Bed occupancy, turnover intervals and MRSA rates in English hospitals

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Abstract

This article (a follow on from an article concentrating on Northern Ireland) examines the relationship between percentage bed occupancy (PO), turnover interval (TI) and methicillin-resistant *Staphylococcus aureus* (MRSA) rates in the acute beds of specialist English hospital trusts and describes the TI and levels of bed occupancy. The data were collected from publicly available data: MRSA rates of blood-borne infection per 1000 bed days from the Department of Health; average length of stay from Hospital Episode Statistics; and percentage occupancy from the Department of Health Hospital Activity statistics were used. Pearson's Correlation coefficients were used as basis for inferential analysis. The mean TI for all trusts was as 0.94 days, median 0.95 days. Twenty percent of trusts had TIs, on average, of less than 0.58 days (13.9 hours) and 10% had a TI less than 0.32 days (7.6 hours). The mean PO was 84.98% and the median was 84.76%. Seventy percent of the trusts exceeded the recommended 82% bed occupancy. The inference from this study is that there is a relationship between TI and PO and rate of MRSA infection in specialist English hospitals and that PO rates are at a level which may interfere with good infection control procedures.

Key words: Infection control ■ Overcrowding ■ MRSA

A recent Department of Health (DH, 2006) report revealed yet another rise in methicillin-resistant *Staphylococcus aureus* (MRSA) rates of infection in English trusts. The latest figures show that there were 3580 MRSA bacteraemia reports — cases where patients have become ill from bloodstream infections — between April and September 2005. Health minister, Jane Kennedy, said that about half of the 174 acute hospitals were failing to meet the 2008 target to cut MRSA cases by 50%. She said (Boseley, 2006),

> **'The NHS must do better. I am disappointed that, despite many trusts making significant reductions in infections, the overall figures do not reflect these improvements. MRSA "hit squads" are to be sent to trusts which are failing to meet targets.'**

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The issue of bed numbers, bed occupancy and their relationship to rates of MRSA infection have yet to be fully addressed by the DH and its political leadership. However, the relationship of bed occupancy and turnover and rates of infection is not straight forward (Cookson, 2005). Spain, which has a low occupancy rate of about 75%, has a 30% MRSA bacteraemias rate (European Antimicrobial Resistance Surveillance Scheme, 2004; European Health for All Database, 2004). The Netherlands and the Scandinavian countries have low rates of MRSA with occupancies of around 85%; the Netherlands has an occupancy rate of 61% and the lowest rates of MRSA in Europe, with less than 1% of clinical isolates positive for MRSA (Wertheim et al, 2004). But wide generalizations fail to take into account variance within individual countries or variations due to types of hospital.

The DH website warns against comparing trusts on the grounds that not all trusts are the same and say this can be partly overcome by categorizing trusts as 'specialist', 'general acute' or 'single specialty'. Correlations of MRSA rates with percentage bed occupancy (PO) and turnover interval (TI) which do not take into account the different risks attached to acute, specialist or single-specialty trusts, may be spurious. The purpose of this paper is to investigate the rates of MRSA in specialist hospital trusts and to assess the relationship of TI and PO on rates of MRSA. It also provides descriptive statistics on TI and PO. Specialist trusts have the highest rates of MRSA and could form a relatively homogeneous group of hospitals in terms of case mix.

Literature

The House of Commons Committee for Public Accounts (CPA, 2000, 2004) has repeatedly noted that high levels of bed occupancy is not consistent with good infection control and bed management practices. They also note that a high percentage of UK hospitals operate at occupancy levels in excess of the DH's 82% target meant to be achieved by 2003–04. The CPA (2000) reported that many UK hospitals were operating at high levels of occupancy and recommended that that infection control should be an integral part of a trust's bed management policies. In the intervening years, the rates of MRSA have increased and the focus has been on compliance with infection control procedures, controlled use of antibiotics and antibiotic

prescribing, and, to a lesser extent, environmental factors such as bed occupancy, inter-ward transfers, reduced average length of stay with patients being discharged before they present with MRSA infections (Crowcroft et al, 1996; Dziekan et al, 2000; Cookson, 2005).

Loss of beds

Between the years 1987–88 to 2004–05 all specialty beds in England fell from 297 341 to 181 784 (-38.8%); general beds from 52 273 to 26 618 (-50%); acute beds from 127 123 to 109 505 (-14.2%). Day-only beds rose by 35% from 6542 to 9160 (DH, 2003). As this happened the average length of stay got shorter and the numbers of patients increased. England has fewer hospital beds than many other European countries and the Government has been concerned to increase the numbers of 'acute' and 'intermediate' care beds (The King's Fund, 2005).

Reductions in beds can add additional pressures to clinical staff and with a more rapid turnover and more patients treated in fewer beds, these pressures can lead to infection control procedures not always being followed. Nursing staff, as a percentage of the total health service workforce, when considered as whole-time equivalents, has decreased by 2.3% between 1996 and 2003. Additionally nursing staff are facing increasing workplace demands as they have taken on many of the tasks delegated by other staff groups (Stubbings and Scott, 2004).

Vicca (1990) showed that the incidence of MRSA infection in intensive care units (ICU) was correlated with peaks of nursing staff workload and reduced patient–nurse ratios within units, and concluded that MRSA spread could be associated with nursing staff workload. A similar finding was reported by Andersen et al (2002) who found that before and after MRSA outbreaks there was high ward activity, overcrowding and understaffing. In a investigation of *Clostridium difficile*-associated diarrhoea (CDAD), Berild et al (2003) found that high bed occupancy and lack of facilities were associated with CDAD. Hospitals with highest rate of single rooms had the lowest rates of CDAD.

Loss of housekeeping

The number of cleaners in the NHS has fallen over the past 20 years from 100 000 to a low of 55 000 in 2003–04. Cleaning staff endure low pay, poor conditions, inadequate cleaning equipment, an intensification of work and a decline in job satisfaction that in turn leads to a high turnover of cleaning staff. As numbers of cleaning staff have declined, the numbers of new guidelines and manuals on cleaning polices and procedures have increased (British Medical Association, 2006). The contracting out of cleaning services has resulted in a fall in cleaning standards and even though an empirical link between this and increase in hospital acquired infection has not been demonstrated, such a link seems tenable (Davies, 2005)

Correlations

The relationship between bed occupancy and increased MRSA rates has been described in acute hospitals by Borg (2003) who demonstrated that peaks of MRSA occurred when bed occupancy was highest and 'overcrowding' put staff under pressure, in terms of maintaining standards of hygiene. Cunningham et al (2005, 2006), in studies of acute trusts, found significant correlations between MRSA rates and levels of bed occupancy and a fast turnover of patients. They concluded that the turnover interval is an important indicator of work pressure and that there were insufficient beds and insufficient time to clean bed and bed spaces and that this was a symptom of what Bignardi and Askew (2000) called 'organizational fatigue'.

A criticism of some studies is that the three types of trusts, specialist, acute and single specialty, have different levels of MRSA rates, different mixes of patients, and therefore, some have higher levels of risk of infection. Cunningham et al (2005, 2006) correlated MRSA rates with PO and TI in three trust types treating all as a homogenous group. But a report has shown that 5 of 30 specialties account for 71% of all bacteraemias: general medicine, general surgery, general ICU, haematology and geriatric medicine (Nosocomial Infection National Surveillance Service, 2002). This report also showed that the sources of bacteraemias varied between specialties and that in most specialties device-related sources accounted for at least half of the bacteraemias.

Hand washing is an important preventative measure in the spread of MRSA, but if MRSA is ward-endemic then ward decontamination followed by screening before admission may be the only ways to reduce UK rates to those found, for example in the Netherlands. If articles of ward furniture are fomites then the elimination of MRSA, even with hand washing, will prove difficult. In a prospective study of 25isolation rooms of patients with MRSA, Sexton et al (2006) have shown that high proportions of surface samples taken from beds, mattresses, linen, tables, chairs and window ledges were positive for MRSA. Over half of the surface samples taken from beds and mattresses were positive for MRSA. Sexton et al (2006) argue that more effective and rigorous approaches to ward cleaning are required. They also suggest that the greater the number of patients in a relatively confined space the greater the risk of infection.

Design and method

The data for MRSA rates were obtained from the DH and are published under the mandatory reporting scheme (DH, 2006). This data also indicated the type of trust from which the rate was obtained, i.e. acute, specialty, or single specialty. Specialist trusts are trusts with specialist services which receive patients referred from other trusts for these services, and general acute trusts provide general acute healthcare services. MRSA rates are measured per 1000 bed days.

The PO for acute beds was obtained from DH Hospital Activity (2005) statistics. This data, in the form of an Excel worksheet, did not contain the TI and in some cases did not identify some trusts by name. Not all cases could be matched on MRSA rate, TI and PO. From a total of 45 specialist hospitals, the authors were able to match 40 trusts for PO and MRSA and 38 trusts for TI and MRSA.

The TI was calculated, where it could be matched, from the average length of stay (ALOS) and percentage occupancy. The ALOS was collected from the Hospital Episode Statistics

(2005) and was inserted into to the Excel worksheet to estimate TI using the formula below.

Definition of terms

MRSA rates per 1000 bed days of patient episodes

The regional Communicable Diseases Surveillance Centres (CDSC) in the UK (2004) define MRSA patient episodes (MRSA PE) as 'the total number of patients from whom blood culture set(s) collected during the quarter grew MRSA. If repeat specimens were collected from a single patient, and the patient was considered to have had two episodes of bacteraemia, then they should be counted as two patients. As an arbitrary measure, if positive blood culture sets are collected more than 14 days apart, they should be considered as reflecting different episodes.'

MRSA (PE) = (Number of MRSA bacteraemias for time period / Average daily bed occupancy x Number of days in time period) x 1000

The CDSCs recommend extreme caution in the use of results but suggest that figures for patient episodes are generally considered to more accurately reflect the actual levels of MRSA bacteraemia.

PO is defined as a measurement of the percentage of time that beds are occupied and is calculated as follows:

(Average daily occupied beds in 1 year / Average daily available beds over 1 year) x 100

TI is defined as a measurement of the average length of time a bed open overnight remains unoccupied between ordinary admissions. Day cases are excluded from the calculation. This measure indicates how long a bed is, on average, empty before being filled. A TI of 1.0 means that beds, on average, remain unfilled for 1 day between the time of the discharge of one patient and the admission of the next. It is calculated thus:

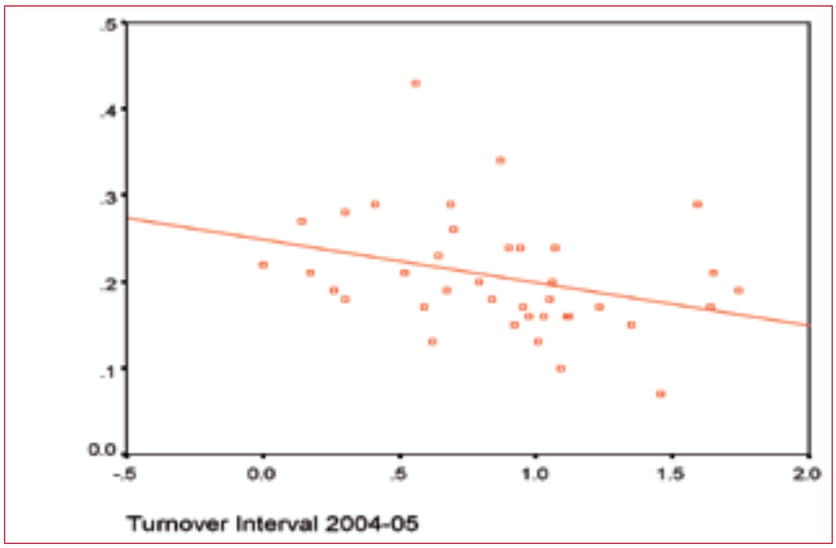


Figure 1. Scatter diagram and line of best fit for MRSA rate per 100 bed days and TI in 38 specialist hospital trusts, r=-0.32, p=0.049.

TI = (100 x Average length of stay / PO) – Average length of stay

Analysis

The data was analyzed using SPSS®. Scatter diagrams and Pearson's correlation coefficients were used to assess the strength and significance of relationships. However, one of the fundamental problems is the effect of outliers (Wilcox, 2001). Our results are for complete data sets with outliers shown in scatter diagrams. Where outliers on the X or Y variable can be observed in the scatter diagrams the authors will report the correlations if these are removed. Readers can, therefore, make judgements on the validity of the analysis.

Results

Figure 1 shows the scatter diagram of MRSA rate and TI. There is a significant and inverse relationship.

Figure 2 illustrates a linear and significant relationship between MRSA rate and PO. One case could be considered as an outlier (63:0.07). When removed from the analysis of MRSA and TI ($r=-0.27$, $p=0.10$) and MRSA and PO ($r=0.31$, $p=0.050$). The mean, median and percentiles of TI and PO are shown in *Table 1*. Seventy percent of specialist hospitals have bed occupancy rates greater than 82%; 20% have PO greater than 90%.

Discussion

It is easier to address issues related to compliance to infection control policies and procedures than to confront those related to bed occupancy, turnover, staffing levels and workload. More guidelines, inspections and action plans are not the answer. By emphasizing the need for these, we focus on individual behaviour of nurses and doctors, important as it is, and not on the structural and systems failures of the NHS as a whole. But even the issue of providing staff with basic facilities is often found wanting. The Healthcare Commission's (2006) annual staff survey considered replies from 209 000 employees in 570 NHS trusts in England. It reported that 1 in 4 respondents said trusts did not do enough to promote the importance of hand cleaning to staff, patients and visitors and nearly 40% of NHS staff do not have constant access to the hot water, soap, paper towels and alcohol rubs needed to prevent the spread of hospital infection. Trusts which fail to give such attention to basic preventative measures are also unlikely to comply with the high standards required to disinfect beds and bed spaces and, as shown, the time available for cleaning because of short TI and high occupancy rates may be insufficient to prepare for safe admissions of patients.

Bagust et al (1999) has shown that the relationship between demand, capacity and the risk of systems failure is reflected in the average occupancy rate:

'At rates above 85%, risks become discernible, and above 90% the hospital system is subject to regular bed crises.'

The results of the current study show that over the year examined, 70% of the specialist trusts have a PO in excess of

the 82% recommended by the Audit Office. Forty percent of trusts exceeded 85% bed occupancy. The TI was 0.58 days or less in 20% of trusts. The TI is likely to be less than this if we examine specialties within trusts, such as acute medicine, acute surgery, haematology and ICU. But the data from English hospitals, unlike the hospital activity statistics in Northern Ireland, does not permit this. Cunningham et al (2005, 2006) found TI of 0.2 of a day in several trusts. Hospital trusts in NI that had a TI of 0.6 of a day for all acute beds had a TI of 0.5 of a day or 12 hours for general surgery wards, and 0.2 of a day for general medical wards.

Hand washing is often cited as a major preventative measure of nosocomial infections. Why does noncompliance remain an issue when its merits are widely known? A number of studies cite reasons for this (Voss and Widmer, 1997; John, 2000; Gould, 2004; McArdle et al, 2006). The emergent reason from these studies is the that hand washing takes considerable time away from the floor and overworked staff do not feel they have enough time without compromising care. This is most likely to happen when bed occupancy is high and the turnover interval low (Hugonnet et al, 2004).

High occupancy levels and fast turnover intervals could reduce the time available for hand hygiene and bed and space cleaning. Akyol et al (2006 p395) argue that:

'Using hand hygiene as a sole measure to reduce infection is unlikely to be successful when other factors in infection control, such as environmental hygiene, crowding, staffing levels and education, are inadequate. Hand hygiene must be part of an integrated approach to infection control'.

This is hardly surprising as McArdle et al (2006) have estimated that 100% compliance by all healthcare workers in ICU would require 230 minutes/patient/day. The time needed to completely clean a modern hospital bed has been estimated at 75 minutes, but often there is only 15 minutes for this (London Assembly Report, 2005).

High occupancy levels also result in a:

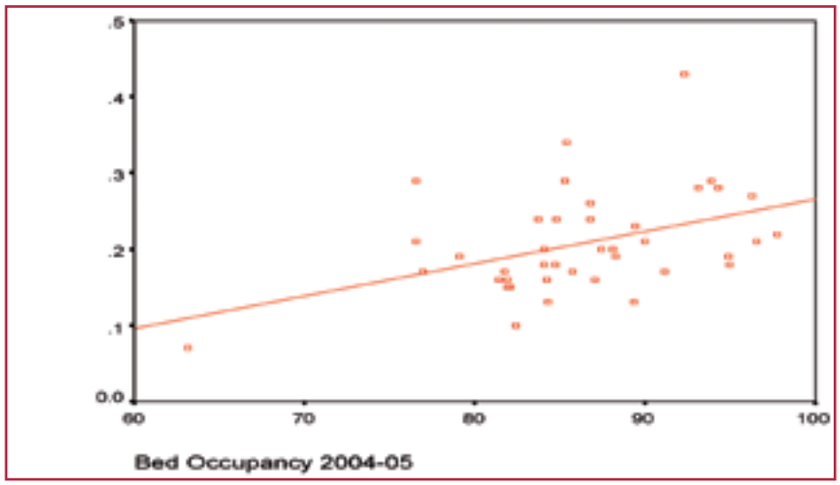
- Failure to meet the 4 hour admission targets for patients who are emergency admissions
- Greater movement of patients within the hospital
- High number of outliers.

One experienced nurse, in an anecdote told to one of the authors, said that it was now difficult to tell if a ward was surgical or medical as it is often 50% of one or the other from each designation.

Duckworth (2003) has referred to the 'stream of guidelines' on MRSA control and the impacts of these, but the UK still has one of the highest levels of MRSA rates in Europe. Early guidelines emphasized the need for a 'search and destroy' approach based on screening of patients and staff. However, these measures were

'Modulated against a background of poor support from management, lack of isolation facilities, high occupancy rates of beds, and understaffing.' (Duckworth, 2003 p1177)

Figure 2. Scatter diagram and line of best fit for MRSA rates per 100 bed days and PO in 40 specialist hospital trusts in the year 2004–05, r=0.46, p=0.006.



A search and destroy policy would require additional isolation beds and thus increase occupancy to even higher levels.

Conclusion

The issues identified in this article have yet to be addressed. Addressing hygiene/environmental measures and even a reduction in bed occupancy levels with an increase in the numbers of nursing and cleaning staff will have a limited effect while we still:

- Admit patients who may be colonized with MRSA
- Fail to decontaminate infected areas
- Isolate those patients with MRSA.

Failure to adopt a search and destroy policy leaves the door open to reinfection and will defeat all environmental procedures for control of MRSA infections in specialist hospitals. Researchers dislike the notion of 'common sense' as a way of arriving at truth. Sadly at a time of evidence-based practice, the common sense knowledge that if you admit patients who harbour MRSA to hospitals that are overcrowded, and where there is insufficient time for bed

Table 1. Bed occupancy, turnover intervals with means, medians and percentiles for the year 2004–2005 in English specialist trusts

		2004–2005	
		Turnover interval	Bed occupancy
Mean		.9421	84.98
Median		.95	84.76
Percentiles	10	.3200	76.7750
	20	.5840	81.7700
	30	.7180	82.2400
	40	.8880	84.0600
	50	.9500	84.7600
	60	1.0380	85.7200
	70	1.0860	87.2450
	80	1.2540	90.0400
	90	1.6200	94.3800

and space cleaning, then you can expect high rates of nosocomial infections. The rise in the incidence of MRSA rates may represent a systems failure in the central and local management of the NHS.

Limitations

This study uses data from two sources on hospital activity statistics from the trusts from which TI was estimated. These trusts may have a number of sites and these would have been combined into ALOS and PO for the trust as a whole. The MRSA statistics are reported for trusts as a whole.

The study also assumes that specialist trusts are fairly homogenous in terms of case mix and would have relatively similar proportion of general surgery, general and geriatric medicine, haematology and intensive care wards, and that these effects would be randomizd over the sample and thus minimised. Further research is needed to control for the affects of case mix on MRSA rates. BJN

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KEY POINTS

- Repeated guidelines on dealing with methicillin-resistant Staphylococcus aureus (MRSA) rates have failed to reduce its prevalence; rates continue to increase and the UK has one of the highest rates of MRSA infection in Europe.
- The focus in prevention has been on hand washing and the proper cleaning of wards.
- 70% of the English specialist trusts exceeded the recommended 82% bed occupancy rate and can be defined as being 'overcrowded'.
- There is a relationship between overcrowding and levels of MRSA infection.
- Nurses, mangers and trust boards must address systems failures in the NHS if rates of infection are to decline.