

A review of infection control in community healthcare: new challenges but old foes

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Received: 29 April 2014 / Accepted: 20 June 2014 / Published online: 4 July 2014
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Abstract The demographics of the healthcare population are changing, with an ever-greater proportion of people being treated outside the traditional hospital setting through community healthcare. This shift in the way that healthcare is delivered raises new concerns over community healthcare-associated infections (HCAIs). A literature search between 2000 and December 2013 was conducted in databases including PubMed, SciVerse ScienceDirect and Google Scholar. National and international guideline and policy documents were searched using Google. Many terms were used in the literature searches, including ‘nosocomial’, ‘healthcare infection’, ‘community’ and ‘nursing home’. The rates of HCAI in community healthcare are similar to the rates found in the acute hospital setting, but the types of infection differ, with a greater focus on urinary tract infections (UTIs) in the community and ventilator-associated pneumonias in the hospital setting. Patients who acquire a community HCAI are more likely to exhibit reduced physical condition, have increased levels of morbidity and have higher mortality rates than individuals without infection. Infection control programmes have been developed worldwide to reduce the rates of hospital HCAIs. Such interventions are equally as valid in the community, but how best to implement them and their subsequent impact are much less well understood. The future is clear: HCAIs in the community are going to become an ever-increasing burden and it is critical that our approach to these infections is brought quickly in line with present hospital sector standards.

Introduction

A healthcare-associated infection (HCAI) is “an infection occurring in a patient during the process of care in a health care facility which was not present or incubating at the time of admission” [1].

The worldwide prevalence of HCAIs is difficult to measure because of differences in reporting regimes. However, the World Health Organization (WHO) recently estimated that the pooled prevalence rate of HCAIs in high-income countries ranged between 5.1 and 11.6 % [1]. The European Centre for Disease Prevention and Control (ECDC) published the results of its first EU community-wide point prevalence study of HCAIs in 2013 [2]. 15,000 HCAIs were reported during the period of the survey. Respiratory tract infections were the most common, followed by surgical site infections (19.6 %) and urinary tract infections (UTIs; 19.0 %) [2]. The results of the ECDC annual epidemiological report of 2013 showed that a diverse range of bacteria and fungi were responsible for HCAIs and that an increasing proportion of these organisms were resistant to standard antibiotic treatment [3].

Programmes designed to reduce the incidence of hospital HCAIs have been developed and revised at national and international levels over a number of years. The WHO published its revised guide to managing such HCAIs in 2002 [4], the USA in 2009 [5] and this was followed by a series of updates (see, for example, [6]), and Scotland produced a “Compendium of Healthcare Associated Infection Guidance” in 2012 [7]. While these documents focused mainly upon the hospital sector, others have also recognised the increasingly complex clinical practice within primary/community care, and the resulting need for contemporary infection prevention and control guidance [8, 9].

An ever-greater proportion of people are being treated outside the traditional hospital setting through community healthcare [10, 11]. This shift in the way in which healthcare

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is delivered has raised new concerns over community HCAs. Community healthcare is distinctly different from acute healthcare and represents a new set of challenges for infection control professionals. Friedman et al. [12] defined community HCAs as those occurring in individuals that:

- Received specific home care (wound care for example) or attended a hospital clinic in the 30 days before the infection
- Were hospitalised for two or more days in the 90 days prior to infection
- Resided in a nursing home or long-term care facility

Guidance on managing community HCAs has been published by a number of regional and national government organisations. For example, a recent strategy to combat community HCAs was published in Wales in 2007 [13], the USA in 2013 [9] and updated recommendations have recently become available in England [8]. The diversity of organisations involved in the provision of community healthcare can lead to differences in the approach to infection control [13]. Coupled with this, healthcare provision often involves the care of patients with chronic underlying conditions [14], which may leave them at a greater risk of infection than the general population.

The purpose of this review is not to be exhaustive but, rather, to focus on the key issues that make community HCAs different from hospital-related HCAs and to highlight current gaps of knowledge and practice within community HCAs.

Methods

A literature search between 2000 and December 2013 was conducted in databases including PubMed, SciVerse ScienceDirect and Google Scholar. Literature prior to 2000 was included as appropriate. The search term list was as follows:

- Healthcare infection OR nosocomial OR MRSA OR *Clostridium difficile* OR extended-spectrum beta-lactamase OR vancomycin-resistant enterococci OR carbapenem-resistant Gram-negative bacilli AND
- Community OR nursing home OR care home OR community care

The literature search was expanded through searches of the references from relevant articles collected in the initial search. National and international guideline and policy documents were searched using Google. The resultant body of literature consisted of 634 articles. A review of these 634 articles for relevance to community HCAs resulted in a final list of 64 manuscripts.

Results

Prevalence

The surveillance of HCAs outside the hospital has been subject to several studies. Table 1 describes the available HCAI prevalence data alphabetically by region and country.

The Americas

In Brazil, home healthcare services (HHCSs) are increasing in number and this has been recognised as a potential area of infection control concern [15]. Araujo da Silva and colleagues investigated cases of HCAI in patients ($n=31$) attending a children's HHCS for more than 24 h during 2008 and 2009. All patients were either from the intensive care unit or the surgical intensive care unit. A total of 129 HCAI episodes were detected during the study period, including 55 (43 %) pneumonias, 19 (15 %) influenza-like illnesses, 18 (14 %) skin infections, 15 (12 %) UTIs and 8 (6 %) conjunctivitis cases. Sixty-nine percent ($n=27/39$) of hospital readmissions were due to an HCAI, three patients died and two of these deaths were linked to an HCAI [15].

In the United States, the Department of Veteran Affairs oversees a number of care home facilities. In 2007, a point prevalence survey was conducted across 133 community living centres, which found that, from a population of 10,939 residents, 575 had at least one HCAI (5.3 %). UTIs were the most common (1.64 %), followed by skin infection (0.72 %) and asymptomatic bacteriuria (0.58 %). The presence of an indwelling device was a significant risk factor for HCAs (3-fold greater risk, $p \leq 0.01$). Ventilator-associated pneumonias were uncommon, as only 10 patients (out of 10,939) were ventilated [16]. A further investigation by the same authors, but focusing instead on nursing homes, found similar results. A total of 11,475 nursing home residents' records were assessed and 591 (5.2 %) had at least one HCAI. Symptomatic (1.58 %) and asymptomatic (0.69 %) UTIs were the most commonly reported [17].

Europe

The ECDC funded a prevalence study on HCAs under the title "Healthcare Associated infections in European Long-Term Care Facilities (HALT)". The project ran from December 2008 to May 2011 and the study group first published results as a pilot study in 2009 [27], before conducting a second surveillance study from May to December 2010. The overall estimated prevalence of HCAs in long-term care facilities was 2.4 % ($n=1,488/61,932$ respectively for the two phases) [28]. As offshoots from the HALT study, a number of articles providing country-specific data on the

Table 1 Prevalence of community healthcare-associated infections (HCAIs)

Region	Country	Year	Setting	Population size	HCAI prevalence	Study type
Americas	Brazil [15]	2008–2009	Children's home healthcare	31	129 HCAI episodes ^a	Prospective follow-up
	USA [16]	2007	Community living centres	10,939	5.3 %	Point prevalence
	USA [17]	2005	Nursing home care units	11,475	5.2 %	Point prevalence
Europe	France [18]	2006–2007	Nursing homes	44,869	11.23 % ^b	Clustered period prevalence
	France [19]	2000	Hospital at home service	376	6.1 %	Point prevalence
	Germany [20]	1998–1999	Nursing home	125	6.0/1,000 resident days	Prospective surveillance
	Ireland [21]	2010	Care homes	4,170	3.7 %	Point prevalence
	The Netherlands [22]	2010	Nursing homes	1,429	2.8 %	Point prevalence
	The Netherlands [23]	2007–2009	Nursing homes	1,275–1,772	6.7–7.6 %	Multiple point prevalence
	Norway [24]	2004–2005	Nursing homes	–	5.2/1,000 resident days	Prospective cohort
	Norway [25]	1997–1999	Nursing/residential homes	13,762	6.5 %	Point prevalence
	Scotland [26]	2010	Care homes	4,870	2.6 %	Point prevalence

Summary of healthcare-associated infection (HCAI) rates reported for community healthcare facilities. The data are presented as the percentage of patients with an HCAI, unless stated otherwise. Articles that focused on specific infections (such as methicillin-resistant *Staphylococcus aureus*) or specific sites (such as bloodstream infections) are not shown

^a Cases of HCAI reported (129) in 31 patients

^b Presumptive cases. The rate of definite cases, confirmed by laboratory investigation, was 4.6 %

prevalence of HCAIs in long-term care facilities have been published [21, 26].

Chami and colleagues investigated the prevalence of HCAIs in nursing homes in France during the period 2006–2007. They undertook five clustered period prevalence surveys of 44,869 residents in 578 facilities. Cases of infection were defined as presumptive unless confirmed by laboratory investigation. The overall prevalence of infections was 11.23 % (6.63 % presumptive and 4.6 % confirmed) [18]. An earlier point prevalence study of 376 patients that took place in a Parisian 'hospital at home' unit found that 6.1 % had at least one HCAI. UTI was the most common HCAI, accounting for half of the reported cases. The most significant independent risk factor for HCAIs was the presence of a urinary catheter [odds ratio (OR)=15.9; 95 % confidence interval (CI) 6.3–40.1, $p < 0.0001$]. The most commonly isolated pathogens were *Escherichia coli* (29.4 %), *Staphylococcus aureus* (29.4 %) and *Enterococcus* spp. (17.6 %) [19].

Engelhart and colleagues used the case definitions described by McGeer et al. in 1991 [29] and applied them to cases of HCAIs in German care homes. The study was undertaken in a 103-bed nursing home in Bonn in 1998 and 1999. The prevalence of HCAIs was 6.0/1,000 resident days. Respiratory tract infections, gastroenteritis, skin/soft tissue infections and UTIs accounted for 94 % of cases [20].

A study in Irish long-term care facilities found that 11.3 % of residents showed signs or symptoms of infection and/or were on antibiotics. This point prevalence survey (part of the HALT study) was conducted in 69 long-term care facilities with 4,170 residents. One hundred and fifty-six infections

(3.7 %) were recorded when physician diagnosis was taken into consideration. No significant differences with the type of facility or length of stay were found. UTIs were the most common and accounted for 40 % of cases, with seven patients having more than one HCAI at the same time [21].

The Dutch data from the HALT study was published in 2010, and from a cohort of 1,429 residents from ten nursing homes, the overall prevalence of infection was 2.8 %. The authors of this study did not report on the types of infections found; however, they did investigate what the risk factors for HCAIs were amongst the residents. The presence of pressure wounds [risk ratio (RR)=2.58; 95 % CI 1.04–6.39] and other wounds (RR=5.70; 95 % CI 2.99–10.86) were reported as risk factors for HCAIs [22]. The prevalence of HCAIs in nursing homes in The Netherlands from 2007 to 2009 was assessed using a single-day prevalence approach. The prevalence of patients with a diagnosed HCAI was 6.7 % (2007), 7.6 % (2008) and 7.6 % (2009). The size of the populations investigated ranged from 1,275 in 2007 to 1,772 in 2009. UTIs followed by pneumonia were the most common HCAIs reported and most HCAIs were amongst residents in rehabilitation units [23].

In Scotland during July 2010, an HCAI prevalence study was undertaken as part of the HALT initiative. The Scottish study included 4,870 residents from 83 care homes. The prevalence of HCAIs was 2.6 % (range 0–13.5 %). The most commonly reported infections were those of the urinary tract (52.7 %), respiratory tract infections (19.4 %) and skin infection (15.5 %) [26].

Based on the information available (Table 1), the prevalence rates reported for community HCAIs during the first

decade of the 21st century appear similar to those reported for hospitals. Given the diverse methodologies employed in the collection and analysis of these data, coupled with the varying definitions of HCAI, comparing results across the studies quoted must be undertaken with caution. This highlights the need for international standardisation of definitions and comparable approaches to data collection. To date, the best example of this is the HALT programme [27].

Health outcome

The literature on health outcomes related specifically to HCAs in community care facilities is much less complete than the data within the acute hospital setting. Where data are available, community HCAs have been shown to negatively impact on health outcomes: for example, during a 30-day evaluation of nursing home residents in Norway, those who had an HCAI were 2.3 times more likely to have shown a reduction in physical condition (95 % CI 1.5–3.4) when compared to residents free from such infections (the prevalence of HCAs was 5.2/1,000 resident days) [24]. When different types of infection were taken into consideration, those with the highest effect on physical condition were lower respiratory tract infection (RR=3.3; 95 % CI 1.9–5.5) and UTI (RR=2.5; 95 % CI 1.5–4.1). There was also an increase in the number of hospital admissions amongst residents who had experienced an HCAI, with a risk ratio of 9.2 % (95 % CI 5.0–17.1). The highest risk was for residents with a lower respiratory tract infection (RR=15.0; 95 % CI 7.8–28.9) followed by UTI (RR=7.9; 95 % CI 4.0–15.6). Overall, 16.1 % of residents who experienced an HCAI during the study period died compared to 2.4 % in the unaffected group [24]. A prospective surveillance study undertaken in a nursing home in Bonn (Germany) provided further evidence that some types of HCAs have more severe outcomes than others. During a 12-month surveillance period, 208 HCAs were recorded for the 125 residents of a nursing home. Respiratory tract infections were the most common (2.16/1,000 resident days) and were also associated with a higher death rate. A total of 30 (24.0 %) residents died in the study, where 13 (43.3 %) of these cases involved an infection as either a direct cause of death or a major contributing factor. Residents with pneumonia were found to be more likely to die than residents with other HCAs (RR=5.09; 95 % CI 1.87–13.89; $p=0.011$) [20].

While evidence suggests that community HCAs result in increased morbidity and mortality, it is unclear whether those admitted to hospital from residential care facilities are more likely to respond poorly to treatment or show less positive outcomes than those admitted to hospital from their own homes. One study [30], undertaken on 10,593 admissions to a geriatric medical care unit, showed that patients from a residential setting stayed, on average, no longer in hospital than those admitted from their own home [16 ± 2 days

(residential), 17 ± 2 days (own home)]. The mean survival time was 61 days (95 % CI 37–84) for patients from a residential setting compared to 48 days (95 % CI 25–72) for those patients admitted from home. When the different types of residential homes were analysed, significant differences in survival times were found. In particular, those patients who had come from private nursing homes had a lower mean survival time compared to those admitted from their own home [24 days, 95 % CI 19–29 (private nursing home), 48 days, 95 % CI 25–72 (own home)]. Once more, the most common site of infection was the respiratory tract, and while the range of pathogens responsible for infection did not differ between groups, no information was provided on antibiotic resistance profiles.

The impact of the hospital on community HCAs may be significant. A study undertaken in 32 German care homes found that, of the 139 residents (7.6 %) who were methicillin-resistant *S. aureus* (MRSA)-positive, all were colonised with strains recognised as circulating within hospitals. No evidence for the presence of community-acquired or livestock-associated *S. aureus* strains was found [31]. Similarly, the prevalence and source of *S. aureus* infections at a university hospital in Israel were investigated from 1988 to 2007. During the study period, 1,347 clinically significant episodes of *S. aureus* bacteraemia were recorded. Six percent ($n=86$) were deemed as community-acquired and all were caused by methicillin-sensitive *S. aureus* (MSSA). All of the remaining 1,261 infections were associated with healthcare; 58.3 % ($n=735$) were hospital acquired and 41.7 % ($n=526$) were acquired in the community healthcare setting. The main risk factor for community healthcare acquisition was stay in hospital in the previous 90 days [32]. It is most probable that there was a close association between the pathogens circulating within the hospital setting and the community healthcare settings, with just a small contribution from the general community. However, this situation may be changing, as hospital-associated strains of MRSA have begun to appear with greater frequency in the community [33]. This mixing of strains between sources (Fig. 1) may result in different levels of infective risk, based not only on the source of the pathogen, but also on the particular circumstance and underlying condition of the individual. The most important pools of pathogens are the hospitals and community healthcare facilities, and research suggests that pathogens flow back and forth between these [34]. Effectively, as traditional pathogens that cause HCAs mix between the two environments, in doing so, they will establish endemic status within communities and cause community HCAs there. Much more rarely, new strains may also come into hospital from the community via zoonosis, as has happened recently with MRSA strain 398 [35] and H₇ influenza virus/coronavirus [36, 37].

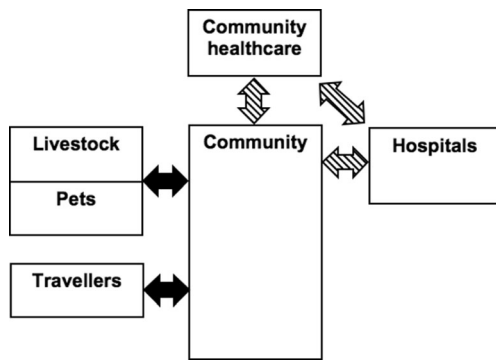


Fig. 1 Interactions of different cohorts in the spread of pathogens causing healthcare-associated infections (HCAIs). Adapted from Gastmeier [34]

Spread of pathogens between healthcare facilities

Meticillin-resistant Staphylococcus aureus

Nursing homes are an important reservoir of MRSA and strains are likely to transfer between these sites, hospitals and the community. In Orange County (USA), evidence for the transfer between different sites has been reported. A multi-centre regional assessment was undertaken in the period 2009–2011. A total of 3,806 nasal swabs from the residents of 26 nursing homes were analysed, of which 837 (22 %) were positive for MRSA. Eighty-three percent of all MRSA isolates belonged to two clonal groups that commonly circulated in local hospitals (USA100 and USA300), which could have been because a high proportion of residents were admitted directly from hospital [38]. A recently published modelling study showed that the addition of MRSA cases within nursing homes into the simulations potentiated the impact of hospital outbreaks, even when the nursing home was not directly linked to the hospital [39]. A comprehensive study of the phylogeny of MRSA [40] has provided a valuable insight into the spread of MRSA through the human population. The genetic relatedness of seven publicly available complete or draft MRSA sequences and 80 additionally sequenced MRSA strains representative of the diversity with the clonal complex 30 (cc30) of MRSA were investigated. The cc30 group was chosen because member strains have been responsible for three separate pandemics over the past 60 years and were additionally responsible for the toxic shock syndrome pandemic of the 1970s and 1980s [41, 42]. The cc30 lineage of MRSA is divided into three distinct clades of a common ancestry: phage type 80/81, Southwest Pacific (SWP) and EMRSA-16 (EMRSA-16 strains predominate in UK hospitals). London and Glasgow were found to be the origin for the spread of EMRSA-16 to surrounding smaller hospitals. Glasgow hospitals were the most probable origin of EMRSA-16 strains isolated from the surrounding population centres in the North and East of Scotland [40].

Clostridium difficile

Clostridium difficile, while traditionally considered a pathogen of the hospital setting, is now increasingly encountered in the community [43] and is the leading cause of infectious diarrhoea in nursing homes [44]. There is evidence for transfer from both the community and hospitals to long-term care facilities [45–47].

A retrospective review of *C. difficile*-associated infection (CDI) in a 200-bed long-term care facility in Baltimore (USA) was undertaken for the period 2001–2004. The incidence of CDI ranged from 0 to 2.62 cases per 1,000 bed days, but those wards where the majority of patients were admitted from hospital had higher CDI rates than wards where the majority of patients had come from the community, suggesting the transfer of *C. difficile* from hospital to care home [45]. A study undertaken at four community nursing homes in Buffalo (USA) found that two-thirds of CDI cases were in patients showing symptoms of CDI within 30 days of admission from hospital [46]. Hospital patients with CDI may also be more likely to go straight to long-term care than those without CDI [48], further increasing the likelihood of transmission between healthcare facilities. Mixing between the community and healthcare facilities also occurs [47–49]. Another study in The Netherlands focused on the epidemiology of the hyper-virulent *C. difficile* ribotype 027 in 50 healthcare facilities from 2005 to 2006. This ribotype was equally distributed amongst those patients with community-onset CDI and healthcare-associated CDI [47], suggesting that the transfer of *C. difficile* strains between the community and healthcare populations is common.

Extended-spectrum beta-lactamase producers, vancomycin-resistant enterococci and carbapenem-resistant Gram-negative bacilli

Drug resistance is a concern for other medically important bacteria such as the Enterobacteriaceae and other Gram-negative bacteria, where multi drug-resistant strains that originated in the hospital setting are now appearing in long-term care facilities and in the community [50–54]. However, the literature on the epidemiology of these important pathogens outside of the acute hospital setting is limited.

Community-focused sampling of the faeces of individuals with gastrointestinal complaints (but not hospitalised within the prior two months) in Buenos Aires, Argentina has showed that 18.9 % ($n=31/164$) of individuals were colonised with an extended-spectrum beta-lactamase (ESBL)-producer and eight (4.9 %) were colonised with carbapenem-resistant Gram-negative bacilli (CRGNB) in one study conducted in 2012 [51]. A similar study undertaken in Amsterdam (The Netherlands) in 2010 and 2011, which included individuals presenting at general practices with gastrointestinal

complaints, reported that 10.1 % ($n=73/720$) of individuals were colonised with an ESBL-producer. No strains of CRGNB were found [52]. While the methods of microbial identification differed between these studies (culture versus culture and molecular methods) and, therefore, care should be taken when comparing these data, the differences in reported prevalence may have been due to dissimilarities in antibiotic use. In Argentina, antibiotics are available over-the-counter [51], whereas in The Netherlands, their use is more tightly controlled [52].

A period prevalence study was undertaken in nursing homes, geriatric clinics and ambulant care in Frankfurt am Main, Germany during the period 2006–2007. Out of 288 patients, 20.1 % ($n=58/288$) were colonised with multi drug-resistant bacteria (determined by culture and molecular methods). In addition, 6.2 % ($n=4/64$) of staff were also colonised. Among the patients, 3.8 % ($n=11/288$) were colonised with vancomycin-resistant enterococci (VRE) and 8.7 % ($n=25/288$) were found to be colonised with ESBL-producers. Twenty-seven (9.4 %) were colonised with MRSA. The most significant risk factors for the carriage of such drug-resistant bacteria were the presence of a urinary catheter (OR=3.1; 95 % CI 1.7–5.9; $p<0.001$), prior hospitalisation (OR=2.1; 95 % CI 1.1–4.0; $p=0.033$) and the presence of a wound or pressure ulcer (OR=2.3; 95 % CI 1.5–4.9; $p=0.03$) [50]. The fact that prior hospitalisation was found to be a significant risk factor for the carriage of multi drug-resistant bacteria suggests that transfer between healthcare facilities may occur (as with MRSA and *C. difficile*). Oteo et al. undertook a prospective surveillance study in Madrid (Spain) during the period 2004–2005. A total of 525 ESBL-producers (*E. coli* strains) were collected, of which 151 were resistant to cefotaxime and ceftazidime. Molecular analysis of these strains showed that four dominant clusters were distributed through the hospitals, long-term care facilities and the community [53]. A similar study undertaken in Dublin (Republic of Ireland) during 2009–2010 aimed to assess the spread of *E. coli* ESBL-producers through the healthcare system. The authors reported that common *E. coli* ESBL clones were found to be distributed between the hospital and several local community healthcare facilities, providing evidence of a ‘revolving door’ situation where strains were being recycled between facilities [54].

Infection control experience in HCAs

Standard infection control practices apply as much in community healthcare as in hospitals. However, because of the unique situation within community healthcare—environments that differ considerably both between one another as well as hospitals, and at-risk populations that may be cohorted together—guidance directed solely at community healthcare has been published by some national regulatory bodies [8, 13].

Arguably, the challenges within the community are much greater than in the hospitals and may require specifically tailored interventions [55]. The diversity of community provision, both in terms of facilities as well as staffing mix, make infection control and prevention more difficult to ensure and monitor. Staff in the community may not be subject to the same training requirements and professional qualifications, and the accountability for the infection control effort may be less clear. It is notable that, although many nations now have mandatory reporting for at least some hospital HCAs, the monitoring and reporting of such performance in the community frequently does not follow the same transparent and public lines and is generally not available to the public or professionals alike. The National Institute for Clinical Excellence (NICE) in England recently updated its guidance on the prevention of community HCAs [8].

While there is a clear focus on reducing the risk of infection through cleanliness and adherence to standard infection control practices, what is not clear is who will promote high qualities of infection control and prevention practice and who will then monitor compliance. The changing nature of the environments experienced by community practitioners (care home, nursing home and individual homes) dictates that there is no easy mapping across to the hospital setting. In the UK, the community care sector is populated by different providers (state, private company and a combination of both), which carry differing challenges on how best to implement and monitor progress. In the hospital sector, there are well-understood mechanisms for infection control practitioners to train, monitor and improve infection control care. In contrast, the diversity of workforces, where staff often show high turnover rates, in the community setting are usually supported by much less resource in terms of infection control training and supervision. This variety of providers is then subject to a mixture of regulatory mechanisms, where inspectors are frequently not infection control specialists. The monitoring and reporting of HCAI prevalence in community care is, thus, more difficult than in the hospital sector. In some recent audits, the prevalence of HCAs in care homes has differed based on criteria [18] and it is often not possible to define the best approach to determining prevalence rates. A focus on device interventions is both appropriate and required because these pose a recognised, but manageable, risk for infection [16, 56]. Additionally, the guidelines rightly highlight the importance of regular review of the requirement for urinary cauterisation [8] because the longer the indwelling device is present, the greater the risk of infection.

A recent study that used the Delphi consensus approach highlighted a number of interventions that were recognised as being important in the reduction of infection in nursing homes [57]. The study was undertaken by 23 specialists, who reviewed the literature and initially made 301 recommendations, which were then assessed by 81 experts from different

medical specialties. The outcome of this work was a final list of 240 items where there was consensus amongst the expert group regarding their importance in infection control. The recommendations were categorised into four areas as follows: standard precautions (hand-washing for example); general non-specific measures for preventing HCAs (immunisation etc.); measures specific to the prevention of HCAs (such as policies on catheterisation); and organisational principles. The researchers highlighted the difficulties they had experienced in locating sufficient literature to inform their work [57]. While this work produced a valuable contribution to understanding HCAI interventions for the community, it did not address the fundamental issues about implementation, compliance and performance reporting that are essential to success. Nor was there any health economic assessment to guide and embed the output in the real world. The mere fact that the final list was for 240 issues is, in itself, a potentially demotivating factor by generating a sense of an overwhelming, unobtainable solution and clear prioritisation amongst these would have been helpful to target focus.

Economic impact

Most of the studies relating to the economics of HCAs relate to issues within hospitals [58–63]. Few studies are available that concentrate on community healthcare.

One study reported on a 3-year point prevalence study of HCAs in long-term care facilities in Norway. A total of 4,400–5,000 residents were studied over the period from 1997 to 1999. There were 4,100–4,600 residents in nursing homes and 210–430 in residential homes. The study involved over 70 institutions. The overall prevalence of HCAs was 6.5%. Post-operative patients had the highest rate of infection. The authors postulated that these infections would have resulted in additional nursing support, bed care and antibiotic treatment. The additional antibiotic costs alone were estimated to be 157,500 Norwegian Kroner (Nkr) (\$22,500) per day, based on a daily cost of 500 Nkr per patient [25].

The costs associated with the management of *S. aureus* in a 375-bed long-term care facility in Connecticut (USA) were assessed in a study involving 90 residents with *S. aureus* conducted between 1996 and 2000. The researchers identified the additional costs in relation to the management and treatment of infections (including drug prescribing, infection management, physician/nursing care). Nursing care accounted for the highest additional costs (median of \$610 for MSSA infections and \$1,347 for MRSA infections). The total costs per patient associated with the management of these infections was \$1,332 (range \$268–\$7,265) for MSSA and \$2,607 (range \$849–\$8,895) for MRSA [64].

These reports, which are limited to direct cost implications related to community HCAs, demonstrate the very restricted

data presently available about the true resource impact of such infections in the community.

Discussion

The importance of infections acquired through the healthcare system was first recognised as a significant concern in the hospital setting and the majority of the interest and work to date on surveillance, prevention and control has been focused there.

Intervention regimes that targeted hospital-based HCAs during the last 10 years effectively reduced the prevalence of HCAs in hospitals. In Scotland, which originally had a high rate of MRSA hospital bacteraemias, programmes of targeted interventions were introduced that reduced these levels from 214 reports in the quarter April to June 2007 to 73 reports in the quarter July to September 2010 (archive of prevalence data available via the Health Protection Scotland website: <http://www.hps.scot.nhs.uk/>). The majority of these reductions were achieved in the hospital environment. Now, community-acquired *S. aureus* bacteraemia, particularly infections caused by meticillin-sensitive isolates, have risen in prominence, such that the infection control and prevention focus is shifting to these community-based infections. Whether similar reductions in these infections, as happened in MRSA hospital bacteraemias, will be achieved remains to be seen and will be determined by whether effective interventions, which may be different from those deployed in the hospital, can be constructed and introduced.

Although it is now recognised that the demographics of the healthcare population are changing, with an ever-greater proportion of people being treated through community healthcare, we are only at the beginning of understanding, defining and measuring community HCAs. A major international weakness in this arena is the present variability in the nature of the community data that are available. This needs to be rectified as a prerequisite to further progress in community HCAs. Whereas the prevalence of HCAs in community healthcare is reported to be similar to that found in the acute hospitals, this must not obscure the appreciation that there are important differences in their composition. In turn, this must necessarily lead to the construction of targeted and focused interventions applicable to the specific needs of infection control and prevention in the community.

The spectres of the past with fears about the transfer of problem organisms such as *C. difficile*, MRSA and ESBL-producers from the hospital into the community now have to be replaced by a broader understanding that will evolve over time of a dynamic and changing playing field where pathogen flow is seen as a two-way phenomenon.

Whilst the principles for infection control and prevention are identical in the hospital and community settings, much less

is known about delivery in the community. There is an urgent need to identify what procedures are most effective in preventing HCAs in the community and how such schemes can be efficiently delivered and monitored. There is a clear need to regulate and professionally manage HCAI delivery and reporting in the community in a fashion that will both provide the necessary epidemiological data as well as ensure the safety of patients in that setting. The present scarcity of data on the impact of infection control in the community means that there is no true appreciation of the full resource implications of the burden of HCAI illness in the community, and it is crucial that this is corrected. The lack of standardisation in epidemiological assessments merely serves to confound these knowledge gaps.

Conclusions

The future is clear: healthcare-associated infections (HCAIs) in the community are going to become an ever-increasing burden and it is critical that our approach to these infections is brought quickly in line with present hospital sector standards. The challenge is to take the best of recent successful experiences in tackling healthcare infections in acute hospitals and to modify that as necessary to fit healthcare undertaken in this very different setting of community practice. An important starting position is the recognition that, until community HCAs are appropriately measured, these infections can never be adequately managed.

Conflict of interest The authors declare that they have no conflict of interest.

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