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Commentary

# Drains and the periphery of the water system — what do you do when the guidance is outdated?

M. Weinbren [a,*], T. Inkster [b], F. Lafferty [c]

[a] *Department of Microbiology, King's Mill Hospital, Sutton-in-Ashfield, UK*
[b] *Department of Microbiology, Queen Elizabeth University Hospital, Glasgow, UK*
[c] *National Services Scotland, Glasgow, UK*

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SUMMARY

The periphery of the water system (defined as the last 2 m of pipework from an outlet and ensuing devices including drainage), is the juncture of multiple inherent risks: the necessity to use materials with higher risk of biofilm formation, difficulty in maintaining safe water temperatures, a human interface with drainage systems, poor design, poor layout and use by staff. Add to this risk a large new healthcare facility capital build programme in England, outdated guidance and bacteria emanating from drainage systems containing highly mobile genetic elements (threatening the end of the antibiotic era), and the scene is set for the perfect storm.

There is an urgent need for the re-evaluation of the periphery of the water system and drainage systems. Consequently, in this article we examine the requirement and placement of hand wash stations (HWSs), design of showers, kitchens and the dirty utility with respect to water services. Lastly, we discuss the provision of safe water to high-risk patient groups. The purpose of this article is to stimulate debate and provide infection control and design teams with support in deviating from the outdated existing guidance and to challenge conventional thinking until new advice is forthcoming.



## Introduction

NHS Scotland Assure is a new service whose remit is to minimize the risk from the healthcare-built environment. The impetus for its formation followed two new build projects that had significant deficiencies preventable at multiple stages of their design and construction, one at the Queen Elizabeth University Hospital in Glasgow and the other in Edinburgh, the Royal Hospital for Children and Young People and Department of clinical neurosciences [1].

It would be very wrong to draw the conclusion that Scotland is alone in experiencing such issues, which occur globally. Two recent reviews of the construction industry and compliance services, The Cole Report (published June 2019) and The Hackett Report (published a month earlier) drew remarkably similar conclusions, an industry that has lost its way [2,3]. Scotland stands out because it has taken the first important step in addressing this serious issue.

Water and drainage services are one of the highest risk systems in a new hospital facility. Knowledge of the risks around water and drainage systems increased substantially following the neonatal *Pseudomonas aeruginosa* outbreak in

* Corresponding author. Address: Department of Microbiology, King's Mill Hospital, Sutton-in- Ashfield, Nottinghamshire, NG17 4JL, UK.
*E-mail address:* michael.weinbren@nhs.scot (M. Weinbren).

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Belfast in 2012 and the arrival of multi-drug-resistant organisms, including carbapenemase-producing Enterobacterales (CPE). However, the Health Building Notes (HBNs) have not kept pace in an era where there is a slow but increasing move to waterless care because of the inherent risks from water and drainage systems [4,5]. The HBNs also include historical recommendations, faithfully and unquestioningly copied from one new build to the next, which fail to stand up to scrutiny. In Holland, in line with carbapenem-resistant organism recommendations from the World Health Organization [6], sinks are moved as far as possible from the patient zone in a new hospital building. No sinks will be placed in the patient room and sinks will only be placed within the shower cells adjacent to the patient room (Joost Hopman, personal communication).

The move towards hospitals with a higher percentage of single-room occupancy (or entirely single-room occupancy) dramatically increases the requirements for water services if traditional practices of placement of a clinical HWS (as well as full *en suite* facilities) in every room, are followed. The periphery of the water system is a difficult area to control as it brings conducive water temperatures together with materials with an inherently higher predisposition to biofilm formation near to drains. An important and often underestimated variable is how staff interact with the periphery of the system. Difficulties in maintaining adequate water turnover in all the single-occupancy rooms could impact on the ability to keep the temperature of cold water within the building below 20°C.

## The role of infection control

In 2013, HTM 04 – 01 handed down responsibility for the periphery of the water system to infection control [7]. This was not an inappropriate decision, but unfortunately no supporting training followed. Unlike Legionella water safety (where management is very much based around engineering controls), *P. aeruginosa* (and allied organisms) transmission prevention is largely based around controlling the interaction of a wide group of individuals with water services; an arena requiring infection control influence. This includes, for example, assessing location of HWS, how they are being used, educating staff on the associated risks, risk assessing the routes whereby water may reach patients in augmented care units, designing appropriate surveillance, etc. Whilst an industry supports Legionella control (including education), this is very much lacking for the periphery of the system and other water- and drain-borne pathogens. Some water treatment companies offer 'pseudomonas risk assessments' but these are based preferentially around engineering controls. A void has developed as the very people who should be developing and performing the training (i.e. infection control practitioners), have themselves not been trained. The awaited British standard (BS 8580-2) hopes to address this shortfall.

The purpose of this document is to provide support to infection control teams who may be involved in new build design or major refurbishment projects to deviate from the outdated HBNs, where safer options exist. This is particularly pertinent as NHS England is about to embark on a nationwide healthcare construction programme.

## Infection control involvement in building projects

Guidelines in general suffer from a lack of clarity, are open to interpretation and cannot be expected to cover every eventuality. Infection control involvement, even where guidance is not outdated, is essential in new build projects to provide the extra translation to guide architects, design teams and clinical colleagues. A common mistake is to involve subject matter experts (including infection control) too late in a project, when most of the design is completed (making it difficult or expensive to change). For infection control input to be effective it requires: (1) appointment of infection control individual(s) with expertise in the built environment, in this instance with respect to water and drainage. (2) The appointment should be prior to engaging architect and design teams (see HBN 00-09; Infection Control in the Built Environment) [8]. (3) The appointee(s) should be backfilled to ensure there is sufficient infection control cover in the existing team. (4) The appointee(s) could be incorporated into a separate management structure relating to the new project (HBN 00-09). This ensures linking with the correct communication channels and also prevents them from being pulled back into the routine day-to-day service. (5) An effective governance system needs to be in place across the project to ensure successful completion of the project. This necessitates the 'project team' effectively communicating with all groups involved within the project. Where there are differences in opinion, no one group should have the right to overrule the other, the matter being escalated in order to have an expert third party opinion.

## The case for change

Whilst a single case of hospital-acquired Legionella should immediately prompt an incident meeting, reporting to Public Health and potential investigation by the Care Quality Commission (previously undertaken by the Health and Safety Executive) this is rarely the case for other waterborne infections despite them outnumbering Legionella cases by several orders of magnitude. The divergence in response is likely driven by a number of factors – Legionella is statutorily notifiable, is seen as a foreseeable infection (i.e. largely preventable), inevitably arises from contaminated water systems and there have been a number of successful prosecutions (inside and outside of healthcare). Other hospital-acquired waterborne infections are largely not notifiable, are usually not exclusively associated with a water source (but this varies with organism), may reflect endogenous carriage and outbreaks rarely lead to prosecution, leading to a culture which does not regard the infection as potentially avoidable. Recognition of transmission events in neonates is easier, not readily clouded by endogenous carriage and perhaps it is for this reason that it was a neonatal outbreak which brought change.

The impetus for change is heightened by the advent of antimicrobial resistance threatening the end of the antibiotic era [9]. Whilst significant effort is being invested into developing new antimicrobial agents and improving antimicrobial stewardship, little resource is invested into reducing the risk from the healthcare-built environment, despite numerous publications detailing transmission of multi-drug-resistant organisms by way of hospital drainage systems. Many of these organisms reside in the human gut. Hence, it should not be a surprise that drainage systems have become their citadels within hospitals [10].

It is quite likely that the bulk of waterborne infections go undetected for the following reasons: (1) Poor discipline around the use of water services by healthcare staff — Grabowski *et al*. found that only one in 25 visits to a clinical HWS were for the correct purpose, hand decontamination [11]. (2) Poor design of outlets/basins and showers. (3) Lack of training of staff on the requirement to report immediately any slowing in drainage of hand wash sinks, toilets and showers. (4) Surveillance in adult areas is mainly designed for detecting transmission events with unusual or highly antibiotic-resistant organisms. (5) With sensitive strains of organisms which are endemic in units, i.e. *P. aeruginosa*, no baseline has been set as to what is an acceptable level of endogenous carriage beyond which transmission and cross-infection should be suspected. (6) Highly antibiotic-resistant organisms are highlighting the role drainage systems have in the dispersal of organisms [12]. Multi-drug-resistant organisms are not thought to possess any special adaptations for dispersing from drainage systems. They merely attract our attention highlighting the well-trodden pathways used by other sensitive organisms. Thus, when Hopman *et al*. removed water services on an intensive therapy unit (ITU) in response to an intractable outbreak with a highly resistant organism emanating from drains, not only was the outbreak terminated but there was an overall reduction in acquisition of Gram-negative organisms [13].

Good infection prevention and control practice requires teams to be proactive. Improvement in use and design of water services should be implemented without the need to await the arrival of a highly antibiotic-resistant organism to highlight deficiencies.

For the purposes of this article, we have decided to look at: (1) HWSs; (2) showers; (3) the dirty utility; (4) kitchens; and (5) the provision of safe water.

## Points to consider when designing water services

### *HWSs*

The World Health Organisation recommends alcohol gel as the preferred method for hand decontamination. Water is required when hands are visibly dirty or contaminated with an organism resistant to alcohol. As gloves are worn for most practices where hands could get visibly contaminated, the requirement to wash hands with water is uncommon.

When considering placement of an HWS the following factors need to be considered.

#### *Is an HWS required?*

Inappropriate placement creates risk either from hand washing not taking place or by increasing risk of transmission of waterborne organisms. Prior to installing an HWS consider the following:

(1) Is an HWS necessary? In 1995, paediatric deaths were linked to contaminated Total Parenteral Nutrition (TPN) prepared in the pharmacy sterile services department. The source of the contamination was traced to aerosols (containing Enterobacter) originating from an HWS. In recognition of the risk posed by water services, HWSs were removed from pharmacy aseptic preparation areas [14]. The philosophy is for staff to decontaminate hands prior to entry into the sterile services area.

(2) What are the criteria for placement of an HWS? Water is necessary where hands are visibly soiled, or alcohol has no activity against the infectious agent. Requirement for placement of an HWS (excluding surgical scrub sinks) could be defined as follows: (i) in rooms housing patients, and (ii) in rooms where blood/body fluids may be handled.

As staff should decontaminate their hands appropriately when leaving these areas, alcohol hand rub should be sufficient for most other ward areas.

The above begs the question: do non-patient areas (e.g., ward drug preparation/clean utility) require an HWS? Do the costs/risks outweigh any benefits? To remove HWSs from patient areas (especially an ITU) would seem a step too far, but has been done successfully to control outbreaks with multi-drug-resistant organisms with an overall reduction of other Gram-negative organisms in one instance [4].

Siting HWSs in areas where not required creates water stagnation, biofilm formation and consequent seeding of the water system. It incurs a cost requiring outlets either to be flushed or removed (including cutting back pipe work to avoid dead legs).

#### *Correct placement*

(1) Accessibility: a prerequisite, but frequently not considered. Building notes guidance (HBN 00-09, Infection Control in the Built Environment) [8] provides advice but this does not always translate from architect drawings into practice. In a state-of-the-art ITU (opened in 2006) HWSs at the end of open bays became inaccessible when patients required ventilation. The route to the HWS (at the rear of the bed space) was blocked by a combination of wall, ventilator and other equipment. Locating the HWS at the front of the bed space would circumvent this. The above was driven by the diktat of one HWS per bed space. Fewer but better-located HWSs are preferable.

(2) Splash risk. Placement requires consideration of splashing, which can travel up to 2 m. HWSs are frequently located beside storage for uncovered clean equipment or due to lack of space equipment is stored around/below an HWS. Locating an HWS close to work surfaces used for drug or procedure preparation is equally a danger, but these scenarios are rarely recognized at design stage or at ward level. In Germany plastic/reinforced glass sheets are placed as a splash barrier between HWSs and work surfaces. The risk to mobile surfaces (i.e. a trolley for sterile procedures) is more difficult to control. Healthcare workers only perceive an HWS in a positive light, are unaware of risks, and naturally will want to wash hands when making up a trolley (within splash distance). The requirement for more than one HWS in a four-bedded bay or one HWS/bed in high-dependency unit areas is not justified in practice.

#### *General design of an HWS*

Despite the universal requirement for an HWS, there is no standard design for installation into healthcare facilities. Variation in design not only exists between hospitals but also within the same organization. Failure to understand the function and risks emanating from an HWS contribute to incorrect installation, location and operation. Table I provides a summary of the factors that need to be considered when a risk assessment has shown that an HWS is required. The risks and benefits of manually operated (elbow essentially) and sensor-operated outlets are highlighted in Table II. As there is evidence that elbow-operated outlets are frequently operated incorrectly (see Figure 1) there should be a drive to look for alternatives such as knee- or foot-operated outlets which offer the benefits of not recontaminating your hands but retain a simpler outlet construction so as not to increase the risk of biofilm formation. Some of the risks to be considered for specific areas are summarised in Table III.

## *Showers*

The risks from showers and wet rooms are discussed in Table IV. The risk from shower drains has been highlighted in a number of reports and perversely would appear to be greater in those who are at highest risk both due to their immunosuppression, and to the side-effects of chemotherapy causing hair loss which blocks the drains [15,16].

## *The dirty utility*

Despite publication of the design of a dirty utility, which provided a flow from dirty to clean in 1949 [17], more than 70 years later it is disappointing to find no standardization or improvement in dirty utility design. Dirty utility design should vary according to the needs of a unit; practical experience suggests that variation is not usually driven by unit requirements but by constraints of available space. As the name implies, the room is used to dispose of some of the most highly contaminated body fluids, but its use, content, design and location are frequently not commensurate with good infection control practices.

In designing a dirty utility, the following are some considerations. (1) Location/number of dirty utility rooms — wards frequently only have a single dirty utility, the location of which rarely takes into consideration the distances staff have to travel to reach it. Figure 2(a) shows the layout of an actual ITU and Figure 2(b) a medical ward detailing the distances staff have to travel carrying contaminated body fluids. In the process, it is necessary to traverse a number of doors (which may require contact with highly touched surfaces) and the potential for transmission of organisms. Lack of the facility to dispose of body fluids in ITU side rooms, combined with the distances required to get to a dirty utility have resulted in inappropriate disposal of fluids in hand wash sinks and documented outbreaks [18]. In France, to negate this problem, an additional sink for fluid disposal is available in ITU side rooms (which has been shown to reduce the frequency of drain colonization with highly resistant organisms) [19]. An alternative solution, which we would favour, is the placement of small macerators in ITU side rooms to facilitate correct disposal of body fluids and minimize the risk of contamination of surfaces whilst traversing the unit to the dirty utility. In medical wards, we suggest the provision of 'mini dirty utilities'. These would consist of a small macerator and HWS only, the advantage being that these are located in close proximity to where staff are working. The 'mini dirty utility' would be in addition to a larger traditional dirty utility where required. (2) Door entry to dirty utility — consideration should be given as to how staff enter the dirty utility, as door handles are likely to become contaminated when operated by staff carrying contaminated secretions. Alternatives include sensor-operator doors, swinging doors which are operated by the member of staff using their back to open the door or potentially not having a door to the room.

*Defining the purpose of the dirty utility*

The design of the dirty utility will be defined by what practices will occur in the room. The following need to be considered.

(1) Storage — although in practice it is common to find clean equipment stored in this area, this is unsafe and must not occur. We recommend that only reusable items (decontaminated in this area) are stored here. The necessity for storage in the dirty utility is frequently a result of failing to allow for adequate storage space in the original design of the ward area.
(2) Decontamination — decontamination may be conducted in this area for a variety of purposes: cleaning of commodes, placement of bedpan washer disinfectors, and where macerators are used it is necessary to decontaminate the 'slipper bedpan' used to hold a disposable bedpan when it can not be placed within a commode.

For decontamination to be safe there needs to be adequate delineated space and a clear flow from dirty to clean. The size of some dirty utilities is so small that it is difficult to see how equipment such as commodes can be safely decontaminated.

The lack of flow from dirty to clean means that clean equipment may become contaminated. In Figure 3(a), a nurse can be seen standing in front of a bedpan washer disinfector. These items are quite tall making it difficult to see any contamination on the top surface. Figure 3(b) shows faecal contamination of the top surface of the washer disinfector. A lack of flow means that clean and dirty bed pans may be placed on the surface. Better design could improve compliance; e.g., if the top of the bedpan washer disinfector was angled to prevent placement of items or redesigning the washer disinfector such that it had two doors (one at either end: one for placement of dirty items and the other for removal of clean items). The washer disinfector could be installed so that it straddled between two rooms — one side being the dirty entrance the other the clean side (as in a Central Sterile Services Department (CSSD)).

We would argue that the requirement for a separate sink for cleaning equipment be assessed. Most items should be disposable and where decontamination is required it preferably goes back to a central service or (as in the example of a commode or slipper bedpan) impregnated wipes or a washer disinfector are used. Where alternative effective decontamination methods are available, the risk from water services is unnecessary, and a sink should not be installed.

## *Disposal of fluids — what is the answer?*

Recognition of issues with disposal of fluids comes to the fore in 'waterless' units — there is no hiding place. That the issue is invisible in standard units may reflect poor practices going unnoticed.

**Table I**
The points to consider when implementing new hand wash stations

| | Ensure | Minimize | Avoid | Consider |
|---|---|---|---|---|
| Water supply | | Use of TMVs —subject to scalding risk assessment | Flexible hoses<br>Flow restrictor (device to restrict the flow of a liquid) | |
| Outlet | Mount on panel above sink<br>Activity space — distance between end of outlet and top of basin is adequate<br>Point of use filters can be readily attached | Use of TMTs subject to scalding risk assessment | Pedestal-mounted outlets<br>Swan neck design<br>Plastic inserts —aerators and flow straighteners (metal flow straighteners are preferred option) | Outlet which can be removed for decontamination in a thermal washer disinfector |
| Outlet operation | Elbow-operated lever set at correct angle<br>Sensor-operated lever: the sensor is readily visible to operator and the sensor has been calibrated to the correct distance. | | | Knee or foot operated outlets.<br>Outlets which can be programmed to flush where use may be infrequent |
| Basin | Recessed drains<br>The gap between rear of basin and panel is sealed to prevent water ingress<br>Recessed drain is not obstructed by excessive sealant when attaching drain downpipe during installation | | Drains located directly beneath outlet<br>Plugs<br>Overflow | Basins with central fin which minimize splashing (Yui *et al*. *J Hosp Infect* 2019; 103:e110—4) |
| Drain | | | | Heat disinfecting waste trap |
| Soap and towel dispenser | | | Placement of soap dispenser above tap to avoid liquid dropping from hands on to outlet | Placement of towel dispenser as far as practically possible to one side to minimize risk of paper falling into basin and obstructing drain |

TMT, thermostatic mixing taps; TMV, thermostatic mixer valve.

**Table II**
The pros and cons of sensor- versus elbow-operated taps

| | Sensor-operated outlet | Elbow-operated outlet |
|---|---|---|
| Cons | Complexity is likely to predispose to biofilm formation<br>Learning curve of user to operate sensor can lead to hand contaminating end of outlet | TMVs often fitted unnecessarily predispose to biofilm formation<br>Elbow-operated handles not used correctly leading to recontamination of hands immediately after washing<br>Tap handle often only opened slightly resulting in little water draw on hot water |
| Pros | Hands-free operation<br>Operation can be automated to flush little used outlets and record data | |

TMV, thermostatic mixer valve.

How should fluids be disposed of within the dirty utility? A number of options are currently available using standard dirty utility design.

(1) Sinks for cleaning. There is usually a sink built into a surface for cleaning equipment. Given that most items are disposable, or wipes can be used for cleaning, there is an argument for no longer providing a sink. Cleaning any item of equipment in a sink without following with a further standardized decontamination process is a high-risk process for waterborne transmission of organisms. Without a sink the other options are a sluice hopper, macerator or washer disinfector.
(2) Sluice hoppers. Poor design or careless use run the risk of dispersal of organisms through splashing or aerosol formation. The risk is compounded by frequent storage of clean equipment in close vicinity (see Figure 4). What is the purpose of a sluice hopper in a clinical dirty utility room? If disposable products are used, everything should go straight to the macerator; if reusable products are used, they should go straight into the bedpan washer. The design of sluice hoppers, location and placement of splash screens are considerations to enable these items of equipment to be used if still required in the future.
(3) Macerators/bedpan washer disinfectors. Contaminated bedpans/bowls whether disposable or reusable can be placed directly either into the bedpan washer disinfector or a macerator. Many modern macerators have an inflatable seal which should minimize or eradicate the risk of dispersal of aerosols when in operation.

The toilet in *en suite* bathrooms can be used for disposal of fluids, etc., provided the person is trained to understand the importance of minimizing the risk of splashing/aerosol generation [20]. In drug preparation area rooms, we would suggest exploring the possibility of using disposable sealable boxes containing absorbent granules. As these rooms are locked, the use of absorbent granules in this area should pose no risk to patients.

(4) Drainage system. The design of the drainage system is important in minimizing the risk of future blockages. Whilst the manufacturers provide guidance on the design of the drainage system that their appliances (macerators/bedpan washer disinfectors) should be connected to, this is rarely incorporated into the design plans. Thus, 90° bends pose a major predisposing factor to blockages, the risks highlighted in a paper going back to at least 2012 still occur [21]. The drainage pipes should have swept bends which may have an implication for overall design in terms of space required in ceiling voids. Although this may incur an extra initial cost, not only should these costs be recouped because of fewer blockages but also the risk to patients will be minimized.

## Kitchens

Kitchens (ward-based or main kitchens) have been sources of outbreaks with waterborne or drainage organisms. This is perhaps not surprising as these are connected to the main drainage system within the healthcare facility. Items which

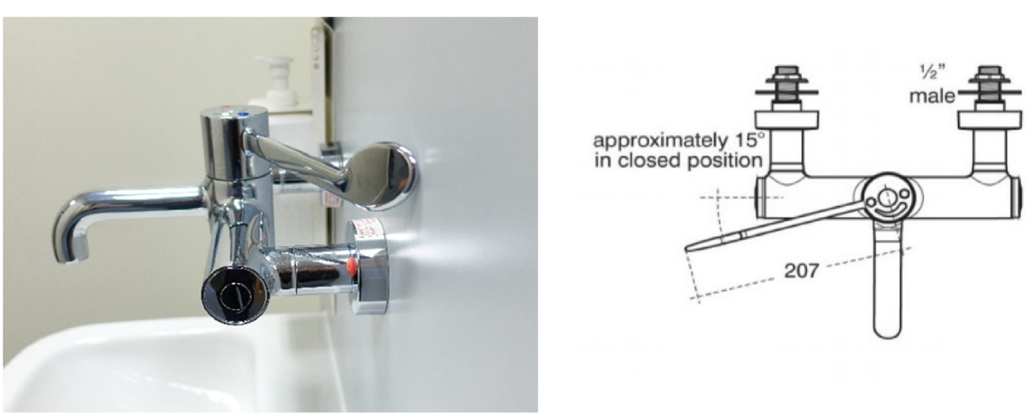


**Figure 1.** (a) Incorrect set-up of elbow-operated lever which is flush with the inspection panel behind making it difficult/impossible to operate with an elbow. (b) Correct set-up requires an angle of 15° in front of the main body of the outlet linking the hot and cold supply.

**Table III**
Risks to consider for specific areas.

| | Recommend | Avoid |
|---|---|---|
| Dirty utility | Flow from dirty to clean — to avoid recontamination of cleaned products; ideally two doors with entry into respective clean and dirty zones<br>Clinical hand wash station required — ensure no other services within 2 m<br>No re-processed equipment should be stored within splashing range (see Figure 4)<br>Ensure correct design and installation of drains — there should be no 90° bends<br>Adequate space for decontamination of items of equipment (such as commodes) | Sluice hoppers — unnecessary splashing risk<br>Clean items (other than re-usable items decontaminated in the room, i.e. commodes and bedpans) should not be stored in the dirty utility |
| Drug preparation area | Alcohol gel dispensers on entry to room<br>Disposable trays for drug administration or a non-water-based method of cleaning | Water services including hand wash station<br>Cleaning trays for drug administration with water |
| Multi-occupancy bays | Consider reducing the number of WHBs in these bays<br>WHBs should be accessible, ensure patient curtains do not obstruct | Placement within 2M of patient or work surfaces or equipment. |
| Treatment rooms | WHB should be situated to avoid risk of splash in vicinity of patients/packs<br>If trough sink is installed there should be no splash and water should fall on to the inclined surface | |
| Ward kitchen | A separate hand hygiene basin should be provided | Patient water jugs should not rest on drains when being filled as this can result in surface contamination |

Support areas are often neglected in terms of design with sufficient space often being an issue. WHB, wash hand basin.

**Table IV**
Points to consider when designing showers or wet rooms

| | Recommend | Avoid |
|---|---|---|
| Shower head | Connecting hose should not be long enough to allow contact with the floor | |
| | The shower head should be able to accept a point of use filter | |
| Shower seat | Should be easily cleanable | |
| Shower curtains | Not recommended | Shower curtains |
| Drain | Shower drain should be offset preventing patient contact and the floor should have a gradient to encourage drainage in the correct direction | Shower drain directly below shower to avoid patient making direct contact |
| | The drain capacity and run off should be sufficient to cope with the volume of water delivered by the shower | |
| | The drain should be easily accessible for cleaning/maintenance | |
| Flooring/walls | The quality of waterproofing materials and attention to detail during construction are important to prevent water ingress behind finish which will encourage fungal proliferation | Poor-quality materials or poor attention to detail during construction combined with inadequate quality checks allowing water ingress and fungal proliferation |
| | Floors should be smooth and easy to clean | |

Attention should be paid to not just the outlet, but the positioning of the drain and the construction materials used in the room.

leave the kitchen (e.g., food and drinking implements) can provide a vehicle of transmission to the patient.

Contamination of drainage systems may occur via a number of routes, including retrograde or disposal of contaminated fluid (the latter being unlikely in a kitchen). Maintenance is an additional and perhaps underestimated risk. In an outbreak in Germany, originating from the main kitchen (which was in a separate drainage system to the main hospital), introduction of the hospital endemic CPE strain was thought to be via a contaminated drain unblocking coil. This had been used in the main hospital drainage system (M. Exner, personal communication). Water from an outlet hit the sieve of a contaminated drain and splashed over nearby salads, which were the vehicle of transmission (Figure 5(a)).

Whilst much thought goes into the design of clinical HWSs, the same processes are not applied to other types of sink. Water directly hitting a drain sieve is at high risk of dispersal of drain organisms, but this is not uncommon in kitchen sink design. Disposal of carbon sources down the drain promote bacterial growth and biofilm formation which can subsequently grow up a drain at the rate of 1 mm/h. Whilst it may be possible to minimize such practices with clinical HWSs, kitchen sinks are necessarily used to dispose of food/drink waste, which will support bacterial multiplication.

Washing/rinsing any equipment in a sink (kitchen or otherwise) incurs a risk of acquiring and transmitting drain organisms if the item does not go through a recognized subsequent decontamination process. Ward dishwashers are an important method for decontaminating utensils, but often lack the appropriate regulatory oversight. In one outbreak (M. Weinbren, personal communication) of a highly resistant strain of *P. aeruginosa*, a causative factor was the ward dishwasher being out of action necessitating washing of patient water jugs in a kitchen sink (from which the outbreak strain was isolated). The dishwasher had been out of action for over a month. We suggest that infection control teams should make enquiries into the timeframe specified in service level agreements for repairing dishwashers. As it is unlikely service providers will be able to repair all dishwashers on the same day, we suggest the safest policy is to have spare functioning dishwashers on site which can be swapped with ones that have failed in order to ensure wards have continuity of use.

Whether dishwashers are located in wards or in centralized locations, they should be subject to regular cleaning and maintenance as per manufacturer's instructions, with responsibilities for such clearly defined. A risk assessment should be undertaken before installing a dishwasher in a ward kitchen and they should be avoided in wards housing immunosuppressed patients, e.g., haemato-

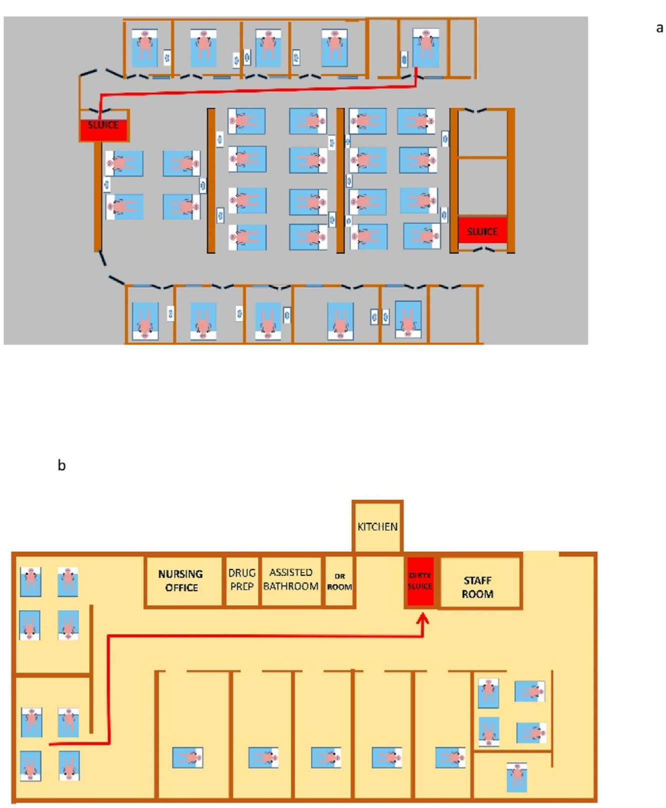


**Figure 2.** Layout of (a) an actual intensive therapy unit and (b) a medical ward detailing the distances staff have to travel carrying contaminated body fluids.

a 

b

**Figure 3.** (a) A nurse standing in front of a bedpan washer disinfector. These items are quite tall making it difficult to see any contamination on the top surface. (b) Faecal contamination of the top surface of the washer disinfector.

oncology units, cystic fibrosis wards. Dishwashers were removed from high-risk wards in one Scottish hospital following a waterborne outbreak and the identification of pathogenic moulds including *Exophiala dermatitidis* from them [22]. Eight patients in one cancer centre developed fungaemia secondary to the pathogenic yeast *Saprochaete clavate* from a contaminated dishwasher [23]. Plumbed-in water coolers may also be present in ward kitchens and should also be subject to risk assessment and regular cleaning/maintenance [7].


**Figure 4.** Clean items stored in close vicinity to sluice hopper placing them at risk from splashes/aerosols. Taps above the hopper will cause significant splashing when used.

There is a further risk over how water is collected for patients. Common practice is to place a bowl or a jug in the sink (Figure 5(b)) whilst filling the receptacle, which is likely to result in contamination of the base with drain organisms. This may subsequently be transmitted to patients, or other surfaces and then on to patients. Whilst point of use filters provide a simple solution to provision of safe water, they often incur the same issues because the receptacle comes into contact with the drain below the filter. A novel innovation developed by Sarah Morter and Marc Lillystone (and in use at the Norfolk & Norwich University NHS hospitals), supported by Professor Fontaine (Chief Nurse and DIPC at the time) and the Trust facilities team, is illustrated in Figure 5(c) — a grate which can be lowered across a utility sink for placement of a receptacle when it is being filled to prevent contact with the sink drain area.

## Providing 'safe water'

Whilst mains domestic water is generally of a high quality, it has a rich microbial flora including organisms which may be pathogenic under certain circumstances. There is a balance between the concentration of organisms and underlying a

b


c

**Figure 5.** (a) Water splashing from a nearby drain in a sink was thought to be the source of a CPE outbreak. (b) Placement of a jug in a sink is likely to contaminate the base with drain organisms. (c) This innovative design was developed at the Norfolk and Norwich University Hospital NHS foundation Trust by Sarah Morter and Marc Lillystone. This unit is installed in multi-occupancy bays providing two functions. It is used for disposal of wash water, minimizing the risk of staff using a hand wash station. Secondly the grate (illustrated in the up position) can be lowered allowing placement of a bowl whilst being filled with water as opposed to being placed in the sink where the bowl would make direct contact with the drain and associated bacteria. Also note splash screens.

immunodeficiencies/predisposing factors in the population to infection. Thus, for people who are otherwise fit and well, mains water represents little risk, but the hospital population is very different.

The quality of water required for patient care can be defined by underlying disease, location, predisposing factors and activity. Thus, Glasmacher [24] has suggested water quality appropriate to a range of immunodeficiencies. In terms of location, the HTM 04—01 classifies hospital settings into risk areas, based around augmented care. Predisposing factors which may not be covered by these publications include the presence of an indwelling intravascular catheter. Lastly, activity would dictate the quality of water required, for example, to be used in a nebulizer (sterile), etc.

A problem arises when water and drainage services come into proximity, as in a basin. The drive for waterless units has predominantly been due to intractable outbreaks with multi-drug-resistant organisms originating from drainage systems. The individuals implementing the change to waterless may be regarded as pioneers. Effecting change is a slow process, often not achieved through proactive thinking but driven in response to crisis. A recent paper from France [25] found a higher rate of multi-drug-resistant bloodstream infections in ITUs meeting three of four conditions: a sink contamination rate of greater than 51%, sinks where visible splashing could be demonstrated in greater than 14% of sinks, more than 21% of sinks close to the patient's bed and no daily bleach disinfection. The concern is that transmission is occurring (not just in France but globally) but is either not being recognized or there is an inertia to alter practice.

Accepting the risk from drains may be inevitable. It then follows for patients in whom sterile water is recommended (due to their immunocompromised status) that they should have no access to sinks. Shower drains represent a risk which in one unit was mitigated by redesign [26]. A risk assessment should be conducted, which includes location of the drain (does patient come into contact with drain?), any evidence of prior transmission events, history of poor drainage/blockages, frequency of routine maintenance and whether those performing the maintenance have been adequately trained in infection control precautions (as well as their equipment being assessed for risk of cross-contamination). Lack of recognition of prior transmission events by itself is insufficient evidence of lack of risk because this often only becomes apparent when there is a marker organism, i.e. a highly antibiotic-resistant strain. An additional factor is how often the patient group uses the shower. Infrequent use, which may occur because the patients are unwell, runs the risk of water stagnation and biofilm formation unless an effective flushing regime exists.

The term 'waterless' is, to a certain extent, a misnomer. Provision of safe water by itself is not the problem, this can be done safely using either sterile water or water that is passed through a point of use filter. It is the interaction with the drainage system (which can not be readily controlled) that is driving the waterless agenda. Moving to a 'waterless' unit requires the following considerations: (1) Staff engagement — education of staff to understand the risks of water and help develop the process; developing ownership and increasing the likelihood of successful implementation. (2) Hand hygiene — the WHO recommends alcohol hand rub as the preferred method of hand decontamination. A reason cited for the continued use of soap and water is alcohol-resistant organisms such as *Clostridium difficile*, even when the incidence is only a few cases a year. Well-maintained portable sinks are an option in this setting. Further work on the efficacy of disinfectant-impregnated wipes in spore removal is urgently required. In a very basic hand washing study, we found alcohol-impregnated wipes to be more effective than alcohol hand rub as the former provided better coverage of all hand areas, including fingertips. (3) Patient bathing — a recent systematic review [27] found there is limited moderate- to high-quality evidence that washing without water is not inferior to the traditional bed bath. (4) Disposal of fluids — the issue when the drainage system is removed (waterless units) is looking for alternative ways of fluid waste disposal. This should not be the case but is indicative of the incorrect use of basins for disposal. Disposable containers with absorbent granules can facilitate discarding small volumes at the bedside.

## Finances

The success of new build projects within and outside of healthcare is usually judged by the media as to whether the project was completed on time and within budget. The impact of media judgement calls on the health service should not be underestimated. This culture needs to be changed. The new Queen Elizabeth University Hospital in Glasgow opened on time and half a million pounds under budget. Thus far, the costs of rectifying the serious underlying issues in the first few years have been estimated to be £20—30 million. The criteria for judging the success of a new construction need to be realigned to patient safety and defining the criteria for what is safe for a water/drainage system.

## Future research

The magnitude of the contribution of water and drainage systems to patient ill-health, antibiotic resistance and healthcare costs has yet to be fully appreciated. Mitigating the risks requires simultaneously both improved surveillance of transmission events and challenging existing design and practices to engender change for the better. Our suggestions (for starters) would include: (1) Investigating whether alternative methods of hand disinfection, i.e. impregnated wipes, are effective against spore-forming organisms; (2) the risk of dispersal of organisms from toilets; (3) alternatives to elbow-operated taps which do not incur the probable risk of increased biofilm formation (as with many sensor-operated devices); and (4) improvement in drainage design to minimize/eliminate blockages or to detect and communicate the presence of blockages at an early stage in order to allow prompt remedial actions.

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