Hand hygiene—the case for evidence-based education

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J R Soc Med 2001;**94**:278–281 SECTION OF EPIDEMIOLOGY & PUBLIC HEALTH, 30 OCTOBER 2000

Among the priorities identified for the National Health Service (NHS) are reductions in hospital-acquired infection and in antimicrobial resistance[1]. These are to be achieved by improved surveillance, optimal antibiotic prescribing and strengthening of basic infection control procedures such as handwashing. According to recent figures[2,3], hospital acquired infection affects 1 in 11 inpatients, carries a 13% mortality and lengthens stay by a factor of 2.5. The extra cost to the NHS is nearly £3000 per patient, and the total annual cost is nearly £1 billion. Between 15% and 30% of hospital-acquired infection is considered preventable, but even a 10% reduction would improve bed management to the tune of 47 000 extra finished consultant episodes per year. The NHS's action plan to reduce hospital-acquired infection[4] holds chief executives personally accountable, and requires handwashing to be implemented in line with Department of Health guidance[5,6].

Healthcare workers' compliance with handwashing is known to be poor, with doctors performing particularly badly[7,8]. When the Department of Health published its handwashing guidance a storm of correspondence in the *BMJ* excused low compliance on grounds of lack of time, poor availability of sinks and soaps, skin sensitivity and lack of evidence. This paper reviews the evidence that patient contact results in contamination of the hands by pathogens and that washing with liquid soap and water or, better, use of an alcohol handrub, greatly reduces hand contamination and infection rates, and presents the case for making hand hygiene a medical educational priority[9].

BACKGROUND

Semmelweis

The first clear evidence of clinical benefit from hand hygiene came from Semmelweis, working in the Great Hospital in Vienna in the 1840s[10]. The hospital had two obstetric departments, and women were admitted alternately, whatever their clinical condition, to one or the other. In the first, they were attended by medical students who moved straight from the necropsy room to the delivery suite. In the second, they were attended by midwives and midwifery students who had no contact with the necropsy room. The incidence of maternal death was as high as 18% in the first department, with puerperal fever the main cause, but only 2% in the second. Semmelweis observed that a colleague died from an illness similar to puerperal fever after being accidentally cut during a necropsy. He concluded that the infecting particles responsible for puerperal fever came from cadavers and were transmitted by hand to women attended by medical students in the first department. He therefore instituted hand disinfection with chlorinated lime for those leaving the necropsy room, after which maternal morbidity in the first department fell to the levels achieved by the second department. In terms of experimental design Semmelweis conducted more than a pre and postintervention study; he performed, albeit inadvertently, a controlled trial. There is also an element of cross-over.

Rammelkamp

Just over a century later another key observation was made. In the wake of the staphylococcal epidemics of the 1950s, Rammelkamp and co-workers[11] demonstrated that direct contact, and not airborne transmission, was the main mode of transmission of *Staphylococcus aureus*. They also demonstrated, in what would now be called a controlled trial, that handwashing between patient contacts reduced levels of *S. aureus* acquisition to the low levels resulting from airborne transmission. Their experimental setting was a neonatal nursery, chosen because babies are born sterile. One group of sterile babies was nursed by a dedicated team of nurses. The other group included index cases with umbilical staphylococcal infection and was nursed by a separate team. Throughout the study the first group of nurses routinely washed their hands between patient contacts. The rate of staphylococcal acquisition was 10%. The second group of nurses washed their hands for the first 20 days of the 50-day study, during which time *S. aureus* acquisition by babies was 14%. In the second half of the study they washed their hands only when they felt it clinically indicated and staphylococcal acquisition rose to 43%.

HANDWASHING: THE EPIC SYSTEMATIC REVIEW 2001

The need to reduce infection and hospital-acquired antimicrobial resistance prompted a systematic review of handwashing by Thames Valley University as part of the EPIC study[12]. This concluded that there was good evidence that

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direct patient contact resulted in hand contamination by pathogens. For example, 80% of staff dressing wounds infected with methicillin-resistant *S. aureus* (MRSA) carried the organism on their hands for up to 3 hours. Immediate washing with liquid soap and water virtually eradicates the organism[13,14]. An intensive-therapy-unit study showed that 40% of all patient–nurse interactions resulted in same-species transmission of *Klebsiella* to healthcare workers' hands, lasting up to 150 minutes, even after contact as slight as touching a patient's shoulder[15]. A study of healthcare workers' hands sampled within half an hour of contact with patients with *Clostridium difficile* infection showed same-species contamination on nearly 60% of hands, even after activities as simple as returning drug charts to the end of beds. Washing with soap and water virtually eradicated the organism[16].

The EPIC review showed that liquid (even non-medicated) soap and water effectively decontaminates hands, but that 70% alcohol or an alcohol-based antiseptic handrub provides the most effective decontamination for a wide variety of organisms (*S. aureus*, *Pseudomonas aeruginosa*, *Klebsiella*, rotavirus[17,18]). Liquid soap and water, medicated or otherwise, comes into its own where there is physical soiling of the hands, but takes a full 90 seconds to apply in the manner recommended by EPIC[12]. Alcohol handrubs take 10–20 seconds to apply[19] and healthcare workers are thus more likely to comply[8]. Indeed, while rubbing the solution into the hands one can be doing something else useful such as communicating with the patient. Time constraints have been identified by EPIC as one of the main barriers to regular handwashing, another being allergies to antiseptic preparations. Allergies are much less likely to arise with alcohol-glycerol preparations, which are now recommended by the Hand Hygiene (formerly Handwashing) Liaison Group for use between patient contacts[20].

The EPIC review provided evidence from trials of various designs in a wide range of settings—in particular enteric illness and intensive care—that handwashing reduces infection rates. However, most studies compare preintervention with postintervention and do not measure handwashing compliance. Many confounding factors are present such as case-mix, length of stay, bed occupancy, staffing levels, intensity of workload, antibiotic use, regional or seasonal changes, and changes in infection control practice[8,12]. Pittet *et al.*[8], for example, reporting that an increase in handwashing compliance was accompanied by a fall in the MRSA-rate, comment that not all this fall could be ascribed to improved hand-hygiene; an intensive MRSA isolation programme was introduced at the same time[21]. The Hand Hygiene Liaison Group has identified nine controlled studies—three randomized control trials, five controlled trials and one multiple crossover trial—where handwashing compliance was measured by direct observation[22,23] of use of water, soap, etc.,[24–26] or enforced by study investigators in a wide variety of settings (Table 1)[10,11,27,28]. These all show significant reductions in

Table 1 **Outcome of randomized (RCT) or other controlled trials (CT) where handwashing has been directly observed or enforced, or consumables have been measured**

Study	*Design*	*Setting (country)*	*Unit comparison*	*Outcome attributable to hand disinfection*
Semmelweis (Ref. 10)	CT	Obstetric department (Austria)	Department	Reduction of mortality from 11% to 1%
Mortimer *et al.* (Ref. 11)	CT	Neonatal nursery (USA)	Cohort of babies	Reduction of *S. aureus* acquisition from 43% to 10%
Black (Ref.26)	RCT	Community (USA)	Child day care centres (USA)	47% reduction in diarrhoea
Khan (Ref. 23)	CT	Community (Bangladesh)	Family	67% reduction in shigellosis
Stanton and Clemens (Ref 21)	RCT	Community (Bangladesh)	Urban community	26% reduction in diarrhoea
Conley *et al.* (Ref 22)	Crossover	Medical ITU (USA)	—	Reduction of nosocomial infection from 33% to 12%
Butz *et al.* (Ref 24)	RCT	Community (USA)	Family day care homes	OR for vomiting 0.35 (0.2, 0.56); OR for diarrhoea 0.72 (0.54, 0.95)
Shahid *et al.* (Ref. 25)	CT	Community (Bangladesh)	Periurban village	Relative risk of diarrhoea 0.38 (0.33, 0.43)
Masters *et al.* (Ref. 27)	CT	School (USA)	Classroom	Relative risk of enteric infection 0.43 (0.25, 0.73) and of all infection 0.75 (0.60–0.95)

ITU=intensive therapy unit; OR=odds ratio with 95% confidence interval

infection-related outcomes, whether in settings with a high infection rate in critically ill patients[10,24] or in relatively healthy populations with low rates of infection[25,28]. The treatment effect is so great that if 'hand-hygiene' were a new drug it would be used by all. So why is it not 'used' by doctors?

DOCTORS, MEDICAL STUDENTS AND HAND-HYGIENE

The Hand Hygiene Liaison Group and the Department of Health issued guidance[5,6] stating that handwashing reflects attitudes, behaviours and beliefs. The influence of role models may be critical and the Liaison Group calls for teaching of elementary hygiene practice at medical school[5]. Semmelweis' original work focused on medical students, but since then handwashing behaviour of students has not been reported. We decided to study this in the final year MB BS objective structured clinical examination (OSCE)[9], because the OSCE assesses learned attitudes and behaviour absorbed from role models. Nearly 200 candidates were assessed during neurological examination of the lower limbs, a task that provides ample opportunity for patient contact (sweaty feet, groins and so on). On the first day students were observed to see whether they asked to use or used the handrub solution provided. 8% did so. On the second day, large signs requesting that they wash their hands were available at that station. Nearly 20% then did so. This year we performed an identical study with first-year clinical medical students at their end-of-year medical OSCE, and observed a similar compliance rate (Hunt D, personal communication). A handwashing questionnaire was administered this time, to test knowledge and attitudes. About three-quarters of the students believed that they washed their hands at least 60% of the time. Nearly all believed that handwashing reduced infection rates, but only two-thirds thought it might reduce infective diarrhoea or antimicrobial resistance.

We concluded from our original study[9] that handwashing should become an education priority. Since assessment is the 'tail that wags the dog', marks for hygiene should be incorporated into all undergraduate clinical assessment and into teaching quality assessment. EPIC[12] asked for trials of behavioural and educational interventions to improve handwashing compliance, reiterating calls made by the Hand Hygiene Liaison Group[5,6]. Part of any educational intervention with medical students should be presentation of the very clear evidence that healthcare workers' hands become contaminated by pathogens after patient contact, that alcohol handrubs are the easiest and most effective means of decontaminating hands between patient contacts and that controlled trial evidence shows that hand-decontamination substantially reduces infection in many clinical settings. Hand hygiene is the practice of evidence-based medicine. Medical school curricula should now treat it thus and should study the efficacy of educational programmes to improve hand hygiene.

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