



Optimal occupancy in the ICU: A literature review



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ABSTRACT

Introduction: In intensive care, occupancy is a commonly used measure. There is inconsistency however in its measurement and optimal occupancy targets need to be defined. The objectives of this literature review were to explore how occupancy is measured, reported, and interpreted and investigate optimal occupancy levels for ICUs.

Method: A literature search was performed using the Medline, Embase and CINAHL databases and citation tracking identified additional relevant articles. Articles published since 1997, written in English and focused on the adult ICU setting were included. As a result, 16 articles were selected for this review.

Results: Although it was apparent there was no commonly accepted or used method for calculating ICU occupancy, methods described as more accurate enumerate actual patient hours in the ICU, use operational (and preferably fully staffed) beds as the denominator, and are calculated daily. Issues pertaining to the utility, interpretation, and reporting of ICU occupancy measures were identified and there were indications that optimal ICU occupancy rates were around 70–75%. It was evident however that setting a uniform target figure for all ICUs would be problematic as there are a range of factors both at the unit and the hospital level that impact occupancy figures and optimal occupancy levels.

Implications: This literature review informed the recommendation of a proposed method for calculating ICU occupancy which provides a realistic measure of occupied bed hours as a percentage of available beds. Despite the importance of gaining an understanding of ICU occupancy at the local and broader health system levels, there are a number of unknown factors that require further research. Appropriate occupancy targets, impact of unavailable beds, and the intrinsic and extrinsic factors on occupancy measurement are a few examples of where more information is required to adequately inform ICU monitoring, planning and evaluation activities.

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Introduction

Most critically ill patients require intensive care urgently and cannot be cared for in other parts of the hospital.¹ For this reason, it is particularly important for intensive care units (ICUs) to have adequate capacity. However, clinicians and the media have depicted problems with bed shortages in Australian ICUs.^{2–5} Adequate critical care service planning and evaluation, and balancing cost and efficiency with the ability to provide adequate and timely patient care require an understanding of the optimal target occupancy for an ICU.

In intensive care, occupancy is regarded as a measure of resource use, unit activity, workload, and increasingly as a quality indicator in combination with other related measures.^{1,6–9} Accurate and consistent measurement of occupancy is required for the purposes of unit, hospital and health system planning, comparisons within and between health systems and providing realistic benchmarks for quality monitoring.^{1,10,11} The way in which occupancy should be operationally defined, measured, interpreted and used in Australian ICUs, however, is unclear.

The aim of this literature review was to synthesise the existing literature pertaining to ICU occupancy in order to inform future quality monitoring, reporting and planning activities in ICUs in New South Wales (NSW), Australia. The specific objectives were to: (1) outline how ICU occupancy has been operationalised in the literature; (2) identify the way ICU occupancy has been and should be measured; (3) outline how measures of ICU occupancy should be reported, interpreted, and used; and (4) identify optimal occupancy levels for ICUs.

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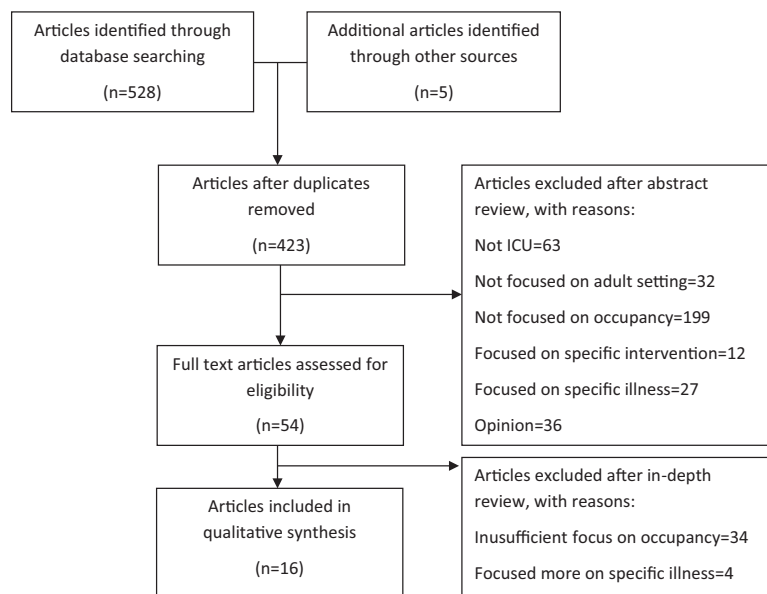


Fig. 1. Flow chart of literature review process.

Methods and materials

A literature search was performed using the Medline, Embase and CINAHL electronic databases. A combination of search terms were used including: intensive care (unit); critical care; occupancy (bed, funded and physical); and beds (available and funded). The search results were then limited to articles published between 1997 and January 2012 and written in English. A staged review process, involving an abstract review, followed by an in-depth review of each article, was used to identify relevant articles to be included in the literature review. Studies reporting occupancy in an ICU context and those with a specific focus on occupancy were included. Studies that discussed beds or bed numbers without a specific focus on occupancy or concentrated on occupancy in relation to specific ICU interventions or illnesses were excluded. Opinion articles such as editorials, letters and comments were also excluded. The numbers of identified, excluded and included articles are shown in Fig. 1.

A narrative review of the literature was then undertaken with data abstraction performed using a summary table containing key elements related to the study aims. A second rater then verified the accuracy of abstraction using the first rater's completed summary table and referring back to the original articles.

Results

A total of 16 articles included in this review are summarised in Table 1. Of these articles there were 13 research studies and three discussion papers. Of the selected articles, six were from the United Kingdom; six from North America and four from Europe.

Operationalisation

The reviewed literature lacks an operational definition of occupancy. This inadequacy has seemingly resulted in uncertainty pertaining to the purpose of measuring occupancy and what information the measure is providing. The US National Library of Medicine broadly defines occupancy as a "measure of inpatient health facility use based upon the average number or proportion of beds occupied for a given period of time".¹² The vague nature of this definition means further operationalisation is required to develop

a more meaningful and practical occupancy definition that allows for consistent interpretation and comparable reporting.

Measurement

Of the 16 articles reviewed, two specifically investigated and compared commonly used occupancy calculation methods with the intention of identifying the most accurate method for ICUs.^{13,14} In each of these studies, the comparison was made by applying commonly used calculation methods to the same datasets (outlined in Fig. 2). Although the reference methods used by both measured hourly ICU occupancy, they differed on the level of granularity in definition and measurement.

It was evident that the different calculation methods used produced marked differences in annual occupancy figures across individual units. This can be seen, for example, in Ridley and Rowan's comparison of methods six and seven. Method six included the entire length of stay of all patients admitted during the study period but no part of the stay of patients admitted just prior to the study period, while method seven (the reference method) included the stay contributed by any patients treated in the ICU during the study period (i.e. equivalent to occupied bed hours). Differences in the patient inclusion criteria used in these two occupancy calculation methods resulted in differences in the numbers of patient days counted and the resulting occupancy figures for the same units and time period (Figs. 3 and 4; constructed using data reported in table form by Ridley and Rowan, 1997).¹³ Using only those patients admitted during the study period, method six mostly overestimated occupancy figures when compared to the reference method. The unit with the greatest difference in occupancy figures had a 77% occupancy rate according to method six and a 65% occupancy rate using method seven.¹³ As can be seen in Figs. 3 and 4 however, the differences between the two methods were inconsistent across individual units. This variation was explained by the differences in patient hours included or excluded from the calculation method and the highly variable patient throughput at each ICU.

The accuracy of some occupancy calculation methods can be questioned when bed unavailability is not factored into calculations. A number of the studies included in this review^{11,15,16} used data from the Hospital Cost Report Information System (HCRIS), an administrative database in the United States containing provider

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