Journal of Hospital Infection 103 (2019) e1–e8

Available online at www.sciencedirect.com

Journal of Hospital Infection

journal homepage: www.elsevier.com/locate/jhin

Review

Four steps to clean hospitals: LOOK, PLAN, CLEAN and DRY

S.J. Dancer [a,b,*], A. Kramer [c]

[a] Department of Laboratory Sciences, Hairmyres Hospital, NHS Lanarkshire, East Kilbride, UK
[b] School of Applied Sciences, Edinburgh Napier University, Edinburgh, UK
[c] Institute of Hygiene and Environmental Medicine, University Medicine Greifswald, Greifswald, Germany

ARTICLE INFO

Article history:
Received 20 November 2018
Accepted 20 December 2018
Available online 27 December 2018

Keywords:
Healthcare environment
Cleaning
Decontamination
Hospital hygiene
Bed space

SUMMARY

Background: Now that cleaning and decontamination are recognized as integral to infection control, it is timely to examine the process in more detail. This is because cleaning practices vary widely within healthcare districts, and it is likely that both time and energy are needlessly wasted with ill-defined duties. Furthermore, inadequate cleaning will not reduce the risk of infection but may even enhance it. The process would benefit from a systematic appraisal, with each component placed within an evidence-based and ordered protocol.

Methods: A literary search was performed on 'hospital cleaning', focusing on manual aspects of cleaning, pathogen reservoirs and transmission, hand hygiene, staff responsibilities and patient comfort.

Results: No articles providing an evidence-based practical approach to systematic cleaning in hospitals were identified. This review therefore proposes a simple four-step guide for daily cleaning of the occupied bed space. Step 1 (LOOK) describes a visual assessment of the area to be cleaned; Step 2 (PLAN) argues why the bed space needs preparation before cleaning; Step 3 (CLEAN) covers surface cleaning/decontamination; and Step 4 (DRY) is the final stage whereby surfaces are allowed to dry.

Conclusion: Given the lack of articles providing practical cleaning guidance, this review proposes a four-step protocol based on evidence if available, or justified where not. Each step is presented, discussed and risk-assessed. It is likely that a systematic cleaning process would reduce the risk of healthcare-associated infection for everyone, including outbreaks, in addition to heightened confidence in overall quality of care.

Introduction

Hospital cleaning has assumed more importance with the realization that pathogens survive in the healthcare environment, and contribute towards the risk of healthcare-associated infection (HCAI) [1,2] The environment enables transmission of the most important healthcare-associated pathogens [3]. These pathogens can persist on surfaces for weeks, and represent a transmission risk for both patients and staff [2]. Environmental screening confirms repeated contamination of items, equipment and general sites in bed spaces and rooms of colonized or infected patients and throughout multiple clinical areas in a healthcare institution [1,3,4]. The

* Corresponding author. Address: Department of Laboratory Sciences, Hairmyres Hospital, East Kilbride G75 8RG, UK. Tel.: +44 1355 585000; fax: +44 1355 584350.
E-mail address: stephanie.dancer@lanarkshire.scot.nhs.uk (S. J. Dancer).

https://doi.org/10.1016/j.jhin.2018.12.015
0195-6701/

highest risk sites for contamination are those situated nearest to the patient [4–6]. Healthcare workers, visitors and patients themselves touch these surfaces and transfer pathogens to other sites, which increases the risk of onward transmission [7–10].

While keeping hospitals clean was originally regarded as an aesthetic necessity, it is now accepted that targeted and frequent cleaning can reduce bioburden in the healthcare environment and associated risk of HCAI [3,11,12]. Evidence supporting cleaning has accumulated over the past decade, along with more traditional infection prevention activities such as hand hygiene, barrier nursing, screening and isolation [13,14]. Indeed, even exemplary hand hygiene will not protect patients from acquiring a specific pathogen if their room was previously occupied by a patient with the same pathogen [15]. The cleaning process itself is subject to debate over which methods should be used; how often it should be performed and by whom; and the choice of equipment, cleaning fluids and wipes, benchmarks, monitoring and risk-based standards [16–18]. Cleaning practices vary considerably, even within the same hospital and health district, and these rely heavily upon available resources and managerial support [3,18].

Cleaners themselves receive little or no training for what they do, and any teaching initiatives may be compounded by time, language and literacy problems [19]. Universally poorly paid, they are expected to perform a physically arduous and repetitive job with additional personal risks from cleaning materials as well as exposure to infected patients [17]. Cleaning staff would likely welcome a systematic aid to good practice with in-built risk assessment for themselves, as well as staff and patients. The four-step guide that is presented here is aimed primarily at domestic rather than nursing staff, and as such prioritizes bed-space items and furniture and not clinical equipment. These statements are supported by published evidence gleaned from the original search, or with basic hygiene principles, if not, and offer a practical approach to alleviating the risk from environmental contamination of surfaces beside the patient [20,21].

Methods

The literature was subjected to a search for practical guidance on cleaning the occupied bed space. No relevant articles were found, which prompted the authors to develop the four-step guide for daily cleaning of the occupied patient bed space that is presented here.

Results

Four steps to clean

Why is a guide for routine cleaning of a bed space necessary? Firstly, because repeated application of a sequential cleaning system would offer a time-efficient and effective method for decontaminating a bed space in the healthcare environment [22]. It is already known that surfaces are regularly missed during cleaning, and that time spent cleaning does not correlate with thoroughness of cleaning [23,24]. Cleaning an area in a methodical pattern establishes a routine so that items or areas are not missed during the cleaning process [22]. A practical guideline would improve cleaning of high-risk near-patient sites and could impact on HCAI risk. Secondly, an explanatory guide would help cleaning staff to understand what they should do, when they should do it, and why they should do it. The principles focus on the occupied bed space because a vacant bed space receives so-called 'terminal' or 'discharge' cleaning, for which there is already comprehensive guidance. An unoccupied bed space is easier to clean as it lacks patient, visitors, clinical equipment and personal belongings. However, while there remains a small HCAI risk for cleaning staff from the terminally cleaned bed space, the risk is arguably greater with a patient *in situ* [15,25]. Patients themselves continually touch high-risk sites, without hand hygiene reminders or opportunities. The four steps are LOOK, PLAN, CLEAN and DRY (Table I).

Step 1: LOOK

A visual assessment is the first stage of the cleaning process. Every cleaner should inspect the area to be cleaned, and consider overall conditions and degree of visual contamination before beginning a cleaning task. Conscious attention to visual dirt, spillages and rubbish will help to target cleaning attention, as will the arrangement of beds and clinical equipment (Figure 1). This initial assessment requires adequate lighting, whether natural daylight or artificial light. Cleaners should also evaluate the cleanliness of a room by ambient temperature, smell and patient status; patients may be asleep, absent, immobile, mobile, undergoing clinical intervention, unconscious or dying. There may be staff and/or visitors present. It is important to consider noise control; cleaning activities and/or equipment may potentially upset a sick patient and disrupt visiting or clinical care.

The overall impression allows a cleaner to initiate cleaning or not, guided by ward staff if necessary. Cleaners should always seek advice for patients in isolation rooms because it is not always obvious why a patient has been isolated. Rooms accommodating patients with HCAI may demand a different cleaning and decontamination regimen than patients in multiple-bedded bays or wards. Provided that cleaning access is timely and appropriate, the decision to clean will be

Table I

'LOOK, PLAN, CLEAN and DRY' system for cleaning an occupied bed space

1. LOOK
Visual assessment: general impression including temperature, smell, visible debris, clutter, space, lighting, patient status, and presence of clinical staff and visitors.
2. PLAN
Organize and prepare for cleaning: wash hands; re-align furniture, equipment and patient's belongings for access; removal of litter, food, spillages, debris, etc. Replenish supplies if needed.
3. CLEAN
i) Cleaning: removal of dirt, smears, stains, grease, dust, etc. according to local policy. ii) Disinfection (if required): applied according to manufacturer's recommendation.
4. DRY
Dry: time for physical drying (water and cleaning fluids). Replace items if moved for cleaning. Assess area, remove equipment and wash hands.

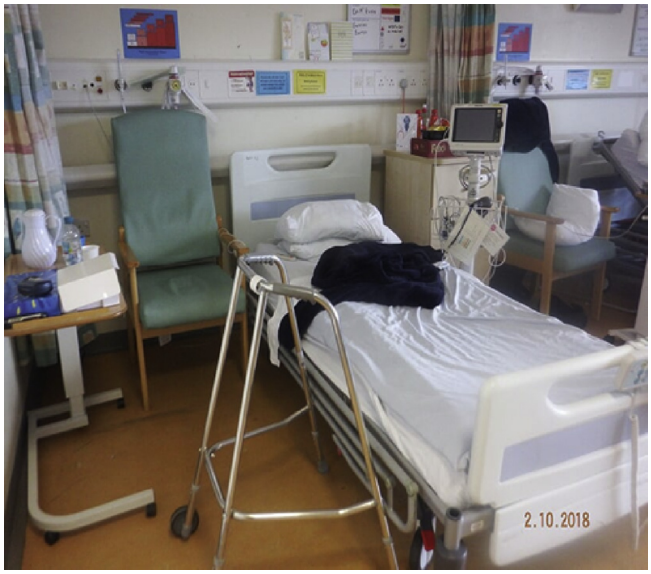

Figure 1. Impediments to cleaning.

followed by Step 2, which requires the cleaner to adjust the area in preparation for the cleaning process.

Step 2: PLAN

This step explains why and how the area to be cleaned needs to be prepared for cleaning. The first action is to wash hands, unless the cleaner has just done so, and assumes that hand-washing facilities, including clean water, are readily accessible. Hands should preferably be washed with liquid soap and water rather than cleaned with hand hygiene products [26]. While hand gels offer an alternative option, alcohol-containing products may be inactive against some pathogens, notably norovirus and *Clostridium difficile*. The cleaner should then don gloves, apron and/or other barrier protection in accordance with local policy.

Preparation for cleaning begins with attention to lighting, unless already resolved. Thus, blinds or curtains should be opened or lights switched on (or off) unless there are good reasons not to do so. Strong smells and/or temperature may guide the cleaner to open a window(s) if possible [27]. Balance between natural ventilation, smell and temperature should be assessed by the cleaner in line with patient comfort, aided by discussion with the conscious patient and/or advice from clinical staff.

Next, furniture and beds may require re-alignment if they are blocking access to sites intended for cleaning. Moving and handling of furniture must comply with local policy so that cleaners are not expected to perform major manoeuvres for the sake of cleaning. Bed rails may need to be raised to protect the patient before elevating the bed for easier access to the underside. It may also be necessary to reposition clinical equipment (e.g. intravenous drip stands, fans, respiratory aids) or patient devices (e.g. catheter bags). Cleaning staff should not necessarily handle such clinical items, and must be able to call on assistance from clinical staff. Similarly, cleaners may need support from clinical staff if the patient's belongings need moving. Near-patient surfaces offer the greatest risk for contamination, so cleaning sites such as the bedside locker and

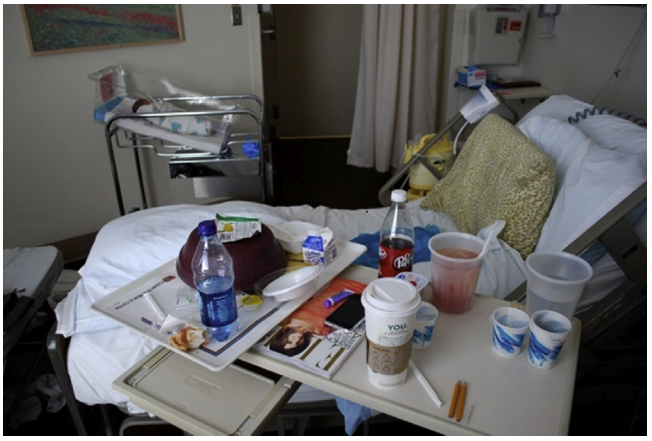

Figure 2. Cluttered bed space. Photo credit: http://www.cbsnews.com/news/in-us-hospital-acquired-infections-run-rampant/.

table should not be omitted just because they are covered with patient belongings (Figures 2 and 3). Personal items can be placed on another surface such as a chair, window sill, ledge or shelf, but never on the bed or the floor.

Once the room or bed space has been organized for access, bins should be checked and emptied, and visible rubbish on the floor and other surfaces should be removed. The conscious patient and visitors may be asked if there are any unwanted items requiring disposal. This includes food and liquid waste and spillages of either. Spillages of blood and body fluids require attention from nursing staff and should be reported immediately; cleaning should cease until such spillages have been decontaminated. Clinical staff should inform cleaning staff about any specific bed spaces that might require enhanced cleaning. In addition, cleaners should be aware of any areas that are challenged by plumbing leaks and building works, or contaminated air, spillages and footwear [28].

Final preparations include replacement of rubbish bags, soap, paper towels and toilet paper; and collection of discarded crockery, glasses, cutlery and water jugs, unless these duties are assigned to other staff. Similarly, dirty linen and towels should be removed and placed in appropriate

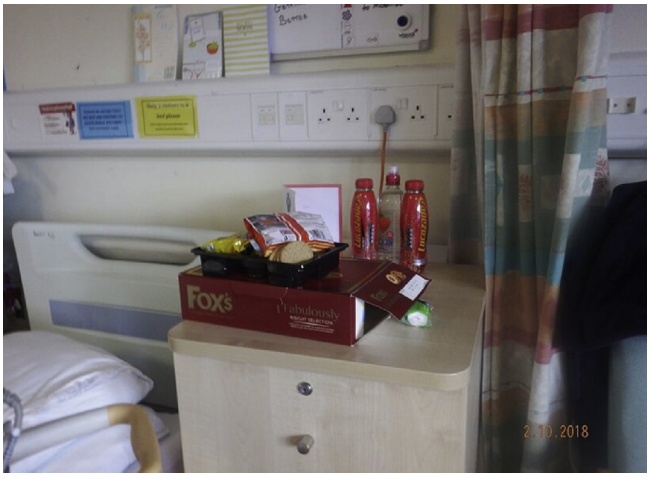

Figure 3. Patient belongings on bedside locker.

receptacles, unless linen disposal is managed by other staff. At this point, staff may collect equipment and cleaning consumables and bring them into the room. All cleaning tasks need the right tools for the job. Cleaning fluids should be freshly prepared from in-use supplies, with attention paid to the expiry date for chosen consumables. Equipment itself should be clean and in a good state of repair. Sufficient clean water, fresh cloths or wipes, and mop heads should be readily available for cleaning staff, with clear instructions on how to manage disposable and non-disposable items.

Step 3: CLEAN

Cleaning refers to the removal of soil from surfaces by use of physical wiping or scrubbing; the chemical action of a surfactant or detergent; and water to wet, emulsify or reduce surface tension [17]. The process removes both dirt and micro-organisms from surfaces, thereby reducing the amount of organic bioburden. Cleaning should always precede disinfection because the presence of soil will impede disinfectant activity [22]. Some hospitals use detergents for routine cleaning, while others choose products that either inactivate or kill living micro-organisms. This is termed 'disinfection' or 'hygienic' cleaning. Unlike detergent-based cleaning, efficacy requirements are set out by harmonized European test standards that include differential surface loading with albumin and sheep erythrocytes. Cleaning and disinfection become inextricably intertwined when wipes are impregnated with disinfectant as the overall effect is a combination of disinfectant activity and physical removal of soil [29].

There are some general principles generally accepted as good practice regardless of whether detergent-based cleaning and/or disinfection cleaning are chosen, as follows [22,30].

Direction of cleaning

- Begin cleaning at the furthest end of the bed space, working towards the exit [30].
- Clean from high (hand height) to low (i.e. do not start with the floor).
- Clean sites nearest to the patient first (e.g. bed head, nurse call button, locker), then sites furthest from the patient (e.g. door handle, sink, bathroom) [5,31].
- Make hand-touch sites a priority (i.e. work to a checklist) (Table II) [32,33].
- Clean a site from least visually dirty to obviously dirty.

Wiping action

- Wipes should be used according to manufacturers' instructions.
- Use one wipe for each site; some sites may require several wipes (e.g. bed frame).
- Unfolding the wipe and using it flat on the surface maximizes the area cleaned and minimizes the amount of hand contact.
- Wipe in one direction without retracing the area already cleaned; wipe a large flat surface using an S-shaped pattern (Figure 4) [22,34–36].

Table II
Order for cleaning the patient bed space

1. Bed frame starting from head to foot (including bed control and patient notes fixtures if present).
2. Patient appliances (nurse call, light switch, etc.).
3. Bedside locker from top downwards.
4. Bed table including underneath and hand adjustment.
5. Furniture (visitor chairs).
6. Window/blind/shutter handles and window sill.
7. Door handles/push plate.
8. Sink and fixtures (if present).
9. Bathroom (if present).
10. Underside of bed including foot brakes.
11. Floor.

- Apply the 'one wipe; one site; one direction' principle [34,37–39].
- Throw away disposable wipes after each site or if visibly soiled; or, if a single cloth is used, decontaminate between each site or discard and choose a fresh cloth [22].
- Be aware that microbes may be transferred between surfaces (via gloved hands, cloths, etc.) [29,35–37].

Detergent vs disinfectant

- Detergent is used for physically removing soil; disinfectant is used for killing microbes [40].
- Impregnated wipes should be used according to manufacturers' instructions, including drying time.
- Cleaning fluids should be prepared, applied and discarded according to manufacturers' guidance and in adherence with local policy.
- Water and detergent are adequate for routine bed-space cleaning provided the 'one wipe; one site; one direction' principle is applied [34,37–39].

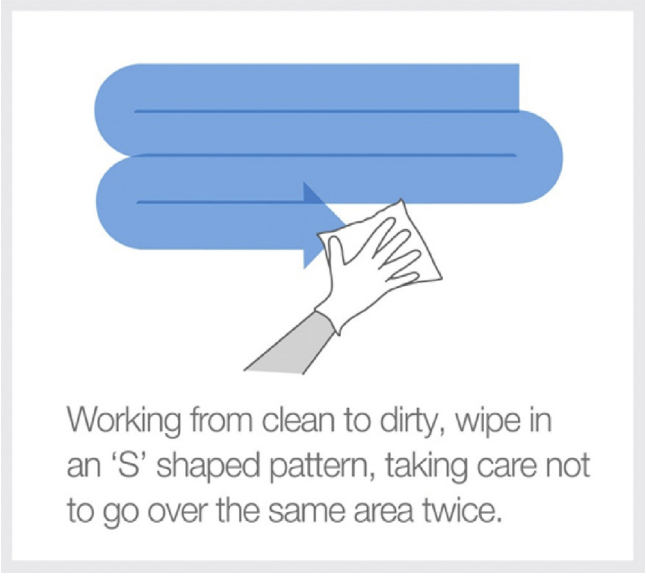

Figure 4. The S-shaped method for cleaning a flat surface. Photo credit: Gama Healthcare.

- Always remove visible soil with detergent and water before the use of disinfectant [22,40,41].
- The physical removal of soil and microbiocidal activity from disinfectant may be achieved by use of a disinfectant-containing wipe [29,34].
- Wiping an area >30 cm^2 reduces the microbiocidal effect of a disinfectant wipe [42].
- Use disinfectants for infected patients or during an outbreak, unless local policy dictates routine use of disinfectant for high-risk patients or sites (e.g. sinks, showers and toilets).

Floors and bathrooms

- Ensuite bathrooms are cleaned after the patient room, beginning with the sink, then shower/bath and finally the toilet. Local policy should guide disinfectant choice.
- As with the near-patient environment, prioritize the hand-touch sites in the bathroom (i.e. taps, handles, nurse call button, grab bars, toilet roll holder, etc.).
- Floor cleaning is the last task to complete.
- Place warning signage before floor mopping begins; verbally warn staff, patients and visitors if floors are wet.
- Sites such as bed rails, bed control (if electric-bed), nurse call bell, bedside locker and bed table constitute the highest priority for cleaning because they are frequently touched and readily provide a reservoir for hospital pathogens [3–6,31,33,43]. There is a two-way direction of transmission between these surfaces and hands, which can only be disrupted by targeted cleaning and hand hygiene. Given that cleaning usually occurs just once per day, and hand hygiene depends on a multitude of factors, it comes as no surprise that infections are readily acquired from bed-space sites [5,7,15,25]. Table II offers a sequential system for cleaning the highest risk hand-touch sites in a bed space.
- Comprehensive coverage removes both organic soil and microbial contamination including planktonic organisms released from biofilm. Physical removal of soil during routine cleaning is preferable to application of disinfectants unless the patient is colonized or infected with transmissible pathogens [34,37,40,43–48].

Step 4: DRY

The final stage encompasses physical drying using clean paper towels or cloths, as well as time for drying of cleaning fluids (detergent and/or disinfectant) on surfaces. The cleaning process is not complete until all surfaces are completely dry. Contact time is usually considered critical to disinfection, but it can be difficult to fulfil in a time-pressured healthcare environment [17,22,32,40]. While the drying time may or may not impinge on disinfection, surfaces should still be allowed to dry, if only for safety reasons [49]. Time for drying could reasonably be utilized by removal of cleaning equipment and fluids to outside the bed-space area or room; and discarding used wipes, cloths, mops, linen, towels and liquids. Re-usable equipment should itself be inspected, cleaned and dried before further use if necessary. Once cleaning utensils have been removed, surfaces can be visually assessed for dampness. If surfaces look and feel dry, furniture (and bed) can be repositioned, doors and windows adjusted, and signage removed; patient belongings should be returned to the top of the locker or bed table, with the host site wiped over and similarly allowed to dry.

This fourth stage should also include the cleaner's own assessment as to overall cleanliness of the bed space or room (Figure 5). If they are satisfied that the process is complete, the area can be signed off verbally or by written notification, labelling or use of a check list. Further monitoring helps to maintain, and improve, the quality of cleaning but it is not necessarily mandatory and will depend upon available resources [3]. Any problems with cleaning should be reported to clinical staff and/or cleaning supervisors. This would include non-completion due to lack of access, patient status, or malfunction or breakages of bed-space and bathroom items or cleaning equipment. Cleaners have a duty to report sites that are missed during cleaning, as well as items or surfaces that are difficult to clean; there may also be difficulties with waste removal such as discarded clinical dressings. They should also mention any sightings of pests such as pigeons, mice and insects [50].

When leaving the patient area, the gloved hand should be subjected to hand disinfection if the cleaner has to fulfil further duties before the next cleaning objective. Otherwise, gloves and any other protective apparel may be removed, and hands washed and dried before further duties.

Discussion

The importance of cleaning has been re-invented over the last decade, and is now generally accepted as a key component of infection prevention. Everyone works better in a clean environment, and visitors notice even if patients (and staff) do not. Aside from aesthetic appearance, the propensity for pathogens to contaminate the environment represents a major risk of infection for patients [50]. In her seminal 'Notes on nursing', from 1860, Florence Nightingale wrote that 'the greater part of nursing consists in preserving cleanliness' [51]. Just a few colony-forming units of *Staphylococcus aureus* or less than 10 spores of *C. difficile* are sufficient to initiate infection, and transfer is facilitated by reservoirs within the

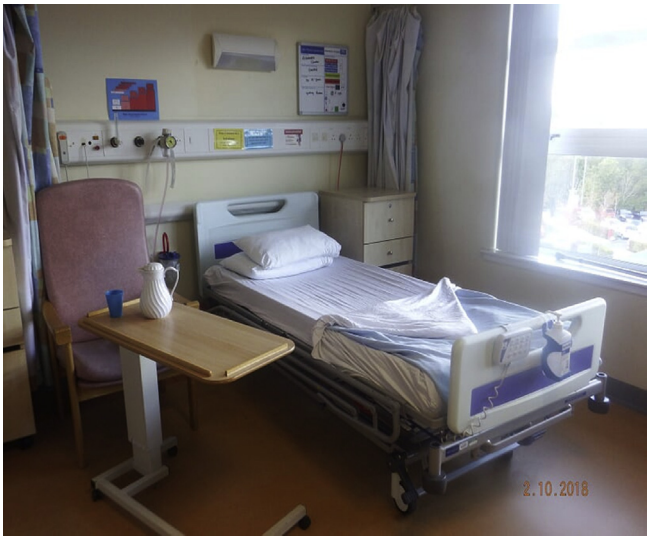

Figure 5. Cleaned bed space.

patient zone [3,5,7,11]. The four steps proposed in this article are an attempt to define and simplify a cleaning strategy for an occupied bed space, whether within a multi-bedded unit or a single room. Each step is supported by scientific evidence if it exists, and common sense where it does not. The intention is to present a systematic guide that targets the highest-risk sites in an ordered process; the aim of which is to reduce near-patient contamination and risk of infection. Standardization is urgently needed for cleaners on an international basis, since there is currently no universal agreement on healthcare cleaning methodologies [18].

Evaluating the outcome of this protocol is beyond the scope of this article, but could conceivably be the fifth step in the process [52]. Environmental monitoring can focus on the impact of cleaning itself (direct observation or fluorescent markers), on surface cleanliness after the cleaner has left (measurement of organic or specific microbial soil), or on HCAI rates as part of a structured and controlled surveillance system [3,16,52]. The efficacy of any cleaning protocol requires robust assessment before widespread adoption by environmental services. These four steps would also benefit from further development as hospital routines evolve and new decontamination methods and equipment become available.

Special education, repeated training and supervision for hospital cleaners is at best infrequent and at worst inadequate (or non-existent) despite the importance of maintaining a safe and pleasing environment for everyone [3,18,53]. Embedding a systematic cleaning protocol into a training schedule would provide trainers and supervisors with a simple and effective teaching aid for cleaning staff, with each step illustrated by figures, photographs and/or video. The aid could also cover cleaning, storage and maintenance of equipment, since dirty utensils compromise any cleaning attempts. The same applies to the water supply and management of cleaning fluids.

This type of education is primarily aimed at cleaning staff, but could also be offered to clinical staff and students in related healthcare disciplines. In some hospitals, bedside cleaning is performed by nurses or clinical support staff; it is hoped that these, and others, would benefit from having a systematic checklist based on known risks. Although cleaning guidelines can always be further developed, practical recommendations to improve cleaners' motivation, (self) training, and audit (part of training) and guidance to positively value cleaners' tasks should also be considered.

While this guide has not included directives on equipment or consumables, there are choices to be made regarding both. There is evidence to show that daily cleaning performed using detergent and water is sufficient to control total bioburden as well as some pathogens [38]. The underlying principle remains focused on removal of dirt rather than destruction of surface microbes [40,44]. This is because repeated exposure of environmental flora to microbiocidal products encourages tolerance and even cross-resistance to antimicrobial agents [54]. Daily use of powerful disinfectants might even consolidate endemic problems with environmental organisms such as vancomycin-resistant enterococci and *Acinetobacter* spp. [40]. However, detergent cleaning should be temporarily replaced with disinfectant if the patient is known to harbour a transmissible pathogen, or if the patient is involved, or might be involved, in an outbreak [54,55].The wiping strategy remains the same but removal of soil should be followed by application of an appropriate disinfectant [56]. The fourth step would then encompass 'contact time' as well as surface drying in order to allow the disinfectant to kill surface pathogens. Specific requirements for chosen disinfectants should be included in the training aid in accordance with infection control advice. The effect of disinfectant agents on cleaners' health and well-being is another important factor not covered in this article. Toxicity issues should be considered in disinfectant choice, with effective protection readily available for cleaning staff if required [17,57].

A practical cleaning guide might help to reduce the risk of HCAI from inadequate hand hygiene. This is highlighted by poor compliance with the Fifth Moment of hand hygiene, namely that of cleaning hands after touching the near-patient environment [20,21]. If staff are appropriately trained and monitored, a systematic cleaning specification would alleviate day-by-day contamination as well as complement concurrent hand hygiene initiatives. The 'Five Moments' themselves provide a logical analogy with 'when to clean' indications, in that staff should always consider the cleanliness of high-risk near-patient sites during patient care, before performing aseptic activities, after discharge of patients, after visible surface contamination, and as part of the multi-barrier strategy to control outbreaks [20]. This analogy further strengthens the principle of a balanced relationship between hand hygiene and cleanliness of hand-touch sites, and neither should be prioritized over the other [58].

Risk-based cleaning has not been universally agreed or documented to date, and yet it offers an additional opportunity for managers to engage with, and support, infection prevention and control throughout the healthcare environment. Given the increasing concern with antimicrobial resistance, a step-by-step cleaning protocol is a straightforward cost-effective addition to all the other established activities imposed on hospitals to reduce HCAI.

Acknowledgements

The authors wish to thank all the cleaners who have freely given their advice and comments on the steps proposed in this article, as well as a range of cleaning methods and systems over the years.

Conflict of interest statement
None declared.

Funding sources
None.

References

[1] Dancer SJ. The role of environmental cleaning in the control of hospital-acquired infection. J Hosp Infect 2009;73:378–85.
[2] Kramer A, Schwebke I, Kampf G. How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. BMC Infect Dis 2006;6:130.
[3] Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. Clin Microbiol Rev 2014;27:665–90.
[4] Lemmen SW, Häfner H, Zolldann D, Stanzel S, Lütticken R. Distribution of multi-resistant Gram-negative versus Gram-positive bacteria in the hospital inanimate environment. J Hosp Infect 2004;56:191–7.

[5] Dancer SJ, White L, Robertson C. Monitoring environmental cleanliness on two surgical wards. Int J Environ Health Research 2008;18:357–64.
[6] Cheng VCC, Chau PH, Lee WM, Ho SKY, Lee DWY, So SYC, et al. Hand-touch contact assessment of high-touch and mutual-touch surfaces among healthcare workers, patients, and visitors. J Hosp Infect 2015;90:220–5.
[7] Bhalla A, Pultz NJ, Gries DM, Ray AJ, Eckstein EC, Aron DC, et al. Acquisition of nosocomial pathogens on hands after contact with environmental surfaces near hospitalized patients. Infect Control Hosp Epidemiol 2004;25:164–7.
[8] Oelberg DG, Joyner SE, Jiang X, Laborde D, Islam MP, Pickering LK. Detection of pathogen transmission in neonatal nurseries using DNA markers as surrogate indicators. Pediatrics 2000;105:311–5.
[9] Stiefel U, Cadnum JL, Eckstien BC, Guerrero DM, Tina MA, Donskey CJ. Contamination of hands with methicillin-resistant *Staphylococcus aureus* after contact with environmental surfaces and after contact with the skin of colonized patients. Infect Control Hosp Epidemiol 2011;32:185–7.
[10] Morgan DJ, Rogawski E, Thom KA, Johnson JK, Perencevich EN, Shardell M, et al. Transfer of multidrug-resistant bacteria to healthcare workers' gloves and gowns after patient contact increases with environmental contamination. Crit Care Med 2012;40:1045–51.
[11] Dancer SJ. Importance of the environment in MRSA acquisition: the case for hospital cleaning. Lancet Infect Dis 2008;8:101–13.
[12] Gebel J, Exner M, French G, Chartier Y, Christiansen B, Gemein S, et al. The role of surface disinfection in infection prevention. GMS Hyg Infect Control 2013;8:Doc10.
[13] Dancer SJ. Infection control in the post-antibiotic era. Healthcare Infect 2013;18:51–60.
[14] Hausemann A, Grünewald M, Otto U, Heudorf U. Cleaning and disinfection of surfaces in hospitals. Improvement in quality of structure, process and outcome in the hospitals in Frankfurt/Main, Germany, in 2016 compared to 2014. GMS Hyg Infect Control 2018;13:Doc06.
[15] Mitchell BG, Dancer SJ, Anderson M, Dehn E. Risk of organism acquisition from prior room occupants: a systematic review and meta-analysis. J Hosp Infect 2015;91:211–7.
[16] Dancer SJ. Do's and don'ts for hospital cleaning. Curr Opin Infect Dis 2016;29:415–23.
[17] Quinn MM, Henneberger PK. National Institute for Occupational Safety and Health (NIOSH), National Occupational Research Agenda (NORA) Cleaning and Disinfecting in Healthcare Working Group. Cleaning and disinfecting environmental surfaces in health care: toward an integrated framework for infection and occupational illness prevention. Am J Infect Control 2015;43:424–34.
[18] Kenters N, Gottlieb T, Hopman J, Mehtar S, Schweizer ML, Tartari E, et al., ISAC Working Group Infection Prevention and Control. An international survey of cleaning and disinfection practices in the healthcare environment. J Hosp Infect 2018;100:236–41.
[19] Dancer SJ. Hospital cleaning in the 21st century. Eur J Clin Microbiol Infect Dis 2011;30:1473–81.
[20] Sax H, Allegranzi B, Uçkay I, Larson E, Boyce J, Pittet D. 'My five moments for hand hygiene': a user-centred design approach to understand, train, monitor and report hand hygiene. J Hosp Infect 2007;67:9–21.
[21] Randle J, Arthur A, Vaughan N. Twenty-four-hour observational study of hospital hand hygiene compliance. J Hosp Infect 2010;76:252–5.
[22] Guideline at a glance: environmental cleaning. AORN J 2017;105:430–5.
[23] Carling PC, Briggs JL, Perkins J, Highlander D. Improved cleaning of patient rooms using a new targeting method. Clin Infect Dis 2006;42:385–8.
[24] Rupp ME, Adler A, Schellen M, Cassling K, Fitzgerald T, Sholtz L, et al. The time spent cleaning a hospital room does not correlate with the thoroughness of cleaning. Infect Control Hosp Epidemiol 2013;34:100–2.
[25] Sunkesula VCK, Kundrapu S, Knighton S, Cadnum JL, Donskey CJ. A randomized trial to determine the impact of an educational patient hand-hygiene intervention on contamination of hospitalized patient's hands with healthcare-associated pathogens. Infect Control Hosp Epidemiol 2017;38:595–7.
[26] Kampf G. Antiseptic stewardship. Basel: Springer; 2018.
[27] King MF, Noakes CJ, Sleigh PA. Modeling environmental contamination in hospital single- and four-bed rooms. Indoor Air 2015;25:694–707.
[28] Balm MND, Jureen R, Teo C, Yeoh AEJ, Lin RTP, Dancer SJ, et al. Hot and steamy: outbreak of *Bacillus cereus* in Singapore associated with construction work and laundry practices. J Hosp Infect 2012;81:224–30.
[29] Sattar SA, Bradley C, Kibbee R, Wesgate R, Wilkinson MA, Sharpe T, et al. Disinfectant wipes are appropriate to control microbial bioburden from surfaces: use of a new ASTM standard test protocol to demonstrate efficacy. J Hosp Infect 2015;91:319–25.
[30] Raghubalan G, Raghubalan S. Housekeeping: operations and management. Oxford: Oxford University Press; 2007.
[31] Solomon SL, Plisko JD, Wittig SM, Edwards LV, Imhoff 3rd RH, DiPietro B, et al. Reducing environmental surface contamination in healthcare settings: a statewide collaborative. Am J Infect Control 2018;46:e71–3.
[32] Sehulster LM, Chinn RYW, Arduino MJ, Carpenter J, Donlan R, Ashford D, et al. Guidelines for environmental infection control in health-care facilities. Recommendations from CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC). Chicago, IL: American Society for Healthcare Engineering/American Hospital Association; 2004.
[33] Huslage K, Rutala WA, Sickbert-Bennett E, Weber DJ. A quantitative approach to defining "high-touch" surfaces in hospitals. Infect Control Hosp Epidemiol 2010;31:850–3.
[34] Sattar SA, Maillard J-Y. The crucial role of wiping in decontamination of high-touch environmental surfaces: review of current status and directions for the future. Am J Infect Control 2013;41:S97–104.
[35] Trajtman AN, Manickam K, Alfa MJ. Microfiber cloths reduce the transfer of *Clostridium difficile* spores to environmental surfaces compared with cotton cloths. Am J Infect Control 2015;43:686–9.
[36] Bergen LK, Meyer M, Høg M, Rubenhagen B, Andersen LP. Spread of bacteria on surfaces when cleaning with microfibre cloths. J Hosp Infect 2009;71:132–7.
[37] Siani H, Cooper C, Maillard JY. Efficacy of "sporicidal" wipes against *Clostridium difficile*. Am J Infect Control 2011;39:212–8.
[38] Bogusz A, Stewart M, Hunter J, Yip B, Reid D, Robertson C, et al. How quickly do hospital surfaces become contaminated after detergent cleaning? Healthcare Infect 2013;18:3–9.
[39] Berendt AE, Turnbull L, Spady D, Rennie R, Forgie SE. Three swipes and you're out: how many swipes are needed to decontaminate plastic with disposable wipes? Am J Infect Control 2011;39:442–3.
[40] Sattar S. Promises and pitfalls of recent advances in chemical means of preventing the spread of nosocomial infections by environmental surfaces. Am J Infect Control 2010;38:S34–40.
[41] Barker J, Vipond IB, Bloomfield SF. Effects of cleaning and disinfection in reducing the spread of norovirus contamination via environmental surfaces. J Hosp Infect 2004;58:42–9.
[42] West AM, Nkemngong CA, Voom MG, Wu T, Li X, Teska PJ, et al. Surface area wiped, product type, and target strain impact bactericidal efficacy of ready-to-use disinfectant towelettes. Antimicrob Resist Infect Control 2018;7:122.

[43] Adams CE, Smith J, Robertson C, Watson V, Dancer SJ. Examining the relationship between surface bioburden and frequently touched sites in Intensive Care. J Hosp Infect 2017;95:76—80.
[44] Dancer SJ. Floor wars: the battle for 'clean' surfaces. J Hosp Infect 2013;84:339—40.
[45] Awadel-Kariem FM, Price E, Cookson B, O'Connor H. *Clostridium difficile* and routine cleaning — alternative options to the use of stronger chlorine-releasing disinfectants. J Hosp Infect 2012;80:184—5.
[46] Speight S, Moy A, Macken S, Chitnis R, Hoffman PN, Davies A, et al. Evaluation of the sporicidal activity of different chemical disinfectants used in hospitals against *Clostridium difficile*. J Hosp Infect 2011;79:18—22.
[47] Rutala WA, Gergen MF, Weber DJ. Efficacy of different cleaning and disinfection methods against *Clostridium difficile* spores: importance of physical removal versus sporicidal inactivation. Infect Control Hosp Epidemiol 2012;33:1255—8.
[48] Gillespie EE, Wilson J, Lovegrove A, Scott C, Abernethy M, Kotsanas D, et al. Environment cleaning without chemicals in clinical settings. Am J Infect Control 2013;41:461—3.
[49] West AM, Teska PJ, Oliver HF. There is no additional bactericidal efficacy of Environmental Protection Agency registered disinfectant towelettes after surface drying or beyond label contact time. Am J Infect Control 2019;47:27—32.
[50] Dancer SJ. Mopping up hospital infection. J Hosp Infect 1999;43:85—100.
[51] Nightingale F. Notes on nursing: what it is, and what it is not. London: Harrison of Pall Mall; 1859.
[52] Havill NL. Best practices in disinfection of noncritical surfaces in the health care setting: creating a bundle for success. Am J Infect Control 2013;41:S26—30.
[53] Litwin AS, Avgar AC, Becker ER. Superbugs vs. outsourced cleaners: employment arrangements and the spread of healthcare-associated infections. Industrial Labor Relations Rev 2016;70:610—41.
[54] Kampf G. Challenging biocide tolerance with antiseptic stewardship. J Hosp Infect 2018 Nov;100(3):e37—9.
[55] Mayfield JM, Leet T, Miller J, Mundy LM. Environmental control to reduce transmission of *Clostridium difficile*. Clin Infect Dis 2000;31:995—1000.
[56] Health Protection Scotland. The NHS Scotland national cleaning services specification. Glasgow: HPS; 2009. Available at: https://www.hps.scot.nhs.ku/resourcedocument.aspx?id=2990 [last accessed January 2019].
[57] Kramer A, Below H, Assadian O. Health risks of surface disinfection in households with special consideration on quaternary ammonium compounds (QACS). In: Bioaerosols — 6th international scientific conference on bioaerosols, fungi, bacteria, mycotoxins in indoor and outdoor environments and human health; 6—9 September 2011, Saratoga Springs, NY, USA.
[58] Smith SJ, Young V, Robertson C, Dancer SJ. Where do hands go? An audit of sequential hand-touch events on a hospital ward. J Hosp Infect 2012;80:206—11.