

The Impact of Organisation and Management Factors on Infection Control in Hospitals: a Scoping Review



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Foreword

Health care associated infections (HCAIs) are neither new nor uniquely British, yet the recent policy and media attention towards HCAIs is unprecedented. HCAIs now have the power to cause fear and anxiety for patients and relatives, are inextricably linked to how quality patient care is defined, and have become a touchstone for public confidence in the NHS. Consequently HCAIs are now one of the top five priority issues in the NHS 2007-8 Operating Framework, sitting alongside matters such as achieving net financial balance and the 18-week target.

It is not therefore surprising that efforts have been made to identify either a single cause or quick-fix solution to the problem. Targets, contracting out, deep cleans and alcohol gels – all have had their day as either the saviour or sinner in the fight against HCAIs. Yet the supporting evidence base for effective interventions to prevent HCAIs is actually fairly slim.

Paucity of evidence for specific policies is not an excuse for inaction. Because the evidence base is not clear-cut, the RCN commissioned King's College London to undertake an independent structured review of the literature regarding organisational factors that impact on HCAIs at ward level.

I am extremely grateful to Professor Peter Griffiths and his colleagues from the Florence Nightingale School of Nursing & Midwifery at King's College for this report, which provides an up-to-date picture of the existing literature.

Whilst it confirms that there is neither a simple direct linear relationship nor a silver-bullet solution to the causes of HCAIs, it does highlight a range of critical risk factors that broadly relate to nurse leadership, staffing and workload considerations. These factors have been consistently highlighted by the RCN as highly significant to both patient infection rates and, more widely, quality patient care and clinical outcomes.

We hope this report is a helpful tool for those engaged in tackling HCAIs in hospitals, especially at ward level, and that it brings a little more light and a little less heat to a challenging issue.

Howard Catton
RCN Head of Policy

Summary

A rapid scoping review sought to identify evidence about organisational and management factors affecting infection control in general hospital settings.

Data source: Medline, Cinahl and the Cochrane Library were searched starting in January 2008. Reference lists of relevant articles were scanned and the Journal of Infection Control was hand-searched. The review considered any direct evidence of impacts on infection outcomes or infection control behaviour and, where evidence was scant, indirect evidence on the impact of organisational characteristics on outcomes.

Quality of evidence: High-quality direct evidence was scant. We identified 34 pieces of 'evidence', the majority observational studies. The standard of reporting was relatively poor.

Findings: Positive leadership at ward level and above appears to be a necessary prerequisite of effective action relating to infection control practices. The effects of such leadership are diffused by direct supervision of large numbers of staff, and clear allocation of direct supervision to appropriate management levels is important. Such senior clinical leadership has potential for widespread impact where role boundaries and responsibilities are clear and high-visibility clinical leadership is demonstrated. Team stability and morale also are linked to improved outcomes. Organisational mechanisms for supporting training, appraisal and clinical governance are significant determinants of effective practice and successful change. Evidence links workloads and rates of infection in terms of nurse staffing, bed occupancy and throughput. High bed occupancy and throughput have been associated with higher rates of methicillin-resistant *Staphylococcus aureus* (MRSA), but wider improvement strategies have weakened these relationships.

Conclusions: The factors identified are organisational characteristics that should be considered 'risk factors' for infection. As with risks at patient and procedure levels they cannot always be eliminated or totally avoided, but appropriate assessment will allow targeting of action to protect patients.

Acknowledgments

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Introduction

Health care associated infection (HCAI) is a global patient safety challenge¹. In developed health systems, estimates of infection associated with health care vary between 4% and 10% (Table 1). In the USA, HCAI prevalence among inpatients is estimated at 5-10% and causes nearly 100,000 deaths annually². It has been estimated that 8-9% of patients acquire an infection while in UK health services' care³, and extrapolations from US figures suggest that 5,000 deaths occur annually in England as a direct consequence of these infections, which also contribute substantially to a further 15,000 deaths⁴. Less well resourced health care economies probably experience a greater burden of infection¹.

Table 1. Estimated prevalence of health care associated infection

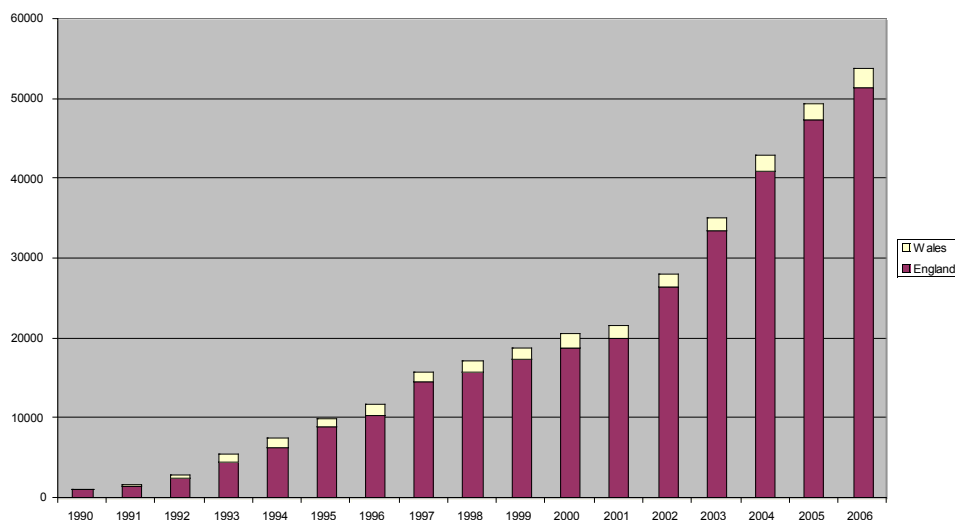
Australia	6%
Denmark	8%
England	9%
France	6-10%
Netherlands	7%
Norway	7%
Spain	8%
USA	5-10%

Source: *Winning Ways*⁵

Public concern about infection is currently high, although there is no clear evidence of an overall increase in rates of HCAI. The first two national prevalence surveys in UK hospitals (1980 and 1994) showed consistent prevalence rates at just over 9%⁶. Preliminary results of a third survey conducted in 2006 give a lower rate of 8.2% for England⁷, while a Scottish survey from 2005 gives an estimate of 9.5%⁸.

The most significant change has been the proportion of difficult-to-treat organisms associated with antibiotic use. For example, methicillin-resistant *Staphylococcus aureus* (MRSA) accounted for just 2% of *S. aureus* bloodstream infections in the UK in 1990, but this rose to peak at 43% of such infections in 2002⁹. The UK has one of Europe's highest MRSA incidence rates¹⁰. Similar increases have been seen in *Clostridium difficile*. For example, reports of *C. difficile* cases in Wales increased 100-fold (from 22 to over 2200) between 1990 and 2006¹¹ (see Figure 1), although changes in surveillance methods and reporting practices no doubt account for some of the increase. Despite this attention and some recent evidence of success³, the problem remains significant and, in the case of *C. difficile*, is still growing.

Figure 1. Reported cases of *C. difficile* in England and Wales 1990-2006



Growing concern about the problem has led to several initiatives, and available guidance and campaigns to prevent infections have burgeoned (Table 2). This review examines the evidence for organisational and management factors which affect quality care relating to infection control and HCAI prevention.

Table 2. Select UK timeline of key actions, guidance and reports relating to HCAI

2000	<p><i>Actions</i></p> <p>The Government sets out the first three years of its strategy for tackling antimicrobial resistance; NHS Plan → national investment of £68 million to improve cleanliness in hospitals.</p>
2001	<p><i>Actions</i></p> <p>Introduction of National Cleaning Standards → assessment and monitoring systems.</p> <p>(April) Introduction of mandatory surveillance of the number of MRSA bacteraemia cases.</p> <p>DH issues <i>Guidelines for Preventing Infections Associated with the Insertion and Maintenance of Central Venous Catheters</i>.</p> <p>EPIC (1) guidelines published: <i>National Evidence-based Guidelines for Preventing Health Care Associated Infections (HCAI) in National Health Service</i>.</p>
2002	<p><i>Guidance/reports</i></p> <p>DH issues <i>Getting Ahead of the Curve: A Strategy for Combating Infectious Diseases</i> (including other aspects of health protection).</p>

2003	<p><i>Actions</i></p> <p>Surveillance extends to other key HCAs, such as glycopeptides-resistant enterococci (GRE), surgical site infections in orthopaedic surgery and <i>C. difficile</i>-associated diarrhoea in patients over 65 years.</p> <p><i>Guidance/reports</i></p> <p>(June) NICE: <i>Infection Control: Prevention of Health Care-Associated Infection in Primary and Community Care.</i></p> <p>(December) DH issues <i>Winning Ways: Working Together to Reduce Health Care Associated Infection in England</i>, a report from the Chief Medical Officer.</p>
2004	<p><i>Actions</i></p> <p>The Chief Medical Officer asks the Healthcare Commission to carry out a review of cleanliness and infection control in England's hospitals.</p> <p>Mandatory surveillance is further extended.</p> <p><i>Guidance/reports</i></p> <p>DH: <i>Towards Cleaner Hospitals and Lower Rates of Infection: A Summary of Action.</i></p> <p>DH: <i>A Matron's Charter: An Action Plan for Cleaner Hospitals.</i></p> <p>National Patient Safety Agency (NPSA), London: <i>Achieving our aims: evaluating the results of the pilot Clean Your Hands campaign.</i></p>
2005	<p><i>Actions</i></p> <p>An enhanced MRSA reporting system introduced in October provides speciality-specific data and distinguishes whether the bloodstream infection was present on admission.</p> <p><i>Guidance/reports</i></p> <p>WHO issues advanced draft of guidelines on hand hygiene in health care.</p> <p>(December) Healthcare Commission: <i>A Snapshot of Hospital Cleanliness in England: Findings from the Healthcare Commission's Rapid Inspection Programme.</i></p> <p>RCN: <i>Good Practice in Infection Prevention and Control: Guidance for Nursing Staff.</i></p> <p>RCN: <i>Guidance on Uniforms and Clothing Worn in the Delivery of Patient Care.</i></p> <p>NHS: <i>Final Scotland Infection Control Standards in Adult Care Homes.</i></p>
2006	<p><i>Guidance/reports</i></p> <p>Department of Health, Social Services and Public Safety issues <i>Ward Sisters' Charter: An Action Plan for Cleaner Hospitals in Northern Ireland.</i></p>

<p>2007</p>	<p><i>Actions</i></p> <p>(January) DH begins quarterly publication of mandatory data on MRSA and C. difficile (2008: <i>Clean, safe care</i>).</p> <p>First phase of enhanced C. difficile reporting system introduced in April (2008: <i>Clean, safe care</i>).</p> <p>(June) Relaunch of the Saving Lives programme using feedback from NHS and stakeholders. Additional guidance was added for taking blood cultures, for isolation of patients with HCAI, and for antimicrobial prescribing (2008: <i>Clean, safe care</i>).</p> <p>(June) Healthcare Commission begins unannounced inspections at 120 NHS trusts to check compliance with the Code of Practice for the Prevention and Control of Health Care Associated Infections (DH, 2008; <i>Clean, safe care</i>).</p> <p><i>Guidance/reports</i></p> <p>(February) Hospital Infection Society releases third prevalence survey of health care associated infection in acute hospitals, summary of preliminary 2006 results</p> <p>EPIC (2) guidelines published: National evidence-based guidelines for preventing health care associated infections (HCAI) in National Health Service (NHS).</p> <p>(July) Health Protection Agency Annual Report and Accounts 2007, Chapter 6 on health care associated infections → key achievements for 2006-7 relate to developing a surveillance programme.</p> <p>(September) DH issues <i>Uniforms and workwear: An evidence base for developing local policy</i>.</p>
<p>2008</p>	<p><i>Guidance/reports</i></p> <p>DH issues <i>Clean, safe care: Reducing infections and saving lives and Health Act 2006 - Code of practice for the prevention and control of health care associated infections</i>, revised version.</p>

Much available guidance focuses upon specific actions that need to be taken to reduce infections. However, increasingly it is being recognised that infection control practices exist within complex clinical settings in large and complex organisations, and that more attention must be paid to the environmental, behavioural and organisational contexts in which care is delivered¹²⁻¹⁵. In 2003, the ‘Winning Ways’ report⁵ identified management and organisational factors as important, although the framework for action was largely limited to a ‘top down’ framework between Department of Health actions and Chief Executives. Recent enquiries into infection outbreaks in England have highlighted failures of management and leadership at all levels in relation to infection control¹⁶. Recent reviews have examined behavioural interventions¹⁷ but wider aspects of organisation and management of care have not been widely considered.

Recognising the importance of clinical management, organisation and leadership and as part of the process of updating the RCN guidance¹⁸, this review aims to scope research evidence relating to:

- Ward management and leadership factors' impact on infection rates or infection-control practices.
- The impact of wider organisational characteristics, such as human resource policies and clinical governance arrangements.
- Effects of team working in ward nursing and relationships between ward nursing teams and others, such as infection control teams, consultant microbiologists and the wider multidisciplinary team.
- The impacts of ward staffing, skill mix, workload, bed occupancy, staff morale and satisfaction.

This review can inform guidance to assist managers of adult general medical/surgical wards, including elderly care and rehabilitation settings. Specifically, it seeks to identify organisational and management factors affecting quality care delivery that relate to infection control and prevention of health care associated infection (HCAI).

Method

This review reflects a rapid appraisal of evidence identified in January 2008 through searches of published research and UK policy documents. Medline and CINHALL were searched for each subtopic addressed in the review, and search strategies were developed with an information retrieval specialist (Table 3). The Cochrane Library was searched for relevant reviews and the *Journal of Infection Control* was hand-searched. Each article's reference list was searched for further material.

We focussed on evidence which could apply to general hospital settings, but where this was scant we included research from other settings. All research studies and systematic reviews were included, but where a systematic review existed we gave this primacy and did not necessarily consider included studies directly. The primary outcomes were infection or infection control practices. Where direct evidence was lacking, secondary outcomes such as general patient outcomes (i.e. length of stay, mortality rates) or staffing outcomes such as job satisfaction were considered.

Table 3. Search terms used

Organisational and management factors	AND	Infection
<p>Leadership and management</p> <p>Free text Leadership Management</p> <p>Subject heading Leadership Management Personnel management</p>		<p>Free text Infection Infection control MRSA</p> <p>Subject heading Infection Infection control</p>
<p>Team work & multidisciplinary team</p> <p>Free text Multidisciplinary care team Infection control team Infection control practitioner Team work</p> <p>Subject heading Infection control practitioners</p>		<p>Infection</p> <p>Free text Infection Infection control</p>
<p>Job satisfaction & staff morale</p> <p>Free text Job satisfaction Staff N2 morale Staff satisfaction</p> <p>Subject heading Job satisfaction Personnel turnover</p>		
<p>Staffing & bed occupancy</p> <p>Free text Staffing Bed occupancy Nurse patient ratio Bank staff</p> <p>Subject heading Personnel staffing and scheduling Temporary employment Workload Nurse patient ratio Bed occupancy Personnel, Hospital Nursing staff</p>		

<p>Quality assurance & human resources</p> <p>Free text</p> <p>Clinical governance Audit Human resources</p> <p>Subject heading</p> <p>Quality assurance, health care Clinical audit Medical audit Employee performance appraisal</p>		
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Evidence was graded using a simple categorisation system, focusing on method, sample size and reported confidence interval. We rated the level of evidence according to the following systems:

- **SR***: Systematic review of high-quality trials/cohort studies (with risk adjustment) with a narrow confidence interval
- **SR**: Other systematic reviews
- **R**: Non-systematic reviews
- **RCT**: Randomised controlled trials
- **O***: Observational study with good adjustment for risk and confounders
- **O**: Observational study without adjustment for risk/confounders and/or no report of sample size
- **Q**: Qualitative studies

A single reviewer initially selected studies and graded evidence. A second reviewer checked all inclusions for relevance, identified further evidence from existing personal libraries and verified evidence grading.

Quality of evidence located

We identified 34 pieces of evidence for inclusion. The majority of literature located consisted of observational studies, which rarely followed widely accepted standards for reporting research, e.g. STROBE. Out of all studies assessing patient-level data, most failed to report the size of the included sample. The majority reported the number of trusts or wards included in the analysis, while two studies gave no indication of the sample size. Likewise, only a small majority of studies reported a confidence interval and some reported no statistical analysis at all. Given the difficulty of conducting randomised controlled trials in this field, the absence of these types of trials in the review is unsurprising. For details on the quality grading and description of each included study, see the appendix.

Leadership and management

Leadership styles

Leadership describes the ability to influence, motivate and enable members of an organisation to contribute to the effectiveness and success of this organization. Positive, proactive leadership styles, based upon shared visions and interaction with staff, have been demonstrated to increase staff and patient satisfaction¹⁹. By contrast, laissez-faire and responsive leadership, with intervention only when problems occur, result in negative experiences¹⁹.

The Healthcare Commission¹⁶ published a summary of findings from 14 investigations into failings in health care systems, including infection control outbreaks. This report was largely based on the qualitative analysis of interviews with staff highlighting the negative impacts of bad leadership, ineffective management, inadequate teamwork and communication between staff, lack of clarity about responsibilities, and staff feeling undermined and unable to raise concerns. Those findings were reflected in investigations looking at outbreaks of *C. difficile* specifically^{20,21}. The Healthcare Commission blamed the following leadership issues for failures in the systems:

- Lack of continuity in leadership (due to high turnover of managers)
- Bullying and harassment by managers
- Lack of clear responsibilities
- Poor teamwork

A recent systematic review assessed the relationship between nursing leadership and patient outcomes in seven studies. Within the review a single study assessed the impact of leadership factors on HCAI specifically. Houser²² used a mixed method design to develop and test a model of nursing demands at unit (ward) level, and explored factors such as leadership, staff expertise, staff stability, teamwork, financial resources and workload. This study found reduced incidence of pneumonia and urinary tract infection (UTI) associated with positive leadership behaviours.

The overall results of the systematic review suggested that leadership style has a strong impact on most patient outcomes assessed, which lends support to this finding although the evidence on the relationship between leadership styles and patient mortality was inconclusive²³. However, all studies included in the review utilised non-experimental, cross-sectional or descriptive designs which limit interpretation of causality.

Moderating effects

Contingency theories of leadership recognise that effective leadership is not simply a product of the leader's approach, but also of the wider situation. Doran et al¹⁹ conducted a descriptive correlation questionnaire survey with a sample of 41 nurse managers, 680 patients and 717 staff in order to examine the impact of the manager's span of

control on nurse, patient and unit outcomes. Span of control is defined as the number of people supervised by an individual manager. The results suggested that a wide span of control decreases the beneficial effects of the positive transformational and transactional leadership styles on nurses' job satisfaction, and further increases the negative effects of responsive and laissez-faire styles. An increase in span of control was correlated with decreased patient satisfaction; it also decreased the positive effects of transformational and transactional leadership styles on patient satisfaction.

In Doran's study, a wide span of control was also found to increase staff turnover, which can be seen as a marker of low job satisfaction. Houser²² generated a number of models which sought to explain the causal relationships between a range of variables, which were then tested in a structural equation modeling analysis. The final model indicated that the reduced incidence of pneumonia and UTI associated with positive leadership behaviours was mediated by staff expertise and stability.

Management structures and roles

Dealey et al²⁴ studied the impact of implementation of the modern matron (senior clinical nurses in a middle management and leadership role) in a single acute teaching trust. Infection control was an explicit goal of the role. The study collected benchmarking data prospectively over two six-month periods, one before the implementation of the modern matron role at the trust, and again for the same period one year later. Data included numbers of cases of MRSA bacteraemias. The second part of the study consisted of a questionnaire survey examining the senior nurses' views of their role and the extent to which they felt they fulfilled those criteria. A similar questionnaire was sent out to clinical directors, group managers and a random sample of nurses examining views on the role of senior nurses and the success of their implementation.

Over the implementation period there was a reduction from 121 cases of MRSA bacteraemias to 107 cases (a reduction of 11.6%). The matrons were perceived as visible and accessible, and as improving patient care. However, the statistical significance of the change observed is unclear, and the ability to attribute any change to the matron role is low given that there were no control settings and that many specific initiatives to reduce infection occurred nationally over the period studied.

Koteyo and Nerlich²⁵ identified challenges to the effective functioning of the role; their work supports the wider findings regarding the moderating effect of span of control. They interviewed a sample of modern matrons to explore cases of difficulty in fulfilling the role. These modern matrons reported that time constraints, organisational barriers and administration duties meant they had too many responsibilities and priorities to juggle. They said that consequently they could not spend sufficient time on the wards to fulfil their Department of Health-mandated roles as figures of 'visibility' and 'authority'.

A national survey of directors of nursing and implementation case studies revealed a similar picture²⁶. While positive impacts of the matron role upon leadership and workforce

issues (such as skill mix management, staffing levels and performance management) were the predominant findings, areas of potential difficulty that could affect a matron's success, as identified by the sample of 414 matrons and their colleagues, were:

- Role conflicts and tensions
- Lack of clarity and shared understandings about the role
- A fragile sense of authority
- Blurred interface with other organisational roles
- Competing priorities
- Role overload
- Inequitable grading and responsibilities

The matron role was generally considered to have had positive impacts on clinical leadership with matrons leading by example, challenging poor practice, encouraging reflection and empowering staff. Other positive impacts identified by respondents included improved patient environment (e.g. cleanliness), care standards, networking and communication, staff morale, responsive education and training, promotion of innovation and development, and infection control management.

Teamwork

Houser²² used a structural equation model to demonstrate that teamwork and expertise had significant effects on nurse-sensitive outcomes, including hospital-acquired pneumonia and UTI. On an organisational level, inadequate teamwork was flagged up as one explanation for failure to control infection outbreaks by the Healthcare Commission¹⁶. This echoes the finding of West et al²⁷, who found that the proportion of staff working in teams was related to adjusted hospital mortality in 62 hospitals. This is echoed by the studies of magnet hospitals²⁸, where good relationships between nurses and doctors are considered to be among the 'magnet' features associated with quality care and lower mortality.

Saizy-Callaert et al²⁹ tested whether a multidisciplinary approach reduced unjustified prescriptions of antibiotics. The study describes the reimplementation of a programme in a 600-bed hospital in 1997 and its effect over the following four years. The programme had the following four objectives: 1) drawing up of a local consensus on which to base a local prescribing guide, 2) a restricted prescription policy for the most expensive antibiotics, 3) regular assessment of antibiotic prescriptions and 4) institutional training and information for prescribers. During the course of the programme prescribing behaviour changed, with a significant reduction in inappropriate prescriptions (from 6% to 3%). The prevalence of MRSA and resistant strains of *Pseudomonas* were unchanged, but infections with *Enterobacteriaceae* producing extended-spectrum β -lactamases fell.

Kaye et al³⁰ studied the impact of a multidisciplinary infection control team on hospital-acquired pneumonia rates in an intensive care unit. The team consisted of a dietician, a pharmacist, a respiratory therapist, a research specialist, an infection control

practitioner and a physician. Its purpose was to assess areas for necessary improvements and to implement interventions to reduce the rates of hospital-acquired pneumonia. The team implemented policy and procedure changes, changed supplies and ordered new equipment, and developed educational tools. Following the implementation of the team, rates of ventilator-associated pneumonia (VAP) dropped from the 90th percentile to below the 75th percentile.

Similarly, Salaripour et al³¹ assessed a multidisciplinary team's success in reducing MRSA rates in high-incidence units. The team comprised the medical director of the affected unit, the clinical manager, the programme director, a senior frontline nurse, an infection control practitioner, the medical director, the director of risk management and quality improvement, and representatives of housekeeping and environmental hygiene services, the microbiology laboratory and engineering/planning. The team sought to identify causes for high incidences of infection, and subsequently implemented intervention measures and long-term preventive actions. These included routine screening, active surveillance for patients with MRSA, restructuring of MRSA policies, development of decolonization protocols, knowledge transfers, education of patients and development of visual aids for staff. During the first five years of the strategy's implementation, infection rates dropped by 60% hospital-wide.

However, while these studies suggest that a multidisciplinary approach to infection control interventions is associated with success, the evidence supports the effectiveness of multifaceted interventions, as opposed to the effectiveness of a multidisciplinary team per se. In all these studies, very little was in place in terms of infection control at the beginning of the study.

Human resource management

Although no studies were located which addressed the impact of human resource factors on infection specifically, a large-scale, multi-centre questionnaire survey provides some tentative evidence for this relationship. West et al²⁷ surveyed a sample of chief executives and human resources directors across 61 hospitals throughout England to examine the relationship between human resource management practices and in-hospital patient mortality generally. The results of this study indicated that staff appraisal and robust training policies (both in terms of extent and sophistication) were strongly associated with lower mortality rates, even after adjustment for patient and other hospital characteristics.

Clinical governance

Clinical governance is the process by which organisations are responsible for providing quality care and are accountable for setting, maintaining and monitoring performance standards. Audit, feedback and clear accountability for clinical performance are key mechanisms to achieve this. The Healthcare Commission's report on investigations into serious failures among NHS health care providers¹⁶ suggested that the organisations

involved either failed to use available data to inform decision-making or that the data generated were not sufficiently detailed to identify failures. One of the investigations was undertaken following two outbreaks of *Clostridium difficile*, which revealed a dysfunctional governance system and insufficient focus on risk management.

A Cochrane systematic review of 118 trials assessed the effects of audit and feedback on the practice of health care professionals (including antibiotic prescribing, hand washing and glove use) and a range of patient outcomes³². The results suggested that audit and feedback can be effective in improving professional practice; however, those effects are generally small to moderate. The single study included on hand washing and glove use showed one of the largest effects³³. Results of a large observational study³⁴ suggest that the benefits are moderated by wider organisational support, with hospitals providing administrative support to the audit programme showing greater improvements.

Workforce and workload

Staffing and skill mix

Between 2004 and 2008 several published reviews aimed to assess the relationship between staffing levels and patient outcomes. Each review focused on different staffing issues and outcome variables but each supports an inverse relationship between staffing, both in absolute numbers of nurses and numbers of registered nurses, and general patient outcomes, and provides some tentative support for an association between staffing and infection specifically.

Hugonnet et al³⁵ conducted a narrative review of seven multi-centre studies to assess the association between understaffing and health care-associated infections. The authors concluded there is sufficient evidence for a relationship between staff downsizing and an increase in nosocomial infections. However, the authors concluded that there is insufficient evidence on absolute numbers for optimal staffing. McCutcheon et al³⁶ conducted a systematic review on the evidence relating nurse staffing to three infection outcomes: sepsis, UTI and pneumonia. The results of this review suggest that in hospitals with registered nurse staffing levels above the 75th percentile, rates of hospital-acquired pneumonia and UTI in medical patients were reduced by 6.4% and 3.6% respectively compared with patients in hospitals with low numbers of registered nurses (25th percentile). In surgical patients, higher staffing was associated with a reduction of 4.9% in UTI rates.

Other reviews provide a slightly more equivocal conclusion. Lang et al.³⁷ aimed to systematically review available evidence on the impact of nurse staffing on patients, nurse employees and hospital outcomes. The review sought to provide guidance on minimum nurse-patient ratios for acute hospitals. The authors concluded that although the literature offers no guidance on specific nurse-patient ratios, nursing hours and skills mix affect some important patient outcomes such as failure to rescue rates, inpatient mortality and length of hospital stay. However, links between staffing and UTI/sepsis was less clear. The

authors concluded that the literature neither confirms nor rules out such a relationship. This concurs with a more recent review citing inconsistent evidence for the relationship between nurse staffing and infection control outcomes, with a relationship found for a link between health care associated bloodstream infections but not UTI³⁸.

A prospective study carried out by Hugonett et al³⁹ assessed data over a four-year period (January 1999 – December 2002) in a medical intensive care (ICU) unit in Switzerland. This study found that, on average, an increase of the nurse-patient ratio by one unit was associated with a 30% reduction of risk of infection in a univariate analysis. This remained unchanged in a multivariate model (controlling for risk factors). The authors concluded that a nurse to patient ratio of 2.2 could have prevented 26.7% of infections acquired during the study period. A major strength of this study is that it assessed the temporal link between staffing levels and infection outcome, showing that staffing levels were consistently lower 2 – 4 days before infection. However, such ratios are not applicable to other clinical settings.

There is scant evidence that directly addresses the link between infections and the nursing team's skill mix (as opposed to absolute numbers of RNs and nurses) in acute-care settings. However, a relationship has been demonstrated between a richer skill mix (in terms of bachelors-qualified nurses) and mortality and failure to rescue⁴⁰. In US nursing homes, large-scale studies using routinely reported data have demonstrated that a higher proportion of RNs is associated with lower rates of urinary tract infection⁴¹, while higher rates of infection have been associated with high use of licensed practical nurses⁴².

Temporary nursing staff and team stability

Houser's structural equation model²² identified staff turnover and vacancies as leading to poorer outcomes, including infections. In 2008, the Department of Health reported the outcome of a three-year investigation into the correlation between the use of temporary nursing staff and rates of MRSA⁴³. The results of this investigation suggested that a proportion of temporary nursing staff 10% above the national average (e.g. 14.3% compared with 13%) was associated with a rise of 1% in rates of MRSA, all else being equal. This study did not, however, assess the possible mechanism through which this relationship may take effect. Interestingly, this study also reported a lessening adverse effect of the use of temporary nurse staff over the year 2005 and 2006. Although there is still a slight positive correlation, it was of much smaller magnitude than in the years previously, suggesting that the adverse effect of temporary staffing has been reduced by wider infection control measures.

Job satisfaction and morale

No studies were located which empirically tested the causal impact of staff morale and satisfaction on infection control in hospitals. These factors are cited as appearing on the causal path of poor practices³⁵. In US nursing homes, lack of management emphasis on

staff satisfaction was associated with higher rates of hospital admission for infection⁴² and evidence on other hospital outcomes shows a consistent relationship between low satisfaction/burnout and adverse outcomes such as mortality and failure to rescue^{44,45}, although the mechanism and, indeed, direction of the relationship is unclear.

Bed occupancy

Evidence from four retrospective surveys of administrative data suggests an association between bed occupancy level and HCAI, in particular MRSA. However, none of these studies provide guidance on absolute numbers, nor do they assess mechanisms by which bed occupancy levels affect patient outcomes.

Three recent retrospective surveys examined the relationship between bed occupancy levels and rates of MRSA in Northern Ireland⁴⁶, England⁴⁷ and Malta⁴⁸ using published administrative data. Two studies^{47,48} found a significant and positive relationship between the two variables, with high bed occupancy leading to higher infection rates. The third study⁴⁶ examined rates for two time periods, but only found a significant relationship for 2002-3, not for 2001-2. In contrast, Houser's structural equation model found no association between bed occupancy and adverse outcomes²². Although the scale of this study was relatively small, it did control for possible intervening variables such as leadership, team stability and skill.

A recent Department of Health publication⁴³ presented the results of a retrospective investigation into bed occupancy levels and rates of MRSA for the period 2001-4. This stated that if all else were equal, hospitals with higher occupancy levels had higher rates of MRSA. Specifically, those hospitals with occupancy levels of 90% or over can expect a 10.3% higher MRSA rate, compared to trusts with an occupancy level of 85% or below.

However, this report also suggests that the relationship between bed occupancy levels and rates of MRSA has diminished for the periods 2004-5 through to 2005-6⁴³. One explanation for this lessening effect may be the overall success of increased policy initiatives to combat HCAI⁴³. Moreover, average bed occupancy in acute wards has reduced in recent years (see Table 4), which may suggest that more acute wards are now operating at optimal levels for bed occupancy, and hence there is too little variation to detect a difference.

Table 4. Average daily number of available and occupied beds for England acute wards

Year	Available beds	Occupied beds	% occupancy
2006-7	104,079	87,474	84.0%
2005-6	108,134	91,290	84.4%
2004-5	109,544	92,948	84.9%
2003-4	109,793	93,971	85.6%
2002-3	108,706	92,712	85.3%

Source: Department of Health, Hospital Activity Statistics, website accessed on 25 February 2008 (http://www.performance.doh.gov.uk/hospitalactivity/data_requests/beds_open_overnight.htm)

A further factor relating to hospital bed management is the bed turnover interval (that is the time between a bed being vacated and another patient being put into it). Cunningham et al^{46,47} examined the effect of turnover intervals on rates of MRSA in two studies; both found a significant negative correlation between turnover intervals and rates of MRSA. The results of a partial correlation indicated that the influence of turnover intervals on rates of MRSA is greater than those of bed occupancy levels per se⁴⁶. However, none of those studies examined the underlying mechanisms by which high levels of bed occupancy and quick turnover intervals may affect rates of MRSA, although the authors suggested overall workloads associated with high turnover and reduced time for environmental cleaning between patients.

High bed occupancy and, to some extent, turnover intervals can also affect the availability of isolation and cohort areas. Although a recent review determined that evidence for the effectiveness of cohort nursing was weak⁴⁹, a systematic review found consistent benefits from interventions that included some degree of isolation, including cohorting⁵⁰, although evidence on isolation wards was more mixed⁵⁰.

Discussion and conclusions

In this review we identified direct and circumstantial evidence for the impact of a number of organisational, management and leadership factors on infection control and rates of infections within hospital wards. The quality of the evidence was not always high and the amount of direct evidence on impact on infection rates was relatively limited, but there is a degree of consistency which can guide practice or, perhaps more significantly, identify circumstances where risk is increased by strains within the system.

Positive leadership at ward level and above seems a necessary prerequisite to maximise effective action in relation to infection control. Doran identifies broad characteristics of positive leadership based on the transformational leadership theory¹⁹. Transformational leaders have and share a vision for what the organisation can be. They invest effort in developing and stimulating others to exceed their own self-interests for a higher purpose. In transactional leadership, leader-follower relationships are based on a series of exchanges or interactions between leader and followers. Fundamentally such leaders must be active and engaged with their teams. These styles contrast with management-by-exception, where the leader takes action only when required or when issues become serious, and laissez-faire styles where the leader avoids leadership responsibilities. The recent Healthcare Commission reports into infection outbreaks^{20,21} provide powerful examples of leadership failures relating to infection control.

Even positive leadership's effects are diffused by direct supervision of large numbers of staff; thus clear allocation of direct supervision to appropriate managerial levels is important¹⁹. Implementation of modern matrons (senior nurses) as middle-level clinical management has been associated with reduced cases of MRSA, although direct evidence

is weak and other initiatives may be directly responsible. However, leadership exhibited by such managers does have the potential to partially span the gap of control between 'ward and board'. Studies on the implementation of modern matrons suggest that role boundaries and responsibilities must be clear and clinical leadership must be visible in order for the roles to be effective²⁴⁻²⁶.

Successful action on infection control has been associated with multidisciplinary programmes, and while the evidence on this point is tangential, the need for action across a range of professions and practitioners is largely self-evident. Thus the issues raised above relating to leadership and management within established professional hierarchies are likely to apply equally to multidisciplinary endeavours that cross these hierarchies. However, the span of control required and challenges to authority and clarity of accountability are likely to be greater. Investigations into infection outbreaks illustrate the difficulties faced by infection control teams in efforts that cut across disciplines, operational units and management levels^{20,21}.

As staff training and support are important, wider organisational mechanisms to support training, appraisal and clinical governance are significant determinants of effective practice and change²⁷. There is indirect evidence of a link between good staff morale and improved outcomes^{28,42}. Poor staff morale is also implicated in higher staff turnover and vacancy rates, also implicated in poorer outcomes²².

Much evidence supports an inverse relationship between staffing and patient outcomes in general. Higher nurse-patient ratios are related to positive patient outcomes³⁸. The link between staffing and rates of infection is less studied and available evidence is more equivocal but generally supports the same relationships. Available evidence also suggests that there is an association between infections and the use of bank and agency staff⁴³. However, the conclusion that infections can be avoided simply by decreasing the use of temporary or agency staff needs to be approached with caution. It is far from clear whether the use of bank or agency staff is independently associated with poor outcomes or is associated with other conditions (vacancies, high turnover, poor morale) where quality is impeded. Since not employing bank or agency staff reduces the workforce and potentially increases workload, the priority must be to address underlying problems and stabilize the workforce.

While fixed nurse-patient ratios are advocated by some and have been implemented in a number of health systems, evidence of direct benefit is largely lacking⁵¹⁻⁵³ and the evidence provided here does not clearly indicate optimum staffing levels. Given the evidence, it seems clear that workload increases on a ward potentially decrease care quality and may contribute to increased infection. Therefore low staffing and high workload should be considered risk factors. Rather than advocating a fixed ratio across entire organisations or unit types, a more sound approach would be to ensure local measures are taken to monitor and match staffing to workload at a unit level.

High bed occupancy and throughput have been associated with higher rates of MRSA^{46,47}, although the relationships have lessened in the face of wider improvement strategies⁴³. The reason for the association is unclear, although both workload and the limited ability to isolate patients in the face of high turnover and occupancy have been

cited⁴⁷. It seems safest to conclude that while there may be no absolute correlation between infection and bed occupancy at levels currently observed in the UK, high bed occupancy represents a strain, albeit one which may not necessarily result in adverse consequences provided that other conditions (e.g. staffing, leadership) are favourable.

In relation to these factors, the importance of audit and feedback and ready information for clinical managers at all levels is clear. Generally the findings emphasise the importance of leadership and clinical governance at all levels. The problem of health care associated infections cannot be solved simply by identifying best infection control practices and issuing guidelines; such practices must be implemented and embedded within supportive systems. The positive factors identified here are, by and large, generic and not specific to infection control. Also, the factors identified apply at many different levels in an organisation and the positive effects of action at any level will be attenuated if the whole system is not supportive. However, positive leadership at any level is potentially beneficial.

This nonspecific guidance may at first seem intangible and perhaps even unhelpful. However, this review has identified a number of 'risks' for infection and infection control problems. None may be sufficient to cause problems and their removal may not be sufficient to rectify problems. Indeed in some cases (for example high turnover) there may be no direct remedial action. However, awareness of these risks provides the potential to prioritise interventions and take preventative actions before harm comes to patients:

- Weak or negative clinical leadership at ward level
- Weak or negative clinical leadership above ward level
- Absence of clear lines of clinical management and responsibility from ward to board
- Excessive 'span of control' among clinical leaders
- Unclear roles and responsibilities for infection control
- Lack of clear policies and active support for training
- Absence of an effective multidisciplinary infection control team perceived as exercising positive leadership at ward or unit level
- High staff turnover
- High use of bank or agency staff
- Low staff morale
- High patient throughput
- Workload not matched to available staffing
- High bed occupancy

An analysis and appraisal of these factors allows for the identification of organisational risk factors, in addition to those traditionally made at the level of the patient and the clinical procedure or interaction, and for preventative efforts to be focused accordingly.

Effective action on infection requires consideration of the wider 'environment' of care, which must include consideration of the functioning of teams and leadership in the organisation as much as the physical environment.

Appendix: Evidence included in the review

Aiken (1994)	<p>Aim: Investigate whether magnet hospitals have lower Medicare mortality than hospitals that are otherwise similar with respect to a variety of non-nursing organisational characteristics</p> <p>Method: Retrospective survey of administrative data</p> <p>Sample size: 39 magnet plus 195 control hospitals</p> <p>Risk adjustment/confounders controlled for: Magnet hospitals matched with 195 control hospitals</p> <p>Confidence interval: After adjusting for differences in predicted mortality, the magnet hospitals have a 4.6% lower mortality rate (P = . 026; CI: 0.9 to 9.4 fewer deaths per 1,000)</p> <p>Comment: –</p> <p>Evidence grading: O+</p>
Aiken (2000)	<p>Aim: Assess the association between educational preparation of nurses and patient outcomes</p> <p>Method: Retrospective survey of administrative data</p> <p>Sample size: 168 adult acute-care general hospitals; 232,342 patients aged 20-86</p> <p>Risk adjustment/confounders controlled for: Hospital characteristics (including size, teaching, technology, status) Patient characteristics (including a total of 133 variables such as age, sex, whether admission was an emergency or a transfer from another hospital, etc.) Surgeon characteristic (whether surgeon was board certified or not)</p> <p>Confidence interval: 10% increase in nurses holding a bachelor's degree was associated with a 5% decrease in both the likelihood of patients dying within 30 days and the odds of failure to rescue (odds ratio 0.95; 95% CI, 0.91-0.99 in both cases)</p> <p>Comment: Very thorough risk adjustment, big sample, narrow CI</p> <p>Evidence grading: O+</p>

<p>Ashman et al (2006)</p>	<p>Aim: Comparing trust nursing directors' perceived outcomes of introducing matrons to the NHS with actual evidence of such outcomes</p> <p>Method: National survey plus 10 subsequent case studies, which consisted of a questionnaire survey with 121 matron nurses, interviews with a subsample of modern matrons and other staff (n=131), and brief questionnaires to patients (n=120), analysis of trust documentation and routinely collected data</p> <p>Sample size: Questionnaire survey: directors of Nursing in all 545 NHS trusts in England in 2003, case studies, interviews</p> <p>Risk adjustment/confounders controlled for: None reported</p> <p>Confidence interval: None reported</p> <p>Comment: Statistics purely descriptive (counts of cases of negative and positive evaluations of modern matrons)</p> <p>Evidence grading: O</p>
<p>Borg, M (2002)</p>	<p>Aim: Assess the relationship between rates of MRSA and level of bed occupancy on non-intensive care settings of general hospital wards</p> <p>Method: Retrospective survey of surveillance data in a 900-bed hospital in Malta over 24 months.</p> <p>Sample size: Not stated</p> <p>Risk adjustment/confounders controlled for: Length of stay. Site of infection</p> <p>Confidence interval: No confidence interval reported (used t-test)</p> <p>Comment: Poorly reported trial</p> <p>Evidence grading: O</p>

<p>Cimiotti et al (2006)</p>	<p>Aim: To examine the association between registered nurse staffing and health care associated bloodstream infections in infants in neonatal intensive care units</p> <p>Method: Prospective cohort in a two level III-IV neonatal intensive care units</p> <p>Sample size: 2675 infants</p> <p>Risk adjustment/confounders controlled for: Birth weight. Intravascular catheterisation. Major surgery. Total parental nutrition. Hand hygiene products used by staff. Registered nurse hours (adjusted for patient case mix).</p> <p>Confidence interval: 95% (0.06-0.79)</p> <p>Comment: Well reported trial</p> <p>Evidence grading: O+</p>
<p>Cunningham et al (2006)</p>	<p>Aim: To examine the relationship between bed occupancy (PO) and turnover interval (TI) and MRSA rates in acute beds of specialist trusts in England</p> <p>Method: Retrospective survey of data obtained from the Department of Health, hospital episode statistics and Department of Health hospital activity statistics</p> <p>Sample size: 40 trusts for PO and MRSA 38 trusts for TI and MRSA</p> <p>Risk adjustment/confounders controlled for: None stated</p> <p>Confidence interval: None reported (used partial correlations)</p> <p>Comment: Not well reported</p> <p>Evidence grading: O</p>
<p>Cunningham et al (2005)</p>	<p>Aim: To examine the relationship between bed occupancy (PO) and turnover interval (TI) and MRSA rates in acute hospitals in Northern Ireland</p> <p>Method: Retrospective survey of hospital surveillance data obtained from the Communicable Diseases Surveillance Centre Northern Ireland and Hospital Statistics</p> <p>Sample size: 12 acute trusts</p> <p>Risk adjustment/confounders controlled for: None stated</p> <p>Confidence interval: None reported (used partial correlations)</p> <p>Comment: Not well reported</p> <p>Evidence grading: O</p>

<p>Curran et al (2006)</p>	<p>Aim: Describe the effect of introducing a cohort area into a vascular surgery ward following sustained cases of MRSA</p> <p>Method: Interrupted time series of 19 months pre-cohort, eight months cohort and eight months post-cohort</p> <p>Sample size: Patients in a 30-bed vascular unit</p> <p>Risk adjustment/confounders controlled for: Changes in rates of MRSA colonized or infected patients were compared to charts published in other wards in the hospital</p> <p>Confidence interval: None reported</p> <p>Comment: Control group consisted of other wards in the hospital; unclear how these wards compared with the intervention ward</p> <p>Evidence grading: O</p>
<p>Dealey et al (2007)</p>	<p>Aim: Examine the success of the implementation of 20 modern matron posts. Topics included changes in MRSA bacteraemias</p> <p>Method: Audit comprising three approaches:</p> <ul style="list-style-type: none"> ♦ Progress against agreed corporate objectives ♦ Senior nurse questionnaire ♦ Trust-wide staff questionnaire <p>Sample size: 1,100 bedded teaching hospital</p> <p>Risk adjustment/confounders controlled for: None reported</p> <p>Confidence interval: None reported. Article merely reports a reduction of 11% in MRSA rates following the introduction of the modern matrons</p> <p>Comment: This study does not report any statistical significance values for the observed reduction in MRSA rates</p> <p>Evidence grading: Q</p>

<p>Department of Health (2007)</p>	<p>Aim: Investigate factors associated with trust-level differences in MRSA with focus on macro-level or organisational factors</p> <p>Method: Retrospective analysis of trust-level data</p> <p>Sample size: All acute NHS trusts in England from 2001-2 through 2005-6</p> <p>Risk adjustment/confounders controlled for: Report did not include individual-level data, hence individual patient risk factors were not controlled for</p> <p>Confidence interval: None stated. Reports level of significance, direction of relationship, mean and standard deviation for each variable</p> <p>Comment: Overall very comprehensively reported, transparent process and decision-making</p> <p>Evidence grading: O</p>
<p>Doran et al (2004)</p>	<p>Aim: Examine the extent to which the manager's span of control influences nurse, patient and unit outcomes. Investigate which leadership styles contribute to optimum nurse, patient and unit outcomes under differing spans of control</p> <p>Method: Descriptive correlational survey</p> <p>Sample size: 41 nurse managers 680 patients 717 nursing staff</p> <p>Risk adjustment/confounders controlled for: Demographics of nurses and managers, such as age, level of education, and experience</p> <p>Confidence interval: None reported. Employed hierarchical linear regression</p> <p>Comment: Minor numerical values presented in the results, but overall a well-conducted and well-reported study</p> <p>Evidence grading: O</p>

Hawryluck (2005)	<p>Aim: Reviewing the literature on failures and successes in management of SARS outbreaks in Toronto. Addresses issues of leadership, infection control, surveillance, communication, education, team morale and staffing level</p> <p>Method: Review</p> <p>Sample size: Not stated</p> <p>Risk adjustment/confounders controlled for: None</p> <p>Confidence interval: No statistical analysis included</p> <p>Comment: Very non-systematic approach, no information on search strategy or inclusion exclusion criteria for quality assessment of included studies; only narrative synthesis of located articles</p> <p>Evidence grading: R</p>
Healthcare Commission (2008)	<p>Aim: Summarise common themes from results of investigative work into serious failings in health care</p> <p>Method: Outcomes largely based on interviews with staff</p> <p>Sample size: 14 trusts which were investigated due to serious failures</p> <p>Risk adjustment/confounders controlled for: None</p> <p>Confidence interval: No numerical values reported</p> <p>Comment: Not very systematic approach to collecting evidence, unclear how interviews were analysed and how quantitative data was used</p> <p>Evidence grading: Q</p>
Houser (2003)	<p>Aim: To test different models of the relationship between workload, leadership, staff expertise, staff stability, teamwork and financial resources, and patient outcomes (i.e. hospital-acquired pneumonia)</p> <p>Method: Mixed method. Qualitative enquiry. Structured equation modeling to test generated hypothesis</p> <p>Sample size: Qualitative part: 36 nurses. Quantitative part: Leadership inventory: 50 nurse managers and 802 staff nurses Work environment scale: 177 nurses</p> <p>Risk adjustment/confounders controlled for: None</p> <p>Confidence interval: Does not report any numerical results</p> <p>Comment: Outcome measures used are weak</p> <p>Evidence grading: O</p>

<p>Hugonnet (2007)</p>	<p>Aim: Determine whether low staffing levels increase infection risks in critical care</p> <p>Method: Observational, single-centre, prospective cohort</p> <p>Sample size: 1,883 patients</p> <p>Risk adjustment/confounders controlled for: Demographics. Admission diagnosis. Acute Physiology and Chronic Health Evaluation (APACHE) II score. Daily invasive device and antibiotic use. Length of stay</p> <p>Confidence interval: Incidence rate ratio, 0.169; 95% confidence interval, 0.50-0.95</p> <p>Comment: –</p> <p>Evidence grading: O+</p>
<p>Hugonnet (2004)</p>	<p>Aim: Review the evidence of absolute nurse shortage, nurse skill mix and threshold above which nosocomial infections and cross-transmission of micro-organisms increases</p> <p>Method: Review</p> <p>Sample size: 29 studies</p> <p>Risk adjustment/confounders controlled for: None reported</p> <p>Confidence interval: N/A</p> <p>Comment: No information on method of review, i.e. search strategy, inclusion or exclusion criteria, quality assessment; source of evidence often lacking</p> <p>Evidence grading: R</p>
<p>Jamtvedt et al. (1998)</p>	<p>Aim: Assess the effects of audit and feedback on clinical practice</p> <p>Method: Cochrane systematic review</p> <p>Sample size: 118 studies</p> <p>Risk adjustment/confounders controlled for: Type of intervention. Intensity of audit. Complexity of targeted behaviour. Baseline compliance.</p> <p>Confidence interval: N/A</p> <p>Comment: Included only RCTs</p> <p>Evidence grading: SR+</p>

Kane et al (2007)	<p>Aim: Examine the association between registered nurse (RN) staffing and patient outcomes in acute hospitals</p> <p>Method: Systematic review</p> <p>Sample size: 28 studies</p> <p>Risk adjustment/confounders controlled for: Adjusted for patient acuity at the individual and hospital level. Separate analyses for intensive care units and for medical and surgical patients</p> <p>Confidence interval: An increase by 1 RN per patient day was associated with a decreased odds ratio of hospital-acquired pneumonia (OR, 0.70; 95% CI, 0.56-088)</p> <p>Comment: Included a meta-analysis</p> <p>Evidence grading: SR+</p>
Kaye (2000)	<p>Aim: Assess the impact of a multidisciplinary infection control team on rates of ventilator-associated pneumonia in medical-surgical care unit.</p> <p>Method: Study describes the creation, development and application of the team</p> <p>Sample size: 583-bed hospital</p> <p>Risk adjustment/confounders controlled for: None reported</p> <p>Confidence interval: None reported. Study does not report any statistical analyses, merely that rates fell below the 75th percentile (from above the 90th percentile)</p> <p>Comment: The team implemented a range of interventions. The success of the team could be describing the success of the individual interventions rather than of the team per se. However, the effectiveness of these factors was not addressed individually</p> <p>Evidence grading: O</p>
Koteyko and Nerlich (2008)	<p>Aim: Identify problems modern matrons face in fulfilling their role and link this back to possible problems in infection control</p> <p>Method: Qualitative study, methods of corpus linguistics and discourse analysis</p> <p>Sample size: Data derived from 11 policy documents and interviews with 11 modern matrons</p> <p>Risk adjustment/confounders controlled for: N/A</p> <p>Confidence interval: N/A (qualitative analysis)</p> <p>Comment: Study does not report on the type of analytical approach taken</p> <p>Evidence grading: Q</p>

Lang et al (2004)	<p>Aim: Determine whether peer-reviewed literature supports specific, minimum nurse-patient ratios for acute-care hospitals and whether nurse staffing is associated with patient, nurse employee or hospital outcomes</p> <p>Method: Review</p> <p>Sample size: 43 studies</p> <p>Risk adjustment/confounders controlled for: N/A</p> <p>Confidence interval: N/A (no statistical synthesis)</p> <p>Comment: No information on the search strategy</p> <p>Evidence grading: R</p>
McCutcheon (2005)	<p>Aim: Synthesise the best available evidence in the area of nurse staffing and patient safety and gather policy recommendations</p> <p>Method: Systematic review</p> <p>Sample size: Nurse staffing and mortality: 6 studies; nurse staffing and adverse patient outcomes: 18 studies</p> <p>Risk adjustment/confounders controlled for: –</p> <p>Confidence interval: N/A Did not include a statistical synthesis</p> <p>Comment: Comprehensive description of search strategy, outcomes, data extraction</p> <p>Evidence grading: SR</p>
National Nursing Research Unit (2007)	<p>Aim: Scope evidence behind the use of cohort nursing</p> <p>Method: Rapid scoping review</p> <p>Sample size: 5 studies</p> <p>Risk adjustment/confounders controlled for: None reported</p> <p>Confidence interval: None reported</p> <p>Comment: Little information on method</p> <p>Evidence grading: R</p>
Rafferty et al (2007)	<p>Aim: Assess the relationships between workload, patient survival and nurse retention</p> <p>Method: Cross-sectional survey combining nurse survey data, discharge abstracts and administrative data</p> <p>Sample size: 30 English Hospital Trusts, 118,752 patients, 3,984 nurses</p> <p>Risk adjustment/confounders controlled for: 300 variables, including demographics, administrative statistics, identities of consultants, specialised diagnosis and procedures</p> <p>Confidence interval: Patients in hospitals with the highest patient-to-nurse ratios had 26% higher mortality (95% CI: 12-49%)</p> <p>Comment: Evidence grading: O+</p>

<p>Saizy- Callaert (2003)</p>	<p>Aim: Describe the impact of a multidisciplinary approach to the control of antibiotic prescription in a general hospital</p> <p>Method: Observational study</p> <p>Sample size: 600-bed hospital</p> <p>Risk adjustment/confounders controlled for: None</p> <p>Confidence interval: None reported. Used chi square and Fisher's exact test</p> <p>Comment: Study aimed to test the effectiveness of multidisciplinary approach but in effect tested a range of interventions which were implemented under the team's instruction</p> <p>Evidence grading: O</p>
<p>Salaripour (2006)</p>	<p>Aim: Describe the introduction of a multidisciplinary infection control team</p> <p>Method: Observational study</p> <p>Sample size: High-risk units at a single hospital (no numerical value given)</p> <p>Risk adjustment/confounders controlled for: Drops in MRSA infections were compared to an internal benchmarking rate</p> <p>Confidence interval: None reported. Study reports Z-test values</p> <p>Comment: Badly controlled comparison groups. Intervention consisted of a series of 13 interventions, thus few inferences can be made about the team per se</p> <p>Evidence grading: O</p>

<p>West (2002)</p>	<p>Aim: Assess the relationship between human resource management practices/organisational practices and organisational performances (including quality in health-care organisations)</p> <p>Method: Cross-sectional postal and telephone questionnaire survey (respondents chose between the two options)</p> <p>Sample size: 61 respondents (human resource directors, chief executives, administrators and associate human resource directors)</p> <p>Risk adjustment/confounders controlled for: Hospital size (measured by total hospital income). Local health needs, assessed through causes of deaths and hospital performance, i.e. cancelled operations and delayed discharge. Data on doctors per bed employed</p> <p>Confidence interval: No confidence interval reported</p> <p>Study reports standardised regression (β) weights from a stepwise regression with mortality as dependent variable, <i>p</i> values and standard deviations</p> <p>Comment: Small sample, crude outcome measure for the dependent variable (mortality rates)</p> <p>Evidence grading: O</p>
<p>Wong and Cummings (2007)</p>	<p>Aim: Examine the relationship between nursing leadership and patient outcomes</p> <p>Method: Systematic review</p> <p>Sample size: 7 studies</p> <p>Risk adjustment/confounders controlled for: N/A</p> <p>Confidence interval: Did not include a meta-analysis or other statistical synthesis</p> <p>Comment: Well-reported systematic review; included quality assessment, comprehensive search protocol, inclusion/exclusion criteria</p> <p>Evidence grading: SR+</p> <p>(All included studies were rated as strong in the quality assessment)</p>

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