Background: The current approach to measuring hand hygiene (HH) relies on human auditors who capture <1% of HH opportunities and rapidly become recognized by staff, resulting in inflation in performance. Our goal was to assess the impact of group electronic monitoring coupled with unit-led quality improvement on HH performance and prevention of healthcare-associated transmission and infection. **Methods:** A stepped-wedge cluster randomized quality improvement study was undertaken across 5 acute-care hospitals in Ontario, Canada. Overall, 746 inpatient beds were electronically monitored across 26 inpatient medical and surgical units. Daily HH performance as measured by group electronic monitoring was reported to inpatient units who discussed results to guide unit-led improvement strategies. The primary outcome was monthly HH adherence (%) between baseline and intervention. Secondary outcomes included transmission of antibiotic resistant organisms such as methicillin resistant *Staphylococcus aureus* (MRSA) and other healthcare-associated infections. **Results:** After adjusting for the correlation within inpatient units, there was a significant overall improvement in HH adherence associated with the intervention (IRR, 1.73; 95% CI, 1.47–1.99; $P < .0001$). Monthly HH adherence relative to the intervention increased from 29% (1,395,450 of 4,544,144) to 37% (598,035 of 1,536,643) within 1 month, followed by consecutive incremental increases up to 53% (804,108 of 1,515,537) by 10 months ($P < .0001$). We identified a trend toward reduced healthcare-associated transmission of MRSA (0.74; 95% CI, 0.53–1.04; $P = .08$). **Conclusions:** The introduction of a system for group electronic monitoring led to rapid, significant, and sustained improvements in HH performance within a 2-year period.

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Oral Presentation

HAI-Proactive: Development of an Automated Surveillance System for Healthcare-Associated Infections in Sweden

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Background: Healthcare-associated infection (HAI) surveillance is essential for most infection prevention programs and continuous epidemiological data can be used to inform healthcare personal, allocate resources, and evaluate interventions to prevent HAIs. Many HAI surveillance systems today are based on time-consuming and resource-intensive manual reviews of patient records. The objective of HAI-proactive, a Swedish triple-helix innovation project, is to develop and implement a fully automated HAI surveillance system based on electronic health record data. Furthermore, the project aims to develop machine-learning–based screening algorithms for early prediction of HAI at the individual patient level. **Methods:** The project is performed with support from Sweden's Innovation Agency in collaboration among academic, health, and industry partners. Development of rule-based and machine-learning algorithms is performed within a research database, which consists of all electronic health record data from patients admitted to the Karolinska University Hospital. Natural language processing is used for processing free-text medical notes. To validate algorithm performance, manual annotation was performed based on international HAI definitions from the European Center for Disease Prevention and Control, Centers for Disease Control and Prevention, and Sepsis-3 criteria. Currently, the project is building a platform for real-time data access to implement the algorithms within Region Stockholm. **Results:** The project has developed a rule-based surveillance algorithm for sepsis that continuously monitors patients admitted to the hospital, with a sensitivity of 0.89 (95% CI, 0.85–0.93), a specificity of 0.99 (0.98–0.99), a positive predictive value of 0.88 (0.83–0.93), and a negative predictive value of 0.99 (0.98–0.99). The healthcare-associated urinary tract infection surveillance algorithm, which is based on free-text analysis and negations to define symptoms, had a sensitivity of 0.73 (0.66–0.80) and a positive predictive value of 0.68 (0.61–0.75). The sensitivity and positive predictive value of an algorithm based on significant bacterial growth in urine culture only was 0.99 (0.97–1.00) and 0.39 (0.34–0.44), respectively. The surveillance system detected differences in incidences between hospital wards and over time. Development of surveillance algorithms for pneumonia, catheter-related infections and *Clostridioides difficile* infections, as well as machine-learning–based models for early prediction, is ongoing. We intend to present results from all algorithms. **Conclusions:** With access to electronic health record data, we have shown that it is feasible to develop a fully automated HAI surveillance system based on algorithms using both structured data and free text for the main healthcare-associated infections.

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High-Risk Interactions for Transmission of CRE to Health Worker Gloves or Gown: A Multicenter Cohort Study

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Background: Carbapenem-resistant *Enterobacteriaceae* (CRE) are a serious threat to public health due to high associated morbidity and mortality. Healthcare personnel (HCP) gloves and gowns are frequently contaminated with antibiotic-resistant bacteria, including CRE. We aimed to identify patients more likely to transmit CRE to HCP gloves or gowns and HCP types and interactions more likely

to lead to glove or gown contamination. **Methods:** Between January 2016 and August 2018, patients with a clinical or surveillance culture positive for CRE in the preceding 7 days were enrolled at 5 hospitals in California, Maryland, New York, and Pennsylvania. Ten HCP–patient interactions were observed for each patient and were recorded by research staff. Following patient care, but prior to doffing, the gloves and gown of each HCP were sampled for the presence of CRE. **Results:** We enrolled 313 CRE-colonized patients, and we observed 3,070 HCP interactions. CRE was transmitted to HCP gloves in 242 of 3,070 observations (7.9%) and to gowns in 132 of 3,070 observations (4.3%). Transmission to either gloves or gown occurred in 308 of 3,070 interactions observed (10%). The most frequently identified organism was *Klebsiella pneumoniae* (n = 171, 53.2%), followed by *Enterobacter cloacae* (n = 36, 11.2%), and *Escherichia coli* (n = 33, 10.3%). Patients in the intensive care unit (n = 177, 56.5%) were more likely to transmit CRE to HCP gloves or gown (OR, 1.65; 95% CI, 1.03–2.64) compared to those not in an ICU and adjusted for HCP type. The odds of CRE transmission increased with the number of different items touched near the patient (OR, 1.32; 95% CI, 1.21–1.44) and with the number of different items touched in the environment (OR, 1.13; 95% CI, 1.06–1.21). Respiratory therapists had the highest rates of transmission to gloves and gown (OR, 3.79; 95% CI, 1.61–8.94), followed by physical therapists and occupational therapists (OR, 2.82; 95% CI, 1.01–8.32) when compared to HCP in the "other" category. Manipulating the rectal tube (OR, 3.03; 95% CI, 1.53–6.04), providing wound care (OR, 2.81; 95% CI, 1.73–4.59), and touching the endotracheal tube (OR, 2.79; 95% CI, 1.86–4.19) were the interactions most strongly associated with CRE transmission compared to not touching these items and adjusted for HCP type. **Conclusions:** Transmission of CRE to HCP gloves and gowns occurs frequently. We identified interactions and HCP types that were particularly high risk for transmission. Infection control programs may wish to target infection prevention resources and education toward these high-risk professions and interactions.
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Hospital Microbiologic Culture Results to Predict the Use of Anti–methicillin-Resistant *Staphylococcus aureus* (MRSA)

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Background: To provide a standardized, risk-adjusted method for summarizing antimicrobial use (AU), the Centers for Disease Control and Prevention developed the standardized antimicrobial administration ratio, an observed-to-predicted use ratio in which predicted use is estimated from a statistical model accounting for patient locations and hospital characteristics. The infection burden, which could drive AU, was not available for assessment. To inform AU risk adjustment, we evaluated the relationship between the burden of drug-resistant gram-positive infections and the use of anti-MRSA agents. **Methods:** We analyzed data from acute-care hospitals that reported ≥10 months of hospital-wide AU and microbiologic data to the National Healthcare Safety Network (NHSN) from January 2018 through June 2019. Hospital infection burden was estimated using the prevalence of deduplicated positive cultures per 1,000 admissions. Eligible cultures included blood and lower respiratory specimens that yielded oxacillin/cefoxitin–resistant *Staphylococcus aureus* (SA) and ampicillin-nonsusceptible enterococci, and cerebrospinal fluid that yielded SA. The anti-MRSA use rate is the total antimicrobial days of ceftaroline, dalbavancin, daptomycin, linezolid, oritavancin, quinupristin/dalfopristin, tedizolid, telavancin, and intravenous vancomycin per 1,000 days patients were present. AU rates were modeled using negative binomial regression assessing its association with infection burden and hospital characteristics. **Results:** Among 182 hospitals, the median (interquartile range, IQR) of anti-MRSA use rate was 86.3 (59.9–105.0), and the median (IQR) prevalence of drug-resistant gram-positive infections was 3.4 (2.1–4.8). Higher prevalence of drug-resistant gram-positive infections was associated with higher use of anti-MRSA agents after adjusting for facility type and percentage of beds in intensive care units (Table 1). Number of hospital beds, average length of stay, and medical school affiliation were nonsignificant. **Conclusions:** Prevalence of drug-resistant gram-positive infections was independently associated with the use of anti-MRSA agents. Infection burden should be used for risk adjustment in predicting the use of anti-MRSA agents. To make this possible, we recommend that hospitals reporting to NHSN's AU Option also report microbiologic culture results.
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Table 1. Hospital Prevalence of Drug-Resistant Gram-Positive Infections Per 1,000 Admissions

Parameter	Prevalence Ratio	95% CI		*P* Value
≥3.97 ≤12.82	1.64	1.38	1.96	<.0001
≥1.84 <3.97	1.30	1.09	1.55	0.0037
<1.84	Reference	. . .	. . .	. . .
Facility type				
Oncology	30.81	11.04	85.95	<.0001
General acute, surgical, critical access	13.88	7.51	25.68	<.0001
Children's, women and children's	5.52	2.86	10.66	<.0001
Women's	Reference	. . .	. . .	. . .
Percentage of ICU beds				
≥7.86 ≤ 47.57	1.30	1.11	1.53	.001
<7.86	Reference	. . .	. . .	. . .