Healthcare-associated infections – on developing effective control systems under a renewed healthcare management debate

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Abstract

Purpose: The development of control systems to sustain the level of healthcare-associated infections (HAIs) is an emerging issue for healthcare management. This is partly due to the perception that HAI became a serious negative impact factor on the performance of healthcare organizations and on related public health dimensions. Throughout the decade of 1990 a significant number of international programmes were developed to understand and to promote effective HAIs prevention and control systems: Patient Safety and the quality improvement of healthcare organizations became common concepts in healthcare management. However, regardless of advances in infection control systems, the rates of incidence of HAIs remained relatively unchanged in the last decades. The purpose of this study is to point out barriers that recent international literature has identified as factors hindering the successful development of control systems to prevent HAIs. The international debate on possible alternatives to strengthen this common healthcare management issue, benefits form one such update.
Methods: A literature review was conducted in a 3-month period by two investigators. The BioMed Central, Pubmed, Emerald, and B-on databases were searched for articles published between January 2006 and September 2011. A standard form was created for data extraction.
Findings: A total of 49 articles met inclusion criteria. Within the analysed articles, 26 were developed in Europe, 15 were developed in North America; 6 were developed in Asia, and 2 in Australia. Thirty (30) different barriers to effective HAIs control systems were identified. The barriers were clustered by dimensions and sub-dimensions. The largest number of barriers clustered, are associated with structures and processes and also barriers associated with healthcare management processes.

Keywords: Healthcare-associated infections, Control systems, Healthcare management, International review

Background

Concerns on healthcare-associated infections (HAI) are not a recent healthcare management issue. The work of Florence Nightingale already indicated that, in the nineteenth century, there was awareness of the need to control infections in military hospitals.[1] And of the fact that infections were a leading cause of death in hospitals lacking control and due to, among other factors, a lack of knowledge on the mechanisms of transmission which began to be identified at the end of the nineteenth century.[2,3] A structured approach to this problem promoted the adoption of methods of basic hygiene, along with the use of antiseptics during surgery, thus, originating the first hospital infection control systems. This problem, however, has become more distinct in its true dimension at the end of the twentieth century, and is now one of the major healthcare management challenges worldwide. A number of factors determined the increasing relevance of the issue in the past three decades: more patients are more susceptible to infections, increase of invasive procedures and related higher risks of infection, mixed populations of patients within the hospital environment promoting the risk of crossing transmission, increase of microbial resistance, inadequate methods of cleaning and hygiene, lack in healthcare management leadership to implement control systems, and

reduced commitment of top management to tackle the problem of hospital infections.[4,5]

We can argue that the year 2000 is a key moment in the recent history of health systems as the problem of HAIs acquired the status of being an emerging issue for healthcare management due to negative impact on performance of healthcare organizations, specifically in three dimensions of the *performance assessment tool for quality improvement in hospitals* (PATH): clinical effectiveness, safety, and patient-centeredness.[6,7] The dimension of 'patient safety' became a prominent issue in a report published in 2000 by the Institute of Medicine (IOM), entitled 'To err is human: building a safer health system', in which the international health management community became aware of shocking numbers of harm associated with medical errors and adverse events from related practice in healthcare organisations. It was also verified that the error rate in healthcare was higher than the error rate observed in others risk sectors (e.g. aviation) but the risk management systems were much more primitive than others developed for others risk sectors.[6–8]

In 2001, the Agency for Healthcare Research and Quality (AHRQ) initiated a large study on Healthcare practice and patient safety. Through a comprehensive analysis of literature and 'experts' opinion 79 types of practice were not only identified mostly related to inpatient setting but also including outpatient setting. Among various risk factors identified, the report highlighted some main problems related to incidents reporting, organizational issues on quality/safety (i.e. legislation, accreditation, market regulation requirements, professional regulation, and healthcare professionals' compliance levels), infection control systems and policies (i.e. surveillance systems at all levels and healthcare practice) and healthcare management systems (i.e. leadership, top management commitment, and team management) amongst the main areas identified.[9,10] Subsequently to this large study, new recommendations for hospital infection control systems were developed, especially aimed at healthcare professionals behaviour-related factors, as well as related to management of hospital structures (i.e. environmental and resources usage) and also aimed at reviewing clinical and healthcare management processes.[10–23]

In essence, as we presented in previous research, there have been a significant number of international programmes developed to understand and to promote the HAIs prevention and control systems and, consequently, improve patient safety and quality improvement of healthcare organizations.[24] In line with advances in implementing infection control systems, we assume that it is relevant to identify and discuss the constraints for the success of HAIs prevention and control systems. To contribute to this focussed debate, we developed a literature review aimed at producing an international update on barriers identified in recent published research.

Methods

Search strategy

The BioMed Central, Pubmed, Emerald, and B-on databases were searched for articles published from 2006 to September 2011 within a set of inclusion and exclusion criteria (Table 1).

A number of titles and abstracts were retrieved for each term and evaluated for relevance. From the relevant abstracts another set of free-text keywords were retrieved to focus the analysis. After selecting the relevant terms (7) and free-text keywords (12) it was then performed a universal search in the databases followed by retrieval of relevant articles, based on the title and abstract (Table 2).

Using a combination of at least one of these headings/terms and one of the free-text keywords as

Table 1: Inclusion and exclusion criteria

Inclusion criteria

(a) Contain abstract;
(b) Be published and available in a journal in public domain;
(c) Address an issue related to HAIs Prevention and Control Systems in hospitals;
(d) Contain a description about HAIs issue study;
(e) Contain a description of the barriers or constraints to prevention and control of HAIs;
(f) Discuss HAI's control systems relevant results about structures (resources, environmental conditions, organizational culture/values), process (clinical processes – best practices, therapy process, and management processes) and results (data, data quality, report);
(g) Contain quantitative data about at least one dimension of Healthcare-associated infection: Patient safety, infection type, hospital characterization (including dimension, structure, resource utilization, planning issues), management issues (programs/methodologies to control infection), communication issues (tools channels, processes, data available) and others;
(h) Have been published between January 2006 and September 2011

Exclusion criteria

(a) Articles not related with healthcare issues
(b) Articles analysing care processes
(c) Non Developed or Developing Countries
(d) Projects with main purpose of financial improvement
(e) Articles analysing change in software and/or hardware and Information Technology;
(f) Articles with description of methods, models and theories without empirical data.

Table 2: MeSH (headings), terms related and free-text keywords.

MeSH
Healthcare-associated infections
Healthcare-acquired infections
Nosocomial infection
Cross infection (MeSH)
Catheter-related infection (MeSH)
Hospital infection
Infection control (MeSH)
Free-text keywords
Prevention
Control
Best practices
Antimicrobial resistance
Surveillance
Hospitals
Patient safety
Barriers
Constraints
Programmes/tools
Standards

well as the inclusion criteria 'publication period', we identified 878 articles from Pubmed, 307 from BioMed Central, 281 from B-on, and 108 from Emerald. After this initial selection all the other inclusion/exclusion criteria were applied and the number of articles to be analysed was reduced to 74 articles from Pubmed, 46 from BioMed Central, 74 from B-on, and 14 from Emerald. Two reviewers independently scanned and evaluated all articles for consideration, and together decided whether or not to obtain the full text article. After this analysis a selection of 49 articles met all the inclusion criteria (see Fig. 1). Full publications of all selected abstracts or articles were obtained (electronic/printed form). All the articles were in English language.

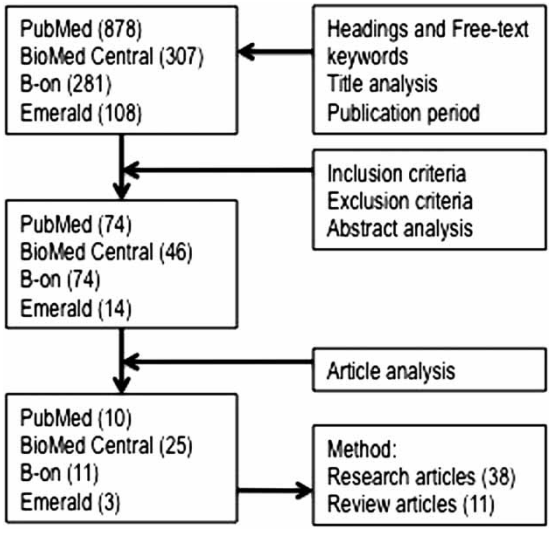

Figure 1: Search strategy.

Data collection and content analysis

A standard form was created for data extraction in Excel with the following labels:

- country or region;
- publication year;
- method
- study setting (hospitals, teaching hospitals, military hospitals, wards hospitals, and intensive unit care hospitals);
- barrier dimension/sub-dimension
- study objective
- key points;
- summary;
- barriers identified.

Table 3 summarizes data extraction results. A total of 38 articles were research studies and 11 were reviews. Of the articles identified, 25 were developed in Europe, 16 in North America; 6 in Asia, and 2 in Australia. One of the studies analysed more than one country (Switzerland and Germany). More than one study reported more than one country information. More than one article identified more than one barrier to HAIs control systems.

Results

From the literature review performed, we were able to identify a set of barriers to the success of HAIs' prevention and control programmes (see Table 4). These barriers were clustered in the three dimensions (structure, processes, and results), based in the Donabedian Triology developed to evaluate quality of care.[25,26] We assume that a healthcare organization is framed in an external context, divided into *macro context* (indirectly related with the organization, such as legislation/regulation, society, and others) and a *micro-context* (directly related with the organization, including suppliers, patients, patients' families, and others). Any analysis of an healthcare organization can be divided in answering to concrete questions such as 'Who we are…', and this includes 'structures' and its four sub-dimensions (infrastructures, resources, environmental conditions, and cultures/values), 'How we do…' being the 'processes' and its two dimensions (clinical processes and management processes), and 'What we get…' as results, divided in two sub-dimensions (data and reporting/communication) (Fig. 2). In this study we only analyse organizational barriers in relation to HAIs.

On the basis of this modelled approach we identified a number of barriers from the literature review undertaken. Below, the dimension and

Table 3: Data extraction results.

Country/region		Method	
Australia	2	Research article (38)	
Canada	1	Prospective study	23
Finland	1	Retrospective study	5
France	2	Modelling study	8
Germany	2	General research	2
Hong Kong	1	Review article (11)	
Italy	4	General review	7
Japan	4	Systematic literature review	4
The Netherlands	1		
Portugal	1	*Barriers per dimension/sub-dimension*	
South Korea	1	Structure (13)	
Switzerland	2	Infrastructures	3
Spain	2	Resources	7
UK	11	Environmental conditions	2
USA	15	Culture and values	1
		Process (14)	
Settings (Hospitals)		Clinical processes	7
Community hospitals	47	Management processes	7
Teaching hospitals	1	Results (3)	
Military hospitals	1	Data	2
		Reporting/communication	1

sub-dimension identified are presented with additional information concerning the published articles in which each set of barriers were identified (Table 4).

Discussion

A total of 49 articles met the inclusion criteria defined for the literature review performed. From these articles it was possible to identify 30 barriers, clustered by dimension/sub-dimension. A detailed analysis of the table shows barriers associated with structures and processes represent the bulk of barriers to implementing control systems to prevent HAIs followed by barriers associated with processes.

On the 'structures' there are the barriers related to infrastructures (hospital size and hospital level) and to resources, mainly associated with lack of health professionals – especially nurses – dedicated on a full-time basis to HAIs prevention and control programmes, as recommended internationally.[16,27] The barrier most identified in the largest number of articles pertains to 'environmental contaminations'. It was given the relevance of this barrier in the HAIs prevention and control, that CDC and Healthcare Infection Control Practices Advisory Committee (HICPAC) launched in 2003 and in 2008, respectively, a set of recommendations for Environmental Infection Control, Disinfection and Sterilization of Healthcare Facilities. Among the related recommendations it stands out, among other factors, the importance of the involvement of health professionals associated with the infection control programme at all stages of development of infrastructure/environment, as well as identification/risk assessment and related construction barriers. These organizations suggest the creation of multidisciplinary teams constituted by both those responsible for infrastructure and health professionals to maximize the effectiveness of infection control programmes.[13,28] Interestingly, the work carried out by Liyanage and Edgu[2] went further arguing for integrated management of infrastructure at the level of environmental contamination and clinical practice in order to better integrate processes and practices undertaken by both clinical and nonclinical activities in interventions for HAIs prevention and control. Also related to the 'structure' dimension a study commissioned in 2001 by the AHRQ on safe practice presents 'organizational culture' as key to improving patient safety. Other authors also argue that medical practice must also take into account the issues related to structures – culture and values to improve the overall quality of healthcare.[29,30]

The review performed allows us to state organizational processes are the source of the largest diversity of barriers to successfully implement effective HAIs prevention and control programmes. On the 'clinical processes' sub-dimension, the barrier 'poor infection control practices' is a key point. This barrier encompasses a range of factors highlighted in the literature reviewed as being primarily responsible for the difficulty of the HAIs control

Table 4: Barriers identified in the studies.

Dimension	Sub-dimension	Barrier identified	Study*
Structures 'Who we are'	Infrastructures	Hospital level (type of ward, size, and type of services)	(2), (5), (22), (45)
		Structure limitations for isolation precautions	(30)
		Overcrowding wards	(8), (17)
	Resources	Under-resourced infection prevention programmes (budget, staff, etc.)	(3), (4), (38)
		Accessibility to hand-hygiene resources	(5), (17), (30), (35)
		Costs (implementation programmes, resources)	(11), (35)
		Temporary nursing staff and reduced number of FTE (fulltime equivalent) associated to infection control (less than the recommended standard)	(17), (19), (20), (35), (41)
		Time consumed by the surveillance programmes	(25)
		Home laundering instead of industrial laundering	(48)
		Workload (healthcare workers)	(5), (8)
	Environmental conditions	Environmental contamination (air, surfaces, floor, bed linen, and others)	(1), (6), (7), (8), (12), (17), (23), (30), (32)
		Clothes contamination (e.g. white coats)	(46), (48)
	Culture and values	No compliance with infection control culture, policies, and social norms (e.g. wearing uniforms in public spaces, resistance to apply rules/standards in practice – more doctors than nurses)	(4), (14), (18), (22), (48)
Processes 'How we do'	Clinical processes	Poor infection control practices (guidelines inconsistently implemented, disinfection not appropriately performed on clinical practice, hand hygiene no compliance, insufficient use of protective equipment, lack in understanding the exact mechanism of pathogen transmission)	(1), (7), (8), (9), (11), (12), (13), (14), (17), (20), (22), (23), (31), (32), (36), (39)
		Biological factors, intubation process, blood transfusion, invasive procedures, and treatment duration (long stay in hospital)	(17), (21), (27), (29), (34), (43), (44)
		Risk factors identification	(26)
		Therapy (use of antibiotics, antimicrobial resistance)	(16), (26), (27), (31), (35)
		Reactive practice instead proactive practice	(30)
		HAIs definition (definitions, ICD codes limitations for HAIs classification)	(3), (41)
		Doctors as HAIs vector (link to different wards)	(46), (47)
	Management processes	Awareness, perceived risk, individual attitude, individual behaviour (healthcare professionals)	(5), (13), (22), (36), (39)
		Knowledge, education, and training	(5), (12), (13), (17) (36), (39), (41)
		Lack of information/quality of information (colonized patients in real time, persistence of pathogen agents on inanimate surfaces, swabs, or clinical samples quality in admission and during hospital stay)	(7), (15), (23)

Continued

Table 4: Continued

Dimension	Sub-dimension	Barrier identified	Study*
		Support operations (ward, bed occupancy, patient turnover, teams management and relationship, workload, domestic services, use of resources, and responsibilities definitions)	(1), (5), (8), (18), (19), (24), (28), (30), (35)
		Lack in the assessment/evaluation methods (ethical limitations, business case, cleaning spaces, hand hygiene, and cost-effectiveness analysis)	(3), (11), (12), (18), (22), (43)
		Lack in leadership	(19), (22), (26), (33)
		Lack in the surveillance methods (no standardized methodologies)	(15), (25), (35), (37), (38)
Results 'What we get'	Data	Lack of data (no data, susceptible to error, underestimated infections rates)	(8), (9), (10), (25), (37), (40)
		Data treatment/analysis limitations	(41), (49)
	Reporting/ communication	Lack in the reporting systems (including feedback, report errors)	(2), (10), (26), (35), (41), (42)

*The numbers pointed refer to the articles reviewed (see references in the Appendix).

systems, with emphasis on the noncomplicance of health professionals to hand-hygiene procedures. This behavioural factor has been identified as a key element for HAIs prevention and control and, although it is considered a simple action, the lack of compliance among healthcare providers is still problematic worldwide. The cause of this phenomenon is often associated with structural factors (i.e. workload, type of wards, and accessibility to hand-hygiene resources) and process factors (i.e. knowledge, training, perceived risk, and individual attitude). Aware of this problem, the CDC and the World Health Organization (WHO) developed a range of strategies for hand-hygiene promotion and improvement. For this purpose the WHO proposed the First Global Patient Safety Challenge, 'Clean Care is Safer Care', focusing part of its attention on improving hand-hygiene standards and practices in healthcare along with implementing successful

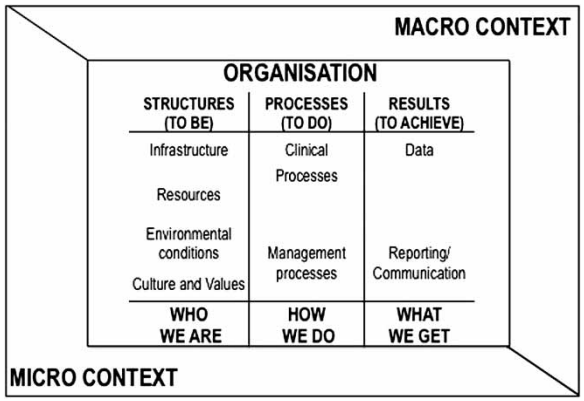

Figure 2: Healthcare organization model.

interventions.[11,31,32] Another important related phenomenon pertains to the poor quality of infection control programmes mirroring the fact that these are designed with no support from scientific evidence and inconsistently implemented including the lack of organisational epidemiologic surveillance programmes. For this reason the WHO developed, in 2009, guidelines on the core components of Infection Prevention and Control Programmes.[16]

Further to this, two other key factors are identified systematically in the international literature reviewed: clinical procedures (such as invasive procedures) and therapy. Related to the former we identified several articles dedicated to the subject. It stands out the analysis made by the AHRQ on patient safety practices. In this work, the interventions undertaken to minimize the effects of invasive procedures in patient safety are analysed in detail.[9] Given the importance of invasive procedures (surgery, invasive devices) in HAIs prevention and control the CDC developed in 2002 (updated in 2011) some guidelines for the prevention of intravascular catheter-associated infections[12,28] and guidelines for disinfection and sterilization in healthcare facilities.[28] The WHO, in 2009, also launched the Second Global Patient Safety Challenge – Safe Surgery Saves Lives.[33,34] On what concerns therapy, it has been argued that this is one of the major concerns worldwide and a large number of articles demonstrate that inadequate therapy, besides being one of the main responsible for HAIs, is also one of the main responsible for antimicrobial resistance, such as MRSA.[4,35–37] To combat the specific problem of therapy control, the CDC,

the WHO, and the European Union have been developing since 2001 a set of recommendations and programmes to assist healthcare organizations in the HAIs prevention and control.[24,38]

Related to 'processes' the literature reviewed allows to add further relevant barriers: 'support operations', 'awareness', 'knowledge', 'surveillance methodologies', 'leadership', 'assessment/evaluation methods', and 'surveillance programmes'. Factors considered to be the causes of failures in these healthcare management activities, include difficulties associated with ward management, healthcare team management, hospital and cleaning services management, role definition, and inadequate use of resources. Some authors also identified poor knowledge management as an important factor hindering organizations' capacity to better integrate processes and practices developed clinical and nonclinical activities, better team management and definition of roles for HAIs prevention and control programmes.[2,39–41] To assist with the resulting healthcare management challenges, as we presented in our previous work related with healthcare management issues, there have been serious developments worldwide to develop and implement programmes and guidelines to promote quality improvements in healthcare, such as accreditation and certification programmes.[24,42–48]

Related to the barriers here defined as 'assessment/evaluation methods' and 'leadership' in healthcare organizations, key international organizations (i.e. WHO, Organisation for Economic Co-operation and Development, Institute for Healthcare Improvement – IHI) have developed recommendations and guidelines to improve the quality of the care delivered.[49–51] Also, the lack of effective 'surveillance methods' is identified in the literature as a key barrier and it has been reported as a problem for HAIs prevention and control due to simple inexistence of any such effort or due to the poor quality of existing surveillance methods and programmes.[52,53] Surveillance programmes are fundamental for HAIs prevention and control systems. Inexistence or inappropriate surveillance systems imply that there will be no information and scientific evidence on the evolution of HAIs and no clear focus on measures to implement. To tackle this problem some international guidelines and programmes were developed to promote the implementation and the quality of organizational surveillance programmes, including those presented in 2009 by the WHO in the 'Core Components for Infection Prevention and Control Programmes' and by the European Union in related Council Recommendations.[16,24,43] On the basis of these recommendations many European countries are currently undertaking surveillance programmes.

Concerning the dimension defined as 'results' three barriers were identified: data quality, data treatment, and reporting/communication. These barriers are clearly related with the lack of effective 'surveillance methods' and related with the absence of reliable epidemiological data. In the USA, a report for 11 states argues that the quality of existing data is often questionable given the difficulties presented by the reporting methodology. Owing to this key healthcare management factor, during the last years a number of networks were established to support and promote the quality of healthcare management data and the quality of data reporting/communication methods.[37] One of the long-term networks dedicated to this purpose is the HELICS project created in 1997 (actually part of the Improving Patient Safety in Europe (IPSE) programme), the EUInfoPas created by the European Union in 2006 (to encourage and support member states in establishing effective patient safety reporting systems) and recently the HAI-Net Project developed at European union level in 2011.[24,37]

Conclusions

A set of healthcare management barriers to the development of effective HAIs prevention and control programmes has been identified in this study. This is a contribution to the international debate on healthcare management approaches to tackle HAIs. This study is a structured update on the key barriers and related recommendations and guidelines developed to overcome difficulties in implementing effective HAIs' prevention and control systems. From the recommendations and guidelines identified, it is clear that a bundle of actions and interventions have been developed both at organizational level and health system level since, at least, 2001. These recommendations and barriers were identified in our previous research that also looked into additional healthcare management issues. Yet, the problem persists. The literature review performed allows to state that it does not seem to be a lack of pertinent recommendations and guidelines and even related solutions to tackle high levels of HAIs. The key problem seems to be on how these are adopted, adapted, developed, implemented, maintained, and evaluated in healthcare organizations. In essence, it is now a problem of effective healthcare management.

The international healthcare management community should be open to critically appraise and

review the approaches adopted to tackle this key contemporary challenge of healthcare organizations.

Further research is needed to explore and clarify why and how failures on effective and sustainable management systems to promote HAIs prevention and control systems are occurring. If it is not due to the lack of pertinent programmes, systems and related organizational options and solutions, it must be due to how these are being implemented.

Appendix

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