Ben Cooper, PhD;[3] Jan Beyersmann, PhD;[4] Martin Wolkewitz, PhD;[4] Matthew Samore, MD;[5] Stephan Harbarth, MD, MS[6]

Affiliations: 1. School of Public Health and Institute for Health and Biomedical Innovation, Queensland University of Technology, Brisbane, Australia; 2. Infectious Disease Clinic, University of Wisconsin Hospital and Clinics, Madison, Wisconsin; 3. Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand; 4. Department of Medical Biometry and Statistics, Institute of Medical Biometry and Medical Informatics, University Medical Center Freiburg, Freiburg, Germany; 5. Division of Clinical Epidemiology, Biomedical Informatics, University of Utah, Salt Lake City, Utah; 6. Service prévention et contrôle de l'infection, Hôpitaux Universitaires de Genève, Geneva, Switzerland.

Address correspondence to Nicholas Graves, PhD, School of Public Health and Institute for Health and Biomedical Innovation, Queensland University of Technology, 60 Musk Avenue, Brisbane, QLD, 4059, Australia (n.graves@qut.edu.au).

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Reply to Graves et al

To the Editor—We appreciate the interest by Graves et al[1] regarding our recent article estimating the proportion of healthcare-associated infections (HAIs) that are reasonably preventable and the related mortality and costs.[2] In their letter, Graves and colleagues suggest that our estimates were intended to galvanize support for infection prevention programs and were generated using studies with important limitations. We wish to address these concerns in this response.

Our analysis was originally performed in 2008 for the Society for Healthcare Epidemiology of America (SHEA), to be included in its written testimony on HAIs to Congress.[3] To inform its testimony, SHEA requested that we review the published literature to estimate the proportion of HAIs that might be preventable. This was a critical question, because the federal government was considering a policy of nonpayment for HAIs as an incentive to reduce HAIs.[4] Although some believed this was an effective strategy to reduce HAIs, others were concerned that not all HAIs were preventable and that the incentive under consideration would present challenges to hospitals caring for patients at high risk for HAIs.[5] To estimate the proportion of preventable HAIs in the most efficient and accurate manner, we used an up-to-date federally funded systematic review that examined the effectiveness of single and multimodal interventions on HAI prevention[6] as well as the most recent and valid estimates of HAI incidence.[7] We also conducted our own systematic review of studies examining the incremental costs of individual HAIs.[2] The dilemma at the time was whether to make an estimate based on data of limited quality or to avoid making such an estimate because of the data limitations and take the chance that other estimates derived using a less scientific approach would inform the policy discussion. SHEA opted to inform the discussion with the best estimates available from the published literature, so the intent of our analysis and our subsequent article was to present those estimates while highlighting their key limitations and caveats.

To ensure that we provided the most accurate and generalizable data on the effectiveness of HAI prevention interventions, we estimated ranges of preventability and included the lowest and highest risk reductions reported by only those studies that were conducted in the United States, were published within the previous 10 years, and received a quality score of moderate or good from the federally sponsored systematic review.[6] Of the 64 studies originally included in the

federal systematic review, our stricter inclusion criteria resulted in 49 exclusions, leaving only the 15 highest quality, most recent, and most generalizable studies available for our analysis. Likewise, to estimate the incremental costs associated with HAIs, we performed a systematic review and only included costs from studies that had 10 or more patients with infection, were conducted in general US patient populations, reported original cost calculations, and were published within the previous 10 years. Results were converted to 2009 dollars using the Consumer Price Index for Hospital Services (US Bureau of Labor Statistics). In addition, when possible we based our summary estimates of cost on studies that used regression models so that we could isolate costs of infections from costs coincident with infections. Where multiple studies for a particular infection measured costs in the same way, we took their range of estimates. Importantly, the cost objective of our article was to estimate the incremental costs of HAIs to hospitals (ie, the additional costs to hospitals of caring for patients who contracted HAI). Because of the limitations of our preventability and cost data, these direct costs were the most robust costs that we could estimate. Dr. Graves and colleagues are correct that these estimates do not factor in the costs of various interventions to prevent HAIs. However, estimating the cost-effectiveness of various interventions or bundles to decrease the incidence of HAI was outside the scope of our article. In addition, our cost estimates did not address the total economic benefit of reducing preventable infections and deaths. Ultimately, the ranges of preventability that we estimated were similar to those previously published,[8] and our estimates of avoidable costs were similar to those in a more recent publication.[9]

Despite our methods to produce the best available estimates, we agree that there are limitations to our analysis. Graves et al[1] highlight some of these limitations in their letter as well as in an excellent review that they have published on the topic.[10] Because of these limitations, we dedicated 6 of the 10 paragraphs of our discussion section to a comprehensive review of the uncertainties stemming from our analysis as well as from the underlying data.[2] In addition, because of these uncertainties, we took steps to ensure that our results were not overstated. In our abstract, we emphasized our main point, that HAIs may not be 100% preventable even with the use of current evidence-based strategies. We also emphasized the relative importance of the individual HAIs (eg, catheter-associated urinary tract infection may be the most preventable, whereas catheter-associated bloodstream infection is likely associated with the highest number of preventable deaths and greatest avoidable costs) without focusing on our exact estimates of preventable infections, mortality, and costs. Our abstract concluded with the conservative statement that "comprehensive implementation of (infection control) strategies could prevent hundreds of thousands of HAIs and save tens of thousands of lives and billions of dollars."[2(p101)] Similarly, in the final sentence of our article, we stress that "Given their limitations, the figures in our study should not be used as a basis for policy decisions but should prompt future studies with robust designs to measure accurately the impact of HAI reduction strategies and the incremental cost of HAIs."[2(p111)] Based on the letter by Dr Graves and colleagues, our concluding remarks seem to be points upon which we can all agree.

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Craig A. Umscheid, MD, MSCE;[1,2,3,4] Matthew D. Mitchell, PhD;[1] Jalpa A. Doshi, PhD[1,3,4]

Affiliations: 1. Center for Evidence-Based Practice, University of Pennsylvania, Philadelphia, Pennsylvania; 2. Center for Clinical Epidemiology and Biostatistics, University of Pennsylvania, Philadelphia, Pennsylvania; 3. Leonard Davis Institute of Health Economics, University of Pennsylvania, Philadelphia, Pennsylvania; 4. Department of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania.

Address correspondence to Craig A. Umscheid, MD, MSCE, Assistant Professor of Medicine and Epidemiology, Director, Center for Evidence-Based Practice, Senior Scholar, Center for Clinical Epidemiology and Biostatistics, Senior Fellow, Leonard Davis Institute of Health Economics, University of Pennsylvania, 3535 Market Street, Mezzanine, Suite 50, Philadelphia, PA 19104 (craig.umscheid@uphs.upenn.edu).

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Low Adherence to Outpatient Preoperative Methicillin-Resistant *Staphylococcus aureus* Decolonization Therapy

To the Editor—Evidence supports methicillin-resistant *Staphylococcus aureus* (MRSA) decolonization with topical antimicrobial and antiseptic agents to prevent infections in select patient groups.[1-5] While therapy effectiveness is heavily impacted by adherence, there is a lack of data on patient-reported adherence to such therapy.[4,6,7] Here we report outpatient adherence to preoperative MRSA decolonization therapy obtained from nursing-administered surveys.

In 2006, the Providence Veterans Affairs Medical Center implemented a preoperative MRSA colonization surveillance and decolonization program. MRSA nares screening was conducted during surgical scheduling appointments from January 2006 to December 2009. Patients were provided 15 minutes of nursing education on MRSA, what to anticipate if MRSA-positive, appropriate decolonization therapy application techniques, and date-specific time lines featuring day-by-day instructions for use prior to surgery.

Surgical Service nurse practitioners contacted MRSA-colonized outpatients a minimum of 7 days prior to surgery to notify them of their screening results, to remind them they would be receiving the decolonization package in the mail or remind them to pick it up from the pharmacy, and to review application techniques and time lines for use. The decolonization regimen was prescribed as follows: mupirocin 2% ointment to both nares twice daily for 5 days prior to surgery and use of hexachlorophene 3% or chlorhexidine gluconate 4% body wash once daily for 3 days prior to surgery.

On the day of surgery, patients were rescreened and administered adherence surveys by nursing to ascertain the number of days each therapy was applied. Proportion of days covered (PDC) was calculated as the number of days therapy was applied, divided by the number of prescribed days of therapy. Complete adherence to the decolonization regimen was defined as a PDC of 1.0 for both mupirocin (5/5 days) and body wash (3/3 days). Colonization persistence was defined as a positive nares culture on the day of surgery. Postoperative MRSA infections were identified from positive clinical cultures in addition to a physician diagnosis of infection and/or nursing notes describing clinical signs of infection in the 30 days following surgery. We assessed differences in colonization persistence and postoperative MRSA infections at different PDC levels with χ^2 and Fisher exact tests as appropriate.

Mupirocin susceptibilities were available for a sample of the MRSA-positive preoperative nares screening isolates, and resistance was defined as low level (minimum inhibitory concentration, 8–128 mg/L) or high level (≥256 mg/L) according to previously described methods.[8] We assessed PDC temporal trends by using nonparametric Spearman rank correlation. All analyses were performed using SAS, version 9.1.3 (SAS Institute). This study was reviewed and approved by the Institutional Review Board.

Of the 45 MRSA-colonized outpatients who received the preoperative decolonization kit, 62.2% applied mupirocin to their nares as instructed for 5 days prior to their scheduled surgery (Table 1). Body wash was applied for 3 days by 46.7% of patients. Most patients were male (1 female), with a mean age of 57 years (standard deviation, 19). Surgery types included various noncardiothoracic surgeries, the majority of which were orthopedic, vascular, urological, hernia repairs, or tumor resections.

Complete adherence to the decolonization regimen was reported by 31.1% of patients (Table 1). The most common patient-reported reason for incomplete adherence related to recall, as several patients could not remember whether and when they applied each topical therapy. Five (11.1%) patients developed a postoperative MRSA infection in the 30 days following surgery, and 17 (37.8%) patients were still colonized on the day of surgery. Colonization persistence and 30-day MRSA infections did not vary significantly by PDC ($P \geq .10$ for all comparisons; Table 1). Body wash PDC decreased significantly over the study period ($P < .03$). No temporal trends were observed in mupirocin PDC, adherence to both mupirocin and body wash, colonization persistence, or MRSA infections.

Mupirocin susceptibilities of preoperative nares screening isolates were available for 40.0% (18/45) of patients. Five (27.8%) of the available isolates were mupirocin resistant (4 high level, 1 low level). Four of 5 patients with mupirocin-resistant isolates were still colonized on the day of surgery (3 high level, 1 low level). Only 1 patient with mupirocin-resistant MRSA (high level) developed a MRSA infection in the 30 days following surgery. This patient was 100% adherent to mupirocin, with 0% adherence to body wash. When patients colonized with mupirocin-resistant MRSA were excluded, no differences were observed in colonization persistence or follow-up MRSA infections by PDC.

Nearly two-thirds of patients completed mupirocin therapy as instructed, while only one-third were fully adherent to both