

## Technical Note

# Nosocomial infections and staff hygiene

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### Abstract

Nosocomial infections are a major source of morbidity and mortality in hospital settings. The most important defences against nosocomial transmission of viral, bacterial, and other infections are detailed and continuing education of staff and strict adherence to infection control policies. The issue is no longer whether hand hygiene is effective, but how to produce a sustained improvement in health workers' compliance.

**Key words:** infection, hand washing, hygiene, microbes, personal computer

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### Introduction

Nosocomial infections are a major source of morbidity and mortality in hospital settings, afflicting an estimated 2 million patients in the United States each year. This number represents up to 5% of hospitalized patients and results in an estimated 88,000 deaths and 4.5 billion dollars in excess health care costs [1].

Among the priorities identified for the National Health Service (NHS) in Europe are reductions in hospital-acquired infection and in antimicrobial resistance [2]. These are to be achieved by improved surveillance, optimal antibiotic prescribing, and strengthening of basic infection control procedures such as hand washing.

#### *General*

Microorganisms on the skin are generally divided into two categories, resident and transient. Resident microorganisms are microbes that normally colonize or live on the skin of most individuals; they generally do not cause infections unless they are introduced into normally sterile body sites and/or unless the host becomes more susceptible [3]. In contrast, transient microorganisms are microbes that are present on the skin for only a short time; they tend to be more pathogenic than the resident and are responsible for most nosocomial acquired infections [4].

In general, at least four factors, some microbial-associated and some host-associated, determine whether an infection will occur. Microbial factors of

importance include the number of microorganisms present. The particular factors that the microbe has will influence its ability to cause an infection. For example, a bacterium that produces a particularly potent toxin can cause an infection that another can not. Third, the most critical factor that the host brings to the interaction is immunologic status. Finally, in order for an infection to occur, the microorganism or its products must come in contact with the host. Contact can happen in a number of different ways. The microbe might directly contact the host, or it might contact the host via an indirect route involving inanimate objects, called fomites, and/or living organisms, called vectors. A piece of computer hardware, or a vector, such as a health care worker, becomes contaminated with a microbe and then serves as a reservoir for transmitting the microorganism to the host by some form of contact [3].

#### *Hand Hygiene*

The most important defences against nosocomial transmission of viruses are detailed and continuing education of staff and strict adherence to infection control policies. Protocols must be available to assist in the management of patients with suspected or confirmed viral infections in the health care setting. All involved in patient care should be aware of the potential dangers to patients of continuing to work while suffering from a respiratory infection, cold sores, or other viral disease.

The important role of adequate hand washing after examining every patient must be emphasized, as must the potential risks to the workers of breaks in hygienic practice such as eating, drinking, smoking, applying cosmetics, or inserting contact lenses in clinical or laboratory areas and from touching their mouths or eyes during the course of their work [5]. The first clear evidence of clinical benefit from hand hygiene came from Semmelweis, working in the Great Hospital in Vienna in the 1840s [6]. The Hand Hygiene Liaison Group has also identified nine controlled studies where hand washing compliance was measured [7,8]. These all show significant reductions in infection-related outcomes, whether in settings with a high infection rate in critically ill patients [6,9] or in relatively healthy populations with low rates of infection [10,11]. The evidence from studies in less developed countries is compelling: the adherence to usual recommendations for hand hygiene, including washing hands with soap and water after using the toilet, before eating, and before preparing food, will decrease, for example, the incidence of diarrhoeal illness.

#### *Hand washing*

Hand washing is emphasised as the single most important measure to prevent cross transmission of microorganisms and thus to prevent nosocomial infections. However, under routine hospital practice, compliance with this measure is still unacceptably low, less than 50% in most studies published in the past 20 years [12,13]. This constant finding is worrying because recent studies have shown that this level of compliance will not reduce the risk of transmission of multi-drug resistant bacteria in hospital [14].

Healthcare workers and especially doctors are not fond of regular hand washing. Most of them admitted that they did not wash their hands between patient contacts. Various reasons were mentioned: lack of adequate and conveniently located sinks, lack of adequate hand towels, lack of water, poor quality soap, lack of hand lotions/lubricants for use after hand washing, skin sensitivity, and lack of time. When asked to propose solutions to the problem of inadequate levels of hand washing, doctors, nurses and other health workers who participated in the focus group discussions suggested that staff training and sufficient supplies where necessary; that mechanisms for continuous supervision and follow-up should be put in place; and good practices should be rewarded [15].

Formal hand washing with soap and water is required when there is soiling. Two basic types of soaps are available for hand washing: soaps that do contain an antimicrobial, and soaps that do not. Because of concern about the emergence of resistance to antiseptics, antimicrobial soaps are generally not recommended for regular hand washing [16].

Doctors and other health workers put themselves and their patients in danger when they fail to observe routine hygiene practices [15]. A recent study reported that gender and profession may interact, because it was shown that women and nurses of both genders tended to wash more often than men and physicians [17]. An earlier study (conducted over 25 years ago) had demonstrated clearly that simple hand washing with running water and soap draws bacteria from deeper layers of the skin, even after alcohol rubs had already been used to disinfect the hands [18]. However, there is also real concern among health workers about the risk of dermatitis caused by frequent washing of hands with harsh detergents, so there is clearly more to hand washing than Semmelweis first noted. Alcohol hand rubs take 10 to 20 seconds to apply and healthcare workers are thus more likely to comply [19]. Indeed, while rubbing the solution into the hands, one can be doing something else useful such as communicating with the patient.

The EPIC review showed that liquid (even non-medicated) soap and water effectively decontaminates hands, but that 70% alcohol or an alcohol-based antiseptic hand rub provides the most effective decontamination for a wide variety of organisms [20]. With hand rubbing the median percentage reduction in bacterial contamination was significantly higher than with hand washing (83% v 58%,  $P = 0.012$ ), with a median difference in the percentage reduction of 26% (95% confidence interval 8% to 44%). The median duration of hand hygiene was 30 seconds in each group. Experimental studies show that hand rubbing is at least as effective as medicated soap in reducing artificial contamination of hands. Many healthcare workers still have reservations regarding its efficacy and are reluctant to use this technique [21]. Hand rubbing with an alcohol based, waterless hand antiseptic seems to be the best method of increasing compliance with hand hygiene. Recent studies have shown a significant improvement in compliance after the introduction of hand rubbing as a substitute for hand washing with plain soap and water [22,23]. The duration (30 seconds) seems sufficient for hand

rubbing with alcohol-based solutions but may not be long enough for hand washing with a medicated soap [21]. Alcohol hand rubs are quick to use (10 to 20 instead of 90 to 120 seconds) and can be used while walking and talking. Thus they overcome objections to hand washing, including lack of time, lack of sinks, and skin damage. Indeed, a recent study has shown that such hand rubs cause less irritation than soaps [24].

#### *Gloves and infections*

Fifty percent of the health workers interviewed said that they prefer to wear gloves, and admitted that they do not change their gloves between patient contacts. Those who preferred gloves saw them as protective devices for themselves, rather than for their patients [15]. Studies have shown the use of gloves to be hazardous for both the patient and the health care worker unless certain precautions are taken. Latex gloves can easily get punctured and/or provide ambient medium (moisture and warmth) for bacteria to breed rapidly. Washing hands and donning them with antimicrobial substances before gloving and washing hands immediately after removing the gloves is recommended [25]. Gloves provide an extra amount of protection, and therefore may be used as an adjunct to hand washing, but not instead of hand washing. There can certainly be circumstances when gloves can be used to decrease the transfer of microbes [26], but it is important to note that gloves alone, without an appropriate protocol for use, could potentially increase transfer.

#### *Infection and personal computers in the healthcare environment*

Over the past 50 years, various forms of computer-based, information management applications have been developed and deployed in clinical settings [27]. While the need for and benefits of having computers at the patient's bedside for use by clinicians has been well studied, little attention has been paid to the potential risks of infection to the patient that these devices might pose [3]. The possible impact of the presence of these devices in patient care areas has not been well studied. However, currently available data indicate that computer hardware placed next to a patient's bed can host microorganisms. However, it has not yet been determined whether computer hardware (PC mice, touch screens, portable devices, etc.) might be a factor in the dissemination of microbes [3]. The authors of a 1998 study [28] concluded that computer

keyboards were not a significant source of the spread of resistant bacteria in their unit. In 1999, Neely *et al.* [29] reported a more extensive epidemiologic investigation which showed that microorganisms were found more often on computer keyboard covers than on any other object in the patients' rooms. In another study, the investigators concluded that computer fans in the ICU did not have a significant impact on the fungal infections in their unit [30]. It is quite possible for a long-living microbe on a computer keyboard to be transferred to a staff member's hands and then to a patient where it could potentially cause an infection [3]. In addition, computer terminals located close enough to the sink could be splattered during the course of cleaning objects or hands and thereby become contaminated with microorganisms. One control measure would be to relocate the computer or to simply place a water impermeable barrier, such as a plastic panel, between the sink and the keyboard. It is also suggested that successful disinfection of computer hardware should be preceded by cleaning. There is no perfect disinfecting agent; each chemical has its own advantages and disadvantages. When choosing these agents, besides efficacy in disinfection, issues such as patient and personnel safety, ease of use, aesthetics, and costs need be considered.

Mobile phones (cell phones) are a source of irritation for some but undeniably useful for many. Their use in hospitals, however, is mostly banned as they are considered potentially hazardous in medical environments. But evidence for serious harm is lacking and more studies are needed to provide conclusive data [31].

#### *Collaboration of scientists to control infections*

Antimicrobial management programs based on an incomplete understanding of the relationship between antimicrobial use and resistance may be fruitless, or at worst even counterproductive. Essential to a successful antimicrobial stewardship program is the presence of at least one infectious diseases-trained physician who designs, implements and administers the program. Supervision by an infectious diseases physician is necessary to ensure that therapeutic guidelines, antimicrobial restriction policies, or other measures are taken and will not put patients at risk. However, smaller hospitals without these personnel may not feel they can support such a program. Pharmacists whose primary role is in processing medication orders and dispensing drugs in the hospital may note when restricted antimicrobials

are ordered and notify the prescriber that authorization is required. However, the broad responsibilities of these pharmacists generally do not allow adequate time for a comprehensive review of antimicrobial therapy.

The clinical microbiology laboratory is a component in the function of antimicrobial stewardship programs. Summary data on antimicrobial resistance rates allow the antimicrobial stewardship team to determine the current burden of antimicrobial resistance in the hospital, facilitating the decisions taken. Infection control staff gathers highly detailed data on nosocomial infections which may assist in the antimicrobial stewardship team's evaluation of the outcomes of their strategies. Hospital epidemiologists have the expertise in surveillance and study design to lend to efforts studying the effect of antimicrobial stewardship measures. None of the efforts of infectious diseases physicians, pharmacists, microbiologists, or infection control practitioners to establish an antimicrobial stewardship program are likely to be successful without at least passive endorsement by hospital leadership. Resistance to compliance with guidelines for antimicrobial usage may be implemented through the establishment of an antimicrobial formulary, such that only selected antimicrobial agents are freely dispensed by the pharmacy. Although restriction strategies may be effective, there are limitations to the approach. There may be inadequate personnel or institutional commitment for a restrictive approach. The increasing computerization of the hospital environment offers new opportunities for programs to optimize antimicrobial use. Extracting antimicrobial use data from these databases would allow monitoring, possibly even in real time, of antimicrobial use within an institution [32].

Finally, formal economical evaluation is needed, which will probably demonstrate that the benefit resulting from cutting down on nursing resources is by far outweighed by the cost of nosocomial infections attributed to staff shortages [33]. In 2000, a study showed that among the 8,460 study patients, 817 (16.6%) developed 1,407 episodes of nosocomial infection and 233 (2.7%) presented with only one nosocomial infection. Mean daily antibiotic cost was \$89.64. Daily antibiotic cost was \$99.02 for pneumonia, \$94.32 for bloodstream infection, \$94.31 for surgical site infection, \$52.37 for urinary tract infection, and \$162.35 for the other infections per patient.) [34].

### *Implementation of good staff hygiene*

Efforts to bridge the gap between the dissemination of guidelines and their actual use are clearly needed but will be challenging. Although education is not sufficient in itself to influence practice, guideline knowledge has been shown to improve medical practice [35]. One survey found no specific hospital characteristics (*e.g.*, affiliation with an academic health centre, geographic location, level of experience of infection control staff) that were significantly associated with high or low guideline implementation or with rates of hand hygiene compliance [36].

### **Conclusion**

In the future, issues of concern about the emergence of nosocomial infections, increasing antimicrobial resistance, and the increase in morbidity, mortality, and costs associated with these infections will drive the need for refinement of molecular approaches to aid in the diagnosis and epidemiologic analysis of nosocomial infections. National and international organizations have recognized the growing problem of antimicrobial resistance and have published recommendations to combat this problem. The issue is no longer whether hand hygiene is effective, but how to produce a sustained improvement in health workers' compliance.

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