

Projecting subacute inpatient activity in New South Wales

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Abstract

We describe the development of a method for estimating and modelling future demand for sub- and non-acute inpatient activity across New South Wales, Australia to 2016. A time series linear regression equation was used, which is consistent with projection models found in the literature.

Results of the modelling indicated an increase in rehabilitation, palliative care and maintenance episodes and bed-days. Projections for other categories of care are problematic due to smaller levels of activity and data quality issues. This project indicated a need for ongoing monitoring of type-changing by facilities and management of data quality. Local planners will need to consider a range of factors when considering the applicability activity projections at a local level, particularly within the specific age and clinical groupings.

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What is known about the topic?

Various acute care planning tools have been used, but not validated, for projecting subacute inpatient needs.

What does this paper add?

We describe the development of *SiAM*, a PC-based modelling tool for subacute care. The tool projected increases primarily attributable to population growth and ageing.

What are the implications for practitioners?

Subacute projections can be made using this methodology.

THE ACUTE INPATIENT projection tool used by the NSW Health Department, *aIM2005*, incorporates subacute activity in its modelling, applying the same methodology for acute and subacute activity.¹ This methodology had not been validated for subacute care, which was seen as a key missing element within the planning process. Health service planners, particularly in rural regions, had requested assistance to develop a more consistent and systematic approach to sub- and non-acute care given the disparate nature of this activity.

In late 2005, the New South Wales Health Department initiated a project requiring development of a methodology for estimating and modelling future demand for sub- and non-acute inpatient activity across NSW to 2016.² The objective of the project was to provide NSW with a well researched and credible projection methodology that can be used to model future demand (and potentially supply) of sub- and non-acute inpatient services. The methodology included consideration of factors that influence overall demand for these services and also the variation in demand across NSW, including:

- Population demographic effects such as growth and ageing to 2016;

- Patterns of disease;
- Changing practice patterns (length of stay and admission rates) including non-bed-based treatment regimes.

The resulting projection tool was named SiAM (subacute inpatient activity modelling), a PC-based package.

Definition of subacute care

The literature on sub- and non-acute care does not present a clear definition of this type of care, referring to it as interim care, intermediate care and post-acute care.³ The project described in this paper defined sub- and non-acute care as that which has the predominant treatment goal of enhancement of quality of life and/or functional status. This includes rehabilitation, palliative care, psychogeriatric care, geriatric evaluation and management (GEM) and maintenance care (Australian National Sub-acute and Non-acute Patient [AN-SNAP] classification).⁴ The term subacute is used in this paper as an abbreviation of sub- and non-acute, although it is recognised that maintenance care in particular is often more closely aligned with non-acute.

Subacute care can be described as care which:

- Is provided to patients with moderate or low acuity, but is more intensive than traditional nursing facility care and less intensive than acute care;
- Is provided to predominantly the elderly;
- Enhances patient outcomes over that which could be achieved in a traditional acute care setting;
- Is provided to patients requiring specific packages of medical, nursing and related care;
- Is time limited and centres around one or more treatment goals.⁵⁻⁷

Subacute care can be provided in either a hospital setting or non-inpatient setting, after or instead of acute hospitalisation.⁸ Gray⁵ states that when subacute care is defined as a separate program, it better matches the level of resources to the treatment goals being sought. However, this may not necessarily mean lower cost, particularly if undertaken within acute hospital environments.⁹⁻¹¹

There is often a high degree of substitution between these different forms of care, reflecting differences in clinical management of patients, in administrative processes including type-changing between different episodes of care and in the availability of appropriate treatment settings for each type of care, particularly in rural areas.

Literature review

The literature review for this project was undertaken during late January–early February 2006, including articles published within the last 10–15 years. A number of search tools were used, incorporating PubMed with Medline citations (National Institute of Health/National Library of Medicine), Scopus, ScienceDirect, Google and Google Scholar. Grey literature was obtained through general web-based browsing of key health care and policy organisations such as jurisdictional health ministries or departments and international health-related agencies.

Further details of the literature are the subject of a separate paper.¹² The literature review identified three main groups of projection methodologies that could inform the development of a subacute projection methodology, notably:

- Projections with a focus on subacute care;
- Projections with a focus on acute care, but which often included subacute care in the overall projections;
- Projections of specific disease/conditions influencing the demand for subacute care.

Most of the subacute activity or beds projections reviewed were relatively unsophisticated. They relied on methods such as estimated ratios of acute to subacute beds based on clinical review of patients, assumed capture rates for palliative care applied to target inpatient population data, or application of current or trended utilisation rates and average lengths of stay (using linear regression) to population projections to determine growth.^{13,14} Other ways future subacute care requirements could be estimated include projecting the underlying workforce supply available using linear regression and historical data, or staffing benchmarks based on summary results of

surveys of therapy time in a sample of hospitals.^{13,15,16}

The use of normative benchmark ratios of beds to population was the most common method of estimating current or future need.^{8,17,18} They have been used largely to provide a policy basis to encourage development of subacute services, but also because of convenience. Despite the extent of use of normative benchmarks, it is not known whether they reflect realistic assumptions about future health budget growth, impact of interventions to reduce demand or avoid admission to hospital, workforce supply constraints and priority setting outcomes for services competing for future funds.

The more general literature on *acute* activity projection methodologies point to some jurisdictions focusing on acute care projections and excluding subacute care completely, while most incorporated subacute activity in the overall activity measures of the acute hospital unit (ie, everything done in the hospital is regarded as acute).¹⁹⁻²² This is partly due to a lack of “type-changing” or episode-differentiation in the data, a desire for simplicity or belief that the same approaches apply equally to acute and subacute care. The most common method of acute care activity projection was use of current or trended utilisation rates applied to population projections.

In regard to the potential use of specific *diseases/conditions* that drive demand for subacute care, such as stroke or cancer, the literature review found a number of disadvantages and complexities that may reduce the appeal of this approach.^{2,23,24} It is suggested that the best use of these disease-specific projections is in reality testing the results of other modelling, particularly whether growth rates are broadly in line with the activity projections.

Key issues that arose from the review of acute care projection methods and are relevant to subacute projections include:

- Choice of age splits to better differentiate the needs within the older age group;
- Several years of trended data to incorporate non-demographic growth in admission rates;
- Appropriateness of simpler mathematical techniques such as linear regression;
- Treatment of estimates for non-inpatient demand;
- Assumptions around efforts to avoid hospitalisation and achieve more appropriate discharge practices into home care, ie, potentially conservable days;
- Treatment of patient flows, private sector and other need influences such as socioeconomic status.

These issues were considered in development of the subacute projection methodology, the scope of which is described below.

Scope of model

New South Wales admitted patient activity data for public and private hospitals from 1998–99 to 2004–05 were analysed for this project (both overnight and same-day activity). Data for patients who were at hospitals on 30 June 2005 but had not been discharged by March 2006 were also obtained and included in the analysis (to obtain a precise estimate of the number of patient-days in a given financial year).

The NSW sub- and non-acute patient (SNAP) data set was used to assess whether the diagnosis codes in the admitted patient data were appropriate to determine the impairment groupings for rehabilitation. The match was found to be reasonable, giving confidence in the use of the impairment categories. The SNAP data set was not used by itself since it is not comprehensive, currently representing around 43% of admitted patient subacute episodes.

Non-admitted patient data were examined for use in developing non-inpatient projections, given that substitution between admitted and non-admitted care is a major issue. However, unavailability of the non-admitted data at a patient level limited the usefulness of this data source. It is expected that future versions of the subacute projections tool can incorporate non-admitted data following current work in NSW around developing a patient-level community health and outpatient data set.

The primary basis for identifying subacute episodes was:

1. Episodes assigned a service category of either rehabilitation, palliative care, maintenance care, geriatric evaluation and management (GEM) or psychogeriatric care; and

2. Episodes with Service Category of Acute which meet one of the following conditions:

a. The diagnosis-related group (DRG) is Z60 rehabilitation.

b. The DRG is B60 non-acute paraplegia, where the principal diagnosis is rehabilitation.

c. The DRG is Z64 where the principal diagnosis is either Z74 (problems related to care provider dependency) or Z75 (problems related to medical facilities and other health care).

The following were excluded from the analysis:

- Mental health;
- Drug and alcohol;
- Mothercraft hospitals;
- Residential aged care facilities;
- Maintenance dialysis and chemotherapy; and
- Maintenance episodes in multipurpose services.

A key requirement of the project was to obtain stakeholder input and feedback to the projection methodology and data issues. Teleconferences were held with all eight area health services in NSW on four occasions during 2006. About 60 area health service staff attended the teleconferences, from clinical, planning, casemix, health service management and data management backgrounds.

Meetings with the SNAP Implementation Steering Committee and its clinical subgroups were also undertaken in March–April 2006. These groups were particularly helpful in determining the approach to several issues, including the subcategories for rehabilitation and palliative care. Including the NSW SNAP committees, the Project Steering Committee and Technical Working Party, overall about 130 people were involved in consultations for this project.

Consultations with clinical groups, led to the following recommendations:

- Ability to identify major groupings of subacute care. For example, one major grouping is

rehabilitation, palliative care, geriatric evaluation and management, psychogeriatrics and maintenance care;

- Groupings adopted should, as far as possible reflect the functional impairment codes;
- Collapsing small groups into larger groups was acceptable, where numbers are too small for sensible projections;
- If possible, specialised services related to brain and spinal injury should be estimated separately;
- Same-day activity should be projected separately;
- Split palliative care into cancer-related and non-cancer-related palliative care.

Clinical consultations also confirmed that the GEM and psychogeriatrics categories are problematic.

The projections are based on five age groups: 0–15 years, 16–44 years, 45–69 years, 70–84 years and 85+ years. However, for some categories, age groups have been merged to ensure an adequate number of observations in each cell. Utilisation rates for males and females were not separately projected as the smaller cell sizes caused as a result would be problematic for small area breakdowns.

The process adopted to identify appropriate groupings for the projections is summarised in Box 1.

The grouping ultimately used for developing projections, following analysis of the data and clinical consultation, is described in Box 2. There are 57 age, same-day/overnight, clinical group cells for which projections were estimated.

Projection model

Following the literature review, consultations and data analysis, the following approach was undertaken for projecting demand for subacute care.

For each age, same-day/overnight, clinical group cell, active patients (patients who were in hospital at any time during a financial year, including those who had not been discharged at the end of the financial year) per 1000 population was calculated for each year of observation

I Process to identify appropriate clinical groupings for projections

- Development of preliminary grouping based on an analysis of *International classification of diseases tenth revision* diagnoses. This grouping searched all diagnoses from principal diagnosis to the sixth secondary diagnosis. Many episodes had diagnoses that would be consistent with more than one functional impairment code. A hierarchy was developed for assignment to groups.
- Linkage of data from the admitted patients data collection and the SNAP (sub- and non-acute patient) data collection, with the relationships between functional impairment code and diagnosis codes investigated.
- Clinical consultation on the proposed groupings and the possibilities for grouping smaller classes.
- Following the development of projections, groups that resulted in very small numbers of active patients were further examined, and where possible further grouped into broader categories.

(1998–99 to 2004–05). These observations were then included in a time series linear regression equation. A simple linear regression specification can be justified, as the time series does not include seasonal variation. The linear functional form assumes that rates will change at a constant rate.

The following formula illustrates the resulting equation that is estimated:

$$\text{Rate} = \alpha + \beta(\text{Year})$$

where

Rate = Active patients per 1000 population;
Year = Year of observation or year to be projected;

β = the slope of the estimated linear relationship.

Each regression model was then assessed to determine whether the slope was greater than

2 Final clinical groupings adopted for projecting activity

Category	Subcategory	Age groupings used (years)
Day only episodes		
Rehabilitation	Orthopaedic conditions	00-44, 45-69, 70-84, 85+
	Other disabling impairments	00-44, 45-69, 70-84, 85+
Palliative care	Palliative care	00-44, 45-69, 70-84, 85+
GEM and psychogeriatrics*	GEM and psychogeriatrics	45-69, 70-84, 85+
Overnight episodes		
Rehabilitation	Stroke	45-69, 70-84, 85+
	Brain dysfunction	00-69, 70+
	Neurological conditions	45-69, 70-84, 85+
	Spinal cord injury	00-69, 70+
	Amputation of limb	45-69, 70-84, 85+
	Arthritis	45-69, 70-84, 85+
	Orthopaedic conditions	00-44, 45-69, 70-84, 85+
	Cardiac	45-69, 70-84, 85+
	Pulmonary conditions	45-69, 70-84, 85+
	Other disabling impairments	00-44, [†] 45-69, 70-84, 85+
Palliative care	Cancer-related	00-69, 70+
	Non-cancer-related	00-69, 70+
GEM and psychogeriatrics*	GEM and psychogeriatrics	45-69, 70-84, 85+
Maintenance	Maintenance	00-44, 45-69, 70-84, 85+

GEM = geriatric evaluation and management. * Episodes for patients < 45 years were mapped to other disabling impairments. † All rehabilitation except brain dysfunction, spinal cord injury and orthopaedic conditions. Grouping younger patients together in Other Disabling Impairments was considered the best approach for dealing with small cell sizes for younger age groups within the other clinical subgroups.

0.05. In these instances, the regression was re-estimated with the constraint that $\beta=0.05$. Each regression model was also assessed to determine whether the slope was less negative. In these instances, the regression was re-estimated using an exponential functional form to ensure that a negative rate will not be estimated for future years.

Average length of stay (ALOS) for each cell was also projected, using an exponential functional form. Where the annual rate of decrease in ALOS was estimated to be less than -0.02 (ie, a reduction of more than 2% per annum), the equation was re-estimated with the constraint that the rate of decrease was -0.02 . Similarly, where the ALOS was estimated to increase at a rate of greater than 0.02

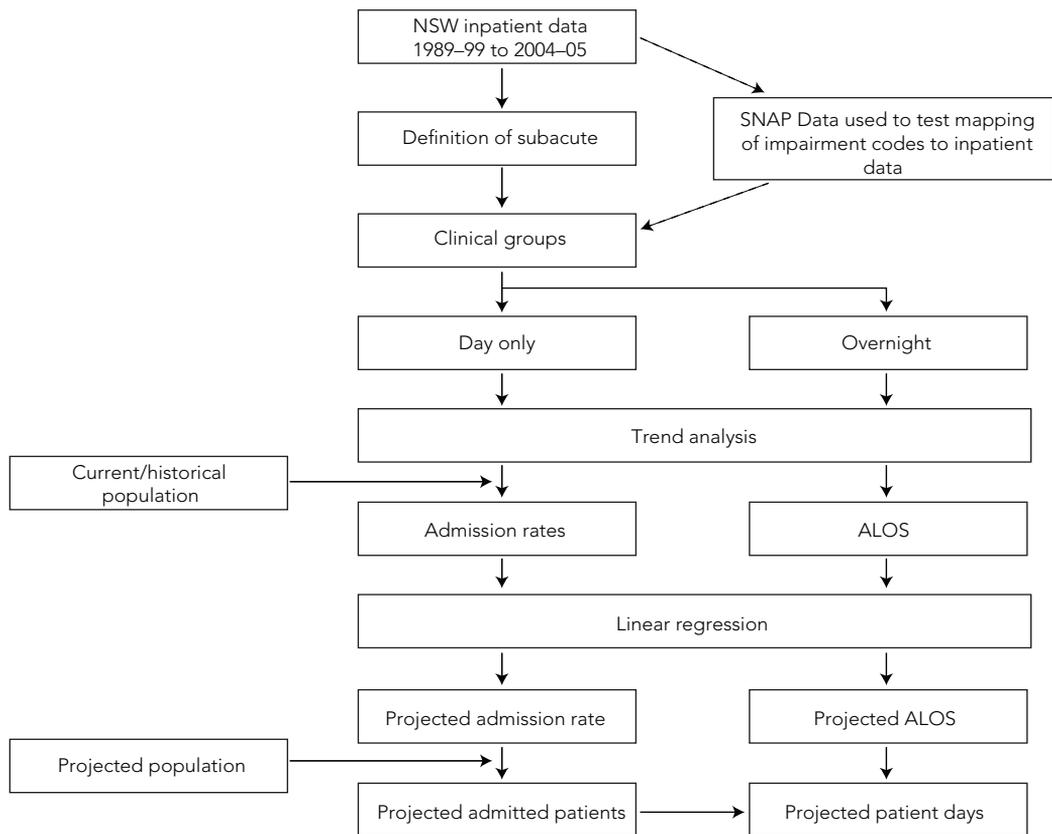
per annum, the equation was re-estimated with the constraint that the rate of increase was 0.02.

The base model assumes that average supply patterns between 2002–03 and 2004–05 will continue in future years. Activity by non-residents of NSW was assumed to continue at the levels of activity evident in the latest year of observation.

Patient days within a financial year include those from patients who have not been discharged at the end of the financial year, as there are many subacute patients whose length of stay is relatively long. Benefits of applying the simple linear regression specification, with the alternative exponential specification, include:

3 Overview of projections approach

State-level demand projections



SNAP = sub- and non-acute patient. ALOS = average length of stay.

- Consistency with the NSW Health Department's acute activity projection tool.
- There are only seven observations for each projection, ie, one for each year and there is no seasonal variation in the model.
- Consistency with findings from the literature review — simple regression is appropriate and used widely in many jurisdictions.
- Greater sensitivity of the model to other factors (such as population projections and the adjustment to the underlying data) meaning any improvement in statistical power through use of more complex mathematical approaches is likely to be marginal.
- It is more widely understood.

The projections approach can be summarised as shown in Box 3.

Results

The resulting base-level projections from the sub-acute inpatient activity model (SiAM) are presented in Box 4.

Significant increases are projected for rehabilitation and palliative care for both active episodes and patient days, but slight declines in average length of stay are projected. For maintenance care, the numbers of active episodes and patient days are expected to increase. Projections for GEM and psychogeriatric categories are problematic, due to small numbers and inconsistencies with the data.

Overall, the projections imply an annual growth rate in subacute patients of 3.3%, and annual growth in patient days of 2.0%. Day-only activity is projected to increase at a slightly higher rate of 3.6% per annum.

The SiAM tool enables modelling of scenarios for each of the clinical subgroup/age types in the model, to tailor the model for local service planning developments. Factors that can be modelled under the scenarios are admission rates for same-day and overnight patients; average length of stay for overnight patients; and relative utilisation. Moreover, the tool enables modelling of supply by facility to reflect assumptions regarding the proportion of activity to be undertaken in hospitals.

4 Summary of projected activity to 2016

Category	2006	2011	2016
Active patients*			
<i>Day only</i>			
Rehabilitation	22 320	26 718	31 743
Palliative care	1 058	1 163	1 359
GEM and psychogeriatric	62	113	174
Total day only	23 440	27 994	33 276
<i>Overnight</i>			
Rehabilitation	30 731	35 418	10 010
Palliative care	8 698	10 037	11 739
GEM and psychogeriatric	2 158	3 025	4 003
Maintenance	7 547	8 725	10 055
Total overnight	49 134	57 205	66 807
Total	72 574	85 199	100 083
Patient days†			
<i>Day only</i>			
Rehabilitation	22 320	26 718	31 743
Palliative care	1 058	1 163	1 359
GEM and psychogeriatric	62	113	174
Total day only	23 440	27 994	33 276
<i>Overnight</i>			
Rehabilitation	566 910	632 799	710 474
Palliative care	111 411	122 180	135 612
GEM and psychogeriatric	30 894	37 972	44 793
Maintenance	227 223	239 994	251 469
Total overnight	936 438	1 032 946	1 142 349
Total	959 878	1 060 940	1 175 625
Average days (in year) per patient (overnight episodes)			
Rehabilitation	18.4	17.9	17.3
Palliative care	12.8	12.2	11.6
GEM and psychogeriatric	14.3	12.6	11.2
Maintenance	30.1	27.5	25.0
Total overnight	19.1	18.1	17.1

* Patients who were in hospital at any time during a financial year, including those who had not been discharged at the end of the financial year. † Based on number of days a patient occupied a bed during the financial year.

Box 5 shows the contribution of various factors to the activity projections, over the 5-year period from 2005–06 to 2011–12. Population growth and ageing are the largest contributors towards projected growth in subacute activity.

Box 6 shows the implied beds for each major category for 2003–04 and 2011–12. The beds include same-day activity and are a guide to the overall requirements. While the results are considered reliable for rehabilitation and palliative care, maintenance care in particular will require further refinement in future revisions of the projections to ensure it reflects new developments in residential aged care, that is, transitional care.

These results illustrate the problematic nature of projecting demand for GEM and psychogeriatrics in NSW, as the bed numbers are small even at the NSW state level. Unfortunately, the data are not reliable for gaining a true estimation of current or projected demand for GEM and psychogeriatric care. Therefore, an alternative approach to projecting demand for this group is required in NSW. It is considered more appropriate that planning for psychogeriatrics be included under the umbrella of mental health planning. Planning for GEM will require consideration of local circumstances and knowledge regarding demand for these services and the availability of local level data, taking into consideration local clinical views. In other states, where GEM activity is more significant and/or data more reliable, projections for this type of care may be less problematic.

Overall, the implied beds per 100 000 population are within the range suggested in the literature for rehabilitation and palliative care (maintenance care benchmarks were not able to be identified in the literature).¹²

Discussion and caveats

The subacute inpatient projections produced from SiAM should be regarded as preliminary. As the projections are based on state average utilisation rates for age/clinical/stay type groups, local planners will need to consider local conditions when considering the applicability of local area

5 Components of growth in subacute care 2005–06 to 2011–12

	Active patients	Patient days
Growth due to population growth	4.3%	4.3%
Growth due to population ageing	6.4%	7.6%
Growth due to utilisation trends	6.7%	-1.3%
Overall growth	17.4%	10.5%

6 Subacute bed implications at 85% occupancy (2003–04 to 2011–12)

Subacute beds	2003–04	2011–12
Rehabilitation	1932	2126
Palliative care	365	398
GEM and psychogeriatrics	61	123
Maintenance	70	774
Total	3058	3420

projections, particularly within the specific age and clinical groupings.

The scope of the projections is affected by what has been historically coded as acute or subacute care. There is a degree of intersection between acute and subacute care (called hidden subacute care) which is sensitive to efforts to improve type-changing. Therefore, given the often inconsistent understanding of the boundary change between acute and subacute inpatient care, subacute care planning should be undertaken in conjunction with acute care planning to ensure overall inpatient demand requirements are properly estimated. As compliance with type-changing improves over time, future projections are likely to be influenced by this change.

Assessment is required of the likelihood that growth in demand can be met by expanding inpatient care versus other forms of care such as outpatient, home or community care. This in turn is affected by assumptions about future workforce supply, budget growth and patient preferences (eg, for palliative care in the home).

The projections are based on admitted patients data only. When the quality of non-admitted data

collections in NSW improves, consideration will be given to incorporation of this activity in future versions of SiAM.

With regard to maintenance projections, these do not incorporate recent developments in residential aged care (such as transitional care), as these developments largely occurred from 2005–06, whereas the base-year data for the projections are 2004–05 and earlier. However, future versions of SiAM will incorporate these developments.

Planners will need to consider private sector supply in local planning (the projections include demand that will be met by the private sector). Same-day activity is particularly relevant to private sector trends, and the high rates of growth in many same-day groups are likely to be concentrated in the private sector (partly reflecting financial incentives to admit patients who would otherwise be treated on a non-admitted basis in the public sector).

The current assumptions incorporated in SiAM and its projections are based on the current models of care in NSW tested against clinicians' views about what might change. Therefore, the tool has incorporated informed opinion about current and likely models of care. As changes in practice influence activity, these will be incorporated into future revisions of the model and hence projections.

Conclusion

The SiAM projection tool was developed to enable a consistent and systematic projection approach to subacute care to be adopted across New South Wales. The growth it projects in subacute activity to 2016 is primarily attributable to population growth and ageing, and the system will need to consider the appropriate allocation of resources to meet this demand, including workforce requirements.

Future iterations of SiAM will consider inclusion of non-admitted data, together with improvements to the GEM, psychogeriatric and maintenance care categories following refinements to associated data collections.

Competing interests

The authors declare that they have no competing interests.

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