Projected acute inpatient activity in New South Wales — *aIM2005*

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Abstract

Objectives: To describe the statewide projections of acute inpatient activity in New South Wales.

Methods: Data on acute inpatient activity in NSW for the period 1998–1999 to 2003–04 were derived from the Admitted Patient Data Collection. Regression analysis was used to project trends in utilisation and length of stay by age group, clinical specialty groups and stay type (day-only and overnight). The projected separation rates and length of stay were subject to clinical review. Projected separation rates (by age group, clinical speciality and stay type) were applied to NSW population projections to derive the projected number of separations. Bed-days were calculated by applying projected overnight average length of stay.

Results: Total acute inpatient activity in NSW public hospitals is projected to increase from around 1.05 million separations in 2004 to around 1.3 million separations by 2017 (24%). Same-day separations are projected to increase from around 368 000 to around 514 000 (40%). Overnight separations are projected to rise from around 690 000 in 2003–04 to around 798 000 in 2016–17 (18%). Overnight bed-days are projected to increase from around 3.7 million in 2003–04 to around 4.1 million bed-days in 2017 (12%). Differences across age groups and clinical specialties are also evident from the modelling.

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HEALTH SYSTEMS ARE COMPLEX and dynamic; characterised by constant change and innovation in the organisation, delivery and funding of health services. Health systems operate in a context of changing social, economic and political environments requiring understanding of new

What is known about the topic?

Since the early 1990s, acute inpatient demand modelling in New South Wales (NSW) has been based on the projection of service and age-specific trends in admission rates and length of stay. The most recent version of this approach is *aIM2005*, a program that allows health service planners to model demand and supply scenarios within a defined population catchment.

What does this paper add?

This paper uses this program to project NSW acute inpatient separations by age group, clinical speciality and stay type.

What are the implications for practitioners?

The 24% increase in separations projected to 2017 reflects clinical practice and demographic trends. The projections provide information for improved planning and investment decisions and highlight issues such as the capacity of existing infrastructure to respond to the projected demand increases, in terms of volume and changing casemix.

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health needs and priorities within the population and the adoption of new clinical practice and technologies in the prevention, diagnosis and treatment of illness.

In the 2004–05 financial year there were just under 2.2 million hospitalisations in New South Wales. Total health expenditure in New South Wales will reach $11.7 billion in 2006–07, representing 27.5% of total NSW Government expenditure.[1,2]

Since the early 1990s, long-term acute inpatient demand modelling in NSW has been based on the projection of specialty service and age-specific trends in admission rates and length of stay. The most recent version of this approach is *aIM2005*, a program that allows health service planners to model demand and supply scenarios within a defined population catchment. The program can therefore be utilised at the sub-area, area and state level. This approach recognises that services need to be planned in a strategic and integrated manner, and that planning should not be based on current year utilisation patterns alone.[3] The program allows health service planners to project future activity by taking into account the main drivers of future demand for health services — trends in hospital admissions, population growth and population ageing. The methodology used is broadly consistent with that of long-term projection tools used in other jurisdictions in Australia and internationally, including the United States, Canada and the United Kingdom.[4-8] The "base case" assumes that the pattern of service provision remains broadly similar to the current pattern of service delivery (eg, location of services, patient flows). The program also enables health service planners to undertake scenario modelling at the local level to model the possible impacts to changes in service provision such as the opening of a new hospital, or providing new clinical services at existing hospitals.

The projections relate to acute care; defined as care in which the clinical intent or treatment goal is to: manage labour (obstetric); cure illness or provide definitive treatment of injury; perform surgery; relieve symptoms of illness or injury (excluding palliative care); reduce severity of an illness or injury; protect against exacerbation and/or complication of an illness and/or injury which could threaten life or normal function; perform diagnostic or therapeutic procedures.[9] Other forms of admitted patient care, such as palliative care and rehabilitation are not planned using the *aIM2005* planning tool; complementary tools have been developed in NSW for planning these forms of "sub-acute" care.[10,11]

This paper describes the broad implications of the base case projections of acute admitted activity in NSW public hospitals over the period to 2017.

Methods

Data sources

The *aIM2005* model is based on three main sources of data — the NSW Admitted Patient Data Collection, small-area population estimates and population projections.

The Admitted Patient Data Collection is a census of all admitted patient services provided by NSW public hospitals, public psychiatric hospitals, public multi-purpose services, private hospitals, and private day procedures centres.

The Australian Bureau of Statistics publishes age-specific population estimates for statistical local areas (SLAs).[12,13] There are 199 SLAs in NSW, with an average population of around 34 000 people. The NSW Department of Planning publishes age-specific population projections at the SLA level. The projections are based on assumptions regarding the components of population changes. The 2004 series of population projections was used for the *aIM2005* model.[14]

Regression analysis

Data were extracted from the Admitted Patient Data Collection and combined with population estimates to derive age-specific separation rates across 138 clinical groups, referred to as enhanced service related groups. Data were extracted for public and private hospital activity for the 6-year period 1997–98 to 2003–04 (finan-

1 Variables used to develop *aIM2005*	
Variable	**Description/categories**
Separations	Number of separations
Length of stay	Measured in days, "day only" assumed to equal one day
Sex	Male/female
Age group	Five-year age groups (0–5, 5–9, 10–14 etc until 85+)
Stay type	Same day and overnight
Place of residence	Statistical Local Area of residence
Enhanced service related group	138 clinical groups defined as aggregations of diagnosis related groups. Designed to reflect clinical specialties in New South Wales hospitals
Place of treatment	Hospital of treatment

cial years). The variables included in the analysis are described in Box 1.

The enhanced service related group (ESRG) variable is based on a classification system developed in NSW for grouping hospital inpatient records into categories corresponding to clinical divisions of hospital activity. Each ESRG group is related to a series of diagnosis related groups. The major purpose of the classification is to assist with the planning of health services by linking every patient episode in NSW hospitals to a meaningful category of clinical specialty.[15]

Trends in statewide separation rates and length of stay (for overnight activity) were examined for each combination of ESRG/age/sex/stay type. Simple linear regression was used to project trends for each combination. In projecting the average length of stay, the length of stay was capped at 90 days for the purposes of the regression analysis. In reporting the total activity, the days beyond 90 days were added back into the total estimate of bed-days.

While linear regression is the underlying method used in projecting future admission rates, experience shows that in certain cases such a method can lead to untenable results. In some cases, an early data point in the series may be much higher or lower than the succeeding points and not be representative of the underlying trend; such a "pivot" point can unduly influence the regression results, much as an outlier can unduly influence the calculation of a mean of a set of numbers. This can lead to erroneously high or low (even negative) admission rates.

To reduce the occurrence of such unrealistic projections within the regressions done for the individual ESRG/age/sex/stay type combinations, a simply understood algorithm is used to limit the growth or decline in admission rates within certain boundaries. A 5% compounding growth in admission rates over 15 years would result in a doubling of the *rate*, an unlikely scenario for most disease processes, and so is used as the upper limit in admission rate growth. A 2% compounding decline over 15 years would result in a drop to 75% of the current admission rate and is used as the lower limit.

Day-only admission rates had limits of –4% and +3% applied to accommodate the larger decline seen in some day-only procedures (mainly due to changes in clinical coding affecting some specialities such as chemotherapy) and the lesser likelihood of large shifts to day-only cases, especially for the elderly. Similarly, limits to changes in overnight average length of stay were set to –2% and +2% (compounding). Such limits are based on the clinical feedback received over several years in several states and empirically deal with many of the concerns expressed. However, further clinical feedback and individual examination of each trend is still required at the end of this automated process. Note that in many cases, the raw regression was not changed as the above limits were not reached.

Trends in separation rate and length of stay were clinically reviewed for a selection of clinical groups. The reviews involved health service planners and clinicians with an expertise in the

2 Acute admitted patient activity New South Wales Public Hospitals 1997–98 to 2003–04 and projected for 2011–12 and 2016–17

	Day only		Overnight		Total	
	Separations	**Bed-days**	**Separations**	**Bed-days**	**Separations**	**Bed-days**
1997–98	339 760	339 760	708 200	3 841 461	1 047 960	4 181 221
1998–99	353 517	353 517	705 143	3 758 831	1 058 660	4 112 348
1999–2000	343 098	343 098	686 205	3 644 075	1 029 303	3 987 173
2000–01	350 020	350 020	685 742	3 600 475	1 035 762	3 950 495
2000–02	360 351	360 351	676 053	3 578 186	1 036 404	3 938 537
2002–03	374 616	374 616	678 077	3 583 196	1 052 693	3 957 812
2003–04	368 109	368 109	689 957	3 670 428	1 058 066	4 038 537
Projected						
2011–12	454 021	454 021	749 662	3 884 085	1 203 683	4 338 106
2016–17	513 568	513 568	798 081	4 117 193	1 311 649	4 630 761

Excludes chemotherapy, renal dialysis and unqualified neonates.

respective clinical areas. The consultation considered whether atypical data points were skewing trends; consistency of trends with epidemiological evidence; and the impact of new diagnostic and treatment modalities on utilisation patterns. Clinical review was undertaken across 15 selected clinical groups and involved around 20 clinicians. Around 100 combinations of age/sex/ESRG were reviewed.

The projected overnight average length of stay was based on the same data with linear regression being used if the trend was upwards, and exponential decline (with a lower limit of 1 day) if the trend was downwards. These projections have been reviewed by teams of clinicians and, where necessary, altered.

The expected number of admissions for a particular SLA was calculated by multiplying the projected statewide separation rate (for each ESRG/age-group/stay type combination) by the projected population.

The projected admissions were then multiplied by the projected average length of stay to yield projected bed-days for each ESRG/age-group/stay type combination for each region of residence.

To determine where the projected admissions will be treated, the referral pattern seen in 2003–04 is used as a template to distribute the admissions. This includes the distribution of activity (at the age/sex/stay type/ESRG level) between public and private hospitals.

Adjustments for relative utilisation

To take account of geographic variation in admission rates, age/sex-standardised comparisons are undertaken comparing actual admissions and expected admissions (based upon the NSW average rate for that specialty). An index is calculated to reflect the relative utilisation.

$$\text{Relative utilisation} = \frac{100 \times \text{Actual admissions}}{\text{Expected admissions}}$$

A relative utilisation of 120, for example, indicates an admission rate 20% above the NSW average. As may be anticipated there is significant variation in admission rates across the state. In NSW, the current approach in demand modelling is to maintain the *absolute difference* between the actual and expected admissions. In a system with increasing admissions over time this has the impact of ensuring a modest movement towards the statewide average rates over time — while still maintaining existing differences.

In presenting the results of the modelling for public hospitals in NSW, all activity related to renal dialysis, chemotherapy and "unqualified"

neonates (well babies who are not separated from their mothers during the mother's stay in hospital) have been excluded from the analysis.

Results

Total acute inpatient activity in NSW public hospitals is projected to increase from around 1.05 million separations in 2004 to around 1.3 million separations by 2017; an increase of 24%. Same-day separations are projected to increase from around 368 000 to around 514 000; an increase of some 40% (Box 2).

Overnight separations are projected to rise from around 690 000 in 2003–04 to around 798 000 in 2016–17; an increase of 18%. Over-

3   Change in public hospital activity and New South Wales population 2004–2017
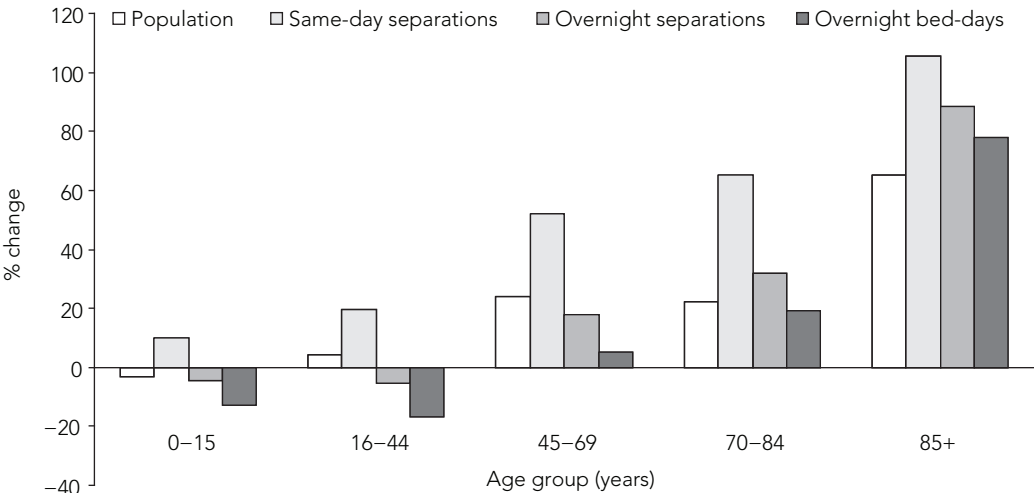
4   Projected growth in separations by service related group — day-only activity
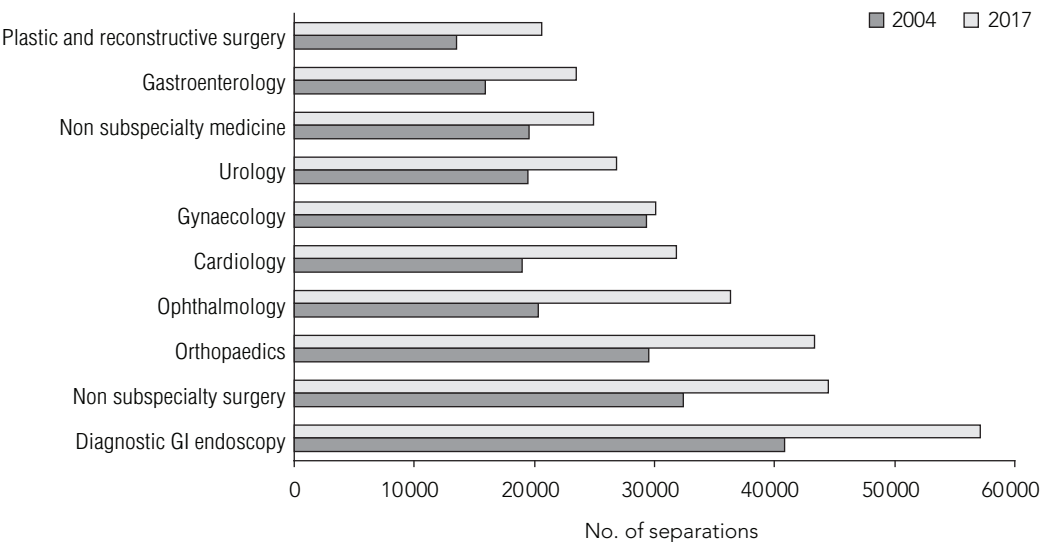
night bed-days are projected to increase from around 3.7 million in 2003–04 to around 4.1 million bed-days in 2017; an increase of around 12% (Box 2).

Projected activity by age groups is illustrated in Box 3, with differences in projected activity across the various age-groups evident. In the 45–69-years age group, the increase in population is accompanied by a strong increase in same-day admissions (about double the size of population growth), indicating large increases in the underlying same-day admission rates in this age group. As in the younger ages, this is accompanied by growth in overnight admissions that is less than the population rate of growth — indicating a small decrease in overnight admission rates. When this is accompanied by projected length of stay reductions, the growth in overnight bed-days is negligible and well below population growth. In the two older age groups, a different pattern is observed, particularly in the 85 years and older age group, which has the highest percentage growth in projected population. This is compounded by growth in underlying same-day and overnight admission rates and, although there are overall reductions in average length of stay, they are not large enough

to offset the increased admission rates. The combined impact of these changes is that the 85 years and older age group is the only age group in which bed-day growth actually exceeds population growth.

The *aIM2005* model allows an assessment of projected demand by different clinical groups for both day-only and overnight activity.

The largest volume of day-only activity is projected for diagnostic gastrointestinal endoscopy, with around 60 000 separations projected, a 40% increase from 2003–04 (Box 4). Ophthalmology and cardiology specialties are projected to have large percentage increases in day-only activity; by 2016–17 it is projected that day-only ophthalmology separations will have grown by 79% from 2003–04 levels, while day-only cardiology separations are projected to increase by around 68% over the same period.

In relation to overnight activity, the large volume clinical specialities are cardiology and respiratory medicine (Box 5). Cardiology is one area where the projected increases in overnight activity are relatively large — these projections indicate that cardiology will account for around 83 000 separations by 2016–17, an increase of 38% from the 2003–04 levels. This is an example

5 Projected growth in separations by service related group — overnight activity
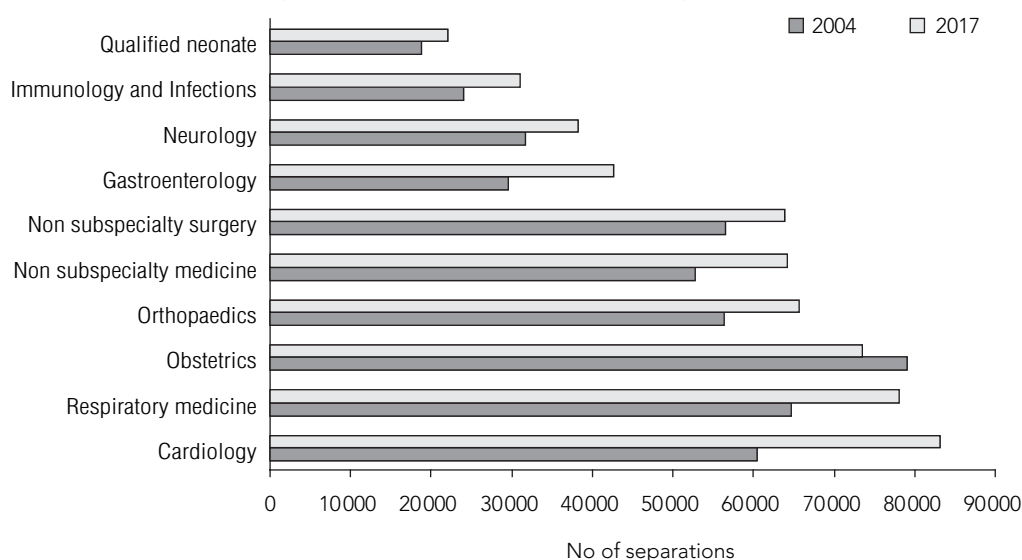
6 Projected share of population and acute inpatient bed-days, New South Wales 2017
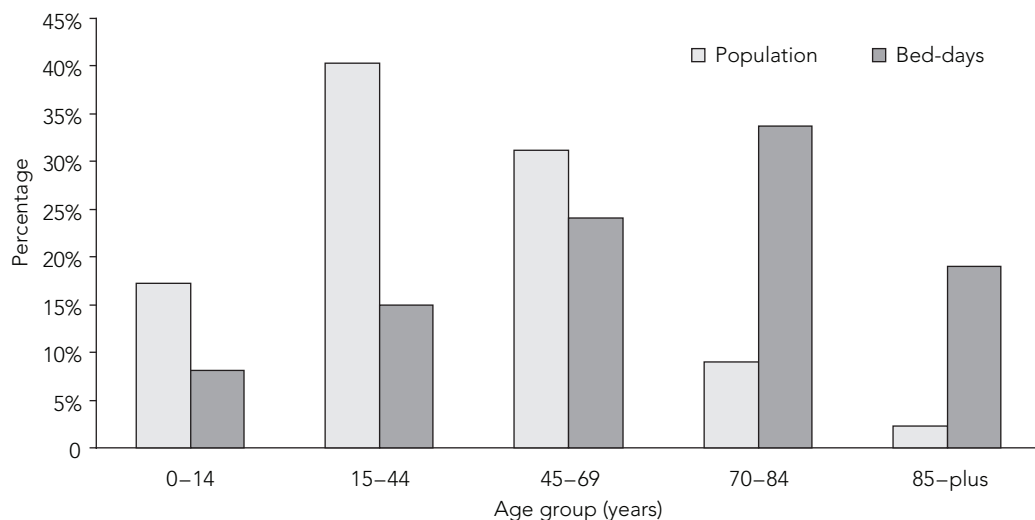
of a clinical area which will be subject to regular review.

There is evidence of a strong relationship between age and acute inpatient demand (Box 6). The 70 years and older age group is projected to comprise around 11% of the NSW population by 2016–17, but are projected to account for around 52% of total acute inpatient bed-days.

Discussion

Projections are undertaken to guide the future development of health services and to guide decisions regarding capital and service enhancement investment. While the individual drivers of future demand for health care are relatively easy to identify, they are complex and interact in ways that are not easy to predict. Planning for the future organisation of health services needs to be responsive to issues such as population growth and ageing and the impacts of trends in clinical practice and technologies in the prevention, diagnosis and treatment of illness.

The *aIM2005* modelling reflects recent trends in clinical practice. The projections outline the volume and type of work that can be anticipated if population projections are correct and the

trends in service utilisation continue into the future. The use of trended rates for combinations of age-group and clinical groups is preferable to the use of a current rate (ie, based on the most recent single year), as the latter may be subject to significant error because it does not necessarily capture trends in clinical practice.[10,11] Where utilisation rates in some specialties were variable, these rates were reviewed with specialists from the clinical specialities, which guided decisions regarding the rate to be used for projections. This qualitative component of the modelling revealed important trends in clinical practice.

Another key feature of the *aIM2005* modelling approach is the strategic focus. The relatively long planning horizon means that the regression approach to estimate trends is appropriate. Alternative methodologies such as time series analysis are better suited for projections with a more operational focus such as modelling the impact of seasonal peaks in activity on bed requirements and waiting lists.[16]

The distinction between projections, forecasts and predictions is an important one. The projections from *aIM2005* reflect a range of assumptions regarding the future size, location and demographic structure of the NSW population. These

projections in turn reflect a range of assumptions regarding future movements in fertility, migration and mortality.[17] They do not imply an "optimal" outcome in terms of health care utilisation. The projections also make assumptions about the future shape of health services — implicitly by the use of the trended utilisation rates and explicitly through the assumptions regarding the supply of future health services (ie, location) and assumptions regarding relative utilisation. Despite inherent uncertainty, projections provide a valuable guide for both planning services and setting policy direction.[18]

When considering the implications of the projections it is important to go beyond a simple calculation of bed numbers based upon projected overnight bed-days. A focus on beds, while convenient and easily understood, fails to take account of the significant pressures on acute hospital providers. The highest projected growth is in same-day activity — where the projected growth substantially exceeds that due to population increase and ageing. These shifts in the pattern of service delivery place significant pressures on hospitals over and above those associated with the supply of beds for overnight patients.

For overnight admissions, high growth specialties tend to be driven by a combined effect of population growth, ageing and clinical trends. While the percentage growth is less than for same-day admissions, the resource implications are even more significant. For a number of specialties, projected decreases in average length of stay, especially in the older age groups, are small or non-existent.

The increase in admissions (whether same-day or overnight) and the nature of these increases will have implications across the hospital system — for emergency departments, theatres, intensive care, specialised coronary care and diagnostics. There are significant implications for the health workforce — both clinical and support — required to provide health services. As such, the quantification of the likely demand into the future is essential as part of a health planning process and needs to be informed by health service planners, health service managers and clinicians.

While the *aIM2005* modelling is concerned with acute activity, the projected increases in acute activity will be accompanied by a significant increase in sub-acute hospital demand. Recent work has been undertaken by NSW Health to extend the projection methods to produce projections of sub-acute activity in NSW.[10,11]

These projections highlight the following issues and provide information for improved planning and investment decisions.

- The capacity of existing infrastructure to respond to the projected demand increases, in terms of volume and changing casemix.
- The specific requirements associated with the strong increases in same-day admissions.
- The need to develop integrated models of service delivery (and associated data collections) to optimise the use of resources, deliver the most appropriate and cost-effective services and allow for shifts in the mode of service delivery.
- The workforce planning requirements to meet projected changes in demand, both in terms of volume and casemix, especially with the significant and ongoing shift towards services for the elderly.
- The balance of services between the public and private sector — especially in view of the need for the public sector to provide for a full range of services for both service and training.

Competing interests

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