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FOR DISCUSSION

How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals

S.J. Dancer*

Scottish Centre for Infection and Environmental Health, Clifton House, Clifton Place, Glasgow G3 7LN, UK

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Summary Increasing numbers of hospital-acquired infections have generated much attention over the last decade. The public has linked the so-called 'superbugs' with their experience of dirty hospitals, but the precise role of cleaning in the control of these organisms in unknown. Hence the importance of a clean environment is likely to remain speculative unless it becomes an evidence-based science. This proposal is a call for bacteriological standards with which to assess clinical surface hygiene in hospitals, based on those used by the food industry. The first standard concerns any finding of a specific 'indicator' organism, the presence of which suggests a requirement for increased cleaning. Indicators would include *Staphylococcus aureus*, including methicillin-resistant *S. aureus*, *Clostridium difficile*, vancomycin-resistant enterococci and various Gram-negative bacilli. The second standard concerns a quantitative aerobic colony count of <5 cfu/cm^2 on frequent hand touch surfaces in hospitals. The principle relates to modern risk management systems such as HACCP, and reflects the fact that pathogens of concern are widespread. Further work is required to evaluate and refine these standards and define the infection risk from the hospital environment.

Introduction

There has been recent concern from the public, media and infection control staff over perceived inadequacies in hospital cleaning.[1,2] There may be a link between dirty hospitals and the rising numbers of hospital-acquired infections (HAI) but there is little evidence to be able to substantiate this at present.[3] Several professional bodies have published standards or audits regarding environmental cleanliness in hospitals.[4,5] Unfortunately, the mechanisms for evaluating the quality of hospital cleaning regimens are limited. Quite often the only

*Tel.: +44-141-300-1100; fax: +44-141-300-1172.
E-mail address: stephanie.dancer@scieh.csa.scot.nhs.uk

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method used is visual assessment, which does not necessarily correspond with microbiological risk.[6,7]

Hospital patients can acquire organisms from many sources, including the environment, but the extent to which the latter contributes towards HAI is largely unknown.[3,8–10] This is because cleaning has never been regarded, let alone investigated, as an evidence-based science.[11] The difficulties in measuring cleaning efficacy are compounded by the lack of standardized methodologies and are rarely quantitative. Environmental screening usually takes place on an *ad hoc* basis after an outbreak, but it is patently impossible to screen the entire surface of a ward and finding the outbreak strain is not guaranteed. Furthermore, organisms still have to be transmitted to patients. As this is thought to occur via staff hands, strategies for controlling HAI are more likely to favour improvements in hand hygiene than comprehensive screening programmes. Cost-benefit and lack of standardized methodologies might also explain the perceived reluctance of private cleaning companies to participate in screening. Certainly, most microbiologists would be cautions about taking environmental samples from hospital wards on a routine basis.[12]

Despite the lack of evidence, the hospital environment may well act as a significant reservoir for potential pathogens.[13] A favourable niche can quickly be found, and retained, unless disturbed by some appropriate cleaning or disinfection process.[3] This reservoir can then be extended by vectors such as air turbulence, aerosolized moisture, an unwashed hand or direct contact with an inanimate object, equipment or material.[13,14] The hands of healthcare workers may well represent the final mode of transmission, but even exemplary hand hygiene cannot be expected to break the chain of infection when the environment is heavily contaminated.[11,14,15]

Cleaning has two main functions: first, non-microbiological, to improve or restore appearance, maintain function and prevent deterioration. Second, microbiological, to reduce the numbers of microbes present, together with any substances that support their growth or interfere with disinfection/sterilization.[16] The term 'cleaning', therefore, can be interpreted in different ways.[7] However, patients and their relatives expect a clean uncluttered environment in hospitals.[10] They criticize hospitals they consider dirty and associate them with a general lack of care.[10,16] Such consumer demands for cleaning aesthetics cannot be disputed. Maintenance of a pristine hospital environment, however, requires funding from scant NHS resources. Furthermore, there is a conflict of interests for private cleaning companies between hygiene standards and profits. The importance of keeping a hospital clean will probably continue to be justified on grounds of 'common sense', but that may not be sufficient to attract managerial attention.[17]

Infection control personnel feel that there is some risk to patients from a dirty ward, but this risk is difficult to demonstrate, and even more difficult to measure. Furthermore, managers responsible for domestic services are not necessarily directed by infection control staff when attempting to set up cleaning schedules for different areas within a hospital. Basic hospital cleaning will continue to be an emotive issue for patients, and problematic for managers and infection control personnel. Without real evidence of its value, however, it is unlikely to become a priority for NHS managers.

Proposal for assessment of surface hygiene

There has always been interest in surface contamination in hospitals, perhaps more so in operating theatres and often in conjunction with air sampling.[18–21] Monitoring programmes do exist for theatre surface colonization and others for specific pathogen in clinical areas of risk.[22–25] Recently, attention has focused on areas outside the theatre environment.[6,7,15] No one set of standards exists for general hospital wards, however, and there is considerable variation in sampling methodologies and quantitative reporting.[7,26] There are further differences in whether sampling is carried out routinely or in response to an infection incident.[25,27] This makes it difficult to compare fluctuating situations in a ward, between wards and between different hospitals, let alone investigate specific levels of contamination in relation to infection risk.

As cleaning could be a cost-effective method of controlling HAI, it should be investigated as a scientific process with measurable outcome. To achieve this, it is necessary to adopt an integrated and risk-based approach. This would include preliminary visual assessment, rapid sensitive tests for organic deposits and specific microbiological investigations.[28] Such an approach has already been established by the food industry to manage cleaning practices in a cost-effective manner and is described elsewhere.[29,30] There is also an index of microbial air contamination (IMA) established for environments at risk, with maximum acceptable levels for different classes of contamination.[31] Even recreational waters are analysed for microbial indicators of human sewage and the corresponding health risk.[32] It has already been suggested that the

surface level environment in hospital wards should be subjected to a similar strategy.[7]

The proposal of the present work focuses upon possible bacteriological standards for assessing surface hygiene, based on standards applied in the food industry,[29,30] but modified to reflect the differences between risk management in food preparation and the risk for acquiring infection in hospital. They are presented after consideration of all available evidence and comprise two main features: first, the identification of an indicator organism of potential high-risk to patients in any amount, and second, the quantitative assessment of organisms found within a specified area, regardless of identity. The latter is included because a heavy burden of any microbes from specified surfaces in a hospital may constitute a risk to patients. It circumvents the difficulties in locating a pathogen, when screening an entire ward. Positive findings for either standard should direct attention to the quality, quantity and methods of cleaning used. These standards would usually be applied before and after cleaning in order to assess efficacy, but could also be used during an outbreak or high-risk incident with a serious pathogen.

Both indicator organisms and those gathered within numerical counts can be identified, quantified, documented and audited. The methods required are simple, cheap and reproducible and could be adopted by any healthcare institution with access to a clinical microbiological laboratory. Furthermore, as evidence becomes available, these standards can be modified to reflect the overall risk of infection, and adapted to high-risk patients, high-risk units and emergency or outbreak situations.

Proposed standards for assessment of surface hygiene

Presence of an 'indicator' organism

Possible indicator organisms are *Staphylococcus aureus*, including methicillin-resistant *S. aureus* (MRSA),[26,33,34] *Clostridium difficile*,[35] multiply resistant Gram-negative bacilli[3,26,36] (as defined by the local consultant microbiologist), vancomycin-resistant enterococci,[26,37,38] and *Salmonella* spp. Also organisms associated with a significant infection risk in a clinical area, or associated with a serious infection incident or outbreak, e.g. aspergillus in units housing immunocompromised patients.[24]

Standard

There should be <1 cfu/cm^2 of the indicator organism(s) present in the clinical environment.

The identification of an indicator organism should generate immediate attention towards cleaning/disinfection practises and frequencies. Repeat sampling is mandatory. Risk assessment would determine a hygiene review, additional cleaning, or even the closure of a clinical area for deep cleaning if thought appropriate.

Total aerobic colony count (ACC)

The total ACC is the total number of aerobic organisms from a sampled area. It can be quantified and provides a general measure of bacterial load. The US Department of Agriculture has specified that microbial counts on food-processing equipment should be <5 cfu/cm^2 before plant start-up and similar microbial surface counts, after cleaning, have been advocated by the Swedish Food Standards Agency.[29,30] UK studies have used <2.5 cfu/cm^2 in evaluating cleaning efficacy.[7] However, the internationally recognized figure of <5 cfu/cm^2 could be used as a starting point.

Surfaces destined for food preparation are not analogous to all surfaces in a hospital. It is proposed, therefore, that contaminated surfaces most likely to pose a risk to patients are those that are frequently touched by hands,[13,39–41] and therefore, it should be these surfaces for which this standard applies.

Standard

The ACC from a hand contact surface* should be <5 cfu/cm^2.

* Hand contact surfaces in hospitals are too numerous to detail in full, but particularly important ones include: handles (door, locker, toilet, tap, bath and shower, cupboard, cabinet, window, chair, fridge, etc.), electrical and other switches (light, television, infusion pump, call-button, computer, hot air drier, fan, radiator, etc.), equipment (blood pressure cuff, stethoscope, tourniquets, urinary catheter bag stands, commode, waste bins, wheel-chair, walking aids, drug trolley, patient notes trolley, phlebotomy trolley, hoist, bed-cage, towel dispenser, portable X-ray machine, ventilator components, electrocardiogram machine, cot sides, etc.), telephone and computer keyboard, linen (sheets, blankets, pillow cases, patient clothing, theatre garments, curtains, woollen fleece, etc.), soft furnishings (chairs, cushions, etc.), toys, furniture (desk, chairs, nurses' station, table, lockers, etc.), shelves (particularly those used for linen, clothing or patient materials/equipment), radiators, mattresses and bed frame, etc.[3,13,33–49] Questionable surfaces include staff clothing, uniforms and white coats; patient notes and other paper products, sterile packaging and other stored items, patients' own belongings, voluntary workers' trolley, flower vases and sharps bins.[50–52]

The finding of ≥ 5 cfu/cm^2 from a hand contact surface, whatever the identity of the organisms, indicates that there might be an increased risk of infection for the patient in that environment. This should generate an evaluation of the cleaning/disinfection practices and frequencies for that surface. This is based on three suppositions: first, an increased microbial burden suggests that there has been insufficient cleaning. This would increase the chances of finding a pathogen. Second, a heavy microbial burden may mask the finding of a pathogen. Third, a heavy concentration of certain organisms implies an increased chance of finding an epidemiologically related pathogen, e.g. coagulase-negative staphylococci and *S. aureus*. This surmise forms the basis of WHO standards regarding water quality.[32] Repeat sampling should follow a risk evaluation, whether or not there has been a change in practice.

Conclusion

We need to be able to judge cleanliness by the same standards, even if this is done by empirically grading set situations.[16] There are already internationally agreed microbiological standards for air, water and food preparation surfaces, so why not for surfaces in hospitals?[29–32] Important health effects may occur after short-term exposure to low-quality water; while the relevant hazards are multiple, they may share a common source.[32] Risk management, reflected in the HACCP principle used by the food industry, encompasses the view that relevant pathogens are widespread, occurring with wide variation in time and space. Absence of a safeguard, therefore, in itself constitutes a hazard.[32] This reasoning could be applied to surface level cleanliness in hospitals.

Widespread adoption of standards would allow risk assessment and evaluation of infection risks to patients (and staff) in hospitals. The ability to compare results between different clinical units and different hospitals would contribute towards further evaluation. Infection control and domestic personnel could justify their actions regarding routine and incident measures. Cleaning efficacy could be subjected to internal audit, with feedback to managers and the infection control committee for regular review. These standards would allow national and local audits on hygiene to be conducted on a scientific basis, rather than the ill-defined and almost certainly subjective criteria used to date.[10] Visual assessment of hygiene has been shown to be a poor indicator of cleaning efficacy.[6,7]

Strong justification for these proposed standards for assessing the microbiological status of hospital surfaces rests upon the current controversy surrounding dirty hospitals and the considerable levels of MRSA found in countries such as the UK, within the European league.[53] The increasing cost of HAI, is an important reason for a serious scientific evaluation of this most basic of control practices.[34,54] Further justification comes from the burgeoning threat of legal activity.

Future work should encompass all available microbiological methods,[28] the role of rapid methods such as bioluminescence,[6,7,28] clinical surface definitions, sampling indications and frequencies, responsibilities and cost, and should attempt to equate the environmental findings with the probability of acquiring a hospital infection. The standards will require practical evaluation and refinement. Graduated risk assessment can then be determined for all areas of the hospital, and types of patient.[55] The cost–benefit of the proposed standards, must be compared with those of hand hygiene programmes, control of antibiotic prescribing and other infection control practises.[9,54]

With the increasing tide of antibiotic resistance, basic hygiene practices may be all we have left. Microbes other than bacteria have not been included in the standards, but additional pathogens that could be considered as indicator organisms would be norovirus, rotavirus and the recently identified coronavirus linked with severe acute respiratory syndrome.[56–59] Hopefully further work will provide the evidence required to promote and evaluate hospital cleaning for the benefit of patients now, and for the future.

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