Table B.33: MDRO, Hand Hygiene—Single Studies

Note: Full references are available in [Section 5.2 reference list](#Section5point2refs).

| Author, Year | Description of Patient Safety Practice | Study Design; Sample Size; Patient  Population | Setting | Outcomes: Benefits | Outcomes: Harms | Implementation  Themes/Findings | Risk of Bias (High,  Moderate, Low) | Comments |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Barnes et al., 201417** | Handwashing on entrance to and exit from patient room (details not specified in the model, just whether or not handwashing was done at both opportunities) | Mathematical model (agent-based modeling) Simulation of the transmission of *A. baumannii,* methicillin-resistant *S. aureus* (MRSA), and vancomycin-resistant Enterococci (VRE) for 1 year using data from the literature and observed data to inform model input parameters compared the effects of hand hygiene and environmental cleaning on rates of MDRO acquisition. | Model based on 20-patient hospital ICU, United States | Baseline rates for hand hygiene compliance of nurses were set at 70% and 85% on entry and exit, respectively, and at 57% and 67% on entry and exit for physicians, respectively, based on observation data from a single facility in the mid-Atlantic region.  The mathematical simulation model found that MDR- *A.* *baumannii* (MDR-AB), MRSA, and VRE acquisition rates increase substantially more if hand hygiene compliance falls than if cleaning thoroughness decreases.  In general, a 2:1 improvement in thoroughness of terminal cleaning compared to hand hygiene compliance is required to achieve an equal reduction in MDRO acquisition rates. | None assessed. | This model found hand hygiene to be a more efficient strategy for preventing transmission of MDROs than terminal cleaning. However, if terminal cleaning is easier to improve than hand hygiene, then improving thoroughness may be the more effective strategy in that facility. | Low to  moderate  Mathematical model only, based on rates at a single hospital. Does not account for other facilities’ baselines. | Organisms/  Outcomes:  MDR-AB, MRSA, VRE  Transmission of MDROs |
| **Cheng et al., 201520** | Strict contact precautions (including single-room isolation) for MDR-AB*-*colonized patients and directly observed hand hygiene in conscious patients immediately before they received meals and medications | Pre-post study of 5,058 patients cultured positive with MDR-AB between January 1, 2004, and June 30, 2014 | A university-affiliated hospital and three extended-care hospitals, with a total of 3,200 beds, Hong Kong | The first case of multiple-drug- resistant MDR-AB bacteremia emerged in 2009, with an incidence that increased from 0.27 (1 case) in 2009 to 1.86 (14 cases) per 100,000 patient-days in 2013 (p<0.001). Following implementation, in July 2013, the incidence of MDR-AB bacteremia decreased from 14 cases in 2013 to 1 case in the first 6 months of 2014 (p<0.001). Nonbacteremic MDR-AB also decreased from 106 to 34 cases over that same period (p<0.001).  Patients from long-term care facilities for older adults (odds ratio [OR] 18.6, confidence interval [CI] 2.1 to 162.4, p=0.008) and history of carbapenem (OR 7.0, CI 1.7 to 28.0, p=0.006) and beta-lactam/ betalactamase use (OR 5.6, CI 1.1 to 28.7, p=0.038) 90 days prior to admission were independent risk factors for MDR-AB bacteremia by logistic regression compared with carbapenem-susceptible *A. baumannii* bacteremia. The overall compliance of hand hygiene of healthcare workers has gradually increased from 23% in 2007 (baseline) and maintained at 75% to 79% between 2011 and 2013. | None assessed. | This study presents a novel hand hygiene approach—reducing MDR-AB bacteremia through patient hand hygiene. Despite increases in staff hand hygiene, direct observation of patient hand hygiene and patient isolation were followed by a reduction in MDR-AB bacteremia. This MDRO is known for widespread environmental contamination, and hand hygiene of patients may protect against MDR-AB acquisition and subsequent bacteremia. | Moderate  Single site study; other parts of the multicomponent intervention (increased staff hand hygiene, contact precautions) may have contributed to results. | Organisms/  Outcomes:  MDR-AB  MDR-AB-related bacteremia |
| **Cheng et al., 201821** | Direct observation of hand hygiene with alcohol-based hand rub (ABHR) performed at 2-hourly intervals during daytime, before meals and medication rounds by a trained nurse in each intervention site.  The hand hygiene ambassador delivered 3 mL ABHR to the hands of residents per occurrence of observed hand hygiene, either at the communal areas or at the bedside. A pocket-sized 60 mL ABHR container was used by the research nurse, and standard-sized 500-mL ABHR containers were placed in the cubicle, corridor, and communal areas of sites for the residents, staff, and visitors. | One month, cluster-randomized controlled study of 10 (five intervention, five control) long-term care facilities in Hong Kong | Ten residential care homes for older adults, Hong Kong | After implementation, the number of organism-positive environmental cultures showed a significant reduction in MRSA (79 of 600 [13.2%] vs. 197 of 600 [32.8%]; p<0.001) and carbapenem-resistant *A. baumannii* (CR-AB) (56 of 600 [9.3%] vs. 94 of 600 [15.7%]; p=0.001) contamination in the intervention arm compared with the nonintervention arm during the study period. The volume of hand rub consumed per resident per week was three times as high in the intervention arm compared with the baseline (59.3 ± 12.9 mL vs. 19.7 ± 12.6 mL; p<0.001) and was significantly higher than the nonintervention arm (59.3 ± 12.9 mL vs. 23.3 ± 17.2 mL; p=0.006). | None assessed. | Observed resident hand hygiene before meals and promotion of use of ABHRs reduced environmental contamination with MRSA and CR-ABand was well received by residents. | Low | Organisms/  Outcomes:  MRSA, carbapenem*-resistant Acinetobacter* species*,* extended-spectrum beta-lactamase (EBSL)-producingEnterobacteriaceae  MDRO colonization, MDRO environmental contamination |
| **D’Agata et al., 20129** | Mathematical model of infection control approach, including hand hygiene decolonization, contact precautions, active surveillance, and screening (for VRE and MRSA) | Mathematical model extending data from clinical individual-level studies to quantify the impact of hand hygiene, contact precautions, reduction of antimicrobial exposure, and screening of surveillance cultures in decreasing the prevalence of MDRO colonization and infection | Model based on a 600-bed tertiary care hospital, United States | Improving compliance with hand hygiene from 60% to 80% and from 80% to 100% decreases the colonization prevalence by 12% and 8%, respectively. Each improvement interval decreased MDRO infections by 8%. Comparatively, similar improvement in compliance with contact precautions (from 60% to 80% and from 80% to 100%) decreases the prevalence of colonization by 10% and 6% respectively, and decreases MDRO infections by 6% and 4%, respectively. Screening patients for asymptomatic colonization also reduces MDRO prevalence, but only among patients receiving antimicrobials. | None assessed. | Improving hand hygiene is essential because it prevents transmission regardless of whether the patient’s colonization status is known and requires fewer supplies and processes to consistently implement than contact precautions. | Moderate  Not a real-world test, but the methodology for the model is based on epidemiologic results of a 600-bed teaching hospital over 1 year. | Organisms/  Outcomes:  MRSA, VRE  MDRO colonization, MDRO-related infections |
| **De la Rosa-Zamboni et al., 201811** | A multimodal, hospitalwide hand hygiene program with alcohol-based hand rubs, periodic education, leadership support, and monthly feedback  “Let’s Go for 100” involved all healthcare workers and encompassed education, awareness, visual reminders, feedback, and innovative strategies. Monthly hand hygiene monitoring and active health care-associated infection (HAI) surveillance were performed in every ward. | Prospective time series analysis.  Intervention implemented in 2013.  Baseline period: (January-August 2013); intervention and followup period (September 2013 through October 2016).  Population: between January 2013 and October 2016, 27,975 patients were discharged from the hospital, yielding a total of 266,524 patient-days, 111,642 central line-days, 30,218 ventilator-days, and 26,327 urinary catheter-days. | 349-bed public teaching and referral pediatric hospital, Mexico | Baseline hand hygiene adherence was 34.9% (SD 3.52) and increased significantly (p<0.0001) over the study period to 80.6% (SD 6.3) during the last 3 months. The increase was statistically significant for use of alcohol-based products (z=2.78 and p=0.005) but not for washing hands (z=0.32 and p=0.745). Adherence increased across all healthcare staff groups.  The HAI rate decreased from 7.54/1,000 patient-days (SD 1.82) to 6.46/1,000 patient-days (p=0.004)). The authors observed a negative correlation between hand hygiene adherence and attack rate for:   * MRSA (coef. -17.10, 95% CI -30.67 to -3.53, p=0.019) * VRE (coef. -54.87, 95% CI -73.28 to ‑36.46, p=0.001) * *Enterobacter* species (coef. -33.04, 95% CI ‑51.14 to -14.94, p=0.002) * Overall MDR-ESKAPE[[1]](#footnote-1) group (-7.76, 95% CI ‑15.08 to 0.37, p=0.059) | N/A | This study shows the impact of a sustained hand hygiene promotion campaign that was associated with reductions in all studied MDROs (MRSA, VRE, and MDR-ESKAPE). The authors note that there are few hand hygiene studies in pediatric settings. Some of the innovative approaches to hand hygiene included messaging for pediatric patients and siblings using a mascot and holding contests among healthcare staff for the most innovative ways to improve hand hygiene compliance. | Low to  moderate  Single study, but long study period. No other policy changes during study period. | Organisms/  Outcomes:  MRSA, VRE, MDR-ESKAPE group  HAIs |
| **Harris et al., 201718** | Mathematical model based on an infection control intervention that included directly-observed hand hygiene on entry/exit of patient room (method not specified) and gown and glove use with patients known to be colonized with MDROs | Mathematical model of the relative effects of hand hygiene, glove and gown use, and dedicated staff on MRSA and VRE acquisition rates. | Hospital ICU, United States | This model was based on a previous study that looked at gown and glove use for MRSA and VRE acquisition, which found no effect on VRE acquisition rates but a large effect on MRSA acquisition rates. This study also found that ICUs in the glove and gown intervention had higher hand hygiene compliance rates than control ICUs (78.3% vs. 62.9%).  Based on the model, the authors estimate that 44% of the decrease in MRSA acquisition was due to universal glove and gown use, 38.1% was due to improved hand hygiene, and 14.5% was due to the reduction in contact rates (a known side effect of contact precautions). | N/A | This model was able to break down a multicomponent intervention and assess the relative impact of hand hygiene in a multicomponent study. In a separate universal gown and gloving study, hand hygiene had almost as much impact as gown and glove use. | Low to  moderate  Mathematical model study but based on the data from a “real world” implementa-tion in several ICUs. | Organisms/  Outcomes:  MRSA, VRE  MDRO acquisition rates |
| **McLaws et al., 200915** | Regional hand hygiene promotion campaign, “Clean hands save lives”  Campaign consisted of placing alcohol-based hand rub dispensers at the point of care (near patient locations), observing hand hygiene compliance, using promotional campaign posters for all audiences, and distributing brochures to encourage patients to confirm hand hygiene compliance. | Pre-post study of a hand hygiene promotion campaign to stop MRSA infections. Sample size not provided.  Campaign included all public hospitals in the New South Wales State of Australia. | 11 hospital, general wards, and ICUs, Australia | Between the pre- and post-campaign periods, there was a 25% fall in MRSA-related non-ICU sterile site infections, from 0.60/10,000 bed-days to 0.45/10,000 bed-days (p= 0.027), and a 16% fall in MRSA-related ICU non-sterile site infections, from 36.36/10,000 bed-days to 30.43/10,000 bed-days (p=0.037). The pre- and post-campaign rates of MRSA infection from ICU sterile sites (5.28/10,000 bed-days vs. 4.80/10,000 bed-days; p=0.664) and non-ICU, non-sterile sites (5.92/10,000 bed-days vs. 5.66/10,000 bed-days; p=0.207) remained stable. Australia-wide MRSA data reported to the Australian Council on Healthcare Standards showed a 45% decline in infections from ICU non-sterile sites, from 25.89/10,000 bed-days to 14.30/10,000 bed-days (p<0.001), and a 46% decline in infections from non-ICU non-sterile sites, from 3.70/10,000 bed-days to 1.99/10,000 bed-days (p<0.001) over the period 2005–2006. | None assessed, beyond failure to reduce MDROs in certain sites. | Although hand hygiene increased markedly in the intervention hospitals, there was no consistent reduction in all MDROs and in all observation sites. However, focusing only on clinical outcomes with hand hygiene does not reflect potential environmental or systemic factors that need to change (e.g., environmental contamination or a workflow at odds with hand hygiene). | Low  Large sample size, and control group available (all other public hospitals outside New South Wales). May have unobserved differences between NSW hospitals and those in other areas. | Organisms/  Outcomes:  MRSA  Hand hygiene compliance rates, MRSA infections |
| **Pires dos Santos et al., 201113** | Alcohol-based hand rub use (coincidental with antibiotic stewardship initiatives) | Pre-post study of association between CR-*P. aeruginosa* (CR-PA) infection rates and alcohol-based hand rubs through three study periods: period 1, before ertapenem use (17 months); period 2, during ertapenem use (33 months); and period 3, after exclusion of ertapenem (15 months). Sample size not provided. | 749-bed hospital, Brazil | CR-PA decreased over the period of ertapenem use as well as during the period of ertapenem restriction. The mean incidence of CR-PA infections per 1,000 patient-days was 0.51 (95% CI, 0.41 to 0.60) in period 1; 0.43 (95% CI 0.36 to 0.49; p=0.33) in period 2; and 0.33 (95% CI 0.26 to 0.41; p=0.34) in period 3. Between period 1 and period 3, this decrease was statistically significant (p=0.04).  There was no significant correlation between CR-PA infection and ertapenem use throughout the study periods. However, by multiple regression analysis, the reduction in the rate of CR-PA infection correlated significantly with the increase in the volume of alcohol used as hand sanitizer (p<0.01; Spearman correlation r=-0.40), which increased from 660.7 mL per 100 patient-days in period 1 to 2,955.1 mL per 100 patient-days in period 3. | None assessed. | The natural experiment in this study (increased hand hygiene due to the H1N1 influenza pandemic) allowed the author to evaluate the relative impact of increased hand hygiene (as measured through hand rub consumption) on CR-PA. In this study, the association between alcohol-based hand rub use and increased CR-PA cases was stronger than the association with ertapenem (a type of carbapenem) restriction. | Moderate  Single-setting study that initially sought to evaluate the impact of antibiotic stewardship; the hand hygiene component was an incidental finding. | Organisms/  Outcomes:  CR-PA  CR-PA-related infections |
| **Rupp et al., 200822** | Alcohol-based hand rub (62% ethyl alcohol and 0.3% triclosan) in the intervention group, compared to soap and water (antimicrobial soap with 0.3% chloroxylenol). Hand rub dispensers were installed inside and outside patient rooms in the first unit, with the same in the second unit during the crossover period. | Prospective crossover controlled trial  Hand hygiene was covertly observed every 60 days by trained individuals; hand hygiene adequacy not assessed, only performance/nonperformance.  Trial included 17,994 minutes of observation, which included 3,678 opportunities for hand hygiene between August 2001 and September 2003. | Two 12-bed ICUs in a single hospital, United States | Hand hygiene adherence rates improved dramatically after the introduction of alcohol-based hand rubs, from 37% to 68% in one unit and from 38% to 69% in the other unit (p<0.001). Hand hygiene rates were also better at higher workloads when the hand rub was available in the unit (p=0.02). However, no significant changes in MDRO, *C. difficile*, or device-associated infection rates were observed. (The authors noted that the infection rates were generally low during the study periods.) | Having fingernails longer than 2 mm, wearing rings, and lacking access to hand gel were associated with increased microbial carriage. | This study demonstrates that hand hygiene compliance can improve dramatically when the equipment is provided in the right place. When this study was conducted, the recommendations against alcohol-based hand rub for CDI had not yet been made, which likely accounts for the lack of effect on CDI rates. In addition, the authors note that active surveillance for MRSA was not done; given dramatic spread of MRSA throughout healthcare facilities and the community, colonization from outside the units may have been the cause of unchanged MRSA rates. | Low to  moderate  Process outcome focus | Organisms/  Outcomes:  MRSA, VRE, MDR-PA, *C. difficile*  Hand hygiene compliance, *C. difficile-*associated diarrhea, MDRO-associated infections, device-associated infections (central venous catheter–related bacteremia, urinary catheter–associated urinary tract infection, and ventilator- associated pneumonia) |
| **Sickbert-Bennett et al., 201623** | Hand hygiene upon entering and exiting patient rooms, observation and immediate feedback from all staff members, and covert observation from trained infection prevention and nursing staff  Other PSPs: HAI surveillance | Longitudinal observational study; over 140,000 observations made over a 17-month period | A single 853-bed acute care hospital, United States | Hand hygiene compliance increased significantly by 10% (p<0.001) and HAIs (including those caused by MDROs) decreased significantly by 14% (p=0.0066). This decrease is estimated to have prevented 22 deaths and saved approximately $5 million. The association between hand hygiene compliance and health care associated-*C. difficile* infection, adjusting for unit-level data, showed a 10% improvement in hand hygiene, associated with a 14% infection reduction (p=0.070). | No association was noted between hand hygiene compliance and MDRO infections (p=0.7492). | Although an improvement in hand hygiene was associated with reduction in overall HAIs and produced cost savings, the authors found that this decrease was mostly driven by *C. difficile* infection and was not seen in MDROs. While hand hygiene was helpful in cost saving and is necessary to support other infection prevention practices, it alone may not be sufficient to control MDROs. | Low to  moderate  Single-site study. No other specific hospitalwide infection prevention goals were adopted during the period of analysis. | Organisms/  Outcomes:  MDROs, *C. difficile*  Hand hygiene compliance, HAIs, HAIs related to MDROs |
| **Sopirala et al., 201412** | Hand hygiene promotion campaign using nurse liaisons to observe and give feedback on compliance with alcohol-based hand rub or soap and water washing on entry and exit of patient rooms  Staff nurses were trained to be liaisons to infection prevention personnel. “Link nurses” would observe hand hygiene, give immediate feedback to staff, identify and report on infection prevention issues in their units, and conduct hand hygiene education with staff. Independent audits were done by graduate students, and compliant units would receive recognition (e.g., plaque, celebratory lunch or dinner). | Pre-post quality improvement study at a single 1,191-bed hospital  Baseline period: January 1, 2006– March 31, 2008  Intervention period: April 1, 2008–September 30, 2009 | Hospital, United States | Hand hygiene gradually increased from 30% in 6 months prior to the intervention to 93% in the 6 months after starting the intervention. Healthcare-associated MRSA incidence rates dropped by 28% from 0.92 cases per 1,000 patient-days to 0.67 (IRR=0.72 [95% CI 0.62 to 0.83], p<0.001). Overall MRSA rates dropped from 4.83 to 4.25 per 1,000 patient-days. Overall MRSA bacteremia decreased from 0.49 to 0.34 per 1,000 patient-days (IRR=0.59 [95% CI 0.42 to 0.84], p=0.003) and health care-associated MRSA bacteremia from 0.18 to 0.10 per 1,000 patient-days (IRR=0.68 [95% CI 0.56 to 0.84], p<0.001). | None assessed. | Hand hygiene promotion and feedback on compliance audits resulted in very high compliance rates that successfully reduced both health care-associated infections and total MRSA cases and bacteremia. | Moderate  Single-site study, and other components were not controlled for in estimating clinical outcomes. | Organisms/  Outcomes:  MRSA  Hand hygiene compliance, health care-associated (HCA) and non-HCA MRSA incidence (infection or colonization), HCA and non-HCA MRSA bacteremia |
| **Vernaz et al., 200814** | Two hand hygiene promotion campaigns using alcohol-based hand rubs: “VigiGerme®” in spring 2003 and “Clean care is safer care” in autumn 2005 (including hand hygiene observations of healthcare personnel). Other protocols included universal MRSA on-admission screening from January to August 2003 in the entire hospital, and from October 2004 to May 2006 in selected surgical wards. | Interventional time series analysis of the temporal relationship between increased use of alcohol-based hand rubs, antibiotic use, and MRSA and *C. difficile* rates.  All hospital patients between February 2000 and September 2006; mean hospitalization days, 51,524 per month | 2,200-bed primary and tertiary care teaching hospital, Switzerland | Over the study period, the average monthly MRSA incidence was 0.15 clinical isolates per 100 patient-days, varying from 0.09 to 0.21 with no overall trend (p=0.71). The monthly incidence of *C. difficile* was 0.027 isolates per 100 patient-days, varying from 0.004 to 0.054, without any trend (p=0.82).  Consumption of hand rubs increased over the study period, from an average of 1.303 L per 100 patient-days in 2001 to 2.016 L per 100 patient-days in 2006, and the effect of the education intervention on increased hand rub use was statistically significant.  Only MRSA showed a temporal association between the increase in hand rub use and a decrease in MRSA rates. | The campaign had no significant effect on MRSA reduction in the multivariable analysis. | This study demonstrated a temporal association between increased hand rub use and MRSA, although a multivariable analysis showed no effect of the hand hygiene promotion campaign on MRSA rates. As confirmed by later studies, alcohol-based hand rubs are less effective for reducing *C. difficile* transmission.  The average antimicrobial use over the study period was 33 defined daily dose/100 patient-days and did not change over time (p=0.29). | Low to  Moderate | Organisms/  Outcomes:  MRSA, *C. difficile*  Consumption of alcohol-based hand rubs |
| **Wares et al., 201619** | Mathematical modeling of the role of hand hygiene in reducing environmental contamination by MDROs and MDRO transmission | Mathematical simulation model looking at antimicrobial use and environmental contamination and other strategies | Modeled on a hospital dialysis unit serving 120 patients, United States | In this model, when hand hygiene compliance was at 0%, the estimated rate of MDRO acquisition almost doubled, from 14.5% at baseline to 23.1%. | Even with 100% compliance, 13.4% of patients still remained colonized. | In the dialysis setting, MDRO colonization is caused by many factors, although hand hygiene is an important one. Simultaneous improvements in hand hygiene, judicious antimicrobial use, and environmental decontamination are needed to reduce MDRO colonization. | Moderate | Organisms/  Outcomes:  Hand hygiene, MDRO transmission  Mathematical model—will need validation in actual dialysis setting |

1. *Enterococcus faecium, S. aureus*, *Klebsiella pneumoniae, A. baumannii,* *P. aeruginosa*,and *Enterobacter* species. [↑](#footnote-ref-1)