Article

Historical and epidemiological evidences linking healthcare facilities management and Infection Control

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DOI(10.1108/F-07-2016-0078)

Emerald Facilities

The History of Healthcare Facilities Management Services: A UK Perspective on Infection-Control

Journal:	*Facilities*
Manuscript ID	f-07-2016-0078.R2
Manuscript Type:	Original Article
Keywords:	Healthcare facilities management, History, HAIs, infection control, NHS, reforms

Table 1: Milestones in the prevention and control of HAIs in the Pre-Modern era

Pioneer contributors	Infection control measures
Sir John Pringle (1707-1782)	– Demonstrated that poor ventilation, overcrowding and insanitary practices lead to infection – Revealed that the preservation of pure air and dispersion of the sick to prevent infections – Campaigned against the indiscriminate fouling of the ground which could lead to faecal contamination and thus the spread of infection (cholera) – Instigated basic infection control measures like the covering of latrines with earth
James Lind (1716-1794)	– Provided instructions on the disinfection of cloths and fomites – Demonstrated the benefit of water filtration in hospitals to prevent water-borne infections – Recommendations on the prevention of vermin in hospitals
Alexander Gordon (1752-1799)	– Identified the hands of healthcare workers as sources of cross infection – Established the benefit of cleaning to reduce risk of infection – Recommended the burning or cleaning of cloths and garments of those suffering from contagious diseases – Showed the relevance of personal hygiene in infection control by instructing healthcare staff to wash themselves thoroughly before attending to patients – Identified dirty and soiled linen used by healthcare professionals as a potential route in the transmission of infections in hospitals – Recommended the fumigation of clothing used by healthcare workers after every use

Table 2: Milestones in the prevention and control of HAIs in the Modern era

Pioneer contributors	Infection control measures
Florence Nightingale (1820-1910)	– Demonstrated the usefulness of cleanliness in the prevention of hospital infections – Demonstrated the benefits of bathing patients and the washing of hospital linen (blankets, towels, sheets) to prevent hospital infections, – Introduced chutes for soiled linen – Showed that hospital catering was important in the convalescence of patients – Demonstrated that hospital maintenance and repairs were an important function in infection prevention – Established the benefit of clean supply of water in hospitals – Established and raised the status of nurses and domestic service workers in infection prevention and control – Provided statistics to show the link between non-clinical services and the incidence of hospital infections – Wrote notes on hospital management and construction

Table 3: History and development of HFM in IC

	1500 Pre-Modern Era (Initial Stage)	1800 Modern Era (Formative Stage)	1945 Contemporary Era (Advanced Stage)
Development of HFM	– Makeshift military hospitals (valetudinarian) – Provision of rooms, beds and kitchens to accommodate sick soldiers – Monasteries served as places for care of the sick, poor and elderly – Establishment of leper centres – Planning, designing and construction of hospitals based on Christian beliefs and teachings – Patient rooms had richly decorated alters, wooden crosses, paintings and chandeliers to beg for healing – Provision of large kitchens and burial grounds – Financial support to maintain the monasteries and care for the sick and venerable came from private donations, farms, husbandry and small businesses operated by the monasteries – Pest houses, quarantine of patients – Fumigation using aromatic herbs and incense to dispel 'bad stench'	– Introduction of pavilion plan, emphasis on natural ventilation of hospitals – Consideration of infection prevention in the planning, design and construction of hospitals – Start in the organisation of Non-clinical services i.e., cleaning, waste, maintenance in UK hospitals – Non-clinical services under the control of hospital matrons – Accommodation to house nurses and other ancillary staff	– A myriad of HFM services (Okoroh *et al*., 2001: p. 160 identified 6 departments and 32 units) to support the provision of healthcare in the NHS. – The focus of HFM geared towards financial performance and efficiency. – The application of different approaches in delivering HFM services i.e., outsourcing, PFI, mixed and in-house.
Epidemiological issues	– Cause of disease associated with the Christian belief that disease was a punishment from God – Infection control practices - e.g. hygiene, cleaning and isolation practices - based on the interpretation of religious books. – Opposition to the washing and cleaning of the body – Ritual purity and penance regarded as healing practices	– Cause of disease became associated with miasma 'bad air' – Non-clinical services (e.g. cleaning, laundry, waste management) implicated in the incidence of hospital infection (puerperal fever) – Increased attention given to hospital hygiene, notably cleaning – Hand hygiene became significant in infection prevention – Purification and disinfection of hospital garments – Separation of nursing profession from domestic services	– Epidemiological evidence linking HFM services with HAIs. – HFM services like cleaning, maintenance, hospital waste, catering implicated in the incidence of HAIs.
Milestone Events	– The cause of infection is associated to inhuman contagions and inanimate non-human miasmata i.e., HFM services like hospital waste etc	– Nightingale's influence gained in the Crimea (1854) raises the profile of HFM service in IC – 'Germ theory' (1845) provides epidemiological evidence linking HFM to infections – The pavilion plan (1858) officially recognises the role of HFM in IC.	– The Bradbeer Report (1954) establishes HFM as a distinct function in the new created NHS. It reduced the level of integration between clinical and non-clinical staff in IC. – The creation of NHS trusts in 1991 separated purchasers and purchasers. – Review into arm's length bodies (ALBs) published in 2010 led to the disbandment of the NHS Estates and fragmentation of HFM services. – The introduction of the Health and Care Act 2012

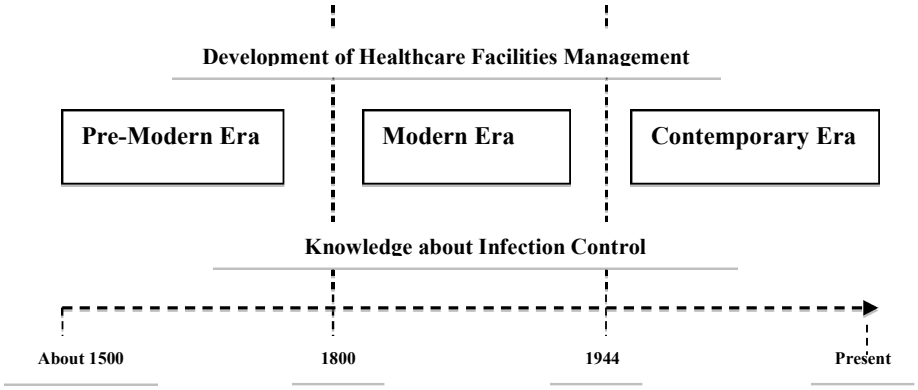

Figure 1: Research framework

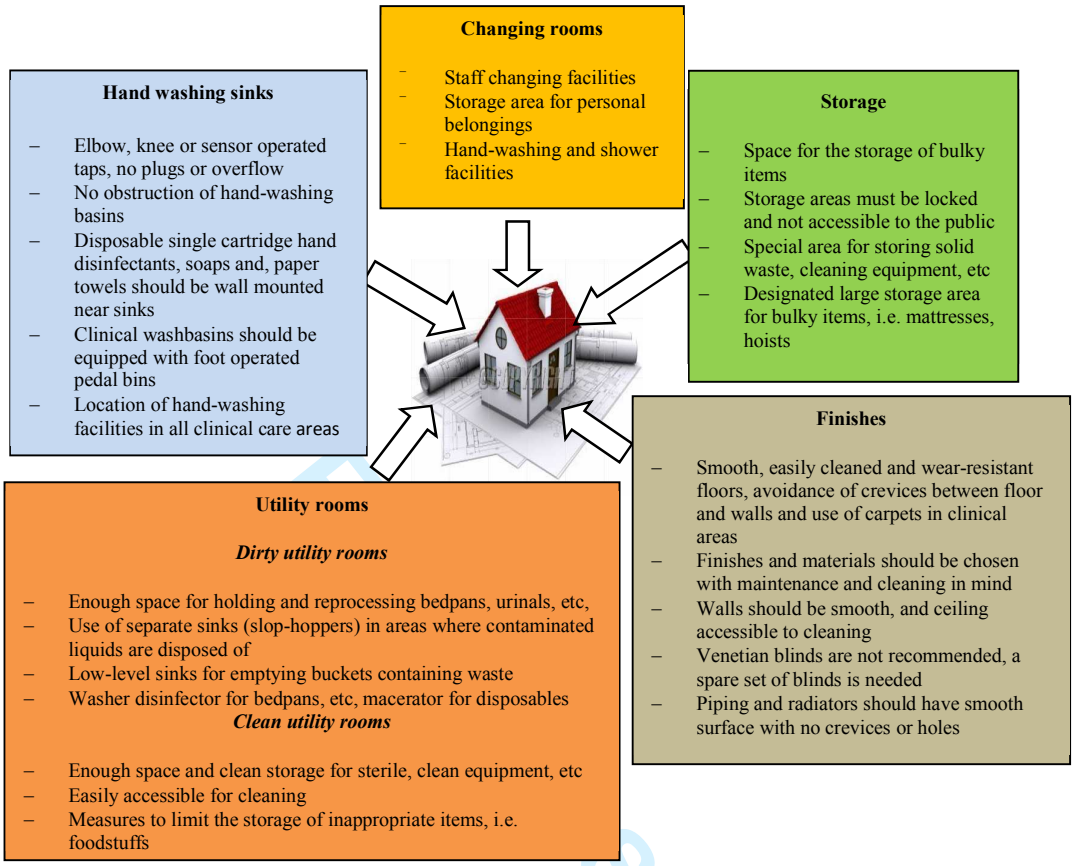

Figure 2: Basic FM Areas in the Planning and Design of Hospitals

The History of Healthcare Facilities Management Services: A UK Perspective on Infection-Control

Abstract

Purpose: The history of the development of non-clinical services in infection control (IC) dates back to the pre-modern era. There is evidence of healthcare facility management (HFM) services in Roman military hospitals. With the fall of the Roman Empire, Christian beliefs and teaching shaped the development of HFM in monastic hospitals. It was not until the late Victorian era that the link between HFM services and diseases caused by 'miasma', or bad air, became established. The discovery of bacteria in the modern scientific era reduced the level of importance previously attached to non-clinical causes of infections. Today, in the NHS, HFM services continue to be treated as though they had no real role to play in IC. This research collates historical and epidemiological evidence to show the link between HFM and IC.

Design/methodology/approach: The evidence gathered in this research paper is primarily based on an in-depth review of research from a wide range of sources. A 'within-study literature analysis' was conducted in order to synthesise the research materials. This involved the application of 'between-source triangulation' to verify the quality of the information contained in the studies, and 'between-source complementarity' to provide an in-depth elaboration of the historical facts.

Findings: Historical and epidemiological evidence shows that HFM services such as cleaning, waste management, catering, laundry and maintenance continue to play a crucial role in IC. This is corroborated by evidence gathered from the work of renowned pioneers in the field of infection control. However, reforms in the NHS have failed to consider this, as HFM services have been largely fragmented through different partnership arrangements.

Practical implications: Among many other things, this research raises the profile of HFM staff in relation to the issue of IC in hospitals. It presents convincing evidence to show that

the relationship between the clinical and non-clinical domains in controlling infections in hospitals has a long history. The findings of this research give HFM staff invaluable information about the significant role of their profession in the control of infections in hospitals.

Originality/value: This is one of the few studies examining the historical development of HFM services, as well as their contribution to IC. Other work in this area has mainly been framed from a clinical healthcare perspective.

Key words: healthcare facilities management (HFM), history, HAIs, infection control (IC), reforms

1. Introduction

The period from 1948 saw a new era in the way non-clinical services are provided in healthcare establishments. These services have now been reorganised under what is known as facilities management (FM) (also called 'facilities'). Shohet and Lavy (2004, p. 211) define FM as "*the application of integrated techniques to improve the performance and cost effectiveness of facilities to support organisational development*".

FM in the healthcare sector (i.e. NHS hospitals) has earned itself the name healthcare facilities management (HFM). The NHS Estates (1998, p. 4) defines HFM as "*the process by which an NHS trust creates and sustains a caring environment and delivers quality hotel services to meet clinical needs at best cost*". Examples of HFM services include the maintenance of property, heating, ventilation and air conditioning (HVAC), etc. Although some of these HFM services i.e. maintenance play a role in infection control, especially in the control of hospital-acquired infections (HAIs), the issue is often not taken seriously by healthcare authorities. The National Audit Office defines HAIs as infections that are neither present nor incubating when a patient, visitor or member of hospital staff enters the hospital (National Audit Office, 2000). The term 'HFM services' is often used interchangeably with 'non-clinical services'. The two are also used interchangeably in this research.

According to Sheldon (2009), healthcare authorities generally underestimate the risks associated with environmental surfaces in the transmission of HAIs. Few UK guidelines and recommendations emphasize the role of HFM in infection control (IC). Dancer (1999), for example, criticises the Department of Health's publication 'The Path of Least Resistance' (examining the unremitting increase in antimicrobial resistance) for devoting only a paragraph to hygiene and cross infection. The level of attention given to HFM means that only a small number of hospitals have an HFM manager sitting in board meetings (Rees, 1998). The presence of an HFM manager in board meetings helps to promote the case for and channel the course of the HFM unit in IC.

Although 25% of NHS spending is on estate and facilities, only a meagre £372,000 was allocated for the financial year 2005 - 2006 to estate and FM research (May and Pinder, 2008). For that same period, clinical research was awarded a staggering £650 million. Whilst all new staff undergo an induction, mandatory training and education on HAI is often restricted to clinical staff. Even where such training and education is provided for non-

clinical staff, temporary HFM workers employed by agencies and working in close proximity to susceptible patients are often left out (Davies, 2005).

With most of the research on this topic carried out by clinicians, the role of HFM in the control of HAI is under-researched. According to May and Pitt (2012), this has made it difficult for research on non-clinical aspects of healthcare issues to be published in clinical domains. The primary focus of the current paper is to raise the profile of HFM by demonstrating its historical significance in IC. This is achieved through an in-depth review of historical and contemporary evidence from a wide range of sources. As shown in Figure 1, the paper is divided into three main sections, covering the pre-modern, modern and contemporary eras. For each of these eras, issues related to the development of non-clinical services and the understanding of IC are examined. The discussion of the modern era focuses on the Victorian hospitals, the period apparently dominated by HFM issues. In the pre-modern and modern eras, the work of prominent pioneers in IC elucidated the role of non-clinical services in IC. The section on the contemporary era focuses on present-day HFM services, i.e., cleaning and laundry, etc, and the role they play in the control of hospital-acquired infections (HAIs). It is also in this section that we examine the recent changes in the NHS triggered by the Health and Care Act 2012. Figure 1 below shows this framework.

INSERT FIGURE 1

2. Within-Study Literature Analysis

Strict criteria were used to select the research materials underpinning this study. These included criteria for the validation of the research materials for authenticity (they had to be genuine, reliable and from dependable sources), for their credibility (free from errors and distortions) and their meaningfulness (clear and comprehensive). It was also required that they should contain relevant information about the history of HFM in IC. Our search of databases such as that of the Institute for Historical Research, Google Scholar and the University of Central Lancashire library catalogue, applying key phrases such as ‘healthcare facilities in the medieval era’, ‘history of hospitals services’, etc produced very few results. This initial search however did result in the identification of 12 journal articles that focused on a number of clinical issues which were relevant to this research. In order to identify

further material, literature searches were also conducted on the databases of organisations such as English Heritage, Historic Scotland and the Hampshire Record Office, etc. By the end of the literature search, 60 research items had been identified and catalogued in a folder. However, a preliminary analysis of the materials suggested that not all of them were relevant to the research topic under investigation. In total, 30 research items were selected because they contained sufficient information for making inferences about the research topic. The selected research materials focused on a wide range of clinical issues, which suggested that traditionally the history of infection control in hospitals has been addressed mainly by clinicians. Therefore, the history of HFM and its role in IC was one of extrapolating from the clinical domain.

The selected research materials were analysed by a method called 'within-study literature analysis'. The first part of the method is similar to the standard literature review that allows the researcher to review every aspect of the selected research materials, including for example the title, the discussion and conclusion (Onwuegbuzie *et al.*, 2012). Apart from providing a broader understanding of the research topic, the 'within-study literature analysis' made it possible for the researchers to conceptualise HFM and its role in IC in a historical context. Unlike in a standard literature review, the 'within-study literature analysis' was used to conduct 'between-source triangulation' and 'between-source complementarity' of the selected research materials. The former was mainly to verify that information contained in one document was corroborated by information contained in other documents, while the latter made it possible to elaborate on ideas identified in one document on the basis of information gathered in others. This method is useful in a research of this nature with ideas extrapolated from different sources. The completion of the 'between-source triangulation' and between source complementarity' resulted in the research material being mined and significant items of information being catalogued into nodes relating to different historical epochs (i.e. the pre-modern, modern and contemporary eras). The information contained in the tables below was developed through these methods.

Once the process of cataloguing, verifying and complementing information was completed, the next step was to use this information to build a coherent and logical account of the history of HFM and its role in IC. In the next section, the results of these analyses are discussed in depth under the headings of the pre-modern, modern and complementary eras.

Whilst the pre-modern section examines IC issues within a broad context, discussion of the modern and contemporary eras is limited to the United Kingdom.

2.1 The Pre-Modern Era (about 1500 to 1800)

The first HFM services can probably be traced to the pre-modern era, the period considered as the dawn of socio-economic development in Europe. During this period, non-clinical services were poorly developed, and healthcare officials had very little understanding and knowledge of IC. Healthcare officials at the time relied on guidance from religious texts to provide cures for diseases. The Charaka-Samhita (a Sanskrit textbook of medicine), published around the fourth century BC, contains one of the earliest pieces of advice on hospital construction and hygiene. For example, a mansion was expected to be spacious, roomy and open to breezes. A mansion was not to "*be exposed to smoke, or dust, or injurious sound or touch or taste or form or scent. . .*" (Selwyn, 1991, p. 9). Advice was also provided on the purity and cleanliness of the mansions. An example of a hospital built in keeping with these principles was a commodious oriental hospital (AD 500) in a remote location in Mihintale in modern-day Sri Lanka (Selwyn, 1991).

In Europe, the earliest documented evidence of a healthcare establishment with non-clinical services can probably be traced to the Romans. Although the Romans did not have services specifically for providing community care for the sick, poor and needy (Cilliers and Retief, 2006), they did however have army hospitals (*valetudinaria*) (several hundred years BC) to take care of soldiers. With the creation of a Roman professional army, it became necessary to establish hospitals close to frontiers rather than send people home for treatment. The legionary hospital at Vetera in Germany is an example of a *valetudinarium* that had rooms, beds and even kitchens to take care of wounded soldiers (Selwyn, 1991).

The fall of the Roman Empire saw the deterioration of hygiene in Europe, starting from around the fifth century AD (Selwyn, 1991). However, Christians, unlike the Romans, embraced charity as one of their basic doctrines. Monasteries sprang up throughout Europe and became the focus of learning and education, scholarship, charity and medicine (Ellerton Church Preservation Trust, 2010). Besides providing accommodation for travellers,

monasteries took care of the sick, poor and elderly. Leper hospitals started appearing in Britain around the 12th century (Historic Scotland, 2010).

Christian beliefs were embedded in the planning, design and construction of healthcare facilities at this time. Traditionally, the sick had been laid in the body of a church with the chancel serving as the chapel (Platt, 1978). These places were often richly decorated with wooden crosses, paintings and chandeliers. However, by the 12th century, separate halls to accommodate the sick were constructed. Recent excavations at the St Bartholomew, Gloucester, and the St Mary hospitals show the chapel was set centrally at right angles to the infirmary hall. The halls were long and divided by wooden screens. However, after the 13th century, common dormitories started giving way to separate rooms to house the sick (Markham, 1997). The St Helen's hospital at Abingdon was rebuilt in 1446 with 13 separate chambers. It also became common practice for separate accommodation to be provided for hospital wardens. Most hospitals also had large kitchens and burial grounds (Markham, 1997).

In these early Christian hospitals there was little understanding of the role of the healthcare built environment in the spread of diseases (see Table I). This is probably one reason why the Black Death or bubonic plague ravaged Europe during the period 1348 - 1359 (Ayliffe and English, 2003). The Black Death demonstrated the importance of segregating infectious patients from the rest of the community. It also prompted the introduction of new forms of prophylaxis that were unknown at the time (Ayliffe and English, 2003). For the first time, it was suspected that the clothes, bedding, and so on of those who were infected contributed to the spread of disease. As a measure to curb the possibility of cross contamination, the authorities carried out the disinfection or burning of fomites, and introduced quarantine (Ayliffe and English, 2003). Plagues also led to the introduction of temporary pest houses to isolate infected patients from the rest of society (Historic Scotland, 2010). In contrast to today's practices, these forms of disinfection or fumigation were nothing more than the usual burning of aromatic herbs and incense.

Despite their unscientific notions about the causes of diseases, early healthcare practitioners must take credit for establishing a link between non-clinical services and the incidence of HAIs. In an attempt to explain the contagiousness of diseases, 18th century physicians divided 'bad air' into two categories: 'inanimate human contagions' and 'inanimate non-human miasmata'. According to the theories of William Cullen, contagions

emanated from patients suffering from such diseases as smallpox, and spread to those around them. Miasmata on the other hand were thought to originate from non-human sources such as swampy ground, and to cause febrile diseases such as typhoid, malaria and yellow fever (Alexander, 1985). It was thought that the air contained invisible minute poisonous particles (miasmas) which when inhaled into the body were capable of causing disease (Alexander, 1985). It was therefore common practice for new healthcare establishments to consider ventilation (Platt, 1978).

Yet although 'contagions' and 'miasmata' were identified as the causes of diseases, little was done by healthcare authorities in the cities and towns to make hospitals safe. Attempts to reduce cross infection and improve the condition of civilian hospitals only gained prominence towards the end of the 18th century. This period was marked by the fading away of the old idea that hospitals were places of refuge or asylum for the poor, sick and destitute. Increasingly, it became accepted that hospitals were places for curing and restoring the health of patients (British Medical Journal, 1897). Improvements in the conditions of healthcare facilities to reduce the incidence of infections, however, occurred much earlier in army and navy hospitals.

Sir John Pringle, who served in the army from 1742 to 1748, was probably one of the earliest physicians to identify the built environment of healthcare facilities as a potential source of infection. Pringle's views about the causes of infection were more advanced than those of his contemporaries. The general belief at the time was that dysentery was caused by foul air, and that treatment involved bleeding, the use of emetics, and purging. Pringle however adopted a preventative and unorthodox approach. He recommended measures to prevent the indiscriminate fouling of the ground by soldiers, the daily covering of latrines with earth, and the moving of camps from foul ground in the event of a dysentery outbreak (Cook, 2001). Similar efforts were also being made at the time by James Lind to improve the condition of naval hospitals. In his book, published in 1757, Lind gave recommendations on the isolation of patients to reduce cross infection, and instructions on the disinfection of cloths and other fomites, the destruction of vermin and the filtration of water.

Another figure in environmental infection control was Alexander Gordon; considered by many as one of the pioneers of British medicine and infection prevention in hospitals. According to Gould (2010), Gordon conclusively showed the contagious nature of puerperal fever and identified methods to prevent its spread. Unlike his contemporaries, he used

detailed observations to show the contagiousness of puerperal fever and to establish that doctors and midwives provided the route through which women became infected. Gordon showed that transmission was mainly through the hands of the physicians and midwives, and he recommended cleaning as a way of preventing the prevalence of the fever. The bedclothes of patients were to be burned or thoroughly purified.

Table 1 summarises the contribution of these three pioneering figures.

INSERT TABLE 1

2.2 The Modern Era (1800 – 1945)

Before the enthronement of Queen Victoria in 1837, healthcare was mainly in the hands of the church. Mortality rates were generally high, and patients had to endure very unhygienic conditions that would not be accepted by today's standards (Platt, 1978). In addition to severely overcrowded hospitals, hospitals also lacked basic infection control practices, i.e. handwashing basins to prevent the spread of infection. According to Alexander (1985), wards had giant beds, each of which was occupied by a number of sick patients crammed together to keep warm. The normal capacity of hospital beds was often exceeded. The salient point is that, regardless of the infectious nature of their illness, patients were all mixed together in single wards.

The early years of the Victorian era did not show any marked improvement in healthcare. Hospitals lacked proper arrangements for the removal of excreta. Sinks, waste pipes and bath-pipes were all directly linked to sewers, leading to the introduction of sewer poisons into hospitals. The lack of evidence-based guidelines on the planning, design and construction of hospitals meant that architects erected huge monumental public buildings that failed to consider infection control and prevention (The British Medical Journal (BMJ), 1897). Whilst the frontages of hospitals were built in the form of Grecian temples with elaborate porticos, the wards were often crowded together. The only consideration given to the prevention of bad air or 'miasma' was ventilation through windows.

Unlike today, Victorian nurses "*performed all the usual duties of servants* [domestics]*, in waiting on and cleaning the patients, beds, furniture, wards, and stairs*" (BMJ, 1897, p. 1661). They were given only two gowns and one cap every year. Their duties and those of the kitchen staff were supervised by matrons who themselves were not nurses (Helmstadter, 2002). Matrons ensured that the wards were cleaned and in good order, and that staff exhibited good moral conduct and attended work according to schedule. They were also in charge of the accommodation provided to nursing staff and their assistants. It can be said that Victorian matrons were the healthcare facilities mangers of yesteryear.

Despite the appalling condition of Victorian hospitals, nothing was done to alleviate the plight of patients. Yet it was the deplorable medical condition of British military hospitals which prompted the British authorities to do something about civilian hospitals. At Scutari, it was common practice to find as many as 10,000 sick soldiers housed in filthy, poorly maintained and vermin-infested barrack accommodation (Hampshire Record Office, 2007). There was an acute shortage of wards, and corridors were often used to accommodate patients suffering from contagious diseases. It was such conditions, and the high rate of mortality suffered by soldiers, that attracted the attention of the likes of Florence Nightingale.

Drawing on her experience of nursing sick and wounded soldiers in the Crimea, Nightingale convincingly showed that cleaning reduced the incidence of infections in hospitals (see Table 2). When she arrived in the Crimea in 1854, she was appalled by what she saw: "*...the beds on which the patients lay were dirty. It was common practice to put a new patient into the same sheets used by the last occupant of the bed, and mattresses were generally flock sodden and seldom if ever cleaned"* (Nightingale, 1854, cited in Wormsbecker, 2002, p. 88). Nightingale mobilized a team of staff to scrub the hospital clean and wash the sheets, blankets and towels. In addition to cleaning the hospital's kitchen and preparing better and more wholesome food for the patients, she got an army of engineers to repair the hospital's drains and improve the supply of water (Hampshire Record Office, 2007). By doing this, Nightingale and her team were able to bring down the rate of mortality at Scutari. Statistics gathered by Nightingale revealed that far more soldiers died from infections, or 'zymotic diseases' that were presumably acquired in hospitals, than in the actual war itself. Using the 'coxcomb' variant of pie charts, Nightingale established a direct link between hospital cleanliness and the rate of infection (mortality). As hospital cleanliness improved, the size of the wedges (monthly mortality rates) on the coxcomb got smaller.

Nightingale's work prompted calls for the UK government to alleviate the plight of sick and wounded soldiers in military hospitals. In 1858, the government appointed a Commission to inquire into the regulations governing the sanitary conditions of the army, the organisation of Military Hospitals and the treatment of the sick and wounded. The findings of the Commission revealed amongst other things the dire state of HFM services in military hospitals. The Commission officially criticised the 'corridor plan' used in the construction of the new military hospital at Netley, and the deplorable conditions in which soldiers received medical treatment. The Commission officially sanctioned the 'pavilion principle' for the construction of military hospitals (Cook, 2001).

Events in military hospitals triggered calls for reforms in civilian hospitals. This was accentuated by the advancing medical knowledge at the time, i.e. insights into ventilation and sanitation. At the time, ventilation was provided by the use of the pavilion plan, which was introduced before the 'germ theory' was articulated (Cook, 2001). Many at the time argued that the pavilion plan led to the dispersion of foul air, which was customarily blamed for diseases. In that it emphasised separation, segregation and ventilation, the pavilion plan was a substantial improvement on the way hospitals had previously been designed and constructed. Amongst the numerous recommendations put forward by the advocates of the pavilion plan was the use of parian cement or impervious material to build the walls and ceilings of hospitals. Up to then it had been common practice for sewage to run under hospital buildings (King, 1966). Cesspools were removed from the immediate vicinity of hospitals, while closets and sinks were isolated from the main building by a ventilated lobby. The pavilion plan was seen by many as both sanitary for the patient and convenient for the healthcare worker (Richardson, 1998, cited in Cook, 2001).

The construction of the first two pavilion plan hospitals began in 1858: the Blackburn Infirmary and the Royal Marine Barracks at Woolwich. Hospitals that adopted the pavilion plan had wards that were only one storey (rarely two storeys) in height. The wards had no corridors that directly connected them together (BMJ, 1897). Instead, the pavilions were set at right angles to a linking corridor connecting the wards to centrally positioned service and administration buildings (English Heritage, 2007). The connecting corridors were either straight or encompassed a large central square, while the pavilions themselves were widely separated by lawns or gardens (King, 1966).

To minimise the 'miasma' originating from the sanitary facilities, they were contained in towers or annexes at the ends of the pavilions. Cross ventilation in the pavilions themselves was achieved through rows of tall, narrow windows that ran from floor to ceiling on both sides. As originally recommended by Tenon and Poyet (the originators of the pavilion principle), beds were placed in pairs between the windows. However, in subsequent years attempts were made to improve cross ventilation by placing only one bed at the window pier (Cook, 2001). Fires were also used judiciously to produce air currents to remove 'noxious vapour' or miasma from the wards.

As medical knowledge advanced towards the end of the Victorian era, there was an increase in the complexity and number of HFM services required to run hospitals safely. This meant that they could no longer rely on natural ventilation alone. Hospitals therefore started adopting the use of combined heating and ventilation systems, notably the plenum system. The plenum system brought in *"air at eaves level, filtered, warmed and humidified it and expelled it at a rate of ten changes a day"* (English Heritage, 2007, p.5). It also became common practice for hospitals to have boiler houses to provide heating and hot water. Other facilities included kitchens, laundries, operating theatres, X-ray rooms, outpatient departments, offices, committee rooms, a chapel, a mortuary and nurses' homes. The implementation of the pavilion plan in the UK marked the recognition of the significance of non-clinical services in the control of HAIs. Table 2 lists Nightingale's contributions in terms of linking HFM services and infections.

INSERT TABLE 2

2.3 The Contemporary Era (1945 – present)

Although HFM has only recently emerged as a discipline, its history in hospitals spans many centuries. As shown in Table 3, the history of HFM in IC could be seen as comprising initial, formative and advanced stages, corresponding to the pre-modern, modern and contemporary eras. It is worth noting the decline of the contribution of HFM in IC over the passage of time. In the discussion that follows, focus is about the FM services in the contemporary era.

INSERT TABLE 3

The creation of the NHS in 1948 marked a turning point in the organisation and management of HFM services in hospitals. At the start of this period, HFM services were managed as separate entities, with lay officers reporting directly to the NHS governing body. This arrangement made it difficult for lay officers to effectively coordinate and manage HFM services. Consequently, many NHS workers started calling for the integration of all support services in one corporate unit. They argued that integration would lead to the development of quality systems for the effective planning and delivery of HFM services (Alexander, 1993). In 1954, the Bradbeer Report introduced a tripartite management system for medical, nursing and lay officers (English Heritage, 2007). This of course was the first step in the separation of HFM services from the rest of NHS services.

The government's decision to create NHS trusts in 1991 provided an impetus for the further development of HFM in the NHS. It brought about the separation of responsibility between the purchasers and providers of healthcare. The responsibility for providing healthcare in the UK was given to self-governing bodies called NHS trusts. Influenced by the experience of private sector and the new business responsibilities they had now been given, many NHS trusts started looking for professional ways of providing non-clinical services. To ensure that the NHS operated in a business fashion, it was asked to separate its activities into core and non-core tasks. The aim was to make it possible for non-core activities to be floated off to private companies, with the savings from such an exercise being made available for patient care within participating NHS trusts (Cook, 1990).

The impact of competitive tendering regulations and the idea of best value are still felt throughout the NHS (Walker *et al*., 2006). The focus of the best value initiative has been on harmonising the interaction between the public and private sectors in the provision of public services in the UK, and it was for this reason that non-clinical services were outsourced to the private sector. However, many years after the outsourcing of the first HFM services in the NHS, the debate about its efficacy in IC still goes on.

In recent years, it has become difficult to demarcate the functional boundary of HFM and identify how it stimulates the core clinical business of the NHS (Gombera and Okoroh, 1999, cited in Okoroh *et al.*, 2001). It seems there is no clear line as to where healthcare FM starts

or ends, and who is 'best fit' to be providing the myriad of services it is responsible for. With over six departments and 32 units (Okoroh *et al*., 2001, p. 160), HFM managers have the daunting task of demonstrating to stakeholders, i.e., local councils and the Department of Health, etc, the contribution which HFM makes to safe patient care. This could be achieved by providing evidence showing the link between the performance of HFM services in IC and the incidence of HAIs in hospitals. There are many researches in the clinical domain that show the epidemiological link between HFM services like cleaning (contamination of equipment and the built environment), catering (food contamination), building maintenance (dust contamination), practices of healthcare FM workers (contact transmission) and HAIs. In the next section, a brief discussion is provided about the link between HFM services and IC.

2.3.1 Synopsis of the Links between HFM Services and Infection Control

The healthcare built environment serves as an ecological niche in which healthcare users might become infected with HAIs. According to Center for Disease Control (CDC) (2003), the way hospitals are designed strongly affects rates of HAIs. The expertise of HFM is invaluable in relation to a number of issues concerning the control of HAIs. According to the Health Protection Agency (HPA) (2008), the poor planning and design of hospitals may manifest itself for example in a failure to include domestic rooms or sluice or clean utility rooms in the facility, or in the fitting of carpets instead of washable floor coverings in clinical areas. The failure to include HFM in the planning and design of hospitals may affect their maintainability and heighten the incidence of HAIs. In order to design IC into hospital buildings, issues such as the ratio of bays to single rooms, the number of beds and the provision of clinical as well as FM services are important. Figure 2 shows some of the areas that HFM can help in the design of IC in hospitals.

INSERT FIGURE 2

Many healthcare professionals consider the provision of hand-washing facilities in hospitals to be the most important initiative to enhance patient safety (Pittet *et al*., 2000). Hand hygiene compliance can also be increased by designing the hospital environment in a way that reduces environmental contamination. HFM staff involved in the cleaning of hospitals play an

important role in reducing environmental contamination, and thus the incidence of HAIs. If surfaces in hospitals remain unclean, they may serve as reservoirs. Without thorough and effective cleaning, the healthcare built environment might become unsuitable for patient care (Quinn *et al*. 2015).

Unlike the food served at home and in restaurants, hospital food needs special care in its preparation. This is because those eating hospital food may be patients (i.e. immune-suppressed, the elderly and children) who are vulnerable to infections. Of the estimated one million people who suffer foodborne illness each year, around 20,000 are admitted into hospital (Food Standards Agency, 2011). In addition to costing the NHS about £1.5 billion, the Food Standards Agency estimate that 500 people die each year because of foodborne illnesses.

The provision of clean linen in hospitals is a fundamental requirement for safe patient care. Hospital linen that has been used by patients suffering from gastrointestinal-related infections or other notifiable diseases may pose a risk of HAIs to healthcare users (Maki *et al*., 1983). High-risk hospital linen usually comes from patients housed in isolation or other high-risk wards. The transmission of microorganisms usually occurs because of the inappropriate handling, storage or processing of clean and soiled linen in hospitals (CDC 2003).

According to Muhlich *et al*. (2003, p. 260), "*waste is more than just rubbish to be disposed of and forgotten about*". This is because the poor handling of hospital waste may result in the incidence of HAIs in hospitals (Akpieyi *et al*., 2015). This mostly involves blood-borne virus infections associated with sharps injuries (Environment Agency, 2002). During maintenance (e.g. plumbing), water may get into structures, areas or items made of porous materials or characterized by cracks and crevices (sink cabinets in need of repair, carpets, ceilings, floors, walls, upholstery and drapes). If unattended, these surfaces might support the growth of mould and serve as potential sources of pathogenic microorganisms (CDC, 2003).

Although the UK government has introduced a number of policies and guidelines to improve environmental infection control, the problem is far from being over. In addition to the lack of integration between clinical and HFM services, there is also an issue with the disintegration of HFM services. A model developed by Lavy and Shohet (2009) called the Integrated Healthcare Facilities Management Model seeks to bring all HFM services together

to improve overall performance. The development of an integrated healthcare system involving HFM will help reduce the current fragmentation and gaps in the provision of patient services across the UK. It will also help improve the level of coordination and ensure the continuous improvement of patient care in hospitals.

As we have demonstrated in this section, FM-associated infections (infections caused by the poor performance of HFM services in IC) contribute to the high prevalence of infections in UK hospitals. Current measures by the UK Government to reduce the incidence of HAIs do not succinctly address the contribution of HFM services. In the next section, we examine the recent changes in the NHS that might affect the performance of HFM in IC.

2.3.2 Recent Changes in the NHS – Implications for HFM

In the last couple of years, the financial position of the NHS has been weakened by the economic recession and the fact that people are now living longer. This has obviously increased the need for healthcare services to reduce their level of expenditure on non-core services such as maintenance and operations (Lavy and Shohet, 2009). The amount of money spent on the NHS has doubled in real terms since 1999 (DH, 2015). This of course has prompted the Government to end its culture of continuously throwing money at the NHS to keep it afloat. In the words of Lord Darzi, "*we just threw money at it* [NHS]*, rather than just reforming it*" (Wood, 2013, p.7). According healthcare officials, the NHS needed to make cost savings of £20 billion, despite the NHS England Medical Director's plea for more clinical and nursing staff in the NHS. With the NHS in financial crisis, the response of the Government has been to carry out a series of radical reforms through the adoption of the Health and Care Act 2012. Apart from the creation of local structures, the reforms resulted in shifting commissioning responsibilities and opportunities to a wider range of providers.

An examination of government guidance documents in relation to the current reforms indicate that the focus is mainly on the changes presently taking place in the clinical domain. According to the new structure established, strategic direction for the provision of healthcare services in England is in the hands of the Department of Health (DH), NHS England, Public Health England and commissioning units, i.e. Clinical Commissioning Groups (CCGs), Healthwatch and Local Authorities. As has been the case with other similar reforms of the UK healthcare system, HFM has not been given the attention it deserves. Although the roles

of the new organizations are clearly stated, it is difficult to say how they will affect the quality of the healthcare services provided (Hunter, 2013). One thing is clear, however, and that is that the Clinical Commissioning Groups (comprising doctors, nurses and other professionals) will in the future have a major role in the way HFM services are procured and delivered in hospitals. They will be directly responsible for secondary care, community services, mental health services and rehabilitation services. It is expected that the CCGs will use their knowledge of the local community to buy services from local suppliers at affordable prices (DH, 2015). Therefore, issues related to contracts with providers of funded serves will be dealt with by the CCGs. It is also worth mentioning small HFMs which will now fall under the remit of Local Authorities running local public health services. This will be a challenging environment for some of the HFM staff, who will have to adapt to new administrative structures.

In the past, many have complained that government technocrats failed to pay particular attention to the contribution of HFM, especially regarding its role in IC in hospitals. Now that changes in the NHS are being implemented against the backdrop of a drastically constrained health budget (Coote and Penny, 2014), it is difficult to see how the CCGs will revolutionize the provision of HFM services in hospitals. According to Taylor-Gooby and Stoker (2011, cited in Hunter, 2013, p. 13), the policies of the previous coalition government that saw the birth of these reforms "… *represent substantial privatisation and a shift of responsibility from state to individual"* [NHS]. This view is also held by Unison (the trade union that represents many HFM staff), which is of the opinion that the reforms will adversely affect the quality of services patients receive in hospitals. With the Health and Care Act 2012 putting clinicians at the forefront of decision-making, one can only wait to see the level of attention they pay to HFM in an NHS that is outside the European Union. This notwithstanding, the integration of primary and secondary care can only offer full benefits if HFM services are part of the equation. As we have demonstrated in the previous sections, HFM remains an integral part of the NHS in the provision of safe patient care.

3. Conclusion

Apart from historical evidence, there is also plenty of recent epidemiological evidence which links the poor performance of HFM services to the incidence of HAIs in hospitals. The way

hospitals are designed strongly affects rates of HAIs. The expertise of HFM is invaluable in relation to a number of issues concerning the control of HAIs. In order to design IC into hospital buildings, issues such as the ratio of bays to single rooms, the number of beds and the provision of clinical as well as FM services are important (see Figure 2). Without thorough and effective cleaning, maintenance, laundry and waste management, the healthcare built environment might become unsuitable for patient care.

For hospitals to reduce the incidence of HAIs and cost, they will have to acknowledge the importance of HFM in IC. Presently, many hospitals seem to operate a two-tier system, with clinical staff operating separately from HFM staff. Such a division can only undermine the role of HFM services in IC. With no real connection to the core business objectives of hospitals, HFM will continue to be treated as an adjunct service in the provision of healthcare. In recent years, market testing has certainly been an issue for HFM to grapple with. It is hoped that the recent healthcare reforms in the UK do not further erode or damage HFM services, resulting in poor quality care for patients.

The integration (internal or external) of clinical and HFM services is critical for the provision of safe patient care in hospitals. Whilst the blame for this lack of integration is always on the clinicians, it is also the responsibility of HFM professionals to demonstrate how they fit into the overarching agenda of the NHS. Most of the research that is currently being conducted in HFM does not focus adequately on some of the core business functions of the NHS, i.e. safe patient care. As this study has demonstrated, IC is affected by HFM. It is an area where a greater level of integration is needed between the clinical and the HFM teams. If these two groups work as a team on a number of issues including IC, the NHS will be able to focus on its vision through the better planning of resources, budgeting, space allocation, and so on. It will also be in a better position to explore the benefits of integrated healthcare, especially following the allocation of significant resources to primary care.

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