Myths of ideal hospital size

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Abstract:

- Current methods used to size hospitals are under-estimating true capacity needed for operational efficiency
- The hospital occupancy rate depends on the volatility in demand not efficiency per se
- Larger bed pools and hospitals can operate at higher average occupancy
- Trends in occupied bed days (rather than admissions and length of stay) give better estimates of future bed requirements
- Cost efficiency should be focussing on staffing the patients in a bed and not staffing beds per se
- Hospitals require supporting meteorological health forecasts if flexible staff deployment is to become a reality

Introduction

The physical capacity of a hospital should provide the environment in which patients are efficiently treated in dedicated bed pools (1-2). Recently Bain et al (3) called for an evidence-based debate on hospital occupancy. Since occupancy and size are linked we must open such debate to the wider issues of size. Trends in occupied bed days show that English hospitals needed as many beds in 2007 as in 1998 – despite a large reduction in available beds (4). Table 1 reveals a 15% increase in occupied beds in Australia over the same period, while Fig. 1 shows a similar trend in Canada. In the absence of new ways to improve efficiency the trends will continue. Yet in the UK ageing infrastructure is being replaced with smaller hospitals (4-5). Does this process have an evidence base?

In the 1960's to the 1990's average length of stay (LOS) was declining and day surgery increasing so rapidly that any attempt to forecast capacity, as long as it was lower, was sufficient to size a hospital (2). Indeed bed demand could have been extrapolated to zero by around 2010. Predictably, by the late 1990's the decline in LOS levelled out (2,6).

How do we size a new hospital?

The accepted method is to forecast admissions and LOS; multiply the two to calculate occupied bed days, divide by 365 to get average occupied beds and apply an occupancy margin (2,7-8). Demography is used to forecast admissions and increases in 'efficiency' are used to forecast lower LOS. In the 1990's the author was involved in the planning for a new hospital. The external demographic-based forecast of admissions after 10 years were surpassed within two years. Thus began my search to understand the real issues behind hospital size conducive to efficient health care.

Experience shows that demography only gives reliable forecasts of admissions for surgical procedures where the intervention rate is stable. Hence orthopaedic demand has been consistently underestimated as musculoskeletal interventions continue to evolve. The same can be said for neurosurgery, vascular surgery, etc. Demographics has been seen to give the 'right' answer simply because it underestimates future activity (2,7-8) thereby 'affirming' the perceived need to reduce bed numbers.

The situation for emergency admission is worse. In Scotland demography explains as little as 10% of the long-term increase in elderly admissions [9]. Long-term trends in some specialties follow cycles while medical admissions appear to involve step-changes [10-16]. 'Injury' and 'infection' exhibit unique patterns [1,16]. Over 58% of emergency diagnoses are subject to a high degree of 'special cause' variation [17]. Special cause variation includes all weather and environmental factors (viruses, etc) influencing health and other sources of non-linear growth [17-19]. How do we explain such real-world behaviour?

The link between health and the environment is widely appreciated. Long term cycles in human longevity, gender ratio and susceptibility to disease are linked with the cycle in solar flare intensity [20-25]. Temperature is fundamental to health and global warming will increase/decrease the incidence of various conditions [26]. Global warming follows a series of short, medium and long term cycles [27] and admissions for particular conditions should exhibit the same behaviour. Infectious diseases are periodic [28-29]. Conditions such as appendicitis show long-term trends which are unrelated to demography [30-32].

Finally, lifetime bed usage is concentrated in the last year of life irrespective of age (33-34). Hence, demography is only a part of a complex equation where total deaths may be the major driving force. In England deaths peaked around 1975, declined thereafter with a projected minimum around 2015 followed by an anticipated steep increase. We are about to enter a period where death, per se, will assume an increasing contribution to the demand for beds. The real world is not behaving in the simplistic way we have been assured of…… although like the mystical 85% occupancy margin no one appears to have stopped to check why we believe what we believe (3).

Average LOS is simply occupied bed days divided by admissions (2,8,35-36). LOS itself follows long term trends which involve peaks and troughs and other behaviour expected of a complex environment-sensitive system (36). A method based on the trends in occupied bed days has therefore been proposed as a better way to forecast bed demand (2,7-8). Efficiency programmes can be incorporated into such forecasts by moving blocks of bed days out of the acute setting. But what occupancy level needs to be applied to the annual average bed demand?

The occupancy margin

Figures 1 and 2 give insight into this problem, namely, the occupancy margin is set by the volatility in admissions and occupied beds and not by efficiency 'per se' (10,13,18-19,37). Queuing theory and the Erlang equation anticipate that the real world is volatile and give insight into the occupancy appropriate to each bed pool (2-3,38). Smaller bed pools (Paediatrics, Intensive Care) must therefore operate at a lower average occupancy than larger ones. A seasonal component to medical bed demand implies different levels of summer/winter bed numbers (8,13,38). Figs 1 and 2 illustrate the importance of supporting meteorological bed demand forecasts which enable hospitals to staff the anticipated occupied beds (39-41) rather than merely staffing the available beds or attempting to use an unreliable seasonal average (see footnote to Fig 2).

Too few beds and chaotic admission into inappropriate specialty beds results in poor patient care and inefficient LOS. The real issue is not about bed numbers but flexible staffing of beds (staff are the real cost) in the face of uncertain demand (18,19,41). In the absence of meteorological forecasts coupled with too few available beds the health services have no other option but to staff the beds and not the patients and others therefore incorrectly conclude that 'beds' are expensive.

To repeat the call made by others (3), can we please have a true evidence-based debate or will health departments continue to insist on the use of outdated and erroneous models simply because they give the perceived 'right' answer? Both patients and clinical staff deserve the tools required to deliver effective and efficient health care.

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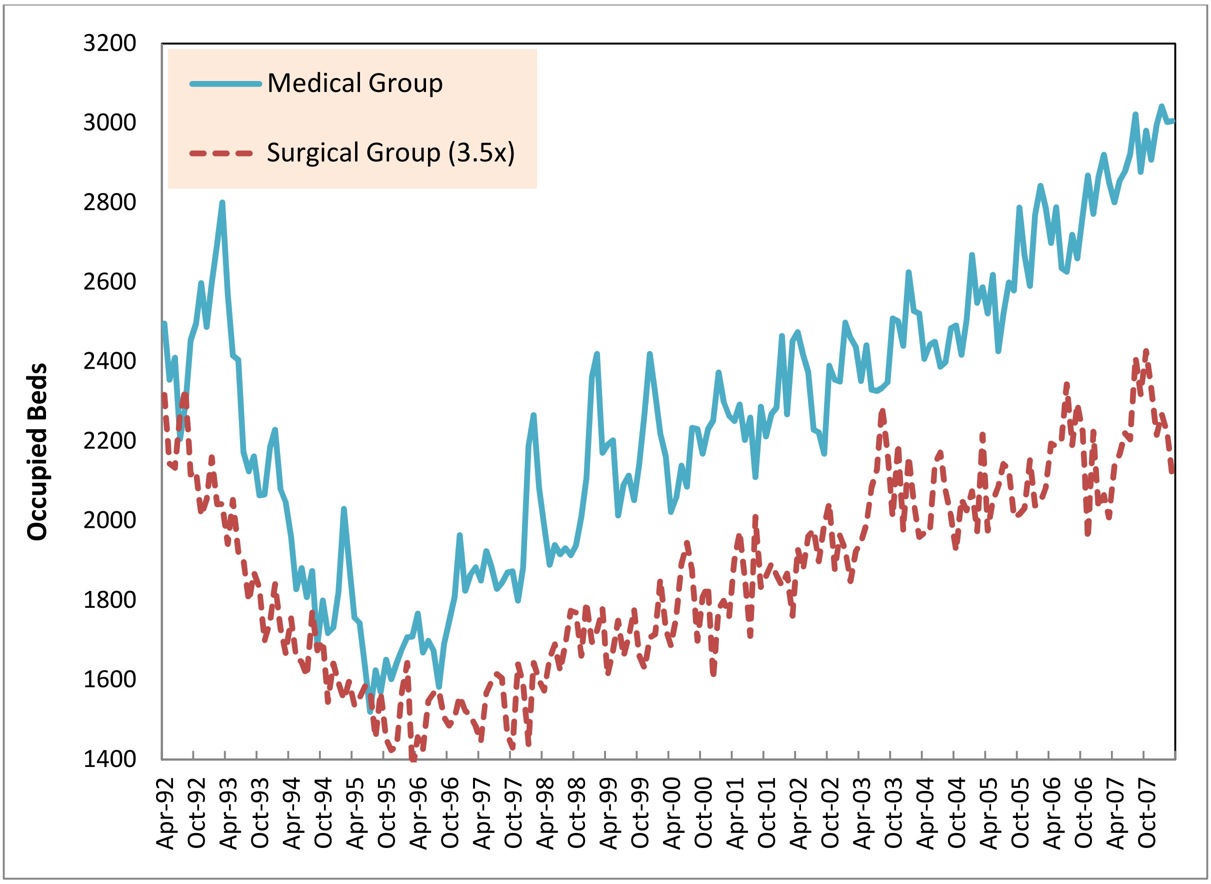
Table 1: Annual average occupied beds in Australia

ICD-10-AM Chapter	1998/99	2000/01	2002/03	2004/05	2006/07	2007/08
I. Certain Infectious and Parasitic Diseases	909	924	979	1,007	1,075	1,083
II. Neoplasms	4,916	5,182	5,340	5,429	5,685	5,742
III. Diseases of the Blood and Disorders of Immune Mechanism	466	443	503	542	603	603
IV. Endocrine, Nutritional, and Metabolic Diseases	913	1,289	1,350	1,472	1,604	1,685
V. Mental and Behavioural Disorders	8,197	6,745	7,450	7,019	7,289	7,470
VI. Diseases of the Nervous System	1,456	1,579	1,621	1,555	1,594	1,629
VII. Diseases of the Eye and Adnexa	550	544	579	611	643	692
VIII. Diseases of the Ear and Mastoid Process	232	215	209	212	210	212
IX. Diseases of the Circulatory System	6,429	6,295	6,157	6,012	6,074	6,096
X. Diseases of the Respiratory System	4,029	3,885	3,934	3,817	3,765	4,091
XI. Diseases of the Digestive System	4,408	4,599	4,683	4,791	5,055	5,119
XII. Diseases of the Skin and Subcutaneous Tissue	1,221	1,201	1,220	1,222	1,268	1,333
XIII. Musculoskeletal System and Connective Tissue	3,484	3,402	3,564	3,627	3,732	3,853
XIV. Diseases of the Genitourinary System	2,548	2,481	2,400	2,382	2,432	2,432
XV. Pregnancy, Childbirth, and the Puerperium	3,862	3,621	3,618	3,608	3,774	3,749
XVI. Conditions Originating in the Perinatal Period	1,181	1,209	1,228	1,281	1,363	1,393
XVII. Congenital Malformations and Chromosomal Abnormalities	320	301	296	290	308	324
XVIII. Symptoms, Signs and Abnormal Findings	2,128	2,349	2,484	2,583	2,811	2,870
XIX. Injury, Poisoning and External Causes	4,706	4,842	4,948	5,163	5,589	5,777
XXI. Health Status and Contact with Health Services	8,949	10,239	11,849	12,544	13,307	14,032
Total All Diagnoses	**61,148**	**61,559**	**64,491**	**65,284**	**68,286**	**70,253**

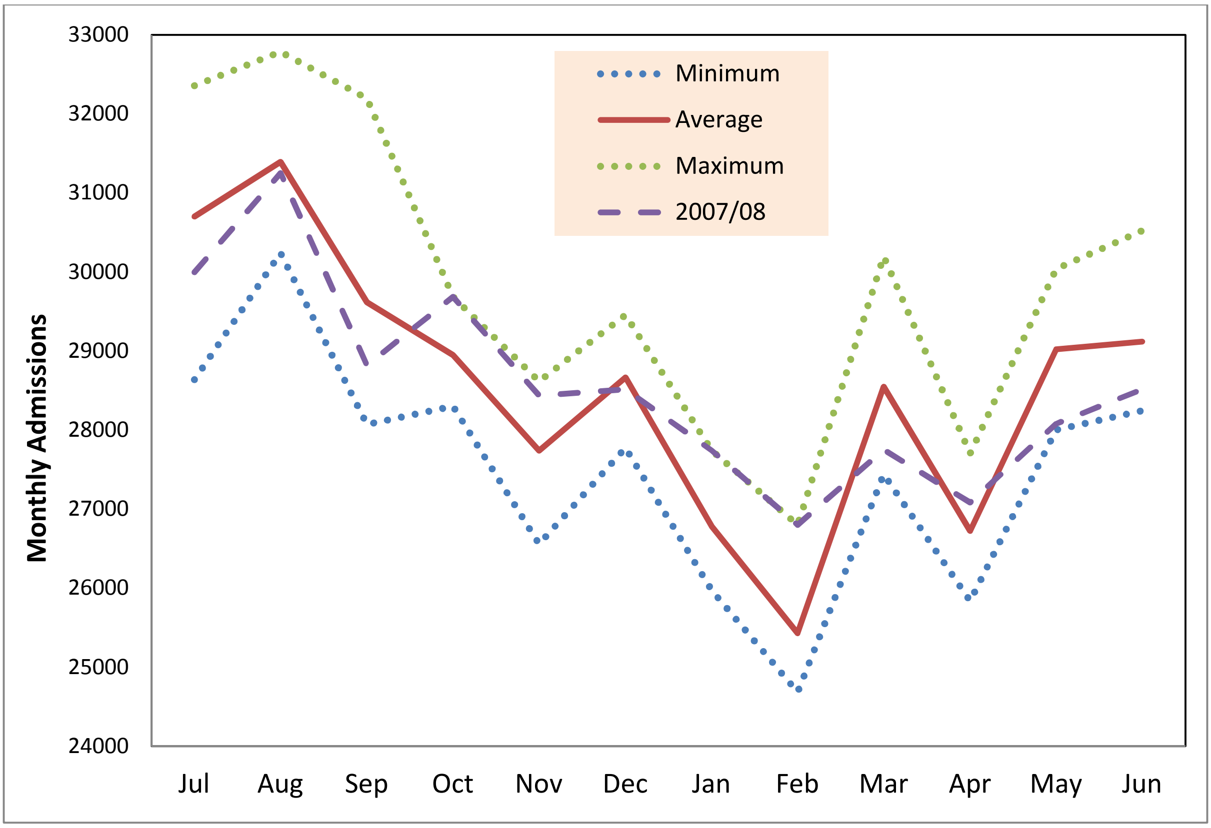
Footnote: Total bed days have been divided by 365 (days per annum) to give annual average occupied beds. The number of available beds then sets the actual average occupancy. Data is from http://d01.aihw.gov.au/cognos/cgi-bin/ppdscgi.exe?DC=Q&E=/AHS/pdx0708

Fig. 1: Trend in bed demand for emergency admission in Alberta, Canada



Footnote: Data kindly provided by Alberta Health Services. The medical group excludes mental health, obstetric and paediatric admissions. Surgical group includes trauma & orthopaedics. Influenza activity was virtually absent between Apr-00 to Dec-07, hence the absence of large winter peaks in this period. The emergence of swine flu in mid-2009 may mark the return to a period of the larger winter peaks in bed demand seen prior to 2000. The trend to lower occupied beds between 1992 and 1995 marks the tail end of the period of rapidly declining LOS. In common with most health care systems the number of available beds has continuously declined over the entire period leading to current average occupancy in excess of 95%.

Fig. 2: Variation in monthly medical admissions, New Zealand



Footnote: Data covering the period 1993/94 to 2008/09 was kindly provided by NZ Ministry of Health. Includes all medical DRG but excludes short stay emergency department activity. All years have been adjusted to give total annual activity equal to that seen in 2008/09. The trend for 2007/08 illustrates the fact that for a single year, monthly admissions can range across all possible limits and hence the 'average' is a poor planning tool.