

Predicting future intensive care demand in Australia

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The number of older people in the community is predicted to increase significantly over coming years as a consequence of the natural ageing of the “baby boomers” — those born in the surge of births after World War II. Some increase in life expectancy may have an additional, but lesser, effect.

Patients older than 65 years represent a major proportion of intensive care admissions, and an increase in the number of people in the community in this age group will most likely increase demand for ICU beds substantially. There are various scenarios regarding the potential effect of this increased demand on the health care system. Robson¹ suggested that major action is required, while others, such as Sparkes et al² and Evans et al,³ argued that the effects will be relatively minor. Only with accurate prediction of future demand will it be possible to appropriately plan and implement strategies to accommodate or otherwise manage demand.

Here, we provide a validated estimate of the future demand for ICU services based on existing, respected datasets.

Methods

We obtained data on intensive care admissions over the decade 1996–2007 from the Australian and New Zealand Intensive Care Society (ANZICS) Core Database. This database records admission data for ICUs throughout Australia and New Zealand. Data collected include the number of admissions, age of patients and duration of stay (bed-days).

Review of data quality suggested that there were complete, reliable data for the entire period from 19 Australian ICUs. This cohort accounted for 19% of the total number of Australian ICU admissions and comprised general ICUs with an admission profile representative of Australian adult intensive care. We assumed that the age distribution of patients admitted to these ICUs was also representative of all Australian ICU patients. The ANZICS Core data that we reviewed covered only adult ICUs. In Australia, most children requiring ICU admission are admitted to specialist paediatric ICUs, so very few patients younger than 15 years are admitted to adult ICUs. There is no reason to believe that this situation will change in the future.

As admissions vary in duration, number of admissions does not give a clear indication of resource utilisation. Thus,

ABSTRACT

Background: Predicting future demand for intensive care is vital to planning the allocation of resources.

Method: Mathematical modelling using the autoregressive integrated moving average (ARIMA) was applied to intensive care data from the Australian and New Zealand Intensive Care Society (ANZICS) Core Database and population projections from the Australian Bureau of Statistics to forecast future demand in Australian intensive care.

Results: The model forecasts an increase in ICU demand of over 50% by 2020, with current total ICU bed-days (in 2007) of 471 358, predicted to increase to 643 160 by 2020. An increased rate of ICU use by patients older than 80 years was also noted, with the average bed-days per 10 000 population for this group increasing from 396 in 2006 to 741 in 2007.

Conclusion: An increase in demand of the forecast magnitude could not be accommodated within current ICU capacity. Significant action will be required.

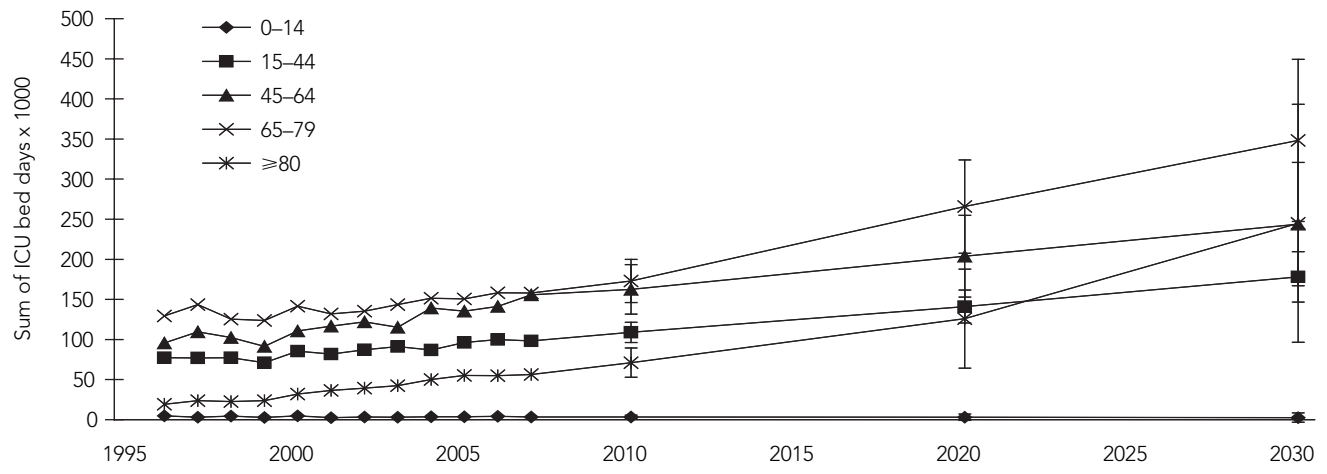
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we chose to present the total number of ICU bed-days occupied. This measure also has immediate financial relevance as a bed-day is a recognised costing unit, and its cost can be estimated with reasonable accuracy.

From the number of ICU admissions and ICU bed-days obtained from the ANZICS Core Database, we estimated the corresponding national figures, after adjusting for the sampling proportion (ie, the proportion of the Australian population that the ANZICS data represented).

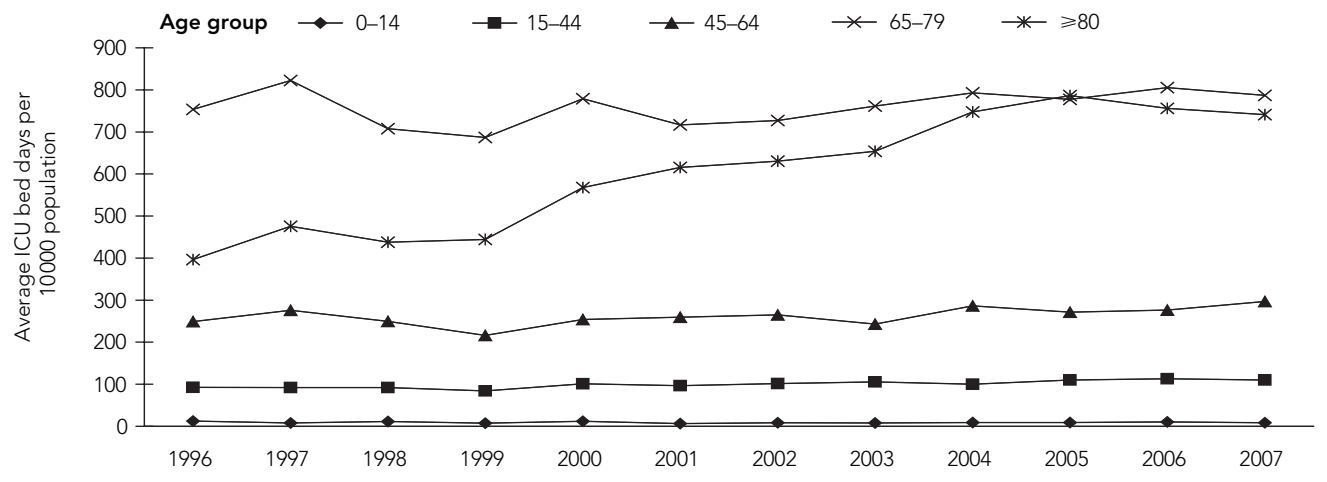
We used data from the Australian Bureau of Statistics (ABS) to evaluate the contribution of population ageing to the observed increase in ICU admissions and to estimate future ICU demand (in total number of bed-days). The ABS conducts regular population surveys and reports Australian population numbers in each age range. It has also developed modelling to predict future population numbers (in total and in each age range). There are three main projections: Series A, B and C. Series B largely reflects current trends in fertility, life expectancy at birth, net overseas migration and net interstate migration, whereas Series A and Series C are based on high and low assumptions for

Figure 1. Number of ICU bed-days in each age group over time: actual (1996–2007) and predicted (2010, 2020 and 2030)*



* For predicted (future) values, points represent "middle ground" estimates (based on ABS Series B population projections), while bars represent 95% confidence intervals.

Figure 2. Average ICU bed-days in each age group (years) over time (actual)*



* Bed-days were adjusted for the population numbers in each age group.

each of these variables. Our analysis used Series B data as these represent the "middle ground" and support prediction from existing and current trends.

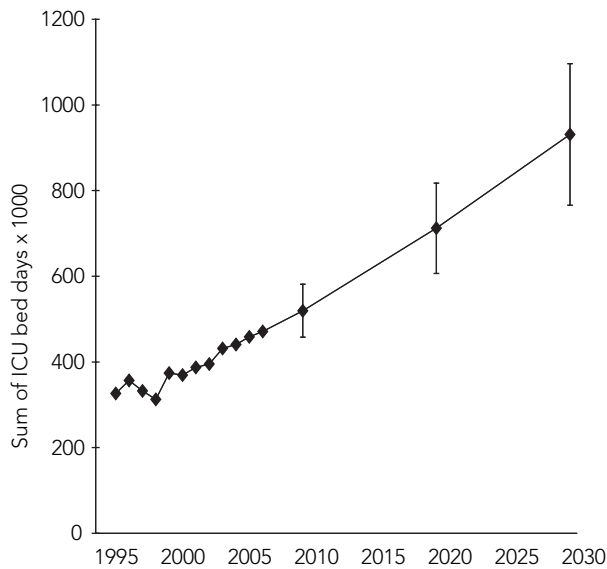
We projected ICU bed-days in 2010, 2020 and 2030 from the national ICU bed-days between 1996 and 2007, using a time series statistical procedure, the autoregressive integrated moving average (ARIMA) model. This model has been used in previous studies to forecast bed-days⁴ and predict the number of beds occupied.⁵ The 95% confidence intervals of all population parameters were also derived. SPSS version 17 (SPSS Inc, Chicago, Ill) was used for the statistical analysis.

Results

The data clearly showed a progressive increase in the number of ICU bed-days between 1996 and 2007 (Figure 1). This included increases in bed-days for all age groups, but the increase for those aged over 80 years was particularly prominent, growing from 5.9% of total ICU bed-days in 1996 to 12% in 2007.

Examination of adjusted ICU bed-days per 10 000 population in each age group revealed that those aged 65–79 years had a consistently higher number of ICU bed-days than other age groups during the early years of the survey (Figure 2). However, the rate for those aged 80 years and

Figure 3. Sum of ICU bed-days in 1996–2007 and population-adjusted projections for 2010, 2020 and 2030*



* For projections, points represent "middle ground" estimates (based on ABS Series B population projections), while bars represent 95% confidence intervals.

over increased significantly throughout the decade, rising from half the rate of the 65–79-years age group in 1996 (at 396 per 10 000) to more than the rate for that age group in 2007 (at 741 per 10 000).

A future increase in numbers of elderly people in the population would result in a further increase in the proportion of patients aged over 80 years in ICUs. Our analysis predicts that this proportion will increase to 26.3% by 2030.

Combining the total number of ICU bed-days for each age group provided the total number of ICU bed-days (Figure 3). The projected estimates included estimates of probability, providing a best-case (low) estimate and a worst-case (high) estimate of the total ICU bed-days required. The model suggests that by 2020 (just over 10 years away), a 51.2% increase in ICU beds will be required, with current total ICU bed-days (in 2007) of 471 358, predicted to increase to a requirement for 643 160 by 2020. The low estimate predicts a 21.5% increase in bed-days and the high estimate a 72% increase.

Discussion

These data clearly show that the number of patients admitted to ICUs in Australia has increased significantly over the past 15 years, and this trend is predicted to accelerate as the Australian population ages.

Our projection is based on the "middle ground" (Series B) population estimate from the ABS.⁶ If the actual population growth is different, and closer to either the high or low assumptions (Series A and C), then this would result in markedly different predictions for future ICU demand.

The data presented in Figure 2 suggest that it is now reasonable to assume that the bed-day rates for the 65–79-years and 80 years and over age groups are similar, and are both higher than rates for other age groups. As age is associated with increasing morbidity, this observation suggests that those aged over 80 were previously excluded from ICUs, but that this practice has changed dramatically over recent years. Bagshaw and colleagues⁷ also noted a marked increase in the rate of ICU admissions for very old patients (> 80 years), reporting an increase of 5.6% per year between 2000 and 2005 from Australian and New Zealand data. They also reported that 80% of these patients survived to hospital discharge, suggesting that ICU admission is effective in this group.

It is important to recognise that, although patients aged over 80 represent a growing proportion of ICU demand, currently the greatest demand is for the 65–79-years age group, and this group will also account for the greatest increase in future demand (as shown in Figure 1).

Our study used national data to forecast and did not consider regional variations. It is clear that areas popular with retirees, such as the Gold Coast in Queensland, will experience a greater increase in demand than the rest of the country.

There is an acute need for strategic planning in the Australian health care system, most critically for ICUs, as lack of availability of ICU beds frequently causes cancellation of elective surgery. Formal planning for future ICU provision has been complicated by fragmented governance and financing throughout the health system and the high recurrent cost of ICU beds. Our projections reveal that current ICU resources will certainly be inadequate to satisfy coming demand. Whatever the initiatives taken to address this, they will require substantial time to develop. Serious planning needs to begin now.

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