

## ECCMID 2015

### The Year in Infection Control

26 April 2015, 9.00 – 11.00, Hall A

#### References

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1.1 Nordmann P, Poirel L. The difficult-to-control spread of carbapenemase producers in Enterobacteriaceae worldwide. *Clin Micro Infect.* 2014; 20: 821-ni 2014.

The spread of carbapenemase producers in Enterobacteriaceae has now been identified worldwide. Three main carbapenemases have been reported; they belong to three classes of  $\beta$ -lactamases, which are KPC, NDM, and OXA-48. The main reservoirs of KPC are *Klebsiella pneumoniae* in the USA, Israel, Greece, and Italy, those of NDM are *K. pneumoniae* and *Escherichia coli* in the Indian subcontinent, and those of OXA-48 are *K. pneumoniae* and *Escherichia coli* in North Africa and Turkey. KPC producers have been mostly identified among nosocomial isolates, whereas NDM and OXA-48 producers are both nosocomial and community-acquired pathogens. Control of their spread is still possible in hospital settings, and relies on the use of rapid diagnostic techniques and the strict implementation of hygiene measures.

1.2 Hayden M, Lin M, Lolans K, Weiner S, Blom D, Moore N, et al. Prevention of Colonization and Infection by *Klebsiella pneumoniae* Carbapenemase-Producing Enterobacteriaceae in Long-term Acute-Care Hospitals. *Clin Infect Dis* 2014 Dec 23 pii: ciu1173 2014.

**BACKGROUND:** *Klebsiella pneumoniae* carbapenemase-producing Enterobacteriaceae (hereafter "KPC") are an increasing threat to healthcare institutions. Long-term acute-care hospitals (LTACHs) have especially high prevalence of KPC. **METHODS:** Using a stepped-wedge design, we tested whether a bundled intervention (screening patients for KPC rectal colonization upon admission and every other week; contact isolation and geographic separation of KPC-positive patients in ward cohorts or single rooms; bathing all patients daily with chlorhexidine gluconate; and healthcare-worker education and adherence monitoring) would reduce colonization and infection due to KPC in 4 LTACHs with high endemic KPC prevalence. The study was conducted between 1 February 2010 and 30 June 2013; 3894 patients were enrolled during the preintervention period (lasting from 16 to 29 months), and 2951 patients were enrolled during the intervention period (lasting from 12 to 19 months). **RESULTS:** KPC colonization prevalence was stable during preintervention (average, 45.8%; 95% confidence interval [CI], 42.1%-49.5%), declined early during intervention, then reached a plateau (34.3%; 95% CI, 32.4%-36.2%;  $P < .001$  for exponential decline). During intervention, KPC admission prevalence remained high (average, 20.6%, 95% CI, 19.1%-22.3%). The incidence rate of KPC colonization fell during intervention, from 4 to 2 acquisitions per 100 patient-weeks ( $P = .004$  for linear decline). Compared to preintervention, average rates of clinical outcomes declined during intervention: KPC in any clinical culture (3.7 to 2.5/1000 patient-days;  $P = .001$ ), KPC bacteremia (0.9 to 0.4/1000 patient-days;  $P = .008$ ), all-cause bacteremia (11.2 to 7.6/1000 patient-days;  $P = .006$ ) and blood culture contamination (4.9 to 2.3/1000 patient-days;  $P = .03$ ). **CONCLUSIONS:** A bundled intervention was associated with clinically important and statistically significant reductions in KPC colonization, KPC infection, all-cause bacteremia, and blood culture contamination in a high-risk LTACH population.

1.3 Gagliotti C, Cappelli V, Carretto E, Marchi M, Pan A, Ragni P, et al. Control of carbapenemase-producing *Klebsiella pneumoniae*: a region-wide intervention. *Euro Surveill.* 2014; Oct 30;19(43). pii: 20943.

Starting in 2010, there was a sharp increase in infections caused by *Klebsiella pneumoniae* resistant to carbapenems in the Emilia-Romagna region in Italy. A region-wide intervention to control the spread of carbapenemase-producing *K. pneumoniae* (CPKP) in Emilia-Romagna was carried out, based on a regional guideline issued in July 2011. The infection control measures recommended to the Health Trusts (HTs) were: phenotypic confirmation of carbapenemase production, active surveillance of asymptomatic carriers and contact isolation precautions for carriers. A specific surveillance system was activated and the implementation of control measures in HTs was followed up. A significant linear increase of incident CPKP cases over time ( $p < 0.001$ ) was observed at regional level in Emilia-Romagna in the pre-intervention period, while the number of cases remained stable after the launch of the intervention ( $p = 0.48$ ). Considering the patients hospitalised in five HTs that provided detailed data on incident cases, a downward trend was observed in incidence after the release of the regional guidelines (from 32 to 15 cases per 100,000 hospital patient days). The spread of CPKP in Emilia-Romagna was contained by a centrally-coordinated intervention. A further reduction in CPKP rates might be achieved by increased compliance with guidelines and specific activities of antibiotic stewardship.

1.4 Kola A, Piening B, Pape U, Veltzke-Schlieker W, Kaase M, Geffers C, et al. An outbreak of carbapenem-resistant OXA-48 - producing *Klebsiella pneumoniae* associated to duodenoscopy. *Antimicrob Resist Infect Control.* 2015;4:8.

**BACKGROUND:** Carbapenemase-producing Enterobacteriaceae (CPE) have become a major problem for healthcare systems worldwide. While the first reports from European hospitals described the introduction of CPE from endemic countries, there is now a growing number of reports describing outbreaks of CPE in European hospitals. Here we report an outbreak of Carbapenem-resistant *K. pneumoniae* in a German University hospital which was in part associated to duodenoscopy. **FINDINGS:** Between December 6, 2012 and January 10, 2013, carbapenem-resistant *K. pneumoniae* (CRKP) was cultured from 12 patients staying on 4 different wards. The amplification of carbapenemase genes by multiplex PCR showed presence of the bla OXA-48 gene. Molecular typing confirmed the identity of all 12 isolates. Reviewing the medical records of CRKP cases revealed that there was a spatial relationship between 6 of the cases which were located on the same wards. The remaining 6 cases were all related to endoscopic retrograde cholangiopancreatography (ERCP) which was performed with the same duodenoscope. The outbreak ended after the endoscope was sent to the manufacturer for maintenance. **CONCLUSIONS:** Though the outbreak strain was also disseminated to patients who did not undergo ERCP and environmental sources or medical personnel also contributed to the outbreak, the gut of colonized patients is the main source for CPE. Therefore, accurate and stringent reprocessing of endoscopic instruments is extremely important, which is especially true for more complex instruments like the duodenoscope (TJF Q180V series) involved in the outbreak described here.

1.5 Epstein L, Hunter J, Arwady M, Tsai V, Stein L, Gribogiannis M, et al. New Delhi metallo- $\beta$ -lactamase-producing carbapenem-resistant *Escherichia coli* associated with exposure to duodenoscopes. *JAMA.* 2014;312:1447-55.

**IMPORTANCE:** Carbapenem-resistant Enterobacteriaceae (CRE) producing the New Delhi metallo- $\beta$ -lactamase (NDM) are rare in the United States, but have the potential to add to the increasing CRE burden. Previous NDM-producing CRE clusters have been attributed to person-to-person transmission in health care facilities. **OBJECTIVE:** To identify a source for, and interrupt transmission of, NDM-producing CRE in a northeastern Illinois hospital. **DESIGN, SETTING, AND PARTICIPANTS:** Outbreak investigation among 39 case patients at a tertiary care hospital in northeastern Illinois, including a case-control study, infection control assessment, and collection of environmental and device cultures; patient and environmental isolate relatedness was evaluated with pulsed-field gel electrophoresis (PFGE). Following identification of a likely source, targeted patient notification and CRE screening cultures were performed. **MAIN OUTCOMES AND MEASURES:** Association between exposure and acquisition of NDM-producing CRE; results of environmental cultures and organism typing. **RESULTS:** In total, 39 case patients were identified from January 2013 through December 2013, 35 with duodenoscope exposure in 1 hospital. No lapses in duodenoscope reprocessing were identified; however, NDM-producing *Escherichia coli* was

recovered from a reprocessed duodenoscope and shared more than 92% similarity to all case patient isolates by PFGE. Based on the case-control study, case patients had significantly higher odds of being exposed to a duodenoscope (odds ratio [OR], 78 [95% CI, 6.0-1008],  $P < .001$ ). After the hospital changed its reprocessing procedure from automated high-level disinfection with ortho-phthalaldehyde to gas sterilization with ethylene oxide, no additional case patients were identified. **CONCLUSIONS AND RELEVANCE:** In this investigation, exposure to duodenoscopes with bacterial contamination was associated with apparent transmission of NDM-producing *E. coli* among patients at 1 hospital. Bacterial contamination of duodenoscopes appeared to persist despite the absence of recognized reprocessing lapses. Facilities should be aware of the potential for transmission of bacteria including antimicrobial-resistant organisms via this route and should conduct regular reviews of their duodenoscope reprocessing procedures to ensure optimal manual cleaning and disinfection.

### 1.6 Muscarella L. Risk of transmission of carbapenem-resistant Enterobacteriaceae and related "superbugs" during gastrointestinal endoscopy. *World J Gastrointest Endosc.* 2014;16:457-74.

To evaluate the risk of transmission of carbapenem-resistant Enterobacteriaceae (CRE) and their related superbugs during gastrointestinal (GI) endoscopy. Reports of outbreaks linked to GI endoscopes contaminated with different types of infectious agents, including CRE and their related superbugs, were reviewed. Published during the past 30 years, both prior to and since CRE's emergence, these reports were obtained by searching the peer-reviewed medical literature (via the United States National Library of Medicine's "MEDLINE" database); the Food and Drug Administration's Manufacturer and User Facility Device Experience database, or "MAUDE"; and the Internet (via Google's search engine). This review focused on an outbreak of CRE in 2013 following the GI endoscopic procedure known as endoscopic retrograde cholangiopancreatography, or ERCP, performed at "Hospital X" located in the suburbs of Chicago (IL; United States). Part of the largest outbreak of CRE in United States history, the infection and colonization of 10 and 28 of this hospital's patients, respectively, received considerable media attention and was also investigated by the Centers for Disease Control and Prevention (CDC), which published a report about this outbreak in *Morbidity and Mortality Weekly Report (MMWR)*, in 2014. This report, along with the results of an independent inspection of Hospital X's infection control practices following this CRE outbreak, were also reviewed. While this article focuses primarily on the prevention of transmissions of CRE and their related superbugs in the GI endoscopic setting, some of its discussion and recommendations may also apply to other healthcare settings, to other types of flexible endoscopes, and to other types of transmissible infectious agents. This review found that GI endoscopy is an important risk factor for the transmission of CRE and their related superbugs, having been recently associated with patient morbidity and mortality following ERCP. The CDC reported in *MMWR* that the type of GI endoscope, known as an ERCP endoscope, that Hospital X used to perform ERCP in 2013 on the 38 patients who became infected or colonized with CRE might be particularly challenging to clean and disinfect, because of the complexity of its physical design. If performed in strict accordance with the endoscope manufacturer's labeling, supplemented as needed with professional organizations' published guidelines, however, current practices for reprocessing GI endoscopes, which include high-level disinfection, are reportedly adequate for the prevention of transmission of CRE and their related superbugs. Several recommendations are provided to prevent CRE transmissions in the healthcare setting. CRE transmissions are not limited to contaminated GI endoscopes and also have been linked to other reusable flexible endoscopic instrumentation, including bronchoscopes and cystoscopes. In conclusion, contaminated GI endoscopes, particularly those used during ERCP, have been causally linked to outbreaks of CRE and their related superbugs, with associated patient morbidity and mortality. Thorough reprocessing of these complex reusable instruments is necessary to prevent disease transmission and ensure patient safety during GI endoscopy. Enhanced training and monitoring of reprocessing staffers to verify the proper cleaning and brushing of GI endoscopes, especially the area around, behind and near the forceps elevator located at the distal end of the ERCP endoscope, are recommended. If the ERCP endoscope features a narrow and exposed channel that houses a wire connecting the GI endoscope's control head to this forceps elevator, then this channel's complete reprocessing, including its flushing with a detergent using a procedure validated for effectiveness, is also emphasized.

1.7 Wendorf K, Kay M, Baliga C, Weissman S, Gluck M, Verma P, et al. Endoscopic Retrograde Cholangiopancreatography-Associated AmpC *Escherichia coli* Outbreak. *Infect Control Hosp Epidemiol*. 2015; epub.

**BACKGROUND** We identified an outbreak of AmpC-producing *Escherichia coli* infections resistant to third-generation cephalosporins and carbapenems (CR) among 7 patients who had undergone endoscopic retrograde cholangiopancreatography at hospital A during November 2012-August 2013. Gene sequencing revealed a shared novel mutation in a *bla* CMY gene and a distinctive *fumC*/*fimH* typing profile. **OBJECTIVE** To determine the extent and epidemiologic characteristics of the outbreak, identify potential sources of transmission, design and implement infection control measures, and determine the association between the CR *E. coli* and AmpC *E. coli* circulating at hospital A. **METHODS** We reviewed laboratory, medical, and endoscopy reports, and endoscope reprocessing procedures. We obtained cultures from endoscopes after reprocessing as well as environmental samples and conducted pulsed-field gel electrophoresis and gene sequencing on phenotypic AmpC isolates from patients and endoscopes. Cases were those infected with phenotypic AmpC isolates (both carbapenem-susceptible and CR) and identical *bla* CMY-2, *fumC*, and *fimH* alleles or related pulsed-field gel electrophoresis patterns. **RESULTS** Thirty-five of 49 AmpC *E. coli* tested met the case definition, including all CR isolates. All cases had complicated biliary disease and had undergone at least 1 endoscopic retrograde cholangiopancreatography at hospital A. Mortality at 30 days was 16% for all patients and 56% for CR patients. Two of 8 reprocessed endoscopic retrograde cholangiopancreatography scopes harbored AmpC that matched case isolates by pulsed-field gel electrophoresis. Environmental cultures were negative. No breaches in infection control were identified. Endoscopic reprocessing exceeded manufacturer's recommended cleaning guidelines. **CONCLUSION** Recommended reprocessing guidelines are not sufficient.

1.8 Kaase M, Hauri A, et al. Plasmid-vermittelter Multispezies-Ausbruch mit Carbapenem-resistenten Enterbacteriaceae. *Epi Bull*. 2014;47.

no abstract available

1.9 Yao Y, Imirzalioglu C, Hain T, Kaase M, Gatermann S, Exner M, et al. Complete Nucleotide Sequence of a *Citrobacter freundii* Plasmid Carrying KPC-2 in a Unique Genetic Environment. *Genome Announc*. 2014;Nov 13;2(6). pii: e011157-14

The complete and annotated nucleotide sequence of a 54,036-bp plasmid harboring a *bla*KPC-2 gene that is clonally present in *Citrobacter* isolates from different species is presented. The plasmid belongs to incompatibility group N (IncN) and harbors the class A carbapenemase KPC-2 in a unique genetic environment.

1.10 Ducombe T, Fauchoux S, Helbig U, Kaisers U, König B, Knaust A, et al. Large hospital outbreak of KPC-2-producing *Klebsiella pneumoniae*: investigating mortality and the impact of screening for KPC-2 with polymerase chain reaction. *J Hosp Infect*. 2015;89:179-85.

**BACKGROUND:** Multi-drug-resistant *Klebsiella pneumoniae* carbapenemase (KPC)-2-producing *K. pneumoniae* are an increasing cause of healthcare-associated infections worldwide. **AIMS:** To investigate the impact of clinical infection on mortality, and examine the effect of use of KPC-2-specific polymerase chain reaction (PCR) on the time to contact isolation during an outbreak. **METHODS:** Cases were defined as patients clinically infected or colonized with KPC-2-producing *K. pneumoniae* between June 2010 and July 2012. Cases were described by demographic and health characteristics, and the association between infection and mortality, adjusted for comorbidities and demographic characteristics, was determined using Poisson regression with robust standard errors. A comparison was made between the time to contact isolation with a culture-based method and PCR using Wilcoxon's rank sum test. **FINDINGS:** Of 72 cases detected, 17 (24%) had undergone transplantation and 21 (29%) had a malignancy. Overall, 35 (49%) cases were clinically infected, with pneumonia and sepsis being the most common infections. Infection was an independent risk factor for mortality (risk ratio 1.67, 95% confidence interval 0.99-2.82). The median time to contact isolation was 1.5 days (range 0-21 days) using PCR and

5.0 days (range 0-39 days) using culture-based methods ( $P = 0.003$ ). Intermittent negative tests were observed in 48% (14/29) of cases tested using culture-based methods. **CONCLUSION:** KPC-2-producing *K. pneumoniae* mainly affect severely ill patients. Half of the cases developed clinical infection, associated with increased risk of death. As PCR accelerates isolation and provides the opportunity for preventive measures in colonized cases, its use should be implemented promptly during outbreaks. Further studies are needed to enhance knowledge about KPC detection patterns and to adjust screening guidelines.

1.11 Collignon P, Athukorala P, Senanayake S, Khan F. Antimicrobial resistance: the major contribution of poor governance and corruption to this growing problem. *Plos one*. 2015;Mar 18;10(3):e0116746.

**OBJECTIVES:** To determine how important governmental, social, and economic factors are in driving antibiotic resistance compared to the factors usually considered the main driving factors-antibiotic usage and levels of economic development. **DESIGN:** A retrospective multivariate analysis of the variation of antibiotic resistance in Europe in terms of human antibiotic usage, private health care expenditure, tertiary education, the level of economic advancement (per capita GDP), and quality of governance (corruption). The model was estimated using a panel data set involving 7 common human bloodstream isolates and covering 28 European countries for the period 1998-2010. **RESULTS:** Only 28% of the total variation in antibiotic resistance among countries is attributable to variation in antibiotic usage. If time effects are included the explanatory power increases to 33%. However when the control of corruption indicator is included as an additional variable, 63% of the total variation in antibiotic resistance is now explained by the regression. The complete multivariate regression only accomplishes an additional 7% in terms of goodness of fit, indicating that corruption is the main socioeconomic factor that explains antibiotic resistance. The income level of a country appeared to have no effect on resistance rates in the multivariate analysis. The estimated impact of corruption was statistically significant ( $p < 0.01$ ). The coefficient indicates that an improvement of one unit in the corruption indicator is associated with a reduction in antibiotic resistance by approximately 0.7 units. The estimated coefficient of private health expenditure showed that one unit reduction is associated with a 0.2 unit decrease in antibiotic resistance. **CONCLUSIONS:** These findings support the hypothesis that poor governance and corruption contributes to levels of antibiotic resistance and correlate better than antibiotic usage volumes with resistance rates. We conclude that addressing corruption and improving governance will lead to a reduction in antibiotic resistance.

1.12 Fisman D, Patrozou E, Carmeli Y, Perencevich E, Tuite A, Mermel L, et al. Geographical Variability in the Likelihood of Bloodstream Infections Due to Gram-Negative Bacteria: Correlation with Proximity to the Equator and Health Care Expenditure. *PLoS One*. 2014;Dec 18;9(12):e114548.

**OBJECTIVE:** Infections due to Gram-negative bacteria exhibit seasonal trends, with peak infection rates during warmer months. We hypothesized that the likelihood of a bloodstream infection due to Gram-negative bacteria increases with proximity to the equator. We tested this hypothesis and identified geographical, climatic and social factors associated with this variability. **DESIGN:** We established a network of 23 international centers in 22 cities. **SETTING:** De-identified results of positive blood cultures from 2007-2011 and data sources for geographic, climatic and socioeconomic factors were assembled for each center. **PARTICIPANTS:** Patients at the 23 centers with positive blood cultures. **MAIN OUTCOME:** Due to variability in the availability of total culture volumes across sites, our primary outcome measure was the fraction of positive blood cultures that yielded Gram-negative bacteria; sources of variability in this outcome measure were explored using meta-regression techniques. **RESULTS:** The mean fraction of bacteremia associated with Gram-negative bacteria was 48.4% (range 26.4% to 61.8%). Although not all sites displayed significant seasonality, the overall  $P$ -value for seasonal oscillation was significant ( $P < 0.001$ ). In univariate meta-regression models, temperature, latitude, latitude squared, longitude, per capita gross domestic product and percent of gross domestic product spent on healthcare were all associated with the fraction of bacteremia due to Gram-negative bacteria. In multivariable models, only percent of gross domestic product spent on healthcare and distance from the equator (ie. latitude squared) were significantly associated with the fraction of bacteremia due to Gram-negative bacteria. **CONCLUSIONS:** The likelihood of bacteremia due to Gram-negative bacteria varies markedly between cities, in a manner that appears to have both geographic (latitude) and socioeconomic (proportion gross

domestic product devoted to health spending) determinants. Thus, the optimal approach to initial management of suspected bacteremia may be geographically specific. The rapid emergence of highly antibiotic-resistant Gram-negative pathogens may have geographically specific impacts.

1.13 Schwab F, Gastmeier P, Meyer E. The warmer the weather, the more gram-negative bacteria - impact of temperature on clinical isolates in intensive care units. *PLoS One*. 2014;9(3):e91105.

**BACKGROUND:** We investigated the relationship between average monthly temperature and the most common clinical pathogens causing infections in intensive care patients. **METHODS:** A prospective unit-based study in 73 German intensive care units located in 41 different hospitals and 31 different cities with total 188,949 pathogen isolates (102,377 Gram-positives and 86,572 Gram-negatives) from 2001 to 2012. We estimated the relationship between the number of clinical pathogens per month and the average temperature in the month of isolation and in the month prior to isolation while adjusting for confounders and long-term trends using time series analysis. Adjusted incidence rate ratios for temperature parameters were estimated based on generalized estimating equation models which account for clustering effects. **RESULTS:** The incidence density of Gram-negative pathogens was 15% (IRR 1.15, 95%CI 1.10-1.21) higher at temperatures  $\geq 20^{\circ}\text{C}$  than at temperatures below  $5^{\circ}\text{C}$ . *E. cloacae* occurred 43% (IRR=1.43; 95%CI 1.31-1.56) more frequently at high temperatures, *A. baumannii* 37% (IRR=1.37; 95%CI 1.11-1.69), *S. maltophilia* 32% (IRR=1.32; 95%CI 1.12-1.57), *K. pneumoniae* 26% (IRR=1.26; 95%CI 1.13-1.39), *Citrobacter* spp. 19% (IRR=1.19; 95%CI 0.99-1.44) and coagulase-negative staphylococci 13% (IRR=1.13; 95%CI 1.04-1.22). By contrast, *S. pneumoniae* 35% (IRR=0.65; 95%CI 0.50-0.84) less frequently isolated at high temperatures. For each  $5^{\circ}\text{C}$  increase, we observed a 3% (IRR=1.03; 95%CI 1.02-1.04) increase of Gram-negative pathogens. This increase was highest for *A. baumannii* with 8% (IRR=1.08; 95%CI 1.05-1.12) followed by *K. pneumoniae*, *Citrobacter* spp. and *E. cloacae* with 7%. **CONCLUSION:** Clinical pathogens vary by incidence density with temperature. Significant higher incidence densities of Gram-negative pathogens were observed during summer whereas *S. pneumoniae* peaked in winter. There is increasing evidence that different seasonality due to physiologic changes underlies host susceptibility to different bacterial pathogens. Even if the underlying mechanisms are not yet clear, the temperature-dependent seasonality of pathogens has implications for infection control and study design.

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2.1 Shears P, O'Dempsey TJ. Ebola virus disease in Africa: epidemiology and nosocomial transmission. *J Hosp Infect* 2015; in press.

The 2014 Ebola outbreak in West Africa, primarily affecting Guinea, Sierra Leone, and Liberia, has exceeded all previous Ebola outbreaks in the number of cases and in international response. There have been 20 significant outbreaks of Ebola virus disease in Sub-Saharan Africa prior to the 2014 outbreak, the largest being that in Uganda in 2000, with 425 cases and a mortality of 53%. Since the first outbreaks in Sudan and Zaire in 1976, transmission within health facilities has been of major concern, affecting healthcare workers and acting as amplifiers of spread into the community. The lack of resources for infection control and personal protective equipment are the main reasons for nosocomial transmission. Local strategies to improve infection control, and a greater understanding of local community views on the disease, have helped to bring outbreaks under control. Recommendations from previous outbreaks include improved disease surveillance to enable more rapid health responses, the wider availability of personal protective equipment, and greater international preparedness.

2.2 Schwedhelm S, Swanhorst J, Watson S, Rudd J. ED Ebola Triage Algorithm: A Tool and Process for Compliance. *J Emerg Nursing* 2015; 41 (2): 165–169.

Nebraska Medicine (formerly known as The Nebraska Medical Center) Biocontainment Unit has cared for 3 patients with known Ebola virus disease (EBV). The unit and staff have been prepared for 9 years to care for a patient with a highly infectious disease. In early August 2014, prior to the first Ebola patient being brought to Nebraska Medicine, the ED Director, also the Nursing Director of the Biocontainment Unit, developed an ED Ebola triage algorithm to be used at the front door by the ED Greeter Nurse.

2.3 Payne R, Muenchhoff M, Mann J, Roberts HE, Matthews P, Adland E, Hempenstall A, Huang KH, Brockman M, Brumme Z, Sinclair M, Miura T, Frater J, Essex M, Shapiro R, Walker BD, Ndung'u T, McLean AR, Carlson JM, Goulder PJ. Impact of HLA-driven HIV adaptation on virulence in populations of high HIV seroprevalence. *Proc Natl Acad Sci USA* 2014; 111(50): E5393-400.

It is widely believed that epidemics in new hosts diminish in virulence over time, with natural selection favoring pathogens that cause minimal disease. However, a tradeoff frequently exists between high virulence shortening host survival on the one hand but allowing faster transmission on the other. This is the case in HIV infection, where high viral loads increase transmission risk per coital act but reduce host longevity. We here investigate the impact on HIV virulence of HIV adaptation to HLA molecules that protect against disease progression, such as HLA-B\*57 and HLA-B\*58:01. We analyzed cohorts in Botswana and South Africa, two countries severely affected by the HIV epidemic. In Botswana, where the epidemic started earlier and adult seroprevalence has been higher, HIV adaptation to HLA including HLA-B\*57/58:01 is greater compared with South Africa ( $P = 7 \times 10^{-82}$ ), the protective effect of HLA-B\*57/58:01 is absent ( $P = 0.0002$ ), and population viral replicative capacity is lower ( $P = 0.03$ ). These data suggest that viral evolution is occurring relatively rapidly, and that adaptation of HIV to the most protective HLA alleles may contribute to a lowering of viral replication capacity at the population level, and a consequent reduction in HIV virulence over time. The potential role in this process played by increasing antiretroviral therapy (ART) access is also explored. Models developed here suggest distinct benefits of ART, in addition to reducing HIV disease and transmission, in driving declines in HIV virulence over the course of the epidemic, thereby accelerating the effects of HLA-mediated viral adaptation.

2.4 Faria NR, Rambaut A, Suchard MA, Baele G, Bedford T, Ward MJ, Tatem AJ, Sousa JD, Arinaminpathy N, P  pin J, Posada D, Peeters M, Pybus OG, Lemey P. HIV epidemiology. The early spread and epidemic ignition of HIV-1 in human populations. *Science* 2014; 346(6205): 56-61.

Thirty years after the discovery of HIV-1, the early transmission, dissemination, and establishment of the virus in human populations remain unclear. Using statistical approaches applied to HIV-1 sequence data from central Africa, we show that from the 1920s Kinshasa (in what is now the Democratic Republic of Congo) was the focus of early transmission and the source of pre-1960 pandemic viruses elsewhere. Location and dating estimates were validated using the earliest HIV-1 archival sample, also from Kinshasa. The epidemic histories of HIV-1 group M and nonpandemic group O were similar until ~1960, after which group M underwent an epidemiological transition and outpaced regional population growth. Our results reconstruct the early dynamics of HIV-1 and emphasize the role of social changes and transport networks in the establishment of this virus in human populations.

2.5 Brown K, Valenta K, Fisman D, Simor A, Daneman N. Hospital ward antibiotic prescribing and the risks of *Clostridium difficile* infection. *JAMA Intern Med* 2015 Feb 23. doi: 10.1001/jamainternmed.2014.8273. Also see accompanying editorial by L. Clifford MacDonald.

**IMPORTANCE:** Only a portion of hospital-acquired *Clostridium difficile* infections can be traced back to source patients identified as having symptomatic disease. Antibiotic exposure is the main risk factor for *C. difficile* infection for individual patients and is also associated with increased asymptomatic shedding. Contact with patients taking antibiotics within the same hospital ward may be a transmission risk factor for *C. difficile* infection, but this hypothesis has never been tested. **OBJECTIVES:** To obtain a complete portrait of inpatient risk that incorporates innate patient risk factors and transmission risk factors measured at the hospital ward level and to investigate ward-level rates of antibiotic use and *C. difficile* infection risk. **DESIGN, SETTING, AND PATIENTS:** A 46-month (June 1, 2010, through March 31, 2014) retrospective cohort study of inpatients 18 years or older in a large, acute care teaching hospital composed of 16 wards, including 5 intensive care units and 11 non-intensive care unit wards. **EXPOSURES:** Patient-level risk factors (eg, age, comorbidities, hospitalization history, antibiotic exposure) and ward-level risk factors (eg, antibiotic therapy per 100 patient-days, hand hygiene adherence, mean patient age) were identified from hospital databases. **MAIN OUTCOMES AND MEASURES:** Incidence of hospital-acquired *C. difficile* infection as identified prospectively by hospital

infection prevention and control staff. **RESULTS:** A total of 255 of 34 298 patients developed C difficile (incidence rate, 5.95 per 10 000 patient-days; 95% CI, 5.26-6.73). Ward-level antibiotic exposure varied from 21.7 to 56.4 days of therapy per 100 patient-days. Each 10% increase in ward-level antibiotic exposure was associated with a 2.1 per 10 000 ( $P < .001$ ) increase in C difficile incidence. The association between C difficile incidence and ward antibiotic exposure was the same among patients with and without recent antibiotic exposure, and C difficile risk persisted after multilevel, multivariate adjustment for differences in patient-risk factors among wards (relative risk, 1.34 per 10% increase in days of therapy; 95% CI, 1.16-1.57). **CONCLUSIONS AND RELEVANCE:** Among hospital inpatients, ward-level antibiotic prescribing is associated with a statistically significant and clinically relevant increase in C difficile risk that persists after adjustment for differences in patient-level antibiotic use and other patient- and ward-level risk factors. These data strongly support the use of antibiotic stewardship as a means of preventing C difficile infection.

2.6 Vale of Leven report. Available (in different formats) at:  
<http://www.valeoflevenhospitalinquiry.org/report.aspx>

2.7 Maiwald M, Assam PN, Chan ES, Dancer SJ. Chlorhexidine's role in skin antisepsis: questioning the evidence. *The Lancet* 2014; 384 (9951): 1344-5.

Chlorhexidine has attracted substantial attention for its role as a skin antiseptic. It has featured in prominent clinical trials, evidence-based guidelines, and keynote presentations at conferences. The compound is widely regarded as the antiseptic of choice for skin preparation before blood culture collection, vascular catheter insertion, and surgical interventions. However, objections have been raised over available evidence. Investigators of clinical trials and authors of systematic reviews often attribute effective antisepsis after a combination of chlorhexidine and alcohol (two antiseptics) to chlorhexidine alone, concluding that chlorhexidine itself is better than competitor antiseptics.

2.8 Kavanagh KT, Calderon LE, Samanet DM. Viewpoint: a response to "Screening and isolation to control methicillin-resistant *Staphylococcus aureus*: sense, nonsense, and evidence". *Antimicrob Resist Infect Control* (2015) 4: 4.

Surveillance and isolation for the prevention of methicillin-resistant *Staphylococcus aureus* (MRSA) has become a controversial topic, one that causes heated debate and appears to be surrounded by both politics and industrial conflicts-of-interest. There have been calls from numerous authors for a movement away from rigid mandates and toward an evidence-based medicine approach. However, much of the evidence can be viewed with an entirely different interpretation. Two major studies with negative findings have had an adverse impact on recommendations regarding active detection and isolation (ADI) for MRSA. However the negative findings in these studies can be explained by shortcomings in study implementation rather than the ineffectiveness of ADI. The use of daily chlorhexidine bathing has also been proposed as an alternative to ADI in ICU settings. There are shortcomings regarding the evidence in the literature concerning the effectiveness of daily chlorhexidine bathing. One of the major concerns with universal daily chlorhexidine bathing is the development of bacterial resistance. The use of surveillance and isolation to address epidemics and common dangerous pathogens should solely depend upon surveillance and isolation's ability to prevent further spread to and infection of other patients through indirect contact. At present, there is a preponderance of evidence in the literature to support continuing use of surveillance and isolation to prevent the spread of MRSA.

2.9 Ghasemzadeh-Moghaddam H, van Belkum A, Hamat RA, van Wamel W, Neela V. Methicillin-susceptible and -resistant *Staphylococcus aureus* with high-level antiseptic and low-level mupirocin resistance in Malaysia. *Microb Drug Resist* 2014; 20(5): 472-7.

The prevalence and spread of mupirocin and antiseptic resistance among colonizing and infectious *Staphylococcus aureus* were determined. *S. aureus* isolated from anterior nares and infection sites of patients hospitalized in the largest tertiary care referral hospital in Malaysia was investigated for mupirocin and antiseptic susceptibility testing, and for PCR detection of *mupA*, *qacA/B*, and *smr* genes.

Twelve isolates showed resistance to mupirocin by disk diffusion, of which 10 (3.8%) harbored the *mupA* gene. Minimum inhibitory concentrations (MICs) ranged from 64 to 768 µg/ml for *mupA* positive and below 46 µg/ml for negative isolates. The *mupA* was more common among ST239 isolates (70%). The *qacA/B* was carried in 67 out of 95 methicillin-resistant *Staphylococcus aureus* (MRSA) (70.5%) and 3 out of 164 methicillin-susceptible *Staphylococcus aureus* (MSSA) (1.8%), while *smr* was carried in 6 out of 95 MRSA (6.3%) strains. MICs ranged from 3.9 to 15.6 µg/ml for benzethonium chloride (BTC) and benzalkonium chloride (BKC), and from 10.3 to 20.7 µg/ml for chlorhexidine digluconate (CHG). Isolates with *qacA/B* and *smr* or *qacA/B* alone showed higher MIC (20.7 µg/ml for CHG and 15.6 µg/ml for BTC and BKC) than the isolates that lacked antiseptic resistance genes (10.3 µg/ml for CHG and 3.9 µg/ml for BTC and BKC). In 16 cases, ST239 was isolated from the infection site and the nares simultaneously, and shared identical resistance patterns (*qacAB* or *qacAB+smr*), suggesting possible endogenous infection. Spread of low-level mupirocin resistance expressing ST239 MRSA and high-level resistance expressing emerging ST1, co-existing with antiseptic-resistant genes showing elevated MICs, should be monitored for effective infection control.

2.10 Macias JH, Ruiz S, Macias AE, Alvarez JA. Substantive effect of chlorhexidine. *J Hosp Infect* 2015; 90: 82-82.

Despite recent improvements in many countries, healthcare-associated infections remain a serious problem, causing morbidity and mortality, and adding to the costs of health care. Only 40% of healthcare personnel exhibit proper compliance with hand hygiene, despite this being the single most important measure for preventing the transmission of infectious agents in hospitals.

2.11 Dancer SJ. Pitfalls in microbiological sampling of the healthcare environment. *Infect Control Hosp Epidemiol* 2015; in press.

No abstract available

2.12 Stewart M, Bogusz A, Hunter J, Devanny I, Yip B, Reid D, Robertson C, Dancer SJ. Microbiological effect of cleaning near-patient sites with electrolysed water. *Infect Control Hosp Epidemiol* 2014; 5(12): 1505-10.

**OBJECTIVE:** This study aimed to monitor the microbiological effect of cleaning near-patient sites over a 48-hour period with a novel disinfectant, electrolyzed water. **SETTING:** One ward dedicated to acute care of the elderly population in a district general hospital in Scotland. **METHODS:** Lockers, left and right cot sides, and overbed tables in 30 bed spaces were screened for aerobic colony count (ACC), methicillin-susceptible *Staphylococcus aureus* (MSSA), and methicillin-resistant *S. aureus* (MRSA) before cleaning with electrolyzed water. Sites were rescreened at varying intervals from 1 to 48 hours after cleaning. Microbial growth was quantified as colony-forming units (CFUs) per square centimeter and presence or absence of MSSA and MRSA at each site. The study was repeated 3 times at monthly intervals. **RESULTS:** There was an early and significant reduction in average ACC (360 sampled sites) from a before-cleaning level of 4.3 to 1.65 CFU/cm<sup>2</sup> at 1 hour after disinfectant cleaning ( *P* < .0001). Average counts then increased to 3.53 CFU/cm<sup>2</sup> at 24 hours and 3.68 CFU/cm<sup>2</sup> at 48 hours. Total MSSA/MRSA (34 isolates) decreased by 71% at 4 hours after cleaning but then increased to 155% (53 isolates) of pre-cleaning levels at 24 hours. **CONCLUSIONS:** Cleaning with electrolyzed water reduced ACC and staphylococci on surfaces beside patients. ACC remained below pre-cleaning levels at 48 hours, but MSSA/MRSA counts exceeded original levels at 24 hours after cleaning. Although disinfectant cleaning quickly reduces bioburden, additional investigation is required to clarify the reasons for rebound contamination of pathogens at near-patient sites.

2.13 Vickery K et al. Intensive Care Unit environmental surfaces are contaminated by multiresistant bacteria in biofilms: combined results of conventional culture, pyrosequencing, scanning electron microscopy and confocal laser microscopy. *J Hosp Infect* 2015; under review.

No abstract available

2.14 Haas JP, Menz J, Dusza S, Montecalvo MA. Implementation and impact of ultraviolet environmental disinfection in an acute care setting. *Am J Infect Control* 2014; 42(6): 586-90.

**BACKGROUND:** Multiple-drug-resistant organisms (MDROs) and *Clostridium difficile* (CD) are significant problems in health care. Evidence suggests that these organisms are transmitted to patients by the contaminated environment. **METHODS:** This is a retrospective study of the implementation of ultraviolet environmental disinfection (UVD) following discharge cleaning of contact precautions rooms and other high-risk areas at Westchester Medical Center, a 643-bed tertiary care academic medical center. Incidence rates of hospital-acquired MDROs plus CD before and during the UVD use were evaluated using rate ratios and piecewise regression. **RESULTS:** The average time per UVD was 51 minutes, and machines were in use 30% of available time. UVD was used 11,389 times; 3,833 (34%) of uses were for contact precautions discharges. UVD was completed for 76% of contact precautions discharges. There was a significant 20% decrease in hospital-acquired MDRO plus CD rates during the 22-month UVD period compared with the 30-month pre-UVD period (2.14 cases/1,000 patient-days vs 2.67 cases per 1,000 patient-days, respectively; rate ratio, 0.80; 95% confidence interval: 0.73-0.88,  $P < .001$ ). **CONCLUSION:** During the time period UVD was in use, there was a significant decrease in overall hospital-acquired MDRO plus CD in spite of missing 24% of opportunities to disinfect contact precautions rooms. This technology was feasible to use in our acute care setting and appeared to have a beneficial effect.

2.15 Dancer SJ. Controlling hospital-acquired infection: focus on the role of the environment and new technologies for decontamination. *Clin Microbiol Rev* 2014; 27(4): 665-90.

There is increasing interest in the role of cleaning for managing hospital-acquired infections (HAI). Pathogens such as vancomycin-resistant enterococci (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA), multiresistant Gram-negative bacilli, norovirus, and *Clostridium difficile* persist in the health care environment for days. Both detergent- and disinfectant-based cleaning can help control these pathogens, although difficulties with measuring cleanliness have compromised the quality of published evidence. Traditional cleaning methods are notoriously inefficient for decontamination, and new approaches have been proposed, including disinfectants, steam, automated dispersal systems, and antimicrobial surfaces. These methods are difficult to evaluate for cost-effectiveness because environmental data are not usually modeled against patient outcome. Recent studies have reported the value of physically removing soil using detergent, compared with more expensive (and toxic) disinfectants. Simple cleaning methods should be evaluated against nonmanual disinfection using standardized sampling and surveillance. Given worldwide concern over escalating antimicrobial resistance, it is clear that more studies on health care decontamination are required. Cleaning schedules should be adapted to reflect clinical risk, location, type of site, and hand touch frequency and should be evaluated for cost versus benefit for both routine and outbreak situations. Forthcoming evidence on the role of antimicrobial surfaces could supplement infection prevention strategies for health care environments, including those targeting multidrug-resistant pathogens.

2.16 Ahlfeld B, Li Y, Boulaaba A, Binder A, Schotte U, Zimmermann JL, Morfill G, Klein G. Inactivation of a foodborne norovirus outbreak strain with nonthermal atmospheric pressure plasma. *MBio* 2015; 6(1): pii: e02300-14.

Human norovirus (NoV) is the most frequent cause of epidemic nonbacterial acute gastroenteritis worldwide. We investigated the impact of nonthermal or cold atmospheric pressure plasma (CAPP) on the inactivation of a clinical human outbreak NoV, GII.4. Three different dilutions of a NoV-positive stool sample were prepared and subsequently treated with CAPP for various lengths of time, up to 15 min. NoV viral loads were quantified by quantitative real-time reverse transcription PCR (RT-qPCR). Increased CAPP treatment time led to increased NoV reduction; samples treated for the longest time had the lowest viral load. From the initial starting quantity of  $2.36 \times 10(4)$  genomic equivalents/ml, sample exposure to CAPP reduced this value by 1.23 log<sub>10</sub> and 1.69 log<sub>10</sub> genomic equivalents/ml after 10 and 15 min, respectively ( $P < 0.01$ ). CAPP treatment of surfaces carrying a lower viral load reduced NoV by at least 1 log<sub>10</sub> after CAPP exposure for 2 min ( $P < 0.05$ ) and 1 min ( $P < 0.05$ ), respectively. Our results suggest

that NoV can be inactivated by CAPP treatment. The lack of cell culture assays prevents our ability to estimate infectivity. It is possible that some detectable, intact virus particles were rendered noninfectious. We conclude that CAPP treatment of surfaces may be a useful strategy to reduce the risk of NoV transmission in crowded environments. **IMPORTANCE:** Human gastroenteritis is most frequently caused by noroviruses, which are spread person to person and via surfaces, often in facilities with crowds of people. Disinfection of surfaces that come into contact with infected humans is critical for the prevention of cross-contamination and further transmission of the virus. However, effective disinfection cannot be done easily in mass catering environments or health care facilities. We evaluated the efficacy of cold atmospheric pressure plasma, an innovative airborne disinfection method, on surfaces inoculated with norovirus. We used a clinically relevant strain of norovirus from an outbreak in Germany. Cold plasma was able to inactivate the virus on the tested surfaces, suggesting that this method could be used for continuous disinfection of contaminated surfaces. The use of a clinical strain of norovirus strengthens the reliability of our results as it is a strain relevant to outbreaks in humans.

### 2.17 O'Connor N, Cahill O, Daniels S, Galvin S, Humphreys H. Cold atmospheric pressure plasma and decontamination. Can it contribute to preventing hospital-acquired infections? *J Hosp Infect* 2014; 88: 59-65.

Healthcare-associated infections (HAIs) affect ~4.5 million patients in Europe alone annually. With the ever-increasing number of 'multi-resistant' micro-organisms, alternative and more effective methods of environmental decontamination are being sought as an important component of infection prevention and control. One of these is the use of cold atmospheric pressure plasma (CAPP) systems with clinical applications in healthcare facilities. CAPPs have been shown to demonstrate antimicrobial, antifungal and antiviral properties and have been adopted for other uses in clinical medicine over the past decade. CAPPs vary in their physical and chemical nature depending on the plasma-generating mechanism (e.g. plasma jet, dielectric barrier discharge, etc.). CAPP systems produce a 'cocktail' of species including positive and negative ions, reactive atoms and molecules (e.g. atomic oxygen, ozone, superoxide and oxides of nitrogen), intense electric fields, and ultraviolet radiation (UV). The effects of these ions have been studied on micro-organisms, skin, blood, and DNA; thus, a range of possible applications of CAPPs has been identified, including surface decontamination, wound healing, biofilm removal, and even cancer therapy. Here we evaluate plasma devices, their applications, mode of action and their potential role specifically in combating HAIs on clinical surfaces.

### 2.18 Pulliam JR. Lower infection rates after introduction of a photocatalytic surface coating. *Am J Infect Control* 2015; 43: 180-1.

Health care facilities contain potentially contaminated surfaces that are either difficult to sanitize or prone to recontamination. Photocatalytic materials exhibit antimicrobial activity when exposed to light and provide a safe, durable coating on a wide range of surfaces. We assessed infection rates before and after introduction of a photocatalytic coating in our facility. Infection rates decreased overall by 30%, a change that was statistically significant ( $P = .02$ ). Similar changes to the built environment merit additional investigation.

### 2.19 Tan Z, Ganapathy A, Orndorff PE, Shirwaiker RA. Effects of cathode design parameters on in vitro antimicrobial efficacy of electrically-activated silver-based iontophoretic system. *J Mater Sci Mater Med* 2015; 26(1): 5382.

Post-operative infection is a major risk associated with implantable devices. Prior studies have demonstrated the effectiveness of ionic silver as an alternative to antibiotic-based infection prophylaxis and treatment. The focus of this study is on an electrically activated implant system engineered for active release of antimicrobial silver ions. The objective was to evaluate the effects of the cathode design, especially the cathode material, on the in vitro antimicrobial efficacy of the system. A modified Kirby-Bauer diffusion technique was used for the antimicrobial efficacy evaluations (24 h testing interval). In phase-1 of the study, a three-way ANOVA ( $n = 6$ ,  $\alpha = 0.05$ ) was performed to determine the effects of cathode material (silver, titanium, and stainless steel), cathode surface area and electrode separation distance on the efficacy of the system against *Staphylococcus aureus*. The results show that within the design space tested, none of these parameters had a statistically significant effect on the antimicrobiality

of the system ( $P > 0.15$ ). Subsequently, one-way ANOVA ( $n = 6$ ,  $\alpha = 0.05$ ) was conducted in phase-2 to validate the inference regarding the non-significance of the cathode material to the system efficacy using a broader spectrum of pathogens (methicillin-resistant *S. aureus*, *Escherichia coli*, *Streptococcus agalactiae* and *Aspergillus flavus*) responsible for osteomyelitis. The results confirmed the lack of statistical difference between efficacies of the three cathode material configurations against all pathogens tested ( $P > 0.58$ ). Overall, the results demonstrate the ability to alter the cathode material and related design parameters in order to minimize the silver usage in the system without adversely affecting its antimicrobial efficacy.

## 2.20 Dancer SJ, Duerden BI. Current controversy: Changes to clinician attire have done more harm than good. *J Royal Coll Phys Edin* 2014; 44(4):293-8.

The introduction of 'bare below the elbows' policies to facilitate handwashing led to the disappearance of the white coat from medical and surgical wards. While rates of key healthcare acquired infections in hospitals, e.g. *Clostridium difficile* and methicillin-resistant *Staphylococcus aureus* bacteraemia, have fallen, argument continues around the contribution of hand hygiene and dress codes to these changes. Conversely, the number of complaints against clinicians continues to rise, and respect for medical staff is falling. Are these phenomena linked to the disappearance of the white coat? Here, we debate the effects of these changes to clinician attire and ask whether the putative benefits in terms of infection control are outweighed by the possible harms to the doctor-patient relationship alleged to be caused by the loss of the white coat.

## 2.21 Edmond MB, Diekema DJ, Perencevich EN. Ebola virus disease and the need for new personal protective equipment. *JAMA* 2014; 312(23): 2495-6.1. Nordmann P, Poirel L. The difficult-to-control spread of carbapenemase producers in Enterobacteriaceae worldwide. *Clin Micro Infect.* 2014; 20: 821-ni 2014.

Preventing transmission of pathogens in the health care setting with the use of personal protective equipment (PPE) has been an area of longstanding debate in the infection prevention community. Recently, reports of nosocomial transmission of Ebola virus to 2 nurses from the same patient in Texas (despite their use of PPE) has generated great concern and presents new challenges, particularly because there is no postexposure prophylaxis or effective antiviral therapy for Ebola, and approximately half of the cases are fatal.

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## 3.1 Fätkenheuer G, Hirschel B, Harbarth S. Screening and isolation to control methicillin-resistant *Staphylococcus aureus*: sense, nonsense, and evidence. *Lancet* 2015 Mar 21;385(9973):1146-9. doi: 10.1016/S0140-6736(14)60660-7

Your meeting starts in 8 minutes. You are standing in front of the room of your patient, Mrs Smith, who you promised to see this morning. The door displays an "MRSA isolation" sign. Will you go in? Probably not, because you are in a rush and first have to put on a mask, gown, and gloves. You may well ask yourself whether these precautions are justified.

## 3.2 Nakao A, Ito T, Han X, et al. Intestinal carriage of methicillin-resistant *Staphylococcus aureus* in nasal MRSA carriers hospitalized in the neonatal intensive care unit. *Antimicrob Resist Infect Control.* 2014 Apr 23;3:14. doi: 10.1186/2047-2994-3-14.

**BACKGROUND:** The current data regarding the correlation between the methicillin-resistant *Staphylococcus aureus* (MRSA) clones carried in the nasal cavity and digestive tract are inadequate. **METHODS:** MRSA strains were isolated from both the feces and nasal swabs of 21 nasal-MRSA carriers ranging from 10 to 104 days of age treated at the neonatal intensive care units of two hospitals. The molecular epidemiological characteristics of the isolates were determined: multilocus sequence types,

spa-types, staphylococcal cassette chromosome mec (SCCmec) types, carriage of four exotoxin genes, and genes contained in commercially available kit. **RESULTS:** The feces of all nasal carriers contained MRSA at levels ranging from  $4.0 \times 10(2)$  to  $2.8 \times 10(8)$  colony forming units/g feces. The MRSA clones isolated from the feces and the nasal swabs of each patient were the same. Four MRSA clones, clonal complex (CC) 8-SCCmec IVI, CC8-SCCmec IVb, CC1-SCCmec IVa and CC5-SCCmec IIa were identified from 21 patients. All CC8-SCCmec IVI strains and one of three CC5-SCCmec IIa strains carried the toxic shock syndrome toxin gene. **CONCLUSIONS:** The feces of tested MRSA carriers contained the same MRSA clones as the nasal isolates in considerable amounts, suggesting that more careful attention should be paid for the handling of excrement in the case of newborn babies or infants than that of adults.

### 3.3 Bellini C, Petignat C, Masserey E, et al. Universal screening and decolonization for control of MRSA in nursing homes: a cluster randomized controlled study. *Infect Control Hosp Epidemiol.* 2015 Apr;36(4):401-8. doi: 10.1017/ice.2014.74.

**OBJECTIVE** The risk of carrying methicillin-resistant *Staphylococcus aureus* (MRSA) is higher among nursing home (NH) residents than in the general population. However, control strategies are not clearly defined in this setting. In this study, we compared the impact of standard precautions either alone (control) or combined with screening of residents and decolonization of carriers (intervention) to control MRSA in NHs. **DESIGN** Cluster randomized controlled trial **SETTING** NHs of the state of Vaud, Switzerland **PARTICIPANTS** Of 157 total NHs in Vaud, 104 (67%) participated in the study. **INTERVENTION** Standard precautions were enforced in all participating NHs, and residents underwent MRSA screening at baseline and 12 months thereafter. All carriers identified in intervention NHs, either at study entry or among newly admitted residents, underwent topical decolonization combined with environmental disinfection, except in cases of MRSA infection, MRSA bacteriuria, or deep skin ulcers. **RESULTS** NHs were randomly allocated to a control group (51 NHs, 2,412 residents) or an intervention group (53 NHs, 2,338 residents). Characteristics of NHs and residents were similar in both groups. The mean screening rates were 86% (range, 27%-100%) in control NHs and 87% (20%-100%) in intervention NHs. Prevalence of MRSA carriage averaged 8.9% in both control NHs (range, 0%-43%) and intervention NHs (range, 0%-38%) at baseline, and this rate significantly declined to 6.6% in control NHs and to 5.8% in intervention NHs after 12 months. However, the decline did not differ between groups ( $P=.66$ ). **CONCLUSION** Universal screening followed by decolonization of carriers did not significantly reduce the prevalence of the MRSA carriage rate at 1 year compared with standard precautions. *Infect Control Hosp Epidemiol* 2015;00(0): 1-8.

### 3.4 Popoola VO, Budd A, Wittig SM, et al. Methicillin-Resistant *Staphylococcus aureus* Transmission and Infections in a Neonatal Intensive Care Unit despite Active Surveillance Cultures and Decolonization: Challenges for Infection Prevention. *Infect Control Hosp Epidemiol*, Vol. 35, No. 4 (April 2014), pp. 412-418

**OBJECTIVE:** To characterize the epidemiology of methicillin-resistant *Staphylococcus aureus* (MRSA) transmission and infections in a level IIIC neonatal intensive care unit (NICU) and identify barriers to MRSA control. **SETTING AND DESIGN:** Retrospective cohort study in a university-affiliated NICU with an MRSA control program including weekly nares cultures of all neonates and admission nares cultures for neonates transferred from other hospitals or admitted from home. **METHODS:** Medical records were reviewed to identify neonates with NICU-acquired MRSA colonization or infection between April 2007 and December 2011. Compliance with hand hygiene and an MRSA decolonization protocol were monitored. Relatedness of MRSA strains were assessed using pulsed-field gel electrophoresis (PFGE). **RESULTS:** Of 3,536 neonates, 74 (2.0%) had a culture grow MRSA, including 62 neonates with NICU-acquired MRSA. Nineteen of 74 neonates (26%) had an MRSA infection, including 8 who became infected before they were identified as MRSA colonized, and 11 of 66 colonized neonates (17%) developed a subsequent infection. Of the 37 neonates that underwent decolonization, 6 (16%) developed a subsequent infection, and 7 of 14 (50%) that remained in the NICU for 21 days or more became recolonized with MRSA. Using PFGE, there were 14 different strain types identified, with USA300 being the most common (31%). **CONCLUSIONS:** Current strategies to prevent infections-including active identification and decolonization of MRSA-colonized neonates-are inadequate because infants develop infections before being identified as colonized or after attempted decolonization. Future prevention efforts would benefit from improving detection of MRSA colonization, optimizing decolonization regimens, and identifying and interrupting reservoirs of transmission.

3.5 Landelle C, Iten A, Ilker Uçkay I, et al. Does Colonization with Methicillin-Susceptible *Staphylococcus aureus* Protect against Nosocomial Acquisition of Methicillin-Resistant *S. aureus*? *Infect Control Hosp Epidemiol*, Vol. 35, No. 5 (May 2014), pp. 527-533

**OBJECTIVE:** To test the hypothesis that methicillin-susceptible *Staphylococcus aureus* (MSSA) carriage may protect against nosocomial methicillin-resistant *S. aureus* (MRSA) acquisition by competing for colonization of the anterior nares. **DESIGN:** Prospective cohort and nested case-control study. **SETTING:** Swiss university hospital. **PATIENTS:** All adult patients admitted to 14 wards of the general medicine division between April 1 and October 31, 2007. **METHODS:** Patients were screened for MRSA and MSSA carriage at admission to and discharge from the division. Associations between nosocomial MRSA acquisition and MSSA colonization at admission and other confounders were analyzed by univariable and multivariable analysis. **RESULTS:** Of 898 patients included, 183 (20%) were treated with antibiotics. Nosocomial MRSA acquisition occurred in 70 (8%) of the patients (case patients); 828 (92%) of the patients (control subjects) were free of MRSA colonization at discharge. MSSA carriage at admission was 20% and 21% for case patients and control subjects, respectively. After adjustment by multivariate logistic regression, no association was observed between MSSA colonization at admission and nosocomial MRSA acquisition (adjusted odds ratio [aOR], 1.2 [95% confidence interval (CI), 0.6-2.3]). By contrast, 4 independent predictors of nosocomial MRSA acquisition were identified: older age (aOR per 1-year increment, 1.05 [95% CI, 1.02-1.08]); increased length of stay (aOR per 1-day increment, 1.05 [95% CI, 1.02-1.09]); increased nursing workload index (aOR per 1-point increment, 1.02 [95% CI, 1.01-1.04]); and previous treatment with macrolides (aOR, 5.6 [95% CI, 1.8-17.7]). **CONCLUSIONS:** Endogenous MSSA colonization does not appear to protect against nosocomial MRSA acquisition in a population of medical patients without frequent antibiotic exposure.

3.6 Datta R, Victor Quan V, Kim D, et al. Protective Effect of Methicillin-Susceptible *Staphylococcus aureus* Carriage against Methicillin-Resistant *S. aureus* Acquisition in Nursing Homes: A Prospective Cross-Sectional Study. *Infect Control Hosp Epidemiol*, Vol. 35, No. 10 (October 2014), pp. 1257-1262

**OBJECTIVE:** To evaluate whether an ecologic inverse association exists between methicillin-susceptible *Staphylococcus aureus* (MSSA) prevalence and methicillin-resistant *S. aureus* (MRSA) prevalence in nursing homes. **METHODS:** We conducted a secondary analysis of a prospective cross-sectional study of *S. aureus* prevalence in 26 nursing homes across Orange County, California, from 2008-2011. Admission prevalence was assessed using bilateral nares swabs collected from all new residents within 3 days of admission until 100 swabs were obtained. Point prevalence was assessed from a representative sample of 100 residents. Swab samples were plated on 5% sheep blood agar and Spectra MRSA chromogenic agar. If MRSA was detected, no further tests were performed. If MRSA was not detected, blood agar was evaluated for MSSA growth. We evaluated the association between MRSA and MSSA admission and point prevalence using correlation and linear regression testing. **RESULTS:** We collected 3,806 total swabs. MRSA and MSSA admission prevalence were not correlated ( $r = -0.40$ ,  $P = .09$ ). However, MRSA and MSSA point prevalence were negatively correlated regardless of whether MSSA prevalence was measured among all residents sampled ( $r = -0.67$ ,  $P = .0002$ ) or among those who did not harbor MRSA ( $r = -0.41$ ,  $P = .04$ ). This effect persisted in regression models adjusted for the percentage of residents with diabetes ( $\beta = -0.73$ ,  $P = .04$ ), skin lesions ( $\beta = -1.17$ ,  $P = .002$ ), or invasive devices ( $\beta = -1.4$ ,  $P = .0006$ ). **CONCLUSIONS:** The inverse association between MRSA and MSSA point prevalence and minimal association on admission prevalence suggest MSSA carriage may protect against MRSA acquisition in nursing homes. The minimal association on admission prevalence further suggests competition may occur during nursing home stays.

3.7 David MZ, Siegel JD, Henderson J, et al. A Randomized, Controlled Trial of Chlorhexidine-Soaked Cloths to Reduce Methicillin-Resistant and Methicillin-Susceptible *Staphylococcus aureus* Carriage Prevalence in an Urban Jail. *Infect Control Hosp Epidemiol*, Vol. 35, No. 12 (December 2014), pp. 1466-1473

**OBJECTIVE:** To assess an intervention to limit community-associated methicillin-resistant *Staphylococcus aureus* (MRSA) dissemination. **DESIGN:** Randomized, controlled trial. **SETTING:** County

Jail, Dallas, Texas. **PARTICIPANTS:** A total of 4,196 detainees in 68 detention tanks. **METHODS:** Tanks were randomly assigned to 1 of 3 groups: in group 1, detainees received cloths that contained chlorhexidine gluconate (CHG) to clean their entire skin surface 3 times per week for 6 months; group 2 received identical cloths containing only water; and group 3 received no skin treatment. During the study, all newly arrived detainees were invited to enroll. Nares and hand cultures were obtained at baseline and from all current enrollees at 2 and 6 months. **RESULTS:** At baseline, *S. aureus* was isolated from 41.2% and MRSA from 8.0% (nares and/or hand) of 947 enrollees. The average participation rate was 47%. At 6 months, MRSA carriage was 10.0% in group 3 and 8.7% in group 1 tanks (estimated absolute risk reduction [95% confidence interval (CI)], 1.4% [-4.8% to 7.1%];  $P = .655$ ). At 6 months, carriage of any *S. aureus* was 51.1% in group 3, 40.7% in group 1 (absolute risk reduction [95% CI], 10.4% [0.01%-20.1%];  $P = .047$ ), and 42.8% (absolute risk reduction [95% CI], 8.3% [-1.4% to 18.0%];  $P = .099$ ) in group 2. **CONCLUSIONS:** Skin cleaning with CHG for 6 months in detainees, compared with no intervention, significantly decreased carriage of *S. aureus*, and use of water cloths produced a nonsignificant but similar decrease. A nonsignificant decrease in MRSA carriage was found with CHG cloth use. **TRIAL REGISTRATION:** ClinicalTrials.gov identifier NCT00785200.

### 3.8 Mody L, Krein SL, Saint SK, et al. A Targeted Infection Prevention Intervention in Nursing Home Residents With Indwelling Devices: A Randomized Clinical Trial. *JAMA Intern Med.* Published online March 16, 2015. doi:10.1001/jamainternmed.2015.132.

**Importance:** Indwelling devices (eg, urinary catheters and feeding tubes) are often used in nursing homes (NHs). Inadequate care of residents with these devices contributes to high rates of multidrug-resistant organisms (MDROs) and device-related infections in NHs. **Objective:** To test whether a multimodal targeted infection program (TIP) reduces the prevalence of MDROs and incident device-related infections. **Design, Setting, and Participants:** Randomized clinical trial at 12 community-based NHs from May 2010 to April 2013. Participants were high-risk NH residents with urinary catheters, feeding tubes, or both. **Interventions:** Multimodal, including preemptive barrier precautions, active surveillance for MDROs and infections, and NH staff education. **Main Outcomes and Measures:** The primary outcome was the prevalence density rate of MDROs, defined as the total number of MDROs isolated per visit averaged over the duration of a resident's participation. Secondary outcomes included new MDRO acquisitions and new clinically defined device-associated infections. Data were analyzed using a mixed-effects multilevel Poisson regression model (primary outcome) and a Cox proportional hazards model (secondary outcome), adjusting for facility-level clustering and resident-level variables. **Results:** In total, 418 NH residents with indwelling devices were enrolled, with 34 174 device-days and 6557 anatomic sites sampled. Intervention NHs had a decrease in the overall MDRO prevalence density (rate ratio, 0.77; 95% CI, 0.62-0.94). The rate of new methicillin-resistant *Staphylococcus aureus* acquisitions was lower in the intervention group than in the control group (rate ratio, 0.78; 95% CI, 0.64-0.96). Hazard ratios for the first and all (including recurrent) clinically defined catheter-associated urinary tract infections were 0.54 (95% CI, 0.30-0.97) and 0.69 (95% CI, 0.49-0.99), respectively, in the intervention group and the control group. There were no reductions in new vancomycin-resistant enterococci or resistant gram-negative bacilli acquisitions or in new feeding tube-associated pneumonias or skin and soft-tissue infections. **Conclusions and Relevance:** Our multimodal TIP intervention reduced the overall MDRO prevalence density, new methicillin-resistant *S. aureus* acquisitions, and clinically defined catheter-associated urinary tract infection rates in high-risk NH residents with indwelling devices. Further studies are needed to evaluate the cost-effectiveness of this approach as well as its effects on the reduction of MDRO transmission to other residents, on the environment, and on referring hospitals. **Trial Registration:** clinicaltrials.gov Identifier: NCT01062841.

### 3.9 van Rijen MM, Bosch T, Verkade EJ, et al. Livestock-associated MRSA carriage in patients without direct contact with livestock. *PLoS One.* 2014 Jun 27;9(6):e100294. doi:10.1371/journal.pone.0100294.

**BACKGROUND:** Livestock-associated MRSA (MC398) has emerged and is related to an extensive reservoir in pigs and veal calves. Individuals with direct contact with these animals and their family members are known to have high MC398 carriage rates. Until now it was assumed that MC398 does not spread to individuals in the community without pig or veal calf exposure. To test this, we identified the proportion of MC398 in MRSA positive individuals without contact with pigs/veal calves or other known risk factors (MRSA of unknown origin; MUO). **METHODS:** In 17 participating hospitals, we determined

during two years the occurrence of MC398 in individuals without direct contact with livestock and no other known risk factor (n = 271) and tested in a post analysis the hypothesis whether hospitals in pig-dense areas have higher proportions of MC398 of all MUO. RESULTS: Fifty-six individuals (20.7%) without animal contact carried MC398. In hospitals with high pig-densities in the adherence area, the proportion of MC398 of all MUO was higher than this proportion in hospitals without pigs in the surroundings. CONCLUSIONS: One fifth of the individuals carrying MUO carried MC398. So, MC398 is found in individuals without contact to pigs or veal calves. The way of transmission from the animal reservoir to these individuals is unclear, probably by human-to-human transmission or by exposure to the surroundings of the stables. Further research is needed to investigate the way of transmission.

### 3.10 Bosch T, Verkade E, van Luit M, et al. Transmission and persistence of livestock-associated methicillin-resistant *Staphylococcus aureus* among veterinarians and their household members. *Appl Environ Microbiol.* 2015 Jan;81(1):124-9

After the first isolation of livestock-associated methicillin-resistant *Staphylococcus aureus* (LA-MRSA) in 2003, this MRSA variant quickly became the predominant MRSA obtained from humans as part of the Dutch national MRSA surveillance. Previous studies have suggested that human-to-human transmission of LA-MRSA, compared to that of other MRSA lineages, rarely occurs. However, these reports describe the transmission of LA-MRSA based on epidemiology and limited molecular characterization of isolates, making it difficult to assess whether transmission actually occurred. In this study, we used whole-genome maps (WGMs) to identify possible transmission of LA-MRSA between humans. For this, we used LA-MRSA isolates originating from a 2-year prospective longitudinal cohort study in which livestock veterinarians and their household members were repeatedly sampled for the presence of *S. aureus*. A considerable degree of genotypic variation among LA-MRSA strains was observed. However, there was very limited variability between the maps of the isolates originating from the same veterinarian, indicating that each of the veterinarians persistently carried or had reacquired the same LA-MRSA strain. Comparison of WGMs revealed that LA-MRSA transmission had likely occurred within virtually every veterinarian household. Yet only a single LA-MRSA strain per household appeared to be involved in transmission. The results corroborate our previous finding that LA-MRSA is genetically diverse. Furthermore, this study shows that transmission of LA-MRSA between humans occurs and that carriage of LA-MRSA can be persistent, thus posing a potential risk for spread of this highly resistant pathogen in the community.

### 3.11 Gastmeier P, Schröder C, Behnke M, et al. Dramatic increase in vancomycin-resistant enterococci in Germany. *J. Antimicrob. Chemother.* (2014) 69 (6): 1660-1664

OBJECTIVES: Among European countries, Germany has one of the highest proportions of vancomycin-resistant *Enterococcus faecium* bloodstream infections. The aim of this study was to investigate the development of vancomycin-resistant enterococci (VRE) in German hospitals and to consider the regional distribution of VRE in Germany. METHODS: Data from three components of the German national nosocomial surveillance system (KISS) from the period 2007-12 were used for analysis: ICU-KISS data on nosocomial primary bloodstream infections and urinary tract infections from intensive care units (ICUs); OP-KISS data on surgical site infections from surgical departments; and Pathogen-KISS data concentrating on VRE cases (infections and colonizations) in ICUs. Trends over time were calculated and a map according to German federal states was prepared. RESULTS: Data from up to 645 ICUs and 681 surgical departments for 2 year periods from 2007 to 2012 were analysed. The proportion of VRE increased significantly for surgical site infections (526%;  $P < 0.01$ ) and bloodstream infections (265%;  $P < 0.01$ ) and non-significantly for urinary tract infections (278%;  $P = 0.07$ ). A large subgroup of ICUs also reported VRE cases in the same period, with a significant increase of 282%. The mapping of federal states showed large variation in VRE proportions and incidence rates in a belt of states with significantly higher VRE proportions from west (North Rhine-Westphalia) to east (Saxony). CONCLUSIONS: The high overall VRE proportion in Germany is mainly due to the situation in four states. There is an urgent need to analyse the epidemiology of VRE in detail to develop appropriate infection control strategies.

3.12 Limbago BM, Kallen AJ, Zhu W, et al. Report of the 13th vancomycin-resistant *Staphylococcus aureus* isolate from the United States. *J Clin Microbiol.* 2014 Mar;52(3):998-1002. doi: 10.1128/JCM.02187-13

Vancomycin-resistant *Staphylococcus aureus* (VRSA), an important multidrug-resistant organism of public health concern, has been infrequently identified in the United States since 2002. All previous VRSA isolates belonged to clonal complex 5, a lineage associated primarily with health care. This report describes the most recent (13th) U.S. VRSA isolate, the first to be community associated.

3.13 Rossi F, Diaz L, Wollam A, et al. Transferable vancomycin resistance in a community-associated MRSA lineage. *N Engl J Med.* 2014 Apr 17;370(16):1524-31. doi: 10.1056/NEJMoa1303359.

We report the case of a patient from Brazil with a bloodstream infection caused by a strain of methicillin-resistant *Staphylococcus aureus* (MRSA) that was susceptible to vancomycin (designated BR-VSSA) but that acquired the *vanA* gene cluster during antibiotic therapy and became resistant to vancomycin (designated BR-VRSA). Both strains belong to the sequence type (ST) 8 community-associated genetic lineage that carries the staphylococcal chromosomal cassette *mec* (SCC*mec*) type IVa and the *S. aureus* protein A gene (*spa*) type t292 and are phylogenetically related to MRSA lineage USA300. A conjugative plasmid of 55,706 bp (pBRZ01) carrying the *vanA* cluster was identified and readily transferred to other staphylococci. The pBRZ01 plasmid harbors DNA sequences that are typical of the plasmid-associated replication genes *rep24* or *rep21* described in community-associated MRSA strains from Australia (pWBG745). The presence and dissemination of community-associated MRSA containing *vanA* could become a serious public health concern.

3.14 Morikane K, Honda H, Yamagishi T, et al. Factors Associated with Surgical Site Infection in Colorectal Surgery: The Japan Nosocomial Infections Surveillance. *Infect Control Hosp Epidemiol*, Vol. 35, No. 6 (June 2014), pp. 660-666

**OBJECTIVE:** Surgical site infection (SSI) is one of the most common healthcare-associated infections (HAIs). This study aims to assess factors associated with SSI after colorectal surgery in Japan, using a Japanese national database for HAIs. **DESIGN:** A retrospective nationwide surveillance-based study. **SETTING:** Japanese healthcare facilities. **METHODS:** Data on colon and rectal surgeries performed from 2008 through 2010 were extracted from a national monitoring system for healthcare-associated infections, the Japan Nosocomial Infections Surveillance (JANIS). Factors associated with SSI after colon and rectal surgery were assessed using multivariate logistic regression. **RESULTS:** The cumulative incidence of SSI for colon and rectal surgery was 15.0% (6,691 of 44,751) and 17.8% (3,230 of 18,187), respectively. Traditional risk factors included in the National Nosocomial Infections Surveillance (NNIS) modified risk index were significant in predicting SSI in the final model for both colon and rectal surgery. Among the additional variables routinely collected in JANIS were factors independently associated with the development of SSI, such as male sex (adjusted odds ratio [aOR], 1.20 [95% confidence interval (CI), 1.14-1.27]), ileostomy or colostomy placement (aOR, 1.13 [95% CI, 1.04-1.21]), emergency operation (aOR, 1.40 [95% CI, 1.29-1.52]), and multiple procedures (aOR, 1.22 [95% CI, 1.13-1.33]) for colon surgery as well as male sex (aOR, 1.43 [95% CI, 1.31-1.55]), ileostomy or colostomy placement (aOR, 1.63 [95% CI, 1.51-1.79]), and emergency operation (aOR, 1.43 [95% CI, 1.20-1.72]) for rectal surgery. **CONCLUSIONS:** For colorectal operations, inclusion of additional variables routinely collected in JANIS can more accurately predict SSI risk than can the NNIS risk index alone.

3.15 Mpogoro FJ, Mshana SE, Mirambo MM, et al. Incidence and predictors of surgical site infections following caesarean sections at Bugando Medical Centre, Mwanza, Tanzania. *Antimicrob Resist Infect Control.* 2014 Aug 11;3:25. doi: 10.1186/2047-2994-3-25.

**BACKGROUND:** Surgical site infection (SSI) is the second most common infectious complication after urinary tract infection following a delivery by caesarean section (CS). At Bugando Medical Centre there has no study documenting the epidemiology of SSI after CS despite the large number of CSs performed

and the relatively common occurrence of SSIs. **METHODS:** This was a prospective cohort study involving pregnant women who underwent a CS between October 2011 and February 2012 at Bugando Medical Centre. A total of 345 pregnant women were enrolled. Preoperative, intraoperative and postoperative data were collected using a standardized questionnaire. Wound specimens were collected and processed as per standard operative procedures; and susceptibility testing was carried out using a disc diffusion technique. Data was analyzed using STATA version 11. **RESULTS:** The overall cumulative incidence of SSI was 10.9% with an incidence rate of 37.5 per 10,000 people/day (95% CI, 26.8-52.4). The median time from CS to the development of SSI was 7 days (interquartile range [IQR] = 6-9 days). Six independent risk factors for post caesarean SSI as identified in this study by multivariate analysis are: hypertensive disorders of pregnancy (HR: 2.5; 95% CI, 1.1-5.6; P = 0.021), severe anaemia (HR: 3.8; 95% CI, 1.2-12.4, P = 0.028), surgical wound class III (HR: 2.4; 95% CI, 1.1-5.0; P = 0.021), multiple vaginal examinations (HR: 2.5; 95% CI, 1.2-5.1; P = 0.011), prolonged duration of operation (HR: 2.6; 95% CI, 1.2-5.5; P = 0.015) and an operation performed by an intern or junior doctor (HR: 4.0; 95% CI, 1.7-9.2; P = 0.001). *Staphylococcus aureus* was the most common organism (27.3%), followed by *Klebsiella pneumoniae* (22.7%). Patients with a SSI had a longer average hospital stay than those without a SSI (12.7 ± 6.9 vs. 4 ± 1.7; P < 0.0001) and the case fatality rate among patients with a SSI was 2.9%. **CONCLUSION:** SSIs are common among women undergoing CSs at Bugando Medical Centre. SSIs were commonly associated with multiple factors. Strategies to control these factors are urgently needed to control SSIs post CS at Bugando Medical Centre and other centres in developing countries.

**3.16 Regimbeau J, Fuks D, Pautrat K, et al. Effect of Postoperative Antibiotic Administration on Postoperative Infection Following Cholecystectomy for Acute Calculous Cholecystitis: A Randomized Clinical Trial. JAMA. 2014;312(2):145-154. doi:10.1001/jama.2014.7586.**

**IMPORTANCE:** Ninety percent of cases of acute calculous cholecystitis are of mild (grade I) or moderate (grade II) severity. Although the preoperative and intraoperative antibiotic management of acute calculous cholecystitis has been standardized, few data exist on the utility of postoperative antibiotic treatment. **OBJECTIVE:** To determine the effect of postoperative amoxicillin plus clavulanic acid on infection rates after cholecystectomy. **DESIGN, SETTING, AND PATIENTS:** A total of 414 patients treated at 17 medical centers for grade I or II acute calculous cholecystitis and who received 2 g of amoxicillin plus clavulanic acid 3 times a day while in the hospital before and once at the time of surgery were randomized after surgery to an open-label, noninferiority, randomized clinical trial between May 2010 and August 2012. **INTERVENTIONS:** After surgery, no antibiotics or continue with the preoperative antibiotic regimen 3 times daily for 5 days. **MAIN OUTCOMES AND MEASURES:** The proportion of postoperative surgical site or distant infections recorded before or at the 4-week follow-up visit. **RESULTS:** An imputed intention-to-treat analysis of 414 patients showed that the postoperative infection rates were 17% (35 of 207) in the nontreatment group and 15% (31 of 207) in the antibiotic group (absolute difference, 1.93%; 95% CI, -8.98% to 5.12%). In the per-protocol analysis, which involved 338 patients, the corresponding rates were both 13% (absolute difference, 0.3%; 95% CI, -5.0% to 6.3%). Based on a noninferiority margin of 11%, the lack of postoperative antibiotic treatment was not associated with worse outcomes than antibiotic treatment. Bile cultures showed that 60.9% were pathogen free. Both groups had similar Clavien complication severity outcomes: 195 patients (94.2%) in the nontreatment group had a score of 0 to I and 2 patients (0.97%) had a score of III to V, and 182 patients (87.8%) in the antibiotic group had a score of 0 to I and 4 patients (1.93%) had a score of III to V. **CONCLUSIONS AND RELEVANCE:** Among patients with mild or moderate calculous cholecystitis who received preoperative and intraoperative antibiotics, lack of postoperative treatment with amoxicillin plus clavulanic acid did not result in a greater incidence of postoperative infections. **TRIAL REGISTRATION:** clinicaltrials.gov Identifier: NCT01015417.

**3.17 Phillips M, Rosenberg A, Shopsin B, et al. Preventing Surgical Site Infections: A Randomized, Open-Label Trial of Nasal Mupirocin Ointment and Nasal Povidone-Iodine Solution. Infect Control Hosp Epidemiol, Vol. 35, No. 7 (July 2014), pp. 826-832**

**BACKGROUND:** Treatment of *Staphylococcus aureus* colonization before surgery reduces risk of surgical site infection (SSI). The regimen of nasal mupirocin ointment and topical chlorhexidine gluconate is effective, but cost and patient compliance may be a barrier. Nasal povidone-iodine solution may provide an alternative to mupirocin. **METHODS:** We conducted an investigator-initiated, open-label, randomized trial comparing SSI after arthroplasty or spine fusion in patients receiving topical

chlorhexidine wipes in combination with either twice daily application of nasal mupirocin ointment during the 5 days before surgery or 2 applications of povidone-iodine solution into each nostril within 2 hours of surgical incision. The primary study end point was deep SSI within the 3 months after surgery. **RESULTS:** In the modified intent-to-treat analysis, a deep SSI developed after 14 of 855 surgical procedures in the mupirocin group and 6 of 842 surgical procedures in the povidone-iodine group ( $P = .1$ ); *S. aureus* deep SSI developed after 5 surgical procedures in the mupirocin group and 1 surgical procedure in the povidone-iodine group ( $P = .2$ ). In the per protocol analysis, *S. aureus* deep SSI developed in 5 of 763 surgical procedures in the mupirocin group and 0 of 776 surgical procedures in the povidone-iodine group ( $P = .03$ ). **CONCLUSIONS:** Nasal povidone-iodine may be considered as an alternative to mupirocin in a multifaceted approach to reduce SSI. **TRIAL REGISTRATION:** ClinicalTrials.gov identifier: NCT01313182.

3.18 Formanek MB, Herwaldt LA, Perencevich EN, Schweizer ML. Gentamicin/collagen sponge use may reduce the risk of surgical site infections for patients undergoing cardiac operations: a meta-analysis. *Surg Infect (Larchmt)*. 2014 Jun;15(3):244-55. doi: 10.1089/sur.2012.209

**OBJECTIVE:** A meta-analysis of all published randomized controlled trials of the effectiveness of gentamicin/collagen sponges for preventing surgical site infections (SSIs). **BACKGROUND:** Despite routine use of systemic prophylactic antimicrobial agents, SSIs continue to be associated with substantial morbidity. **RESULTS** conflict of studies of the efficacy of gentamicin/collagen sponges for preventing SSIs. However, many of these studies have assessed sponge use in only a single specific type of operation. The general effect of sponge use among different types of operations has not been previously assessed. **METHODS:** The PubMed and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases were searched for articles appearing from 1990 through January 2012 that were related to gentamicin/collagen sponge use and SSIs. Summary estimates were obtained through a random effects model. After reviewing 714 article abstracts and reviewing 22 articles in detail, we pooled the odds ratios (OR) for 13 independent study populations (cardiac,  $n=4$ ; colorectal,  $n=4$ ; pilonidal sinus,  $n=2$ ; hernia,  $n=2$ ; gastrointestinal,  $n=1$ ) in which the association between prophylactic use of gentamicin/collagen sponges and SSIs was assessed. **RESULTS:** Pooling of the results of all studies included in the review in a random effects model showed a significant protective effect of prophylactic use of gentamicin/collagen sponges against SSI (pooled OR: 0.66; 95% confidence interval [CI]: 0.45, 0.97;  $n=13$ ). However, when the data were stratified by type of operation, a significant protective effect was observed in cardiac procedures (pooled OR: 0.59; 95% CI: 0.37, 0.96;  $n=4$ ) but not in colorectal procedures (pooled OR: 0.74; 95% CI: 0.29-1.92;  $n=4$ ). **CONCLUSION:** Use of gentamicin/collagen sponges was associated with a reduced risk of SSI following cardiac operations but not following colorectal procedures.

3.19 Goodliffe L Ragan K; Larocque M, et al. Rate of Healthcare Worker–Patient Interaction and Hand Hygiene Opportunities in an Acute Care Setting *Infect Control Hosp Epidemiol*, Vol. 35, No. 3 (March 2014), pp. 225-230

**OBJECTIVE:** Identify factors affecting the rate of hand hygiene opportunities in an acute care hospital. **DESIGN:** Prospective observational study. **SETTING:** Medical and surgical in-patient units, medical-surgical intensive care unit (MSICU), neonatal intensive care unit (NICU), and emergency department (ED) of an academic acute care hospital from May to August, 2012. **PARTICIPANTS:** Healthcare workers. **METHODS:** One-hour patient-based observations measured patient interactions and hand hygiene opportunities as defined by the "Four Moments for Hand Hygiene." Rates of patient interactions and hand hygiene opportunities per patient-hour were calculated, examining variation by room type, healthcare worker type, and time of day. **RESULTS:** During 257 hours of observation, 948 healthcare worker-patient interactions and 1,605 hand hygiene opportunities were identified. Moments 1, 2, 3, and 4 comprised 42%, 10%, 9%, and 39% of hand hygiene opportunities. Nurses contributed 77% of opportunities, physicians contributed 8%, other healthcare workers contributed 11%, and housekeeping contributed 4%. The mean rate of hand hygiene opportunities per patient-hour was 4.2 for surgical units, 4.5 for medical units, 5.2 for ED, 10.4 for NICU, and 13.2 for MSICU ( $P < .001$ ). In non-ICU settings, rates of hand hygiene opportunities decreased over the course of the day. Patients with transmission-based precautions had approximately half as many interactions (rate ratio [RR], 0.55 [95% confidence interval (CI), 0.37-0.80]) and hand hygiene opportunities per hour (RR, 0.47 [95% CI, 0.29-0.77]) as did patients without precautions. **CONCLUSIONS:** Measuring hand hygiene opportunities across clinical settings lays

the groundwork for product use-based hand hygiene measurement. Additional work is needed to assess factors affecting rates in other hospitals and health care settings.

3.20 Diller T, Kelly JW, Blackhurst D, et al. Estimation of hand hygiene opportunities on an adult medical ward using 24-hour camera surveillance: validation of the HOW2 Benchmark Study. *Am J Infect Control*. 2014 Jun;42(6):602-7. doi: 10.1016/j.ajic.2014.02.020.

**BACKGROUND:** We previously published a formula to estimate the number of hand hygiene opportunities (HHOs) per patient-day using the World Health Organization's "Five Moments for Hand Hygiene" methodology (HOW2 Benchmark Study). HHOs can be used as a denominator for calculating hand hygiene compliance rates when product utilization data are available. This study validates the previously derived HHO estimate using 24-hour video surveillance of health care worker hand hygiene activity. **METHODS:** The validation study utilized 24-hour video surveillance recordings of 26 patients' hospital stays to measure the actual number of HHOs per patient-day on a medicine ward in a large teaching hospital. Statistical methods were used to compare these results to those obtained by episodic observation of patient activity in the original derivation study. **RESULTS:** Total hours of data collection were 81.3 and 1,510.8, resulting in 1,740 and 4,522 HHOs in the derivation and validation studies, respectively. Comparisons of the mean and median HHOs per 24-hour period did not differ significantly. HHOs were 71.6 (95% confidence interval: 64.9-78.3) and 73.9 (95% confidence interval: 69.1-84.1), respectively. **CONCLUSION:** This study validates the HOW2 Benchmark Study and confirms that expected numbers of HHOs can be estimated from the unit's patient census and patient-to-nurse ratio. These data can be used as denominators in calculations of hand hygiene compliance rates from electronic monitoring using the "Five Moments for Hand Hygiene" methodology.

3.21 Barnes SL, Morgan DJ, Harris AD, Carling PC, Thom KA. Preventing the transmission of multidrug-resistant organisms: modeling the relative importance of hand hygiene and environmental cleaning interventions. *Infect Control Hosp Epidemiol*. 2014 Sep;35(9):1156-62.

**OBJECTIVE:** Hand hygiene and environmental cleaning are essential infection prevention strategies, but the relative impact of each is unknown. This information is important in assessing resource allocation. **METHODS:** We developed an agent-based model of patient-to-patient transmission-via the hands of transiently colonized healthcare workers and incompletely terminally cleaned rooms-in a 20-patient intensive care unit. Nurses and physicians were modeled and had distinct hand hygiene compliance levels on entry and exit to patient rooms. We simulated the transmission of *Acinetobacter baumannii*, methicillin-resistant *Staphylococcus aureus*, and vancomycin-resistant enterococci for 1 year using data from the literature and observed data to inform model input parameters. **RESULTS:** We simulated 175 parameter-based scenarios and compared the effects of hand hygiene and environmental cleaning on rates of multidrug-resistant organism acquisition. For all organisms, increases in hand hygiene compliance outperformed equal increases in thoroughness of terminal cleaning. From baseline, a 2:1 improvement in terminal cleaning compared with hand hygiene was required to match an equal reduction in acquisition rates (eg, a 20% improvement in terminal cleaning was required to match the reduction in acquisition due to a 10% improvement in hand hygiene compliance). **CONCLUSIONS:** Hand hygiene should remain a priority for infection control programs, but environmental cleaning can have significant benefit for hospitals or individual hospital units that have either high hand hygiene compliance levels or low terminal cleaning thoroughness.

3.22 Monsalve MN, Pemmaraju SV, Thomas GW, et al. Do Peer Effects Improve Hand Hygiene Adherence among Healthcare Workers? *Infect Control Hosp Epidemiol*, Vol. 35, No. 10 (October 2014), pp. 1277-1285

**OBJECTIVE:** To determine whether hand hygiene adherence is influenced by peer effects and, specifically, whether the presence and proximity of other healthcare workers has a positive effect on hand hygiene adherence. **DESIGN:** An observational study using a sensor network. **SETTING:** A 20-bed medical intensive care unit at a large university hospital. **PARTICIPANTS:** Hospital staff assigned to the

medical intensive care unit. **METHODS:** We deployed a custom-built, automated, hand hygiene monitoring system that can (1) detect whether a healthcare worker has practiced hand hygiene on entering and exiting a patient's room and (2) estimate the location of other healthcare workers with respect to each healthcare worker exiting or entering a room. **RESULTS:** We identified a total of 47,694 in-room and out-of-room hand hygiene opportunities during the 10-day study period. When a worker was alone (no recent healthcare worker contacts), the observed adherence rate was 20.85% (95% confidence interval [CI], 19.78%-21.92%). In contrast, when other healthcare workers were present, observed adherence was 27.90% (95% CI, 27.48%-28.33%). This absolute increase was statistically significant ( $P < .01$ ). We also found that adherence increased with the number of nearby healthcare workers but at a decreasing rate. These results were consistent at different times of day, for different measures of social context, and after controlling for possible confounding factors. **CONCLUSIONS:** The presence and proximity of other healthcare workers is associated with higher hand hygiene rates. Furthermore, our results also indicate that rates increase as the social environment becomes more crowded, but with diminishing marginal returns.

### 3.23 Mela A, Whitworth DE. The fist bump: A more hygienic alternative to the handshake. *Am J Infect Control* Volume 42, Issue 8, August 2014, Pages 916–917

The handshake is a commonplace greeting in many cultures, but it has the potential to transmit infectious organisms directly between individuals. We developed an experimental model to assay transfer of bacteria during greeting exchange, and show that transfer is dramatically reduced when engaging in alternative so-called dap greetings known as the high five and fist bump compared with a traditional handshake. Adoption of the fist bump as a greeting could substantially reduce the transmission of infectious disease between individuals.

### 3.24 Stewardson AJ, Harbarth S, Graves N. Valuation of Hospital Bed-Days Released by Infection Control Programs: A Comparison of Methods. *Infect Control Hosp Epidemiol*, Vol. 35, No. 10 (October 2014), pp. 1294-1297

We performed a contingent valuation survey to elicit the opportunity cost of bed-days consumed by healthcare-associated infections in 11 European hospitals. The opportunity cost of a bed-day was significantly lower than the accounting cost; median values were €72 and €929, respectively ( $P < .001$ ). Accounting methods overestimate the opportunity cost of bed-days.

### 3.25 Dick AW, Perencevich EN, Pogorzelska-Maziarz M, et al. A decade of investment in infection prevention: a cost-effectiveness analysis. *Am J Infect Control*. 2015 Jan;43(1):4-9. doi: 10.1016/j.ajic.2014.07.014.

**BACKGROUND:** Health care-associated infection (HAI) rates have fallen with the development of multifaceted infection prevention programs. These programs require ongoing investments, however. Our objective was to examine the cost-effectiveness of hospitals' ongoing investments in HAI prevention in intensive care units (ICUs). **METHODS:** Five years of Medicare data were combined with HAI rates and cost and quality of life estimates drawn from the literature. Life-years (LYs), quality-adjusted LYs (QALYs), and health care expenditures with and without central line-associated bloodstream infection (CLABSI) and/or ventilator-associated pneumonia (VAP), as well as incremental cost-effectiveness ratios (ICERs) of multifaceted HAI prevention programs, were modeled. **RESULTS:** Total LYs and QALYs gained per ICU due to infection prevention programs were 15.55 LY and 9.61 QALY for CLABSI and 10.84 LY and 6.55 QALY for VAP. Reductions in index admission ICU costs were \$174,713.09 for CLABSI and \$163,090.54 for VAP. The ICERs were \$14,250.74 per LY gained and \$23,277.86 per QALY gained. **CONCLUSIONS:** Multifaceted HAI prevention programs are cost-effective. Our results underscore the importance of maintaining ongoing investments in HAI prevention. The welfare benefits implied by the advantageous ICERs would be lost if the investments were suspended.