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Discussion paper

Infection control: Evidence-based common sense

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Abstract When compared against classical sciences, infection control is very much the ‘new kid-on-the-block’. This means that activities directed by infection prevention and control are more likely to reflect ‘common sense’ rather than robust evidence. Indeed, hand hygiene, isolation, screening, decontamination and cleaning remain hotly debated, especially the current vogue for bathing patients in antiseptics. So, which of these provide measurable benefit, and which do not? And why is it important? Do we actually need irrefutable evidence for the advice that we dispel on a daily basis? This opinion piece examines the main components of a modern day infection control service and assesses their worth from a mainly UK perspective. The findings suggest that the framework for preventing infection is structurally sound, despite the lack of evidence. Biological sciences, by their very nature, do not easily fit into neat equations; they remain subject to measurement variables, tempered by patient status and microscopic pathogens. Despite this, numerous reports from healthcare facilities all over the world stand testimony to basic hygiene, particularly when confronted by outbreaks. Managers and others who seek to undermine traditional infection control practices should be challenged, particularly when imposing knee-jerk policies for which there is no evidence at all. Given the insidious creep of antimicrobial resistance, infection prevention and control will inevitably assume the status it has hitherto been denied. Common sense, however defined, eventually turns into scientific evidence at some stage but this progression relies upon continued accumulation, evaluation and integration of evidence by professionals and policy makers.

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Highlights

- Infection control is a relatively ‘young’ science and does not yet have a robust evidence base.
- Increasing antimicrobial resistance provides a new focus on infection prevention.
- Hand hygiene and cleaning hand-touch sites are better together.

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- Screening identifies an unknown reservoir of colonised patients. You can't control what you don't know about!
- Accurate surveillance permits analyses of infection prevention strategies.
- Making senior managers responsible for infection control creates an infection control ethos throughout the institution.

Introduction

Controlling infection has long been recognised as key to good health. Over the past century, doctors have discovered how to isolate and identify microbes of human interest, along with their reservoirs and major modes of transmission. Tracing the origin of these pathogens and interrupting spread between environmental, non-human and human reservoirs underpins the basis of infection prevention and control practiced in today's hospitals.

The first UK Infection Control nurses were appointed in the late 1950's; just as the first national infection control guidelines were published in 1959 [1]. The trigger for these was a decade or more of problems with the 'hospital staphylococcus', an organism wreaking havoc in surgical wards and furthermore becoming increasingly resistant to penicillin [2]. The staphylococcal pioneers of the day quickly established the epidemiology of ubiquitous *Staphylococcus aureus*, including human carriage, role of the air and environmental longevity [3]. The infection control response in hospitals reflected burgeoning knowledge of *S. aureus* and its reservoirs, and endorsed a staple diet of patient isolation, screening, hand washing, natural ventilation and cleaning [3]. These activities relied heavily on common sense, since there was little in the way of evidence at the time. It wasn't until 1985, with the publication of the SENIC study, that definitive surveillance data demonstrated tangible benefits of infection control in hospitals [4]. Since then, the speciality of infection prevention and control is recognized as a fundamental necessity for all healthcare institutions, with increasing numbers of staff, policies, protocols and guidelines providing a framework for delivery.

How much progress have we made, then, toward securing a robust evidence base for infection prevention activities in hospitals over the last 50 years? The answer to that is very little, if one considers the comments from recent reviews [5]. Studies examining much of what we do in the name of infection control concludes that evidence supporting individual components of an infection prevention programme is piecemeal and poor quality, and even the evidence for 'bundles' of interventions fares little better. The whole is still questionable, subject to confounding, bias, quality and scale.

Following outbreaks of specific organisms, the public made hospital-acquired infection an electoral issue in the UK [6]. This led to the introduction of targets for key pathogens, with responsibility devolved to healthcare managers [7,8]. The target culture has flourished to incorporate hand hygiene compliance and environmental inspections, along with directives on doctor's dress, watches, vases of flowers, magazines and toys in the waiting room

[9,10]. On the wards, clinical staff live in fear of 'zero tolerance' of their hand washing skills, with doctors themselves accused of scruffiness and suspect personal hygiene [11]. While these interventions have been implemented in the name of infection control, they lack rigorous studies and merely showcase the predictable knee-jerk response from policy makers charged with public health responsibilities. They also intimate what might happen when the antibiotics finally run out.

Hand hygiene

Hand hygiene itself, the most obvious, the oldest (and simplest) of all infection control activities has a shaky lead over most other interventions from the evidence base viewpoint [12]. Perhaps because it is so simple, it has attracted funding, research and political support. It cannot be argued that new build hospitals with plenty of spare rooms and state of the art ventilation, are a lot more expensive than providing bottles of alcohol gel. Furthermore, hygiene misdemeanours are firmly in the hands of clinical staff and far removed from government offices. The hand hygiene proponents claim that their efforts saved the UK from MRSA, but one only has to examine the data to see that there were many other interventions introduced over the same time period that could all have contributed towards falling rates of MRSA bacteraemias [13,14]. These include surveillance programmes, rapid molecular tests, antibiotic prescribing policies, the 'deep clean' initiative, and screening all patient admissions for MRSA. While some, or all, may have contributed towards decreased MRSA rates, no effect has been seen on rates of multiply-resistant coliforms, vancomycin-resistant enterococci or *S. aureus* bacteraemias [14]. The latter is perhaps the real thorn in the UK hand hygiene story, since all the emphasis on hand hygiene and extra gel failed to impact on rates of a close epidemiological relation of MRSA [13,14].

Screening

Universal screening for MRSA carriage with subsequent decolonisation has almost certainly had a beneficial effect on MRSA carriage and infection rates [14,15]. The MSSA bacteraemia rate might also have decreased, as it has in Australia, if patients had been screened for MSSA as well as for MRSA [14,16]. In the UK, screening swabs arriving in the microbiology laboratory are plated onto MRSA chromogenic agar, which cannot support the growth of methicillin-susceptible *S. aureus* (MSSA). Thus, infection control staff readily identify patients with MRSA and treat accordingly, while those with MSSA remain unidentified. Patients are

more at risk from MSSA infection than MRSA, especially those requiring surgical intervention [17].

It has long been known that you can't control what you don't know about, so screening patients (and staff) for a variety of pathogens remains a popular pastime for well-resourced institutions. Many hospitals are now introducing targeted screening for carbapenemase-producing coliforms, since these organisms are essentially untreatable and constitute a significant risk for onward transmission. Patient screening is not without critique; although heavily defended if the evidence base is challenged [18–21]. The decolonisation programmes offered to carrier patients have also been criticised; for lack of clinical benefit and concern over increasing resistance or tolerance to the agents used in the topical clearance regimens [15,18,22]. Indeed, the current vogue for bathing everyone with antiseptics, notably chlorhexidine, has ignited much discussion with, as yet, no clear decision to help policy makers [23].

Isolation

Once a patient has been identified with a potentially transmissible pathogen, they are usually isolated in a side-room, preferably with adjoining bathroom. Once again, there is little substantial evidence to support this type of segregation from the infection prevention point of view, while there is evidence to show that isolated patients tend to suffer from loneliness and reduced clinical attention [15,22,24]. Indeed, understaffed wards cannot provide the nursing care required for isolated patients since they are not continually observed. Keeping the door of an isolation room closed ought to be an important part of the package, as well as donning the usual barrier protection before entry [15]. There is little evidence for either. Doors are habitually left open, which encourages staff (and visitors) to enter without taking additional precautions. In that case, isolating a patient acts as little more than a visual reminder that they have a transmissible infection rather than a serious attempt at curtailing onward transmission.

There is another facet to infection prevention involving single-room occupancy, and that is proof that patients accommodated in a room which previously held an infected patient are more likely to acquire the same pathogen as that of the prior occupant [25]. While this offers a comment on hospital cleaning standards, or even the possibility of airborne transmission, it also suggests that the risk of acquiring an infection persists – regardless of any local hand hygiene or barrier nursing endeavours.

Barrier protection

Plastic gloves and aprons are provided in most healthcare facilities for dealing with infected or colonised patients. These will not protect staff from acquiring pathogens on their own skin, clothes or uniforms, but, as with isolation rooms, they do offer token recognition towards infection control. Staff wearing barrier protection remind visitors as well as themselves that some patients and activities are deemed high risk for infection. Colour coding in the intensive care unit, for example, allows the nurse in charge to spot a visitor to the 'wrong' bed, should staff encroach

upon a patient zone not allocated to them for care. The biggest problem with glove use is that the wearer assumes that they are impervious to hospital germs, which is not necessarily the case. Most brands are at risk of microscopic holes or tearing, and even careful removal invariably contaminates staff hands. Whatever material is used, gloves are still able to acquire hospital pathogens and spread them through touch [26,27]. Thus, hand hygiene is less of a priority while the gloves stay on and this may itself lead to transmission events [26,28]. Staff subconsciously view gloves as barrier protection primarily for themselves, and not for patients, and this clearly compromises patient centred care.

Cleaning

Hospital cleaning has also come in for intense criticism, especially following the impromptu 'Deep Clean' of English hospitals [29]. Those who direct healthcare strategies still do not understand the removal of dirt, or its significance, probably because cleaning remains an undervalued component of infection prevention [30]. Yet, it is a fundamental necessity for all healthcare environments and equally as important as hand hygiene [31]. Hands certainly transmit germs to patients but they have to make contact with a reservoir on a hand-touch site before they can do that. If the surface area of all the hands on a ward (including staff, patients and visitors) is calculated and compared against the surface area of all hand-touch sites on that ward, one can arguably demonstrate a tangible measure of the relative importance of both [14]. Is there evidence to support surface cleaning in hospitals? Yes, plenty, particularly studies that combine cleaning with other initiatives, including hand hygiene [25,32–34]. Changing societal views on cleaning hands, including the motivation to actually do it, is a lot more difficult than implementing an environmental cleaning specification, even if the latter requires monitoring and feed-back [30,35].

Increased attention on the role of the healthcare environment in transmitting hospital pathogens has awakened interest from business and industry, with strategies aimed at superseding traditional manual cleaning with detergent and water [36]. Novel biocides and cleaning products, antimicrobial coatings, auditing practices and automated equipment are widely accessible, but most have not been comprehensively assessed against patient outcome nor subjected to appropriate cost-benefit analyses [37]. It is singularly unhelpful when studies showcasing a new product claim patient benefit but are then found to be confounded by concurrent infection control and/or antimicrobial stewardship initiatives [37].

Bundles

So-called 'bundles' are collections of different activities designed to reduce HAI for a particular intervention such as catheter care, a surgical procedure or intubation of a patient needing ventilatory support. They do seem to work, because carefully chosen and well-maintained bundle practices result in less infection among patients [38,39]. Of

course, the efficacy of any individual component cannot be assessed nor compared against any other intervention. If a bundle is small and contains only the very best evidence, notably better outcomes are achieved. It is also possible that success is dependent not just on choice of component but on compliance monitoring, since interventions that do not work may not have been reliably implemented [40]. The whole point of the bundle is to drive compliance, especially if results of the intervention are monitored and fed back.

To a certain extent, 'bundles' of infection control activities are an excuse for lack of evidence for each component [41]. Since there is so little robust evidence for many of the things performed in the name of infection control, bundles represent a best guess at the current time, even if some of them turn out to be a spectacular waste of money. There is also a risk that some of the elements might do more harm than good, for example, universal application of antiseptics, antibiotics, or other prophylactic agents [40,42,43].

Surveillance

The basis for all infection prevention strategies is reliable surveillance [44]. Without clearly defined incidence data collected over time, infection trends cannot be identified or used correctly to inform control strategies. Accurate surveillance data is also dependent upon the availability of local resources, since any deficit in trained personnel and/or microbiology services may compromise meaningful surveillance. If there is access to an appropriate laboratory, it is essential to ensure that samples are processed efficiently with optimal recovery of key organisms and that transport and storage media are organised to maintain viability. Otherwise, bias is introduced that could skew the data. In the UK, national surveillance centres and reference laboratories have been set up for the express purpose of capturing specific pathogens and reporting surveillance trends [8]. These are published regularly for the benefit of microbiologists, public health, government and the public. The UK also contributes towards several surveillance systems established for European countries, including antimicrobial consumption trends [45,46]. However, comparing and contrasting HAI, antimicrobial resistance and consumption rates across the world, so important for global targets and action, are not currently available. Since resistance mechanisms travel across borders at liberty, courtesy of international travel, far distant policy makers need to work together to understand evolving threats from resistant pathogens [47].

Managers' role

Whilst effective infection control undoubtedly saves money, there remains persistent conflict between economic restraints and the principles underlying basic infection prevention [48]. Managers seek to run a hospital along the lines of an industrial business, with 100% bed occupancy, increasing turnover and yet more targets imposed on rapid processing and quality 'end-products'. However, patients are neither uniform nor standardised, and their myriad healthcare needs do not necessarily fit into a pre-determined production line, either. The whole is confounded by the fact that it is impossible to control,

let alone prevent, infection in a hospital filled to capacity, understaffed, with open visiting, lengthening waiting times and subject to government targets [49]. What meagre evidence we have, on safe bed occupancy rates, hand hygiene, screening, cleaning and so on, is automatically rendered ineffective for a hospital bursting at the seams [50]. Within the soup of human proximity, antimicrobial exposure, inadequate cleaning and artificial ventilation, antibiotic-resistant organisms of the day happily tutor the multi-drug resistant pathogens of tomorrow.

Managers keen to reduce costs are centralising healthcare facilities without considering clinical risk review as justification for service cuts. Should this concern an underutilised clinical service or a rare test, for example, then centralisation is clearly rational, but this is not always the case. The centralisation of accident and emergency departments, basic laboratory services or routine surgical specialities erodes the quality of the clinical service without necessarily saving money [51]. This also forces specimens, staff and/or patients to travel much longer distances than they would have done, sometimes with detrimental effect. Some healthcare boards or regions have also centralised infection control services, which increases response time to significant incidents as well as encouraging the spread of antimicrobial resistance and risk of outbreaks. It is difficult to defend an on-site infection control presence when this 'teenage' science does not yet have the evidence it needs to defend local services or give it the priority it deserves.

Best practice based on current evidence

So what constitutes effective prevention and infection, and how do we establish best practice in our hospitals? [52] Microbiologists and infection control practitioners tacitly assume that, despite the lack of evidence, our infection control framework is structurally sound. Fleshing out the detail will take time, as always with a new science, but the undeniable spectre of untreatable infection provides an increasingly strong focus [53]. There is nothing wrong with current components of the infection prevention mantra, other than the irritating and hysterical add-ons that will fade with the evidence to come. Basic hygiene has stood the test of time, from the Greeks and their silver pots, to Florence Nightingale and her open windows [54]. It's a fact of life that there may have to be a fatal outbreak of pan-resistant microbes in our overcrowded hospitals before general acceptance of safe bed occupancy rates, for example, but the things we do now to stop pathogens spreading between patients are tried and tested and should continue (Highlights) [55].

One particular activity, not yet mentioned, has profound effects on the incidence and prevalence of many of the pathogens associated with HAI. This is antimicrobial stewardship, which is a rather pompous term for appropriate management of anti-infective prescribing. Like cleaning, stewardship is easier to implement than hand hygiene, and it has a rapid and measurable impact on resistance rates of hospital pathogens, including *Clostridium difficile*. [56,57] Provided one can safely discard the possibility of septic shock, it is entirely justifiable to terminate an antibiotic

cocktail for a patient with persistent infection. Re-culturing specimens without the pressure from potent antibiotics means that the laboratory has a chance of isolating the pathogen and thus improves future therapeutic choice. Indeed, in true paradoxical form, patients often get better if the clinician has the courage to reign in antimicrobial prescribing. Reducing overall antibiotic consumption throughout hospital, community, and across an entire country, means a few more years' insurance for the prudent before pan-resistance threatens [58,59].

And for infection control professionals? What can we do to defend patients against the germs? Perhaps it is time to refocus on a culture of hygiene for our patients, our families and ourselves. Older colleagues may remember how things were before the explosion of antimicrobial agents last century but younger folk will have grown up with the mantra of 'a pill for every ill'. Medical, and indeed, all healthcare students are not necessarily taught much about hygiene and its definition at college or university [11,14]. The pendulum favouring the importance of 'clean' is beginning to swing back, and faced with diminishing antibiotic options, it's not difficult to see why [60]. All healthcare practitioners should keep faith with common sense surrounding the definition of hygiene and stick with traditional values. Evidence for what we do in the name of infection prevention and control will undoubtedly appear as antibiotic therapies dissipate. While the 20th century introduced life-saving anti-infectives and vaccines, the 21st will herald infection prevention and control, all underpinned by formative studies on pathogen transmission [48].

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