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Using systems approach to infection outbreaks

The last few years have seen a great deal of media attention in the UK regarding hospital infection control.^{1,2} High profile hospital outbreaks involving *Clostridium difficile* and MRSA have made infection control into a central priority for the NHS and other healthcare systems worldwide.³

The focus of debates so far has been on improving hygiene within hospitals (e.g. hand washing). Very little work has been conducted on the wider behavioural, social and organisational factors that may also determine infection control outbreaks.⁴

One possible way forward is to adopt a systems approach in order to probe deeper into the causes of hospital-based infection outbreaks. This type of work has been used to understand the complex interplay of factors that contribute to accidents and disasters (e.g. railway, aviation and construction accidents).⁵⁻⁷

Systems approach

Hospitals provide good examples of complex large-scale sociotechnical systems involving a large diversity of professions spanning a range of roles and specialisms as well as technologies and artefacts ranging from the latest e-health applications (e.g. electronic patient record systems) to more established physical design components (e.g. wards and buildings). Within systems ergonomics, a number of modelling frameworks exist⁸ for understanding the dynamic interaction

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between levels within large-scale sociotechnical systems (Fig. 1).

The framework has been used to identify the lessons learned from the May 2000 outbreak of *E. coli* which occurred in Walkerton, Canada.⁹ These ranged from decisions made at governmental levels (e.g. privatisation initiatives), the action of actors within the system (e.g. failures to take water samples), as well as equipment failures (e.g. shallow water wells). More recently, this type of approach has been used to analyse the main events and contributory factors leading up to the infection outbreaks at Maidstone and Tunbridge Wells NHS Trust.¹⁰

Clostridium difficile outbreaks in the Maidstone and Tunbridge Wells NHS Trust

Background and contributory factors leading up to the outbreaks

During the period between April 2004 and September 2006 an estimated 90 people died in the care of the Maidstone and Tunbridge Wells NHS Trust as a result of becoming infected with the *Clostridium difficile* bacteria. The report from the Healthcare Commission¹¹ identified a number of factors that contributed to the outbreaks that occurred within the Trust. These can be summarised in terms of five main themes: the role played by external organisations; management of the Trust; clinical management on the hospital wards; the role played by the infection control team; and, equipment and hygiene factors.

The role of external organisations

The setting of government-led targets and financial pressures on NHS Trusts are mentioned as background, contributory factors that had an impact on the day-to-day operation of the Maidstone and Tunbridge Wells NHS Trust. In particular, the report highlights the need for Trust board members and managers to meet targets for the use of beds. Higher bed

occupancy meant that there was less time for the cleaning and a higher probability of transmission of infection between patients.¹² The need to meet financial targets such as spending on equipment and buildings also placed pressure on the Trust to cut back on financing for new buildings and isolation areas.

Infection control within the UK NHS is regulated by a number of organisations including the Health Protection Agency (HPA). The creation of the HPA in April 2005 coincided with the first outbreak at the Trust. One part of the HPA, the Health Protection Unit (HPU), was set up in order to support organisations in their management of infections. The report highlights that this caused some confusion within the Trust at the time of the outbreaks, as the expectation was that the HPU could provide guidance covering the supervision and monitoring of infection control. Similar problems were encountered within the much larger Strategic Health Authority (SHA) which is responsible for implementing government policy and fiscal control within regions of the UK.

Management of the Trust

The report describes a catalogue of problems and failures associated with the management of the Trust at the time of the outbreaks. In terms of clinical risks and incidents, management strategy in general “had been fragmentary and poorly understood”.¹³ The style of leadership within the Trust and the overall management culture were also criticised. Many staff described the leadership of the chief executive as being

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“autocratic” or “dictatorial”.¹⁴ The report concluded that the person appointed as director of infection prevention and control had “no real understanding of the role at the outset”.¹⁵ Turnover of managers and directors was also high. Finally, the Trust’s management of staffing was criticised heavily in several places. The number of nurses working on wards had fallen since the period 2002/03 and at the same time the number of beds had also reduced. In 2006/07 the number of nurses per bed was 1.52, the same number as in 2003/04.¹⁶

Clinical management on hospital wards

A review of the case notes of 50 patients who had died having had *Clostridium difficile* infection found that in 80% of the cases, at least one element of the clinical management, or monitoring of *Clostridium difficile* at ward level was unsatisfactory.¹⁷ A number of elements were mentioned including: infrequent reviews of patients by doctors; lack of systematic monitoring as to whether or not a patient was recovering from *Clostridium difficile* infection; and, failure to change antibiotic treatment when a patient failed to respond to the initial treatment.¹⁸

There was also little evidence that once *Clostridium difficile* infection had been diagnosed, patients were monitored for severe signs of the infection.¹⁹ The management of fluids and nutrition on the wards was also inconsistent. In 36% of the cases there was evidence of poor fluid management and in 34% nutritional needs had not been assessed or managed.²⁰

Infection control team

The role played by the infection control team within the Trust was a complex one, and one made difficult by problems relating to accountability, the amount of resources available to it and its ability to function as a team. The arrangements for accountability were not clear (e.g. who was responsible for the team).²¹ Infection control nurses were accountable to the director of nursing. However, the pathology manager held the budget for these nurses, but did not consider that he had any management responsibility for infection control.

Equipment and hygiene

Hygiene practices within the Trust and the state of hospital buildings contributed a great deal to the outbreaks. Wards, bathrooms and commodes were not clean and patients had in some cases to share equipment (e.g. walking frames) which were not cleaned before use.²² The infection control team was keen to isolate patients once they had been identified as having *Clostridium difficile* infection. However, the scarcity of side rooms made this difficult. As a result many patients before and after the outbreaks were kept on open wards. The design of buildings and their age meant that many wards did not have sufficient space for storage or the provision of hand basins in utility rooms. The buildings in the Trust were

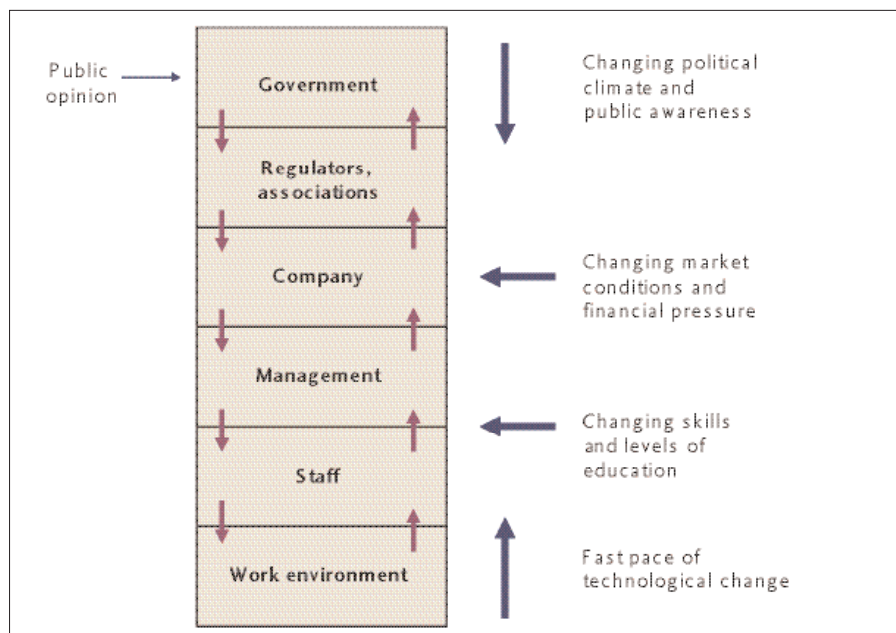


Figure 1: Systems ergonomic framework.⁷

generally old or in a poor state of repair and when they were first opened did not have adequate cleaning and laundry services.²³

Analysing outbreaks using systems approach

The outbreaks which occurred within the Maidstone and Tunbridge Wells NHS Trust represent the combined impact of a complex set of factors extending over several years. In common with most examples of accidents, disasters or large-scale adverse events, the outbreaks can be viewed as a combination of a number of interrelated systemic factors and influences.^{24, 6}

Figure 2 attempts to use some of the elements of the systems ergonomic framework described earlier (Fig. 1) alongside a small sample of the contributory factors in order to further analyse the outbreaks.

Government, regulatory bodies and Trust governance

At the very highest level of the system it is difficult to pinpoint exactly the role played by government-set targets as a discrete factor leading to the outbreaks. Targets placed many individuals, particularly those at Trust board and management levels under a great deal of pressure. This pressure in itself may have led them to make poor decisions, and in some cases to prioritise bed occupancy rates at the expense of the risk of an infection outbreak. Previous research on the influence that targets have on management decision-making in healthcare tends to be equivocal.^{25, 26} Despite this it seems likely that within the Trust targets exerted considerable pressure on the system as a whole and this pressure filtered down various levels of the system.

Poor communication, confusion of responsibilities and accountabilities between and within the various regulatory bodies delayed the time in which they could react to

the outbreaks. A separate report by the Healthcare Commission²⁷ examined the underlying causes of serious failures in NHS healthcare providers and identified large-scale organisational processes such as mergers and poor change management procedures as common factors. Within the wider literature on large-scale accidents and disasters²⁸ the nature of organisational linkages and structures are also widely acknowledged to be significant explanatory factors.

Hospital management

Within the hospital, the actions of senior managers were identified as significantly contributing to the failure to prevent and deal with the outbreaks. The link between management, human resource management (HRM) practices and work performance outcomes has been investigated in detail in the last few years and there is a growing body of evidence supporting a link between high-involvement HRM practices and employee productivity.²⁹ High involvement HRM practices typically include empowering employees to make their own decisions and the presence of self-managed teams. There is strong evidence to suggest that aspects of management behaviour partially shape and determine the culture of safety within organisations.³⁰ Within healthcare specifically, there is evidence that some aspects of high involvement HRM are associated with lower mortality rates (after adjustment for patient and hospital characteristics).³¹

Aside from the way in which senior managers behaved at the Trust, the question still remains as to why they ignored, or at least failed to realise, the seriousness of the outbreaks and their consequences. Many of the managers interviewed as part of the Healthcare Commission investigation

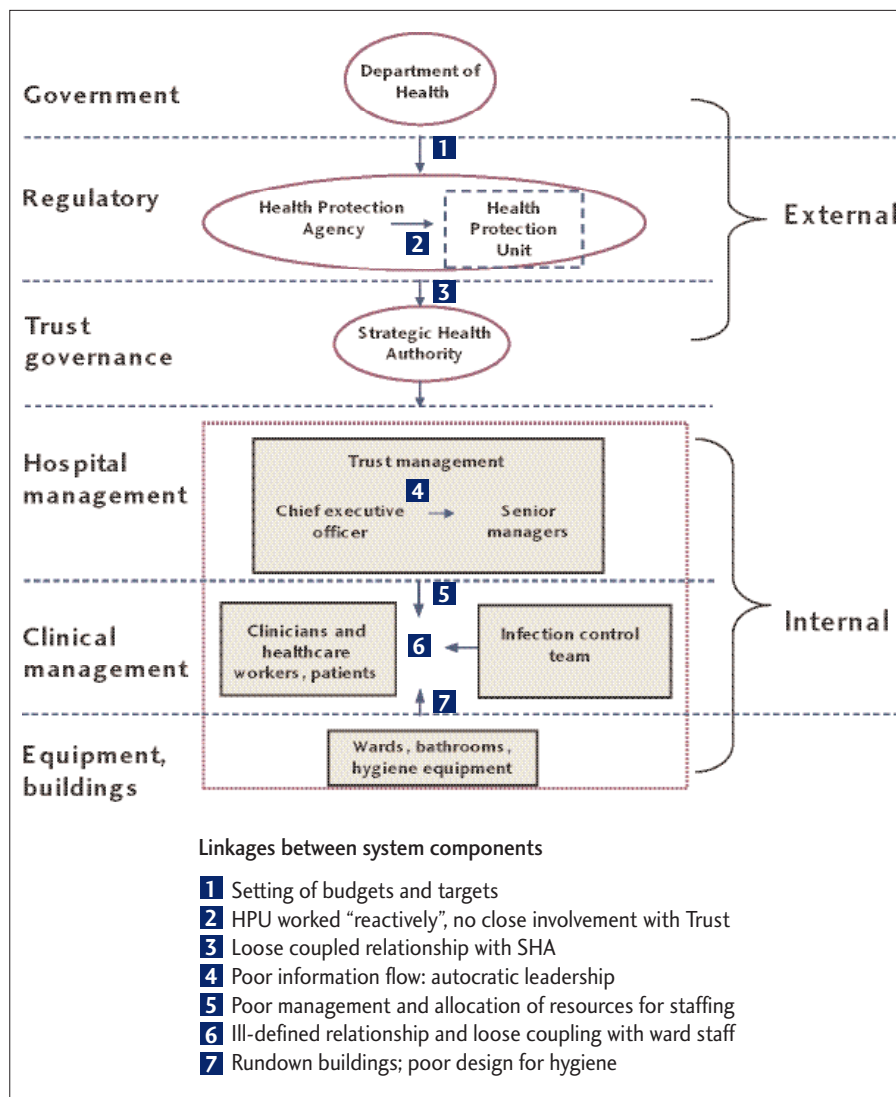


Figure 2: Mapping of infection outbreak influencing factors with system levels and boundaries.

reported that they were aware of how serious the situation had become within the Trust, but were powerless to do anything about it. One possible explanation could be so-called "normalisation of deviance,"³² namely that managers over time began to accept and take for granted the level of infection risk within the Trust. Only after the level of risk built up to a point where it could not be controlled, did they begin to realise the gravity of the situation.

Clinical management, equipment and buildings

Understaffing and general lack of resources together played a part in the outbreaks. In general, the research literature provides some evidence that lower levels of staffing increase the likelihood of infections occurring. For example, researchers found an inverse relationship between staff downsizing and the rate of hospital-based infection.³⁵ Little research has been conducted on the impact of job satisfaction/morale on hospital infection levels. However, work in other domains (e.g. manufacturing and service industries) suggests that lower levels of

satisfaction are linked to lower levels of job performance.³⁴

It might be conjectured that the behaviour of clinicians and other healthcare professionals within the Trust shares similarities with those of senior managers and Trust board managers. Many individuals at ward level were aware of the levels of poor hygiene and inadequate patient monitoring practices, but saw no way to improve the situation. These so-called "cultures of entrapment"³⁵ inhibit an organisation's ability to break out of patterns of behaviour that over time can lead to adverse outcomes. In

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the case of the Trust they may provide some means with which to explain shared boundary spanning behaviours between levels within the hospital subsystem (Fig. 2).

Ways forward

The analysis presented in the article has shown that there are advantages in examining hospital-based infection outbreaks from a systems perspective. Many of the issues that have been discussed have not been researched in much depth within infection control, particularly organisational and managerial behaviour. The article has only touched on some of the behavioural issues involved with a system as complex as hospital-based healthcare. Much more research needs to be carried out, the aim being that the outcomes from this can be translated into practice. We are currently in danger of only seeing one part a much larger picture. Adopting a systems approach is one step towards filling in the missing details, particular as they relate to causal relationships that may exist between system levels such as the interaction between management styles, aspects of hospital architecture and design,³⁶ individual behaviour (e.g. hand washing), and outcomes (e.g. infection rates). A better understanding of these relationships will ultimately help to choose appropriate interventions, the likelihood being that these will need to go beyond the current focus on individual behavioural change. We need to examine in more detail the wider human, social and organisational issues, as well as related aspects of the design and construction of hospitals.

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