The patient environment: When is it important in infection control?

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The environment

The word is much used but definitions vary widely

The definition I will use in the healthcare context includes

- ward and treatment area floors, walls, bedside lockers, bed-curtains etc that have no or minor patient skin contact
- parts of medical devices that have patient skin contact such as blood pressure cuffs
- items that have prolonged patient contact (mattress/pillow covers)
- items that have staff hand contact

Essentially, anything that is close to a patient, non-animate and non-invasive, or that may make contact with staff hands immediately before patient contact.

Risks to patients: modified Spaulding classification

HIGH - Anything that enters a normally sterile body area

MEDIUM - Anything in contact with intact mucous membrane

LOW - Anything in contact with intact skin (*some "environment" in this category*)

MINIMAL – Items not normally in close contact with the patient (*some "environment" in this category*)

Hospitals and microbial ecology

- Hospitals select out microbes that are
  - **Antibiotic resistant**
  - **Good at transferring**
  - **Good at replicating in a host (infection or colonisation)**
- Hospitals take people with similar susceptibilities (e.g. a ward full of people with surgical wounds, tracheostomies or urinary catheters) and put them close together in the same space.
- Hospitals are the ideal environmental niche for some microbes. They will evolve in this niche.
- The environment outside the hospital rarely contributes significant microbes – the problems are from within.
- **The hospital environment should be considered mostly in terms of indirect transfer between patients**

Infection

To produce an infection, it needs:

Sufficient numbers of a suitably virulent microbe to be transferred to a susceptible site on susceptible patient

The factor most amenable to intervention is the reduction of the numbers of microbes transferred.

Those patient-derived microbes that are on a possible transmission pathway to a susceptible site are of the most significance.

Those patient-derived microbes that are on a transmission pathway that might lead to patient colonisation are also of some significance, particularly with multiresistant organisms where colonisation can precede infection. Microbial numbers are important for colonisation as well as infection.

Routes of infection

Routes of infection can be short

e.g. source patient *to* staff hand *to* susceptible patient

or multi-step

e.g. source patient *to* air *to* surface *to* staff hand *to* susceptible patient

The more direct the route (i.e. the fewer steps), the less dilution of the inoculum and so the greater the microbial numbers transferred and thus the greater the chance of transmitting infection

Routes of infection

The less the dilution in a route of transmission, the greater the microbial numbers that will transfer

e.g. source patient *to* air *to* surface *to* staff hand *to* susceptible patient

will transfer fewer microbes than

source patient *to* staff hand *to* bedcurtain *to* staff hand *to* susceptible patient

Surface to surface contact will involve less dilution of an inoculum than via the air.

Routes of infection

The absence of observable infection transmission is not a reassurance that routes of transmission do not exist

It is possible that non-pathogens are transferring between patients at present

That routes of transmission exist, may be shown in the future when an organism capable of causing infections arrives in that environment

Environmental cleaning: patient contact surfaces

The greater the contact, the more important the surface

e.g. mattress covers important – bed-sheets are fairly transparent to the passage of contamination; contact is prolonged

The frame under a bed may be dusty, but how would contamination in this make patient contact?

The more contact is on a route of transmission, the more important the surface

e.g. flush handle (patient hand contact) more important than toilet seat (non-hand contact): for transmission of faecal-oral infections hand contact surfaces are more important

Clostridium difficile

There are examples where it is suggested that cleaning has a role in reducing transmission

Wilcox et al J Hosp Infect (2003) 54; 109-14 (a significant decrease in one ward where hypochlorite was used, but not in another)

And examples where it has not

McNulty et al J Antimicrob Chemother (1997) 40; 707-11 (“an outbreak …. continued despite increased cleaning …”)

However, it is thought that patients’ acquisition of spores from the environment is part of the transmission dynamic and that reducing this probably plays a role in reducing levels, but only after other, more significant measures (primarily rapid isolation on suspicion of infection, together with general control over antibiotic use) have been put in place.

Levels of evidence in infection control

Infection control is not the natural home of evidence-based practice

Adequately controlled studies are rare

Changes in response to outbreaks are multiple (planned and unplanned)

Infection levels will rise and fall naturally; these may coincide with interventions

It is easier to publish good news stories than “we did this and nothing happened” stories

Single examples and anecdote are often all that exists

Extrapolation and analogy are much used

Care with people who say “*Prove this does/does not make a difference*”. There is little high grade evidence in infection control, but this is not a valid reason for inaction. There is a good case for expert consensus.

Routine environmental cleaning

Cleaning can remove 80% contamination on a floor

Disinfection can remove 95% of contamination on a floor

An hour later, both surfaces are back to their former contamination levels

In occupied areas there is no real advantage to using routine environmental disinfection instead of routine environmental cleaning.

Non-routine environmental disinfection

Where there is a spill of potentially-infectious body fluid, disinfecting the areas after spill removal could add to safety.

Using disinfectants on gross spills - the disinfectant may not penetrate the spill and may be inactivated by the organic matter in the spill

Environmental disinfection can be useful in terminal (i.e. once a patient has left) decontamination of an isolation room, bedspace or emptied ward, when an end to recontamination can be defined.

There is no point in emptying a ward, disinfecting it, then putting the same patients back into it.

Environmental disinfection may also be useful for decontamination of a bedspace and associated equipment on an open ward as a terminal procedure.

Aesthetic vs. hygienic

Just because something looks dirty does not mean it is an infection risk – but patients have a right to be cared for in a clean environment whatever the infection risk or lack of it

Conversely, and more importantly, just because something looks clean does not indicate the lack of an infection risk

The aesthetic and the hygienic do not always equate

Deep cleaning?

There was an initiative in England in 2007/8 to “deep clean” every hospital ward as a one-off exercise.

- There was no definition of what a “deep clean” involved
- It was unclear if this was an infection control initiative
- It tended to happen in occupied wards with the patients in place or temporarily moved around within the ward

It is unlikely that deep cleaning, of whatever definition, as a single or periodic event plays a significant role in infection control.

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Terminal cleaning for infection control

If environmental cleaning/disinfection is required as a terminal infection control procedure, it will usually require coordination of different staff groups

In the UK different staff groups may be responsible for different environmental items e.g.

- *floors and low surfaces – normal cleaning staff*
- *bed-curtains and high surfaces – specially trained cleaning staff*
- *mattress covers and blood pressure cuffs – nurses or healthcare assistants*
- *monitoring equipment – technicians*

So organising cleaning for infection control requires a coordination of each of those groups to achieve a thorough clean without cleaned areas being recontaminated by uncleaned equipment or omitted from the process.

If normal cleaners are just told to "*do a very thorough clean*", many relevant surfaces will not be included.

Environmental cleaning: staff hand contact surfaces

Superficially located contamination is passed on by contact with high efficiency: i.e. If person A deposits contamination on a surface by hand contact, it will transfer mostly to person B who has the next contact with it, leaving sequentially less for persons C, D, E etc. to acquire.

If a hand contact surface (e.g. door handle) has 100 contacts per day, cleaning it once per day will decontaminate it between contact 100 and contact 101 (1%).

Cleaning it twice per day will decontaminate it between contacts 50 and 51, and contacts 100 and 101 (2%).

Similarly 4 times a day gives 4% decontamination between contacts.

If this surface is a vector of infection, would increased attention to staff hand hygiene be more productive than increased cleaning frequencies?

Keyboards

Should be amenable to cleaning/disinfection

Membrane, not traditional keys (common in food industry)

Can get keyboards that “remind” users if not disinfected

But should still treat them as contaminated surfaces

Bedcurtains

It seems inevitable that staff will use contaminated gloved hands to open and close bedcurtains.

If a patient is infected or colonised with a MDRO, the curtains should be changed in terminal clean

There is a problem where, in ICU for example, adjacent bed spaces share a common curtain

This forms a point of common staff hand contact for both beds

Low air loss beds

Complex structure – easy to contaminate, difficult to decontaminate. Cleaning the permeable outer cover will not prevent microbial transfer to the next user.

The most susceptible patients are placed on these mattresses. They will have prolonged contact with them.

Need to be decontaminated in specialist facilities by a validated process, normally from the bed rental company, though some hospitals also have the facilities. This is not something that can be done on the ward.

Need to ensure that all low airloss mattresses particularly from high risk units, infectious cases or during outbreaks get a full decontamination before reuse. (Ideally, this should be routine).

Thermostatic mixer valve (TMV) taps/faucets

The use of TMVs is common – prevents patient scalds

TMV taps, particularly sensor operated, have large internal surface areas of plastic and rubber that can support the growth of biofilms

Normally assorted environmental gram negative bacteria

There have been outbreaks of MDROs in high dependency units (ICUs and SCBUs) where the tap itself appeared to be a source of the MDR strains.

It seems likely that patient wash fluids have been emptied down handwash sinks and subsequent cleaning has inoculated the tap from the sink with retrograde colonisation of the existing biofilm with the resistant strain

The long term approach is still being explored, but a short term approach could be changing TMV sensor taps for more conventional mixer taps in areas where patients are unlikely to operate taps.

Healthcare laundry

Many healthcare fabrics will be in sequential, prolonged contact with multiple patients.

These fabrics will become heavily contaminated with microbes infecting and colonising these patients.

Making these fabrics safe for reuse is probably the most substantial decontamination application in healthcare but, as it occurs remotely, one of the least considered.

Laundering should be a combined cleaning + disinfection process

- Heat disinfection is capable of good QA time/temperature monitoring
- Chemical disinfection has energy-saving advantages but often lower QA

Processed fabrics must not be directly or indirectly contaminated by unprocessed fabrics

- The same vehicles will be used for collecting and delivering laundry; often the same carriers within hospitals and vehicles.