

Literature

Year in Infection control ECCMID 2018

Clin Infect Dis. 2017 Apr 1;64(7):839-844. doi: 10.1093/cid/ciw856.

[Epidemiology of Carbapenem-Resistant *Klebsiella pneumoniae* in a Network of Long-Term Acute Care Hospitals.](#)

[Han JH](#)^{1,2,3}, [Goldstein EJ](#)^{4,5}, [Wise J](#)², [Bilker WB](#)^{2,3}, [Tolomeo P](#)², [Lautenbach E](#)^{1,2,3}.

BACKGROUND: The rapid emergence of carbapenem-resistant *Klebsiella pneumoniae* (CRKP) represents a major public health threat, including in the long-term acute care hospital (LTACH) setting. Our objective in this study was to describe the epidemiologic characteristics of CRKP in a network of US LTACHs.

METHODS: An observational study was performed among 64 LTACHs from January 2014 to March 2015. Clinical cultures were included, with the first CRKP isolate recovered from each patient per study quarter evaluated. LTACH and geographic area-based CRKP prevalence and clinical and microbiologic characteristics were described.

RESULTS: A total of 3846 *K. pneumoniae* cultures were identified, with an overall carbapenem resistance rate of 24.6%. There were significant differences in CRKP rates across geographic regions, with the highest in the West (42.2%). Of 946 CRKP isolates, 507 (53.6%) were from a respiratory source, 350 (37.0%) from a urinary source, and 9 (9.4%) from blood. Among 821 unique patients with CRKP colonization or infection, the median age was 73 years. There was a high prevalence of respiratory failure (39.8%) and the presence of a central venous catheter (50.9%) or tracheostomy (64.8%). Resistance rates of CRKP isolates were high for amikacin (59.2%) and fluoroquinolones (>97%). The resistance rate to colistin/polymyxin B was 16.1%.

CONCLUSIONS: Nearly 25% of *K. pneumoniae* clinical isolates in a US network of LTACHs were CRKP. Expansion of national surveillance efforts and improved communication among LTACHs and acute care hospitals will be critical for reducing the continued emergence of CRKP across the healthcare continuum.

PMCID: PMC5399931

PMID: 28013258

J Antimicrob Chemother. 2017 Mar 1;72(3):668-677. doi: 10.1093/jac/dkw459.

[Global prevalence of carbapenem resistance in neutropenic patients and association with mortality and carbapenem use: systematic review and meta-analysis.](#)

[Righi E^{1,2}, Peri AM^{2,3}, Harris PN², Wailan AM², Liborio M⁴, Lane SW^{5,6}, Paterson DL².](#)

BACKGROUND: Carbapenem-resistant Gram-negative bacteria are recognized as a cause of difficult-to-treat infections associated with high mortality.

OBJECTIVES: To perform a systematic review of currently available data on distribution, characteristics and outcome associated with carbapenem-resistant bloodstream infections in adult neutropenic patients.

METHODS: Included studies were identified through Medline, Embase and Cochrane databases between January 1995 and April 2016. Random effect meta-analysis was used to quantify the association between carbapenem resistance and mortality and between carbapenem exposure and resistance.

RESULTS: A total of 30 studies from 21 countries were included. Overall carbapenem resistance varied from 2% to 53% (median 9%) among studies. Infections due to carbapenem-resistant *Pseudomonas* spp. were reported in 18 (60%) studies showing high median resistance rates (44% of all carbapenem-resistant Gram-negatives and 19% of *Pseudomonas* isolates). Resistance of Enterobacteriaceae was less commonly reported and bloodstream infections due to carbapenem-resistant *Klebsiella* spp. were mainly documented from endemic areas (Greece, Italy, Israel). Carbapenem resistance in *Acinetobacter* spp. was reported in 9 (30%) studies (median resistance 58% of *Acinetobacter* isolates). Mortality rates ranged from 33% to 71% (median 50%) in patients with carbapenem-resistant infections. Carbapenem resistance appeared to correlate with mortality (OR 4.89, 95% CI 3.30-7.26) and previous exposure to carbapenems (OR 4.63, 95% CI 3.08-6.96).

CONCLUSIONS: Carbapenem resistance represents a threat to neutropenic patients. In this group, resistance is likely promoted by previous carbapenem use and leads to high mortality rates. The knowledge of resistance patterns is crucial and can direct clinicians in the use of alternatives to carbapenem-based regimens.

PMID: 27999023

Am J Infect Control. 2018 Jan;46(1):54-59. doi: 10.1016/j.ajic.2017.07.022. Epub 2017 Sep 19.

[Stalking a lethal superbug by whole-genome sequencing and phylogenetics: Influence on unraveling a major hospital outbreak of carbapenem-resistant *Klebsiella pneumoniae*.](#)

[Kaiser T¹, Finstermeier K¹, Häntzsch M¹, Faucheux S², Kaase M³, Eckmanns T⁴, Bercker S⁵, Kaisers UX⁵, Lippmann N⁶, Rodloff AC⁶, Thiery J¹, Lübbert C⁷.](#)

BACKGROUND: From July 2010-April 2013, Leipzig University Hospital experienced the largest outbreak of a *Klebsiella pneumoniae* carbapenemase 2 (KPC-2)-producing *Klebsiella pneumoniae* (KPC-2-Kp) strain observed in Germany to date. After termination of the outbreak, we aimed to reconstruct transmission pathways by phylogenetics based on whole-genome sequencing (WGS).

METHODS: One hundred seventeen KPC-2-Kp isolates from 89 outbreak patients, 5 environmental KPC-2-Kp isolates, and 24 K pneumoniae strains not linked to the outbreak underwent WGS. Phylogenetic analysis was performed blinded to clinical data and based on the genomic reads.

RESULTS: A patient from Greece was confirmed as the source of the outbreak. Transmission pathways for 11 out of 89 patients (12.4%) were plausibly explained by descriptive epidemiology, applying strict definitions. Five of these and an additional 15 (ie, 20 out of 89 patients [22.5%]) were confirmed by phylogenetics. The rate of phylogenetically confirmed transmissions increased significantly from 8 out of 66 (12.1% for the time period before) to 12 out of 23 patients (52.2% for the time period after; $P < .001$) after implementation of systematic screening for KPC-2-Kp (33,623 screening investigations within 11 months). Using descriptive epidemiology, systematic screening showed no significant effect (7 out of 66 [10.6%] vs 4 out of 23 [17.4%] patients; $P = .465$). The phylogenetic analysis supported the assumption that a contaminated positioning pillow served as a reservoir for the persistence of KPC-2-Kp.

CONCLUSIONS: Effective phylogenetic identification of transmissions requires systematic microbiologic screening. Extensive screening and phylogenetic analysis based on WGS should be started as soon as possible in a bacterial outbreak situation.

PMID: 28935481

J Hosp Infect. 2018 Mar;98(3):253-259. doi: 10.1016/j.jhin.2017.08.024. Epub 2017 Sep 4.

[Risk factors for acquisition of OXA-48-producing Klebsiella pneumonia among contact patients: a multicentre study.](#)

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BACKGROUND: Cohorting carbapenemase-producing Enterobacteriaceae (CPE) carriers during hospitalization limits in-hospital spreading.

AIM: To identify risk factors for CPE acquisition among contacts of an index patient in non-cohorted populations.

METHODS: A multicentre retrospective matched case-control study was conducted in five hospitals. Each contact patient (case) who acquired Klebsiella pneumoniae (KP)-OXA-48 from an index patient was compared to three contact (controls) with the same index patients matched with hospitalization in the same unit and similar exposure times.

FINDINGS: Fifty-one secondary cases and 131 controls were included. By univariate analysis, exposure time (odds ratio: 1.06; 95% confidence interval: 1.02-1.1; $P = 0.006$), concomitant infection at admission (3.23; 1.42-7.35; $P = 0.005$), antimicrobial therapy within the last month before hospitalization (2.88; 1.34-6.2; $P = 0.007$), antimicrobial therapy during the exposure time (5.36; 2.28-12.6; $P < 0.001$), use of at least one invasive procedure (2.99; 1.25-7.15; $P = 0.014$), number of invasive procedures (1.52; 1.05-2.19; $P = 0.025$), and geographical proximity (2.84; 1.15-7.00; $P = 0.023$) were associated with CPE acquisition. By multivariate analysis, antimicrobial therapy during the exposure time (odds ratio: 6.36; 95% confidence interval: 2.46-16.44; $P < 0.001$), at least one invasive procedure (2.92; 1.04-8.17; $P = 0.041$), and geographical proximity (3.69; 1.15-11.86; $P = 0.028$) were associated with acquisition.

CONCLUSION: In this study, geographical proximity, invasive procedure, and antimicrobial therapy during exposure time were significantly associated with KP-OXA-48 acquisition.

PMID: 28882642

J Hosp Infect. 2017 Nov;97(3):218-225. doi: 10.1016/j.jhin.2017.07.018. Epub 2017 Jul 22.

[The association between infection control interventions and carbapenem-resistant Enterobacteriaceae incidence in an endemic hospital.](#)

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BACKGROUND: Israel experienced a national outbreak of carbapenem-resistant Enterobacteriaceae (CRE) starting in 2006.

AIM: To assess the association between infection control (IC) interventions implemented in a referral hospital in Israel and CRE incidence.

METHODS: Retrospective quasi-experimental study of prospectively collected data. CRE incidence, defined as the number of patients newly acquiring CRE in surveillance or clinical samples per 100,000 hospital-days, was plotted quarterly between 2005 and 2016. IC interventions were applied at different time-points throughout this period. Data were collected on IC staffing, number of rectal surveillance cultures, and carbapenem consumption. Autocorrelated segmented linear regression analysis was used to assess the time-points at which a significant change in the CRE incidence trend occurred, and the association between the timing of IC intervention implementation and observed CRE trends was assessed. Trends between time-points were expressed as quarterly percent change (QPC) with 95% confidence intervals (CIs).

FINDINGS: Between 2005 and 2008, CRE incidence increased significantly (QPC: 19.7%; CI: 11.5-28.4), reaching a peak of 186.6 new acquisitions per 100,000 hospital-days. From mid-2011 until the end of follow-up, there was a significantly decreasing incidence trend (QPC: -4.5; CI: -6.4 to -2.5). Cohorting of patients, screening of contacts and high-risk patients on admission were insufficient to control the epidemic. Improved hand hygiene compliance, cohorting with dedicated nursing staff, addition of regular screening in high-risk departments, and carbapenem restriction were required. Decreasing CRE incidence was observed with an infectious diseases/IC staffing of 1.2-1.5 per 100 beds and 20,000-36,000 yearly CRE surveillance samples.

CONCLUSION: A multi-faceted hospital-wide intervention programme is required to control CRE in hospital settings.

PMID: 2874350.

Clin Infect Dis. 2017 Aug 15;65(4):581-587. doi: 10.1093/cid/cix370.

[The Potential for Interventions in a Long-term Acute Care Hospital to Reduce Transmission of Carbapenem-Resistant Enterobacteriaceae in Affiliated Healthcare Facilities.](#)

[Toth DJA^{1,2}](#), [Khader K^{1,2}](#), [Slayton RB³](#), [Kallen AJ³](#), [Gundlapalli AV^{1,2}](#), [O'Hagan JJ³](#), [Fiore AE³](#), [Rubin MA^{1,2}](#), [Jernigan JA³](#), [Samore MH^{1,2}](#).

BACKGROUND: Carbapenem-resistant Enterobacteriaceae (CRE) are high-priority bacterial pathogens targeted for efforts to decrease transmissions and infections in healthcare facilities. Some regions have experienced CRE outbreaks that were likely amplified by frequent transmission in long-term acute care hospitals (LTACHs). Planning and funding of intervention efforts focused on

LTACHs is one proposed strategy to contain outbreaks; however, the potential regional benefits of such efforts are unclear.

METHODS: We designed an agent-based simulation model of patients in a regional network of 10 healthcare facilities including 1 LTACH, 3 short-stay acute care hospitals (ACHs), and 6 nursing homes (NHs). The model was calibrated to achieve realistic patient flow and CRE transmission and detection rates. We then simulated the initiation of an entirely LTACH-focused intervention in a previously CRE-free region, including active surveillance for CRE carriers and enhanced isolation of identified carriers.

RESULTS: When initiating the intervention at the first clinical CRE detection in the LTACH, cumulative CRE transmissions over 5 years across all 10 facilities were reduced by 79%-93% compared to no-intervention simulations. This result was robust to changing assumptions for transmission within non-LTACH facilities and flow of patients from the LTACH. Delaying the intervention until the 20th CRE detection resulted in substantial delays in achieving optimal regional prevalence, while still reducing transmissions by 60%-79% over 5 years.

CONCLUSIONS: Focusing intervention efforts on LTACHs is potentially a highly efficient strategy for reducing CRE transmissions across an entire region, particularly when implemented as early as possible in an emerging outbreak.

PMID: 28472233

Infect Control Hosp Epidemiol. 2018 May;39(5):516-524. doi: 10.1017/ice.2018.49. Epub 2018 Mar 19.

[The Economic Value of the Centers for Disease Control and Prevention Carbapenem-Resistant Enterobacteriaceae Toolkit.](#)

[Bartsch SM¹](#), [Huang SS²](#), [McKinnell JA³](#), [Wong KF⁴](#), [Mueller LE¹](#), [Miller LG³](#), [Lee BY¹](#).

OBJECTIVE: While previous work showed that the Centers for Disease Control and Prevention toolkit for carbapenem-resistant Enterobacteriaceae (CRE) can reduce spread regionally, these interventions are costly, and decisions makers want to know whether and when economic benefits occur.

DESIGN: Economic analysis SETTING Orange County, California

METHODS: Using our Regional Healthcare Ecosystem Analyst (RHEA)-generated agent-based model of all inpatient healthcare facilities, we simulated the implementation of the CRE toolkit (active screening of interfacility transfers) in different ways and estimated their economic impacts under various circumstances.

RESULTS: Compared to routine control measures, screening generated cost savings by year 1 when hospitals implemented screening after identifying ≤ 20 CRE cases (saving \$2,000-\$9,000) and by year 7 if all hospitals implemented in a regional coordinated manner after 1 hospital identified a CRE case (hospital perspective). Cost savings was achieved only if hospitals independently screened after identifying 10 cases (year 1, third-party payer perspective). Cost savings was achieved by year 1 if hospitals independently screened after identifying 1 CRE case and by year 3 if all hospitals coordinated and screened after 1 hospital identified 1 case (societal perspective). After a few years, all strategies cost less and have positive health effects compared to routine control measures; most strategies generate a positive cost-benefit each year.

CONCLUSIONS: Active screening of interfacility transfers garnered cost savings in year 1 of implementation when hospitals acted independently and by year 3 if all hospitals collectively implemented the toolkit in a coordinated manner. Despite taking longer to manifest, coordinated regional control resulted in greater savings over time. *Infect Control Hosp Epidemiol* 2018;39:516-524.

PMID: 29552995

Int J Qual Health Care. 2017 Oct 1;29(6):785-791. doi: 10.1093/intqhc/mzx120.

[Comparative epidemiology of Clostridium difficile infection: England and the USA.](#)

[King A](#)¹, [Mullish BH](#)², [Williams HRT](#)², [Aylin P](#)¹.

OBJECTIVE: To examine whether there is an epidemiological difference between Clostridium difficile infection (CDI) inpatient populations in England and the United States.

DESIGN: A cross-sectional study.

SETTING: National administrative inpatient discharge data from England (Hospital Episode Statistics) and the USA (National Inpatient Sample) in 2012.

PARTICIPANTS: De-identifiable non-obstetric inpatient discharges from the national datasets were used to estimate national CDI incidence in the United States and England using ICD9-CM(008.45) and ICD10(A04.7) respectively.

MAIN OUTCOME MEASURES: The rate of CDI was calculated per 100 000 population using national population estimates. Rate per 100 000 inpatient discharges was also calculated separated by primary and secondary diagnosis of CDI. Age, sex and Elixhauser comorbidities profiles were examined.

RESULTS: The USA had a higher rate of CDI compared to England: 115.1/100 000 vs. 19.3/100 000 population ($P < 0.001$). CDI age profiles differed between the countries ($P < 0.001$): in England, patients ≥ 75 years constitute a larger proportion of CDI cases, whilst those aged 25-70 constitute more cases in the US ($P < 0.001$). Overall adjusted odds of CDI in females compared to males was elevated in both England (odds ratios (OR) 1.26 95% CI [1.21,1.31] $P < 0.001$) and the USA (OR 1.20 95% CI [1.18,1.22] $P < 0.001$). The proportion of CDI patients with comorbidities was greater in the USA compared to England apart from dementia, which was greater in England (9.63% vs. 1.25%, $P < 0.0001$).

CONCLUSIONS: The 2012 inpatient CDI rate within the USA was much higher than in England. Age and comorbidity profiles also differed between CDI patients in both countries. The reasons for this are likely multi-factorial but may reflect national infection control policy.

PMID: 29025123

J Hosp Infect. 2017 Dec 16. pii: S0195-6701(17)30689-8. doi: 10.1016/j.jhin.2017.12.014. [Epub ahead of print]

[Clostridium difficile classification overestimates hospital-acquired infections.](#)

[McLure A](#)¹, [Clements ACA](#)², [Kirk M](#)², [Glass K](#)².

BACKGROUND: Clostridium difficile infections occur frequently among hospitalized patients, with some infections acquired in hospital and others in the community. International guidelines classify

cases as hospital-acquired if symptom onset occurs more than two days after admission. This classification informs surveillance and infection control, but has not been verified by empirical or modelling studies.

AIM: To assess current classification of *C. difficile* acquisition using a simulation model as a reference standard.

METHODS: *C. difficile* transmission was simulated in a range of hospital scenarios. The sensitivity, specificity and precision of classifications that use cut-offs ranging from 0.25 h to 40 days were calculated. The optimal cut-off that correctly estimated the proportion of cases that were hospital acquired and the balanced cut-off that had equal sensitivity and specificity were identified.

FINDINGS: The recommended two-day cut-off overestimated the incidence of hospital-acquired cases in all scenarios and by >100% in the base scenario. The two-day cut-off had good sensitivity (96%) but poor specificity (48%) and precision (52%) to identify cases acquired during the current hospitalization. A five-day cut-off was balanced, and a six-day cut-off was optimal in the base scenario. The optimal and balanced cut-offs were more than two days for nearly all scenarios considered (ranges: four to nine days and two to eight days, respectively).

CONCLUSION: Current guidelines for classifying *C. difficile* infections overestimate the proportion of cases acquired in hospital in all model scenarios. To reduce misclassification bias, an infection should be classified as being acquired prior to admission if symptoms begin within five days of admission.

PMID: 29258917

Ann Intern Med. 2017 Aug 1;167(3):152-158. doi: 10.7326/M16-2733. Epub 2017 Jul 4.

[Increasing Incidence of Multiply Recurrent *Clostridium difficile* Infection in the United States: A Cohort Study.](#)

[Ma GK](#)¹, [Brensinger CM](#)¹, [Wu Q](#)¹, [Lewis JD](#)¹.

BACKGROUND: *Clostridium difficile* infection (CDI), the most common health care-associated infection, often recurs. Fecal microbiota transplantation is increasingly used to treat multiply recurrent CDI (mrCDI).

OBJECTIVE: To determine whether the incidence of mrCDI is increasing in proportion to CDI and to identify risk factors for mrCDI.

DESIGN: Retrospective cohort study. **SETTING:** United States.

PARTICIPANTS: 38 911 718 commercially insured patients in the OptumInsight Clinformatics Database, of whom 45 341 developed CDI.

MEASUREMENTS: Age- and sex-standardized incidence rates for CDI and mrCDI.

RESULTS: From 2001 to 2012, the annual incidence of CDI and mrCDI per 1000 person-years increased by 42.7% (from 0.4408 to 0.6289 case) and 188.8% (from 0.0107 to 0.0309 case), respectively. The increase in mrCDI incidence was independent of known risk factors for CDI. Those who developed mrCDI were older (median age, 56.0 vs. 49.0 years; adjusted odds ratio [aOR] per 10-year increase in age, 1.25 [95% CI, 1.21 to 1.29]) and were more likely to be female (63.8% vs. 58.7%; aOR, 1.24 [CI, 1.11 to 1.38]) and to have used antibiotics (72.3% vs. 58.8%; aOR, 1.79 [CI, 1.59 to 2.01]), proton-pump inhibitors (24.6% vs. 18.2%; aOR, 1.14 [CI, 1.01 to 1.29]), or corticosteroids (18.3% vs. 13.7%; aOR, 1.15 [CI, 1.00 to 1.32]) within 90 days of CDI diagnosis. Chronic kidney disease (10.4% vs. 5.6%; aOR, 1.49 [CI, 1.24 to 1.80]) and diagnosis in a nursing

home (2.1% vs. 0.6%; aOR, 1.99 [CI, 1.34 to 2.93]) were also associated with increased risk for mrCDI.

LIMITATION: The primary analyses included only commercially insured patients in the United States.

CONCLUSION: Relative to CDI, mrCDI incidence has disproportionately increased, indicating a rising demand for mrCDI therapies.

PMID: 28672282

Clin Infect Dis. 2017 Aug 1;65(3):433-441. doi: 10.1093/cid/cix338.

[Comparison of Control of Clostridium difficile Infection in Six English Hospitals Using Whole-Genome Sequencing.](#)

[Eyre DW](#)¹, [Fawley WN](#)², [Rajgopal A](#)³, [Settle C](#)⁴, [Mortimer K](#)⁵, [Goldenberg SD](#)⁶, [Dawson S](#)⁷, [Crook DW](#)¹, [Peto TEA](#)¹, [Walker AS](#)¹, [Wilcox MH](#)².

BACKGROUND: Variation in Clostridium difficile infection (CDI) rates between healthcare institutions suggests overall incidence could be reduced if the lowest rates could be achieved more widely.

METHODS: We used whole-genome sequencing (WGS) of consecutive C. difficile isolates from 6 English hospitals over 1 year (2013-14) to compare infection control performance. Fecal samples with a positive initial screen for C. difficile were sequenced. Within each hospital, we estimated the proportion of cases plausibly acquired from previous cases.

RESULTS: Overall, 851/971 (87.6%) sequenced samples contained toxin genes, and 451 (46.4%) were fecal-toxin-positive. Of 652 potentially toxigenic isolates >90-days after the study started, 128 (20%, 95% confidence interval [CI] 17-23%) were genetically linked (within ≤2 single nucleotide polymorphisms) to a prior patient's isolate from the previous 90 days. Hospital 2 had the fewest linked isolates, 7/105 (7%, 3-13%), hospital 1, 9/70 (13%, 6-23%), and hospitals 3-6 had similar proportions of linked isolates (22-26%) (P ≤ .002 comparing hospital-2 vs 3-6). Results were similar adjusting for locally circulating ribotypes. Adjusting for hospital, ribotype-027 had the highest proportion of linked isolates (57%, 95% CI 29-81%). Fecal-toxin-positive and toxin-negative patients were similarly likely to be a potential transmission donor, OR = 1.01 (0.68-1.49). There was no association between the estimated proportion of linked cases and testing rates.

CONCLUSIONS: WGS can be used as a novel surveillance tool to identify varying rates of C. difficile transmission between institutions and therefore to allow targeted efforts to reduce CDI incidence.

PMCID: PMC5850028

PMID: 28575285

Infect Control Hosp Epidemiol. 2017 Aug;38(8):906-911. doi: 10.1017/ice.2017.114.

[Burden of Clostridium difficile Infections in French Hospitals in 2014 From the National Health Insurance Perspective.](#)

[Leblanc S](#)¹, [Blein C](#)¹, [Andreumont A](#)², [Bandinelli PA](#)³, [Galvain T](#)³.

OBJECTIVE: To describe the hospital stays of patients with Clostridium difficile infection (CDI) and to measure the hospitalization costs of CDI (as primary and secondary diagnoses) from the French national health insurance perspective

DESIGN: Burden of illness study

SETTING: All acute-care hospitals in France

METHODS: Data were extracted from the French national hospitalization database (PMSI) for patients covered by the national health insurance scheme in 2014. Hospitalizations were selected using the International Classification of Diseases, 10th revision (ICD-10) code for CDI. Hospital stays with CDI as the primary diagnosis or the secondary diagnosis (comorbidity) were studied for the following parameters: patient sociodemographic characteristics, mortality, length of stay (LOS), and related costs. A retrospective case-control analysis was performed on stays with CDI as the secondary diagnosis to assess the impact of CDI on the LOS and costs.

RESULTS: Overall, 5,834 hospital stays with CDI as the primary diagnosis were included in this study. The total national insurance costs were €30.7 million (US \$33,677,439), and the mean cost per hospital stay was €5,267±€3,645 (US \$5,777±\$3,998). In total, 10,265 stays were reported with CDI as the secondary diagnosis. The total national insurance additional costs attributable to CDI were estimated to be €85 million (US \$93,243,725), and the mean additional cost attributable to CDI per hospital stay was €8,295±€17,163, median, €4,797 (US \$9,099±\$8,827; median, \$5,262).

CONCLUSION: CDI has a high clinical and economic burden in the hospital, and it represents a major cost for national health insurance. When detected as a comorbidity, CDI was significantly associated with increased LOS and economic burden. Preventive approaches should be implemented to avoid CDIs. Infect Control Hosp Epidemiol 2017;38:906-911

PMID: 28756805

Lancet Infect Dis. 2017 Sep;17(9):990-1001. doi: 10.1016/S1473-3099(17)30325-0. Epub 2017 Jun 16.

[Effect of antibiotic stewardship on the incidence of infection and colonisation with antibiotic-resistant bacteria and Clostridium difficile infection: a systematic review and meta-analysis.](#)

[Baur D¹, Gladstone BP¹, Burkert F¹, Carrara E¹, Foschi F¹, Döbele S¹, Tacconelli E².](#)

BACKGROUND: Antibiotic stewardship programmes have been shown to reduce antibiotic use and hospital costs. We aimed to evaluate evidence of the effect of antibiotic stewardship on the incidence of infections and colonisation with antibiotic-resistant bacteria.

METHODS: For this systematic review and meta-analysis, we searched PubMed, the Cochrane Database of Systematic Reviews, the Cochrane Central Register of Controlled Trials, and Web of Science for studies published from Jan 1, 1960, to May 31, 2016, that analysed the effect of antibiotic stewardship programmes on the incidence of infection and colonisation with antibiotic-resistant bacteria and Clostridium difficile infections in hospital inpatients. Two authors independently assessed the eligibility of trials and extracted data. Studies involving long-term care facilities were excluded. The main outcomes were incidence ratios (IRs) of target infections and colonisation per 1000 patient-days before and after implementation of antibiotic stewardship. Meta-analyses were done with random-effect models and heterogeneity was calculated with the I² method.

FINDINGS: We included 32 studies in the meta-analysis, comprising 9 056 241 patient-days and 159 estimates of IRs. Antibiotic stewardship programmes reduced the incidence of infections and colonisation with multidrug-resistant Gram-negative bacteria (51% reduction; IR 0.49, 95% CI 0.35-0.68; $p < 0.0001$), extended-spectrum β -lactamase-producing Gram-negative bacteria (48%; 0.52, 0.27-0.98; $p = 0.0428$), and methicillin-resistant *Staphylococcus aureus* (37%; 0.63, 0.45-0.88; $p = 0.0065$), as well as the incidence of *C difficile* infections (32%; 0.68, 0.53-0.88; $p = 0.0029$). Antibiotic stewardship programmes were more effective when implemented with infection control measures (IR 0.69, 0.54-0.88; $p = 0.0030$), especially hand-hygiene interventions (0.34, 0.21-0.54; $p < 0.0001$), than when implemented alone. Antibiotic stewardship did not affect the IRs of vancomycin-resistant enterococci and quinolone-resistant and aminoglycoside-resistant Gram-negative bacteria. Significant heterogeneity between studies was detected, which was partly explained by the type of interventions and co-resistance patterns of the target bacteria.

INTERPRETATION: Antibiotic stewardship programmes significantly reduce the incidence of infections and colonisation with antibiotic-resistant bacteria and *C difficile* infections in hospital inpatients. These results provide stakeholders and policy makers with evidence for implementation of antibiotic stewardship interventions to reduce the burden of infections from antibiotic-resistant bacteria.

PMID: 28629876

Infect Control Hosp Epidemiol. 2017 Nov;38(11):1306-1311. doi: 10.1017/ice.2017.191. Epub 2017 Sep 13.

[Use of Implementation Science for a Sustained Reduction of Central-Line-Associated Bloodstream Infections in a High-Volume, Regional Burn Unit.](#)

[Sood G¹, Caffrey J², Krout K³, Khouri-Stevens Z⁴, Gerold K⁵, Riedel S¹, McIntyre J³, Maragakis LL¹, Blanding R⁶, Zenilman J¹, Bennett R⁷, Pronovost P⁸.](#)

OBJECTIVE: We describe the use of implementation science at the unit level and organizational level to guide an intervention to reduce central-line-associated bloodstream infections (CLABSIs) in a high-volume, regional, burn intensive care unit (BICU).

DESIGN: A single center observational quasi-experimental study.

SETTING: A regional BICU in Maryland serving 300-400 burn patients annually.

INTERVENTIONS: In 2011, an organizational-level and unit-level intervention was implemented to reduce the rates of CLABSI in a high-risk patient population in the BICU. At the organization level, leaders declared a goal of zero infections, created an infrastructure to support improvement efforts by creating a coordinating team, and engaged bedside staff. Performance data were transparently shared. At the unit level, the Comprehensive Unit-based Safety Program (CUSP)/ Translating Research Into Practice (TRIP) model was used. A series of interventions were implemented: development of new blood culture procurement criteria, implementation of chlorhexidine bathing and chlorhexidine dressings, use of alcohol impregnated caps, routine performance of root-cause analysis with executive engagement, and routine central venous catheter changes.

RESULTS: The use of an implementation science framework to guide multiple interventions resulted in the reduction of CLABSI rates from 15.5 per 1,000 central-line days to zero with a sustained rate of zero CLABSIs over 3 years (rate difference, 15.5; 95% confidence interval, 8.54-22.48).

CONCLUSIONS: CLABSIs in high-risk units may be preventable with the use of a structured organizational and unit-level paradigm. *Infect Control Hosp Epidemiol* 2017;38:1306-1311

PMID: 28899444

Lancet Infect Dis. 2017 Apr;17(4):381-389. doi: 10.1016/S1473-3099(16)30517-5. Epub 2017 Jan 13.

[Health-care-associated infections in neonates, children, and adolescents: an analysis of paediatric data from the European Centre for Disease Prevention and Control point-prevalence survey.](#)

[Zingg W¹, Hopkins S², Gayet-Ageron A³, Holmes A⁴, Sharland M⁵, Suetens C⁶; ECDC PPS study group.](#)

BACKGROUND: In 2011-12, the European Centre for Disease Prevention and Control (ECDC) held the first Europe-wide point-prevalence survey of health-care-associated infections in acute care hospitals. We analysed paediatric data from this survey, aiming to calculate the prevalence and type of health-care-associated infections in children and adolescents in Europe and to determine risk factors for infection in this population.

METHODS: Point-prevalence surveys took place from May, 2011, to November, 2012, in 1149 hospitals in EU Member States, Iceland, Norway, and Croatia. Patients present on the ward at 0800 h on the day of the survey and who were not discharged at the time of the survey were included. Data were collected by locally trained health-care workers according to patient-based or unit-based protocols. We extracted data from the ECDC database for all paediatric patients (age 0-18 years). We report adjusted prevalence for health-care-associated infections by clustering at the hospital and country level. We also calculated risk factors for development of health-care-associated infections with use of a generalised linear mixed-effects model.

FINDINGS: We analysed data for 17 273 children and adolescents from 29 countries. 770 health-care-associated infections were reported in 726 children and adolescents, corresponding to a prevalence of 4.2% (95% CI 3.7-4.8). Bloodstream infections were the most common type of infection (343 [45%] infections), followed by lower respiratory tract infections (171 [22%]), gastrointestinal infections (64 [8%]), eye, ear, nose, and throat infections (55 [7%]), urinary tract infections (37 [5%]), and surgical-site infections (34 [4%]). The prevalence of infections was highest in paediatric intensive care units (15.5%, 95% CI 11.6-20.3) and neonatal intensive care units (10.7%, 9.0-12.7). Independent risk factors for infection were age younger than 12 months, fatal disease (via ultimately and rapidly fatal McCabe scores), prolonged length of stay, and the use of invasive medical devices. 392 microorganisms were reported for 342 health-care-associated infections, with Enterobacteriaceae being the most frequently found (113 [15%]).

INTERPRETATION: Infection prevention and control strategies in children should focus on prevention of bloodstream infections, particularly among neonates and infants.

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J Hosp Infect. 2017 Nov;97(3):226-233. doi: 10.1016/j.jhin.2017.07.020. Epub 2017 Jul 25.

[Incidence, risk factors, and outcome of multidrug-resistant *Acinetobacter baumannii* acquisition during an outbreak in a burns unit.](#)

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BACKGROUND: Multidrug-resistant *Acinetobacter baumannii* (MR-AB) can cause outbreaks in a burns unit.

AIM: To study the incidence, risk factors and outcome of MR-AB colonization during an outbreak.

METHODS: A prospective study was conducted from April to November 2014 in a burns unit in Paris. Weekly surveillance cultures of patients and their environment were performed. MR-AB acquisition, discharge, or death without MR-AB colonization were considered as competing events. To identify risk factors for colonization, baseline characteristics and time-dependent variables were investigated in univariate and multivariate analyses using Cox models. MR-AB strains were genotypically compared using multi-locus sequence typing.

FINDINGS: Eighty-six patients were admitted in the burns unit during the study period. Among 77 patients without MR-AB colonization at admission, 25 (32%) acquired MR-AB with a cumulative incidence of 30% at 28 days (95% CI: 20-40). Median time to MR-AB acquisition was 13 days (range: 5-34). In multivariate analysis, risk factors for MR-AB acquisition were ≥ 2 skin graft procedures performed [hazard ratio (HR): 2.97; 95% confidence interval (CI): 1.10-8.00; $P = 0.032$] and antibiotic therapy during hospitalization (HR: 4.42; 95% CI: 1.19-16.4; $P = 0.026$). A major sequence type of MR-AB (ST2) was found in 94% and 92% of patients and environmental strains, respectively, with all strains harbouring the blaOXA-23 gene. MR-AB colonization increased length of hospitalization (HR: 0.32; 95% CI: 0.17-0.58; $P = 0.0002$) by a median of 12 days.

CONCLUSION: A high incidence of MR-AB acquisition was seen during this outbreak with most strains from patients and their environment belonging to single sequence type. MR-AB colonization was associated with more skin graft procedures, antibiotic use, and prolonged hospitalization.

PMID: 28751010

Infect Control Hosp Epidemiol. 2017 Sep;38(9):1107-1109. doi: 10.1017/ice.2017.127. Epub 2017 Jul 11.

[Environmental Surfaces in Healthcare Facilities are a Potential Source for Transmission of *Candida auris* and Other *Candida* Species.](#)

[Piedrahita CT](#)¹, [Cadnum JL](#)¹, [Jencson AL](#)¹, [Shaikh AA](#)², [Ghannoum MA](#)³, [Donskey CJ](#)².

ABSTRACT: Contaminated surfaces have been implicated as a potential route for dissemination of the emerging multidrug-resistant fungal pathogen *Candida auris*. In laboratory testing, *C. auris* and other *Candida* species persisted for 7 days on moist or dry surfaces. *Candida* species were recovered frequently from the hospital environment, particularly from moist surfaces.

PMID: 28693657

J Hosp Infect. 2017 Nov;97(3):296-300. doi: 10.1016/j.jhin.2017.07.021. Epub 2017 Jul 26.

[Public health and healthcare-associated risk of electric, warm-water bidet toilets.](#)

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BACKGROUND: In recent years, installation of bidet toilets within hospitals in Japan has raised concerns regarding potential for cross-contamination by antimicrobial-resistant bacteria from patients who are hospitalized over an extended period.

AIM: To investigate the distribution of antimicrobial-resistant bacteria recovered from bidet toilets at a university-affiliated hospital in Japan.

METHODS: All 292 electric bidet toilets at a university hospital were sampled for contamination. Swabs for culture were used to sample water-jet nozzles and toilet seats.

FINDINGS: Of the 292 toilet seats sampled, warm-water nozzles of 254 (86.9%) were found to be contaminated by one or more of the following organisms: *Staphylococcus aureus*, *Streptococcus* spp., *Enterococcus* spp., Enterobacteriaceae and non-Enterobacteriaceae Gram-negative bacteria. *S. aureus* was recovered from one water-jet nozzle and nine toilet seats; of these, methicillin-resistant *S. aureus* was recovered from the water-jet nozzle and from one toilet seat. Both the water-jet nozzle and seat of the same toilet were contaminated with a CTX-M-9 group extended-spectrum β -lactamase-producing *Escherichia coli*. Of the Gram-negative isolates recovered from samples, the organism with the highest frequency of isolation was *Stenotrophomonas maltophilia*, which was recovered from 39 bidet toilets.

CONCLUSION: Warm-water nozzles of bidet toilets are contaminated with a wide range of bacteria, making them a potential vehicle for cross-infection. In the hospital setting, shared use of bidet toilets must consider the clinical background of patients. Based on these findings, these devices must be part of the risk management programme, and steps should be included for monitoring and disinfection.

PMID: 28756169

Am J Infect Control. 2017 Nov 1;45(11):e143-e147. doi: 10.1016/j.ajic.2017.06.002. Epub 2017 Aug 2.

[Antimicrobial resistance of 3 types of gram-negative bacteria isolated from hospital surfaces and the hands of health care workers.](#)

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BACKGROUND: There has been an increased focus in recent years on antimicrobial resistance of bacteria isolated from clinical samples. However, resistance of bacteria from hospital environments has been less frequently investigated.

METHODS: According to hygienic standard for disinfection in hospitals, samples were collected from hospital inanimate surfaces and the hands of health care workers after daily cleaning. An automatic microorganism analyzer was used to identify bacteria and test for antimicrobial susceptibility. Polymerase chain reaction was used to detect antimicrobial resistance genes.

RESULTS: The detection rate of bacteria in general wards was significantly higher than that in intensive care units. The isolates were predominantly gram-negative (GN) bacteria, with *Pseudomonas aeruginosa*, *Enterobacter cloacae*, and *Klebsiella pneumoniae* being the most common. *P. aeruginosa* isolates from other surfaces were much higher than those from medical instruments. *E. cloacae* was isolated more frequently from the hands of other staff than medical staff. Most *P. aeruginosa* and *K. pneumoniae* were resistant to sulfonamides and β -lactam antimicrobials. Only 1 strain of *P. aeruginosa* and 1 strain of *K. pneumoniae* showed multiple antimicrobials resistance.

CONCLUSIONS: The GN bacteria isolated from hospital environments demonstrate variable resistance to antimicrobials.

PMID: 28780198

Clin Infect Dis. 2017 Oct 15;65(8):1412-1419. doi: 10.1093/cid/cix462.

[The Role of Patient Care Items as a Fomite in Healthcare-Associated Outbreaks and Infection Prevention.](#)

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ABSTRACT: Patient-care items can serve as a source or reservoir for healthcare-associated pathogens in hospitals. We reviewed healthcare-associated outbreaks from medical equipment and provide infection prevention recommendations. Multiple healthcare-associated outbreaks via a contaminated patient-care item were identified, including infections with multidrug-resistant organisms. The type of patient care items implicated as a fomite causing healthcare-associated infections (HAIs) has changed over time. Patient populations at risk were most commonly critically ill patients in adult and neonatal intensive care units. Most fomite related healthcare-associated outbreaks were due to inappropriate disinfection practices. Repeated healthcare-associated outbreaks via medical equipment highlight the need for infectious disease professionals to understand that fomites/medical devices may be a source of HAIs. The introduction of new and more complex medical devices will likely increase the risk that such devices serve as a source of HAIs. Assuring appropriate cleaning and disinfection or sterilization of medical equipment is necessary to prevent future fomite-associated outbreaks.

PMID: 28520859

Infect Control Hosp Epidemiol. 2017 Nov;38(11):1371-1373. doi: 10.1017/ice.2017.205. Epub 2017 Oct 13.

[Self-monitoring by Environmental Services May Not Accurately Measure Thoroughness of Hospital Room Cleaning.](#)

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No abstract available

PMID: 29025436

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[Controlling a possible outbreak of Candida auris infection: lessons learnt from multiple interventions.](#)

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BACKGROUND: Multidrug-resistant *Candida auris* infection has been reported from five continents in recent years. The prevalence of *C. auris* invasive infection has been estimated at

5.3% for intensive-care-acquired candidaemia in India. The transmission of the organism between the patients and from environment to patients is rapid.

AIM: To understand the intra-hospital dynamics of *C. auris* transmission and to determine the possible interventions to prevent its spread.

METHODS: Surveillance of intensive care units was carried out to assess patient colonization, environmental contamination and hand carriage of the yeast among healthcare workers. Interventions including chlorhexidine washing of patients and decontamination of environmental surfaces with stabilized hydrogen peroxide disinfectant (Ecoshield) were undertaken. We further evaluated the effectiveness of frequently used disinfectants in the hospital against *C. auris* on various inanimate surfaces, and its persistence on hospital fabrics.

FINDINGS: Three cases of *C. auris* bloodstream infection were detected over a period of three months. Many patients admitted at the same time, in the same area, were colonized by *C. auris*. Surveillance detected *C. auris* contamination of environmental surfaces and hands of healthcare workers. Interventions such as chlorhexidine washing and appropriate use of disinfectants could eradicate *C. auris* from patients and hospital environment.

CONCLUSION: The frequently used disinfectants in our hospital and current hand hygiene practices were efficient against *C. auris* if proper contact time and procedures were followed. Evaluation of possible persistence of *C. auris* on dry fabrics showed that they can persist for up to seven days.

PMID: 28939316

J Hosp Infect. 2017 Oct;97(2):175-179. doi: 10.1016/j.jhin.2017.06.010. Epub 2017 Jun 10.

[Automatic environmental disinfection with hydrogen peroxide and silver ions versus manual environmental disinfection with sodium hypochlorite: a multicentre randomized before-and-after trial.](#)

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BACKGROUND: New technologies for automated disinfection have been developed, including the use of hydrogen peroxide atomized by specific equipment, with associated silver compounds.

AIMS: To compare the effectiveness of an automated disinfection system with hydrogen peroxide <8% and silver ion versus a manual method with 0.5% sodium hypochlorite solution when evaluating the reduction of microbial mesophilic contamination and *Clostridium difficile* presence; and to evaluate the time required for both of these processes.

METHODS: This was a randomized multicentre trial performed in different hospital wards that had been occupied previously by patients with *Clostridium difficile* infection. When patients were discharged their rooms were randomized to one of two decontamination arms. The surfaces were sampled using swabs, before and after disinfection. Swab samples were cultured for quantitative detection of microbial mesophilic contamination and qualitative detection of *C. difficile*.

FINDINGS: Before disinfection, 13% of surfaces decontaminated with hydrogen peroxide and silver ions and 20% of surfaces decontaminated with sodium hypochlorite showed presence of *C. difficile* spores. After disinfection, the samples containing *C. difficile* were 0% ($P < 0.001$) in the group decontaminated with hydrogen peroxide and silver ions, and were 3% ($P < 0.001$) in the

group decontaminated with sodium hypochlorite. This difference was not statistically significant; nor was the difference in the reduction of the microbial mesophilic contamination.

CONCLUSION: The differences between the groups were not statistically significant; however, the disinfection with hydrogen peroxide and silver ions is preferable due to less dependence on operators.

PMID: 28610932

Infect Control Hosp Epidemiol. 2017 Oct;38(10):1240-1243. doi: 10.1017/ice.2017.162. Epub 2017 Aug 10.

[Effectiveness of Disinfectants Against *Candida auris* and Other *Candida* Species.](#)

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ABSTRACT: Contaminated surfaces are a suspected source for dissemination of the globally emerging pathogen *Candida auris*. In laboratory testing, sporicidal and improved hydrogen peroxide disinfectants were highly effective against *C. auris*, *C. glabrata*, and *C. albicans*. The widely used quaternary ammonium disinfectants exhibited relatively poor activity against all of the *Candida* species.

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[Environmental cleaning and disinfection of patient areas.](#)

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ABSTRACT: The healthcare setting is predisposed to harbor potential pathogens, which in turn can pose a great risk to patients. Routine cleaning of the patient environment is critical to reduce the risk of hospital-acquired infections. While many approaches to environmental cleaning exist, manual cleaning supplemented with ongoing assessment and feedback may be the most feasible for healthcare facilities with limited resources.

PMID: 29102556

Am J Infect Control. 2017 Oct 1;45(10):1133-1138. doi: 10.1016/j.ajic.2017.04.003. Epub 2017 May 23.

[Health problems and disinfectant product exposure among staff at a large multispecialty hospital.](#)

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BACKGROUND: Hospital staff expressed health concerns after a surface disinfectant product containing hydrogen peroxide, peracetic acid, and acetic acid was introduced. We sought to determine if this product posed a health hazard.

METHODS: An interviewer-administered questionnaire on work and health characteristics was completed by 163 current staff. Symptoms that improved away from work were considered work-related. Forty-nine air samples were taken for hydrogen peroxide, peracetic acid, and acetic acid. Prevalence ratios (PRs) were calculated using Poisson regression, and standardized morbidity ratios (SMRs) were calculated using nationally representative data.

RESULTS: Product users reported higher prevalence of work-related wheeze and watery eyes than nonusers ($P < .05$). Workers in the department with the highest air measurements had significantly higher prevalence of watery eyes (PR, 2.88; 95% confidence interval [CI], 1.18-7.05) than those in departments with lower air measurements, and they also had a >3-fold excess of current asthma (SMR, 3.47; 95% CI, 1.48-8.13) compared with the U.S.

CONCLUSIONS: This disinfectant product was associated with mucous membrane and respiratory health effects. Risks of mucous membrane irritation and asthma in health care workers should be considered in development of disinfection protocols to protect patients from hospital-acquired infections. Identification of optimal protocols that reduce worker exposures while maintaining patient safety is needed.

PMCID: PMC568554

PMID: 28549881

J Hosp Infect. 2018 Mar;98(3):275-281. doi: 10.1016/j.jhin.2017.10.025. Epub 2017 Nov 28.

[Control of endemic multidrug-resistant Gram-negative bacteria after removal of sinks and implementing a new water-safe policy in an intensive care unit.](#)

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BACKGROUND: Contaminated handwashing sinks have been identified as reservoirs that can facilitate colonization/infection of patients with multidrug-resistant (MDR) Gram-negative bacteria (GNB) in intensive care units (ICUs).

AIM: To assess the impact of removing patients' sinks and implementing other water-safe strategies on the annual rates of ICU-acquired MDR-GNB.

METHODS: This six-year quasi-experimental study was conducted from January 2011 to December 2016. The intervention was carried out in August 2014 in two adult ICU wards with 12 rooms each. To assess the changes in annual MDR-GNB rates before and after the intervention, we used segmented regression analysis of an interrupted time-series. Crude relative risk (RR) rates were also calculated.

FINDINGS: The incidence rates of MDR-GNB were 9.15 and 2.20 per 1000 patient-days in the pre- and post-intervention periods, respectively. This yielded a crude RR of acquiring MDR-GNB of 0.24 (95% confidence interval: 0.17-0.34). A significant change in level was observed between the MDR-GNB rate at the first point of the post-intervention period and the rate predicted by the pre-intervention time trend.

CONCLUSION: The implementation of a new water-safe policy, which included the removal of sinks from all patient rooms, successfully improved the control of MDR-GNB spread in an ICU with endemic infection. Our results support the contribution of sink use with the incidence of MDR-GNB in endemic environments.

PMID: 29104124