

Hospital infection control units: Staffing, costs and priorities

[Brett G. Mitchell](#), PhD, MAdvPrac^{a, b, c},

[Lisa Hall](#), PhD^c,

[Deborough MacBeth](#), PhD^d,

[Anne Gardner](#), PhD^b,

[Kate Halton](#), PhD^c

^a Faculty of Nursing and Health, Avondale College of Higher Education, Wahroonga, NSW, Australia

^b School of Nursing, Midwifery and Paramedicine, Australian Catholic University, Dickson, ACT, Australia

^c Institute of Health and Biomedical Innovation, Queensland University of Technology, Brisbane, QLD, Australia

^d Infection Prevention and Control Department, Gold Coast Hospital and Health Service, Gold Coast, QLD, Australia

Available online 31 March 2015

Abstract

Background: This paper describes infection prevention and control professionals' (ICP) staffing levels, patient outcomes and costs associated with the provision of infection prevention and control services in Australian hospitals. A secondary objective was to determine the priorities for infection control units.

Methods: A cross sectional study design was used. Infection control units in Australian public and private hospitals completed a web-based anonymous survey. Data collected included details about the respondent; hospital demographics; details and services of the infection control unit; and a description of infection prevention and control related outputs, patient outcomes and infection control priorities.

Results: Forty-nine surveys were undertaken, accounting for 152 Australian hospitals. The mean number of ICPs was 0.66 per 100 overnight beds (95% CI 0.55-.0.77). Privately funded hospitals have significantly fewer ICPs per 100 overnight beds, compared to publicly funded hospitals ($P<0.01$). Staffing costs for nursing staff in infection control units in this study totalled \$16,364,392 (mean \$380,566). Infection control units managing smaller hospitals (<270 beds) identified the need for increased access to infectious diseases or microbiology support.

Conclusion: This study provides valuable information to support future decisions by funders, hospital administrators and ICPs on service delivery models for infection prevention and control. Further, it is the first to provide estimates of the resourcing and cost of staffing infection control in hospitals at a national level.

Introduction

Over the past decade, the prevention and control of healthcare associated infections (HAIs) has been at the forefront of safety and quality initiatives in hospitals internationally. In Australia, reducing the incidence of HAIs in hospitals is one of the priorities for the Australian Commission for Safety and Quality in Health Care (ACSQHC)¹. Like similar agencies internationally, the ACSQHC acknowledges that the success of multi-million dollar HAI programs are almost entirely dependent on the capacity of the infection control professionals (ICPs) to implement the recommended strategies, lead hospital quality improvement efforts and infection prevention and control programs^{2,3}. Despite the fact that infection control programs have been running for some time, little is known about their structure, effectiveness or sustainability. Apart from work on ICP competencies⁴⁻⁶, there is scarce information regarding infection control structures and service delivery models internationally. Specifically, since a sentinel study published in 1985⁷, there is very little literature that explores infection control staffing levels in hospitals⁸⁻¹⁰ and no data associated with the cost of providing infection control services at a national level have been published in the peer reviewed literature.

To inform decisions, it is critical funders, hospital administrators and ICPs to have access to information on the organisational support, staffing and resources required to deliver an infection control program. Further, such information will assist the development of robust business cases related to infection control activities, and the subsequent decisions around investment. The aim of this paper is to describe existing hospital based infection control

programs at a national level in Australian public and private hospitals, building on previous published work¹⁰⁻¹³. The specific research questions used to address this aim are:

1. What are the infection control staffing levels in Australian hospitals and how do these staffing levels differ between hospitals?
2. What are the quantifiable outputs produced by Australian infection control units?
3. What is the relationship between the incidence of healthcare associated *Staphylococcus aureus* (HCA SAB) and hospital-identified *Clostridium difficile* (CDI) infection and staffing levels and hospital demographics?
4. What are the salary costs of infection control nurse staffing in Australian hospitals?
5. What are the stated infection control priorities in Australian hospitals?

The findings of this study form part of a larger project aimed at providing recommendations to health services regarding the organisational support, staffing, skills and expertise required by infection control units.

Methods

Study design

A cross-sectional study design was used. Participants completed an anonymous online web-based survey.

Participants and setting

Australian hospitals are managed by either a public (government) governance system, or by private entities. There are 1338 individual hospitals in Australia, of which 56% are public hospitals. There are 87,315 overnight hospital beds (3.9 per 1000 population), 67% of these are public hospital beds¹⁴. Infection control units may provide services to an individual or group of hospitals. The participants in this study were from the infection control units in Australian public and private hospitals. The true number of ICPs and infection control units in Australia is not known.

Recruitment and data collection

Between November 2013 and April 2014, the lead infection control co-ordinators of infection control units were invited to participate in the study. Direct contact was made with lead infection control co-ordinators via post and or email, inviting participation. Where names of infection control co-ordinators were publicly available, the letters were addressed accordingly; otherwise, a generic invitation was used. Participation in the study was voluntary and anonymous. In each invitation, a unique identification code was included to ensure duplicate samples from the same hospital could be identified. The study was promoted using advertisements on the discussion list of the peak professional body representing ICPs in Australia (Australasian College for Infection Prevention and Control) and a flyer was placed in the conference bag for those attending the national infection control conference in late 2013.

An online confidential web-based cross-sectional survey was developed using a combination of instruments used in previous studies from the USA, UK and Australia^{2, 10, 12, 13, 15, 16}, with additional questions added to further address the aims of the study. Participants were asked demographic information about their hospital including the number of hospital beds and the number of hospitals the unit provides a service to; current staffing level, grades and contracted hours; details about information technology systems used to support practice; and hours spent undertaking various infection control activities. Barriers and enablers to evidence based practice were also explored using a Likert scale, with a focus on resource, professional and cultural challenges¹⁷. Participants were also asked to provide details on specific infection control related outputs and patient outcomes in the previous 12 months. Outputs included the number of infection prevention and control policies developed/reviewed; accepted peer-reviewed journal publications with listed authors from the infection control unit; and conference presentations (oral or poster presentations at conferences, associated with work undertaken by the infection control team). Patient outcomes included infection rates for HCA SAB, and hospital-identified CDI. The definitions used for infection rates were based on nationally agreed definitions, supported by various tools and existing validation processes¹⁸⁻²⁰.

Data analysis

Data were imported into and analysed using IBM SPSS V21.0. Comparison of descriptive demographic variables was undertaken using independent t-tests, with non-parametric independent data compared using the Mann-Whitney test. The full time equivalent (FTE) of a position was calculated on the assumption of a 38 hour working week. Mean FTE and 95%

confidence intervals per 100 overnight hospital beds were calculated using Poisson distribution. The incidence of HCA SAB and CDI were calculated as: number of cases per number of patient days X 10,000; 95% confidence intervals (CI) were calculated for Poisson distributed counts.

Staffing costs of nurses in infection control units was calculated using the FTE pay rates, according to the Queensland Health Enterprise Bargaining Agreement (1st April 2014) and 30% on-costs. It was assumed that all staff were on contract or had permanent positions and received no casual loading. Annual staffing expenditure per 100 hospital beds was calculated, with 95% CI determined, using bootstrapping with 10,000 iterations. Costs in this paper are presented in US dollars using the average annual exchange rate for 2013 of US\$1 = A\$1.036.

For questions that required participants to rank a response, mean scores and standard deviations were calculated. Analysis of variance (ANOVA) was performed to compare any differences between variable mean scores. A homogeneity of variance test was conducted prior to the ANOVA one way, and if the assumption of homogeneity was not concluded then a Kruskal-Wallis test was conducted.

Ethical considerations

Human research ethics approval was granted by several organisations, including the Avondale College of Higher Education, Hunter New England Health Service, Queensland Health, and the Department of Health South Australia. All participants were required to complete a consent form prior to completing the survey.

Results

Surveys from forty-nine individual infection control units were completed, accounting for 152 Australian hospitals with 19,436 overnight hospital beds (see Table 1). No duplicate responses from an infection control unit were received. Infection control units were responsible for between one and forty-six individual hospitals (median 1). The 19,426 overnight beds constitutes data representing 22.2% of all Australian hospital beds (both public and privately funded)¹⁴. The median number of overnight beds that each infection control unit was responsible for was 270 beds. Sixty seven per cent of the responses were from publicly funded hospitals. The surveys were completed by ICPs who had a mean age of 50 years, an average of 10 years' infection control experience, and 27 years' experience of working in health.

The mean number of ICPs in the Australian hospitals surveyed was 0.66 per 100 overnight beds (95% CI 0.55-0.77). There was relative consistency in the mean of ICPs per 100 beds across different sized hospitals (in terms of overnight beds) (Table 1). Privately funded hospitals have significantly fewer ICPs per 100 overnight beds, as compared to publicly

funded hospitals ($P < 0.01$) (Table 1). Infection control units that were led by a credentialed ICP had higher staffing ratios compared to units without ($p < 0.01$).

Table 2 displays the unadjusted incidence of hospital-identified CDI and HCA SAB stratified by hospital demographics. Mean FTE staffing per 100 overnight beds is also presented to enable benchmarking. The incidence of hospital-identified CDI was significantly higher in private hospitals, compared to public hospitals ($P < 0.01$); whereas the incidence of HCA SAB was higher in public hospitals ($P < 0.01$).

Staffing costs for nursing staff in infection control units in this study totalled \$16,364,392 per annum. The mean salary for nursing staff per infection control unit, and per 100 hospital beds, is presented in Table 3.

Figure 1 displays responses to the identification of priorities for additional resources by respondents. Improved information technology systems and pre-developed training DVDs and other online learning packages were reported as additional resources with the highest priority. Respondents from infection control units responsible for managing a smaller number of hospital beds (≤ 270 beds) indicated a significantly higher priority for increased access to infectious diseases or microbiologist support ($p < 0.01$) compared to larger hospitals (> 270 beds). Conversely, infection control units responsible for managing larger hospitals identified a significantly higher need for dedicated research time ($p = 0.02$) and increased access to senior management ($p = 0.04$).

Discussion

This study provides a current description of infection control resources in Australian hospitals. The sample surveyed in this study is comparable to the wider Australian hospital system, as the proportion of respondents from public (77%) and private hospitals (23%) in our survey is close to the overall national picture (67% public). Further, for the first time, we have provided an estimate of the cost of providing infection control services at a national level, described the incidence of two infections against hospital size and staffing and identified national priorities for infection control units.

Our data indicate infection control nurse staffing to be 0.66 FTE per 100 overnight beds, or 1 FTE per 152 beds. These data are consistent with a study exploring infection control staffing in the United States¹⁰, which found the staffing level to be 0.69 FTE per 100 beds. However this latter study, undertaken by Stone and colleagues, included non-nurse staffing, for example, infectious disease physician support. Unlike the study in the United States, we did not find staffing to be negatively correlated to bed size—the proportion of FTEs per 100 beds was relatively consistent by hospital size (Table 1). We did however, identify significantly lower infection control nurse staffing in private hospitals, as compared to public hospitals. One explanation for this difference could be the use of consultants and consultancy firms in private hospitals, to assist with elements of an infection control program. These data were not consistently captured in our study and hence not reported.

A recommendation of 1 FTE ICP per 250 beds (0.4 ICPs/100 beds) was initially highlighted in 1985⁷. However, the scope and role of infection prevention has changed significantly during this time. A Delphi study in 2002 revised the recommendation for ICP staffing to a minimum of 1 FTE, regardless of size or setting⁹. Further, the authors recommended that FTEs be increased with the size of the hospital. In our study 30% of infection control units had less than 1 FTE staffing. It is important to note that our study is descriptive, and we have not determined what constitutes adequate infection control staffing. However our study did identify that infection control units are providing services to more than just hospital inpatients. This is an important consideration when reflecting on existing staffing recommendations and when developing new recommendations in the future.

In Table 2, we presented data on the incidence of two infections against the mean FTE per 100 beds and the hospital demographics. The purpose of presenting data in this manner was so that individual hospitals can reflect on their staffing, hospital demographics and their incidence of hospital-identified CDI and HCA SAB. Risk adjustment was not possible from the data collected. One unexpected result from undertaking this analysis was the incidence of hospital-identified CDI. We found the incidence of CDI to be higher in private hospitals. The latter has implications for future research and the scope of CDI surveillance programs, but there are limitations with CDI surveillance, for example ascertainment bias as a result of variations in laboratory testing methods, testing efforts and the catchment areas of the hospitals²¹.

This study has, for the first time, provided an estimate of the costs of staffing an infection control service at a national level. The estimated cost of infection control nurse staffing from hospitals in our study is \$16,364,392 annually. If this figure is extrapolated to all Australian hospitals, approximately \$76 million is allocated to infection control nurse staffing. This figure represents 0.14% of all hospital expenditure in Australia²². There are an estimated 177,000 HAIs and 1,970,142 bed days lost to HAIs each year in Australia, with post-surgical site infections costing approximately \$20 million alone²³. These data come with several caveats. First, our data only identified nurse staffing, thereby excluding administrative personnel, consultancies, infectious disease physicians and microbiologist support, all of which frequently form a valuable component of an infection control department. Second, our data are estimates, based on the self-reported staffing levels provided by respondents. To translate FTE data to a figure, we used an enterprise bargaining agreement in one State and applied this to all States. The choice to use one bargaining agreement and to apply this unilaterally was taken in the absence of having access to individual private hospital pay scales, and also due to the benefits associated with using a standardised approach.

The ranking of infection control priorities by respondents has important implications for policy makers and provides insight into the challenges faced by infection control units and indicates where future national initiatives could be centred. We wanted to understand the priorities for infection control excluding human resources so additional ICP staffing was not an option given to the respondents. Improved information technology was the highest priority for infection control teams. Information technology solutions, such as electronic

surveillance systems, are designed to support and enhance decision making in infection control²⁴. The role and scope of ICPs has been evolving, with surveillance activities accounting for a large proportion of the infection control workload¹⁰. The increasing availability and use of information technology solutions has the potential to decrease the time spent on conducting manual surveillance, thereby making infection control teams more efficient, and potentially releasing capacity for other initiatives²⁵. Respondents in our study also considered the development of infection control training DVDs and online learning packages, a useful resource. In 2010, national infection control guidelines in Australia were launched²⁶, and it may be that hospitals are seeking resources to efficiently implement these guidelines in addition to the benefits associated with consistent education for healthcare workers. The latter is particularly pertinent when clinicians work across more than one organisation or sector.

Priorities for resources did vary, depending on the number of hospital beds for which the infection control unit was responsible. One potential reason for the smaller hospitals wanting increased access to infectious disease physician or microbiologist support, as compared to the larger hospitals, is that the smaller hospitals are less likely to employ an infectious disease physician or a microbiologist. The challenge in accessing infectious disease support makes the implementation of evidence-based recommendations, for example antibiotic stewardship program recommendations, more challenging²⁷. Larger hospitals identified access to senior management as a greater priority than smaller hospitals. Larger hospitals are not necessary optimal environments for enhanced communication between clinicians and management. In a study exploring the mergers of

hospitals, authors in the United Kingdom found mergers had a negative effect on the delivery of services because of a loss of managerial focus on services, and that planned developments in services were delayed²⁸.

This study has a number of strengths and limitations. First, building on a survey previously piloted and tested¹⁰ and administering this survey in a confidential electronic format is a strength. No bias as a result of using a web based survey is expected. The survey contained skip logic and cross-field validity checking during data entry, thereby increasing the internal validity of the data^{29,30}. A further strength of this study was our ability to capture data from infection control units providing services to a large proportion of all Australian hospital beds (22%). Our sample included 17 tertiary referral hospitals, accounting for 59% of all Australian tertiary referral hospitals¹⁴. We cannot definitively comment on whether our data are overrepresented by these hospitals, but this risk is reduced as many infection control units providing services to a tertiary hospital also provide services to smaller hospitals. We have not reported the scope of practice for ICPs, and how differences in practice may relate to individual or organisational demographic data; an associated study will enable reporting of these data elsewhere³¹. The indirect comparisons between staffing levels and CDI and SAB incidence data come with caveats. These data were incidence data for the preceding 12 months, whereas the staffing levels were cross-sectional. For these reasons, we have not made sweeping claims regarding the correlation of staffing and rates of infection. Detailed description on how to answer questions, in addition to availability of researchers to answer queries, were two measures taken to reduce bias. How much the

person completing the survey engaged with the entire infection control team when answering the questions is unknown.

Conclusion

This study provides a current description of infection control resources in Australian hospitals. We have, for the first time, provided an estimate of the costs of staffing an infection control service at a national level. This will enable international comparisons to be made, when such data becomes available. These data will also enable a debate about whether the current level of investment in infection control human resources is adequate. Apart from human resources, we identified improved information technology as the highest priority for infection control teams.

Notes

Acknowledgments

We thank all infection control professionals who participated in this study. We also appreciate the in-kind support provided by the Australasian College of Infection Prevention and Control.

Funding

No funding was received.

Conflict of interest

We declare we have no conflicts of interest.

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Table 1. Infection control unit staffing in Australian hospitals

Variable	Total IC nurse hours per week	Total overnight hospital Beds	Mean FTE IC nurses per 100 beds	95% CI
Demographic				
All hospitals (n=152 hospitals)	4841	19436	0.66	0.55-0.77
Overnight Beds				
≤ 100	190	720	0.69	0.24-1.62
101-500	965	4507	0.56	0.37- 0.83
501-800	1599	6332	0.66	0.51- 0.88
≥801	2087	7877	0.70	0.54-0.91
Hospital Type				
Public	4392	14902	0.79	0.77-0.82
Private	449	4534	0.43	0.39-0.47
Credentialed ICP leading the unit				
Yes	2100	6897	0.80	0.77-0.83
No	2741	12539	0.57	0.55-0.60
Unit outputs				
Oral or poster presentations associated with unit in preceding 12 months:				
0	1538	6106	0.66	0.48-0.90
1-3	870	3893	0.59	0.37-0.86
4+	1557	4837	0.85	0.61- 1.14
Infection control policies undergoing review and or approved in preceding 12 months:				
0	540	1736	0.82	0.45-1.34
1-10	678	2744	0.65	0.38-1.03
11-20	1483	6089	0.64	0.46- 0.88
21+	1224	3997	0.81	0.55-1.11

Note: IC = infection control. FTE = full time equivalent, based on 38 hours per week. 95%CI = 95% confidence intervals.

Table 2. Annual unadjusted incidence of infection, infection control staffing and hospital demographic

Demographic	Mean FTE IC nurses per 100 beds	Incidence SAB (95%CI)	Incidence CDI (95%CI)
IC Overnight Beds			
≤ 100	0.69	0.68 (0.18-1.73)	<0.01
101-500	0.56	0.88 (0.72-1.07)	2.50 (2.22-2.82)
501-800	0.66	1.43 (1.21-1.69)	5.27 (4.82-5.75)
≥801	0.70	1.14 (0.96-1.33)	2.34 (2.08-2.69)
Hospital Type			
Public	0.79	1.20 (1.08-1.33)	0.65 (0.61-0.69)
Private	0.43	0.67 (0.46-0.95)	1.41 (1.08-1.81)

Note: SAB is healthcare associated *Staphylococcus aureus* bacteraemia per 10 000 patient days in the 2012-13 financial year. CDI is hospital-identified *Clostridium difficile* infection per 10 000 patient days in the 2012-13 financial year.

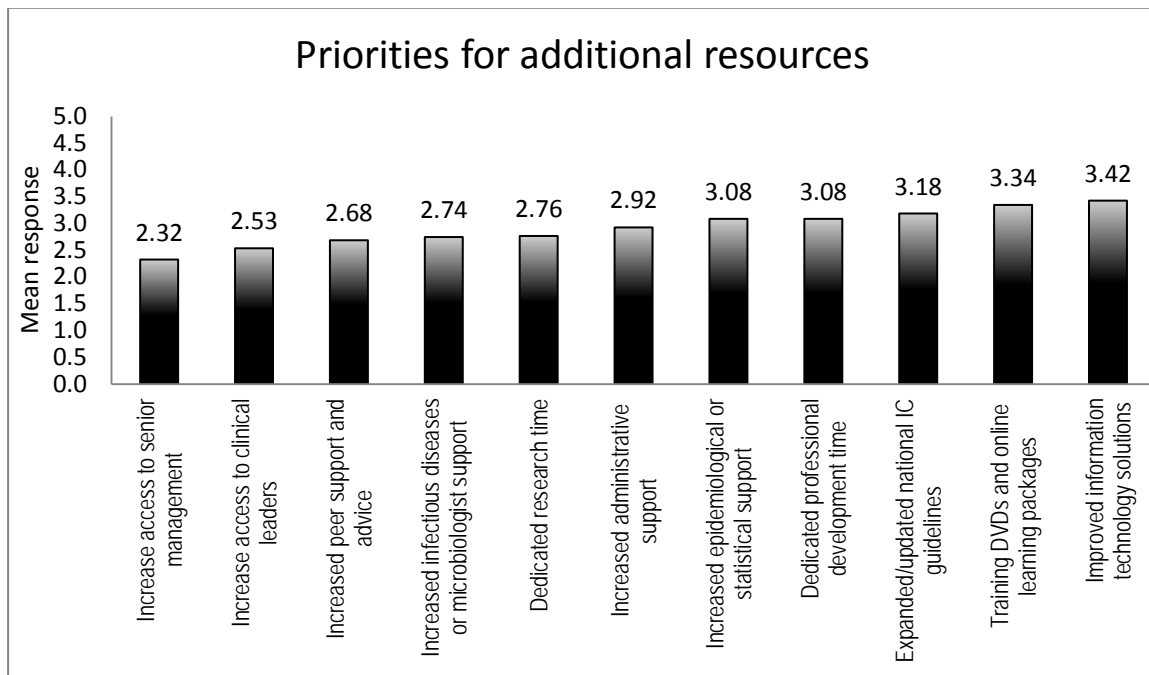
Table 3. Nurse staffing expenditure in Australian Infection control units

Demographic	Total (\$)	Mean salary (\$)	95% CI (\$)
All hospital infection control units	16,364,392	380,566	272,985-509,472
Annual expenditure per 100 hospital beds			
All	16,364,392	103,585	82,072-134,379
≤ 100 beds	1,066,129	176,648	99,007-291,877
101-500 beds	3,255,937	75,166	61,732-89,996
501-800 beds	4,682,579	81,603	63,021-100,784
≥801 beds	7,359,747	110,988	82,608-151,596

Note: 95% CI = 95% confidence intervals. 95% CI calculated using bootstrapping at 10,000 iterations.

The cost per case is expressed in US dollars using the 2013 average exchange rate (\$1 = 1.036 Australian Dollars).

Figure 1. Priorities for additional infection control resources



Note: Scale = Likert scale 1-4; 1 low priority; 3 = moderate priority; 5=high priority.