were balanced between randomisation groups. Baseline prevalence of seropositivity for measles and rubella antibodies were less than 1·2% for measles and less than 1·6% for rubella, supporting waning of maternal antibody by 8 months of age. Although the authors report that six of the seven measles seropositive infants at baseline did not seroconvert according to their criteria, baseline and post-vaccination concentrations were above the seroprotective concentration of 200mIU/mL or more for all seven infants, which suggests that they would be protected. Likewise, while seven of the ten rubella seropositive cases also failed to seroconvert, all had protective concentration of 10 IU/mL or more before and after vaccination.

Overall, these new data provide reassurance for countries wishing to roll out LJEV vaccination at the same time as measles and rubella vaccination, while maintaining the high prevalence of measles and rubella seropositivity required for eradication. They also show that maternal antibody has generally waned by 8 months of age and thus MCV can be given at this early time point to improve herd immunity in this vulnerable age group.

Katie L Flanagan
Department of Immunology and Pathology, Monash University, Melbourne, VIC, Australia; School of Health and Biomedical Science, RMIT University, Melbourne VIC, Australia; and School of Medicine, Faculty of Health Sciences, University of Tasmania, Launceston, TAS 7250, Australia
katie.flanagan@ths.tas.gov.au

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Can cleaning REACH further in reducing hospital infections?

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Few well controlled studies have helped us to understand whether, when, and to what extent the contaminated health-care environment contributes to the transmission of pathogens that can cause health-care-associated infection.[1] Into this context lands the Researching Effective Approaches to Cleaning in Hospitals (REACH) study, by Brett Mitchell and colleagues published in *The Lancet Infectious Diseases*,[2] a multicentre stepped-wedge randomised controlled trial of enhanced environmental hygiene (used here to described cleaning or cleaning and disinfection) in reducing health-care-associated infection. Previous studies have shown that switching to more powerful disinfectants,[3,4] introducing automated room decontamiation,[5,6] or making changes to environmental hygiene protocols (eg, by increasing the frequency of cleaning or disinfection)[7] can reduce transmission or health-care-associated infection, or both. However, this is the first randomised controlled trial to investigate the effect of a systematic bundle of interventions to improve environmental hygiene, targeting both routine daily cleaning and cleaning and disinfection at patient discharge.

The study was done in 11 Australian hospitals between May, 2016, and July, 2017. The intervention involved a review of the environmental hygiene approach in each hospital and a structured, tailored set of recommendations to improve product choice, technique, audit, training, and communication of performance; a unique aspect was to raise the organisational profile of environmental hygiene. The primary outcomes were incidences of health-care-associated *Staphylococcus aureus* bacteraemia, *Clostridium difficile* infection, and vancomycin-resistant enterococci infection of usually sterile sites. Vancomycin-resistant enterococci infections reduced by 37% (from 0·35 to 0·22 per 10 000 occupied bed-days; relative risk 0·63, 95% CI 0·41–0·97, p=0·0340), but no significant changes were seen in the incidence of *S aureus* bacteraemia (0·97 to 0·80; 0·82, 0·60–1·12, p=0·2180) or *C difficile* infection (2·34 to 2·52; 1·07, 0·88–1·30,

p=0·4655). Hand hygiene compliance or antimicrobial use did not change during the study period. The reduction in vancomycin-resistant enterococci infections resonates with other studies that seem to suggest vancomycin-resistant enterococci is more environmental than other pathogens, with a greater proportion of cases that can be prevented through environmental hygiene interventions. For example, a study[5] evaluating the effect of hydrogen peroxide vapour found that the effect in reducing room-to-room transmission of vancomycin-resistant enterococci was noticeably greater than for the other pathogens included in the study (meticillin-resistant *S aureus*, *C difficile*, and antibiotic-resistant Gram-negative bacteria). Given the extent to which vancomycin-resistant enterococcus is shed into the environment, its gastrointestinal niche, and its extraordinary ability to survive in the dry environment (one study[8] found that it could survive on dry surfaces for more than 4 years),[1] it is not surprising to see vancomycin-resistant enterococci being affected more by an intervention to improve environmental hygiene.

There are several possible reasons why the intervention did not cause a further reduction in *S aureus* bacteraemia. *S aureus* bacteraemia has declined nationally in Australia in response to several interventions, meaning that the transmitted portion of cases might have already been largely addressed, leaving mainly *S aureus* bacteraemia with an endogenous source. The study did not evaluate the acquisition of colonisation, which would be a more sensitive indicator of the effect of the cleaning bundle on *S aureus*.

C difficile was on a downward trend before the intervention, which continued during the intervention, but the rate of decline did not increase. This finding was more surprising than that of *S aureus*, given that environmental hygiene interventions have reduced *C difficile* infection in other studies.[1,3,6,7] It could be that *C difficile* is less environmental than we give it credit for, as has been suggested by research showing that patient-to-patient transmission of *C difficile* in hospitals might not be commonplace.[9] However, it is more probable that the lack of focus on the use of an effective sporicidal agent for environmental hygiene related to *C difficile* explains why the intervention had no effect on *C difficile* infection. Mitchell and colleagues' findings suggest that more focused efforts are required to reduce the transmission of *C difficile* spores through an environmental hygiene intervention.

The secondary outcome was the removal of fluorescent markers, used as an objective measure of cleaning performance. The intervention improved the percentage of frequent touch points cleaned in bathrooms (from 55% to 76%) and in bedrooms (from 64% to 86%). There is some evidence that the reduction in transmission is proportional to the efficacy of environmental hygiene.[10,11] For example, in a laboratory study,[10] the degree to which *C difficile* spores were transmitted from mouse cages correlated with the efficacy of environmental hygiene. Therefore, in Mitchell and colleagues' study, it would have been interesting to see whether fluorescent marker removal correlated with outcomes related to health-care-associated infection. The association between the degree of contamination and the risk of transmission warrants future study.

There are few randomised controlled trials of infection prevention and control interventions, so this is a vital study. Although pragmatic, it is well designed and well executed, with some exciting outcomes (kudos to the authors). This study should prompt all health-care staff to review and optimise our environmental hygiene policies and protocols, and the way in which we educate and motivate staff who are responsible for environmental hygiene in hospitals to maximise patient safety.

Jonathan A Otter
NIHR Health Protection Research Unit (HPRU) in HCAIs and AMR, Imperial College London, London W12 0NN, UK
j.otter@imperial.ac.uk.

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How fluoroquinolones poison the neighbourhood

Flickr/AlainKotok

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The global crisis in antibiotic resistance results from a complex interplay of multiple variables, all interacting, and, thereby creating unpredictable behaviour. The increasing incidence of infections caused by antibiotic-resistant bacteria in humans in many parts of the world is, amongst other things, influenced by selective antibiotic pressure and cross-transmission in healthcare settings, transfer of patients and healthy carriers of such bacteria between health-care settings and across the globe, antibiotic-induced selection of resistant bacteria in animals with spillover to humans through direct contact or food, and environmental contamination through human and animal excretions.

By contrast with these well known and widely studied risks, transmission of resistance between humans outside health-care settings in the so-called open population, is less well studied. In this issue of the journal, Marcelo Low and co-workers make an important contribution to elucidating and quantifying this aspect in the epidemiology of antibiotic resistance[1]. They used detailed information in 1733 geographical areas in Israel on healthcare consumption (including antibiotic use) from more than 3 million inhabitants and more than 2 million urine culture results in a sophisticated population-based case-control study. In 300 105 events with *Escherichia coli* growth and 1 899 168 urine cultures with no growth, they showed—not unexpectedly—a dose–response relationship between the amount of fluoroquinolone consumption and the risk of fluoroquinolone-resistant (FQ-R) *E coli* in urine cultures. The novelty is in the finding that the amount of fluoroquinolone use in the neighbourhood was also associated—again in a dose-dependent manner—with the risk of FQ-R *E coli* among patients who had not used fluoroquinolones in the year before.

Not surprisingly, the direct association between fluoroquinolone use and FQ-R *E coli* bacteriuria was stronger than the indirect association in the neighbourhood. When estimating the relative contribution of both mechanisms to all FQ-R *E coli*, personal fluoroquinolone consumption among female patients accounted for 46%, whereas the neighbourhood fluoroquinolone consumption accounted for about 25% of the cases. Consequently, 71% of the FQ-R *E coli* bacteriuria was explained by direct or indirect exposure to fluoroquinolones, and the direct to indirect contribution was close to a 2:1 ratio. Of note, if the effects of fluoroquinolone use in an individual were to last more than 1 year, then some indirect exposure might in fact have been direct exposure.

Obviously, a higher risk of urinary tract infection with FQ-R *E coli* in the open population poses a serious threat. Yet, fluoroquinolone consumption was also associated—again in a dose-dependent manner—with a higher prevalence of culture negative urine samples. This raises the question of whether the associations derived in a retrospective study were subject to observation bias. As it is unlikely that neighbourhood fluoroquinolone consumption sterilises urine in patients who had not used these antibiotics, lower culture positivity prevalence in such patients must result from one or a combination of two possible mechanisms. Possibly general practitioners in neighbourhoods with higher fluoroquinolone consumption had a lower threshold for ordering urine cultures, possibly resulting in more sterile urine cultures, but this would not threaten the validity of the study as the authors restricted the primary analysis to culture positive patients. Furthermore, there might have been differences in the timing of urine cultures between neighbourhoods. If more patients received treatment with fluoroquinolones