home health, rehabilitation and so on (Victorian Auditor-General's Office 1998). The need for continuity of care, and for patients and costs shifting between hospital care and community health services, should be taken into consideration once outpatient and community services data become available.

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