
**TITLE: Risk Factors and Carriage of Vancomycin-Resistant Enterococcus and Extended Spectrum Beta-Lactamase producing bacteria: Clinical Evidence**

**DATE:** 27 April 2012

## RESEARCH QUESTIONS

1. What is the evidence regarding the risk factors for patient carriage of vancomycin-resistant enterococcus (VRE) or extended spectrum beta-lactamase producing bacteria (ESBL)?

2. What is the evidence regarding the risk of infection with VRE or ESBL in patients who are carriers of these organisms?

3. What is the evidence regarding the risk of long-term carriage of VRE or ESBL in patients who are colonized or infected with these organisms?

4. What is the evidence regarding the length of time patients remain carriers of VRE or ESBL?

## KEY MESSAGE

Forty-two non-randomized studies were identified regarding the risk factors and carriage of VRE and ESBL: thirty-three studies were identified regarding the risk factors for patient carriage; six studies regarding the risk of infection with VRE or ESBL in patients who are carriers of these organisms; two studies regarding the risk of long-term carriage in patients who are colonized or infected with VRE or ESBL; and one study was identified regarding the length of time patients remain carriers.

## METHODS

A limited literature search was conducted on key resources including PubMed, The Cochrane Library (2012, Issue 3), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and abbreviated lists of major international health technology agencies, as

well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search for VRE and ESBL was limited to English language documents published between Jan 1, 2007 and Apr 20, 2012. Internet links were provided, where available.

## RESULTS

Rapid Response reports are organized so that the higher quality evidence is presented first. Therefore, health technology assessment reports, systematic reviews, and meta-analyses are presented first. These are followed by randomized controlled trials and non-randomized studies.

Forty-two non-randomized studies were identified regarding the risk factors and carriage of VRE and ESBL: thirty-three studies were identified regarding the risk factors for patient carriage; six studies regarding the risk of infection with VRE or ESBL in patients who are carriers of these organisms; two studies regarding the risk of long-term carriage in patients who are colonized or infected with VRE or ESBL; and one study was identified regarding the length of time patients remain carriers. No relevant health technology assessment reports, systematic reviews, meta-analyses, or randomized controlled trials were identified. Additional references of potential interest are provided in the appendix.

### Health Technology Assessments
No literature identified.

### Systematic Reviews and Meta-analyses
No literature identified.

### Randomized Controlled Trials
No literature identified.

### Non-Randomized Studies

*Risk factors for patient carriage of VRE and ESBL*

1. Kee SY, Park CW, Lee JE, Kwon YJ, Pyo HJ, Western Dialysis Physical Association, et al. Healthcare-associated risk factors of vancomycin-resistant Enterococci colonization among outpatients undergoing hemodialysis. Jpn J Infect Dis. 2012 Jan;65(1):57-60. PubMed: PM22274159

   Stool specimens and data were obtained from 399 outpatients undergoing hemodialysis (HD) in order to estimate the colonization rate of vancomycin-resistant enterococci (VRE) and to determine risk factors for VRE acquisition. The prevalence of VRE colonization in outpatients ranged from 0%-22.2%. **Risk factors associated with VRE colonization were high hierarchy of hospital, short duration of HD, recent hospitalization, prior use of antimicrobial products, high platelet count, and low hemoglobin/albumin/blood urea nitrogen/creatinine levels, showing that VRE colonization was more common in patients with prior infections and poor nutritional status.** Although pulsed-field gel electrophoresis (PFGE) analysis showed that most VRE isolates had diverse patterns, 2 paired cases from separate hospitals presented identical PFGE types.

2. Leung W, Malhi G, Willey BM, McGeer AJ, Borgundvaag B, Thanabalan R, et al. Prevalence and predictors of MRSA, ESBL, and VRE colonization in the ambulatory IBD population. J Crohns Colitis. 2012 Jan 9.
PubMed: PM22398097

BACKGROUND AND AIMS: **Inflammatory bowel disease (IBD) patients may be at increased risk of acquiring antibiotic-resistant organisms (ARO). We sought to determine the prevalence of colonization of methicillin-resistant Staphylococcus aureus (MRSA), Enterobacteriaceae containing extended spectrum beta-lactamases (ESBL), and vancomycin-resistant enterococci (VRE) among ambulatory IBD patients.** METHODS: We recruited consecutive IBD patients from clinics (n=306) and 3 groups of non-IBD controls from our colon cancer screening program (n=67), the family medicine clinic (n=190); and the emergency department (n=428) from the same medical center in Toronto. We obtained nasal and rectal swabs for MRSA, ESBL, and VRE and ascertained risk factors for colonization. RESULTS: Compared to non-IBD controls, IBD patients had similar prevalence of colonization with MRSA (1.5% vs. 1.6%), VRE (0% vs. 0%), and ESBL (9.0 vs. 11.1%). Antibiotic use in the prior 3months was a risk factor for MRSA (OR, 3.07; 95% CI: 1.10-8.54), particularly metronidazole. Moreover, gastric acid suppression was associated with increased risk of MRSA colonization (adjusted OR, 7.12; 95% CI: 1.07-47.4). **Predictive risk factors for ESBL included hospitalization in the past 12months (OR, 2.04, 95% CI: 1.05-3.95); treatment with antibiotics it the past 3months (OR, 2.66; 95% CI: 1.37-5.18), particularly prior treatment with vancomycin or cephalosporins.** CONCLUSIONS: **Ambulatory IBD patients have similar prevalence of MRSA, ESBL and VRE compared to non-IBD controls. This finding suggests that the increased MRSA and VRE prevalence observed in hospitalized IBD patients is acquired in-hospital rather than in the outpatient setting.**

3. Ofek-Shlomai N, Benenson S, Ergaz Z, Peleg O, Braunstein R, Bar-Oz B. Gastrointestinal colonization with ESBL-producing Klebsiella in preterm babies--is vancomycin to blame? Eur J Clin Microbiol Infect Dis. 2012 Apr;31(4):567-70.
PubMed: PM21814760

**In this study, we examine the possible association between treatment with vancomycin and colonization with extended-spectrum beta-lactamase (ESBL)-producing Klebsiella in our neonatal intensive care unit (NICU).** Variables compared between newborns which developed rectal colonization and those who did not include: gestational age, birth weight, gender, and total length of hospital stay until positive stool culture or discharge, treatment with vancomycin, and positive blood culture for coagulase-negative Staphylococcus. **We found that lower birth weight, younger gestational age, and treatment with vancomycin were statistically significant risk factors for gastrointestinal colonization with ESBL-producing Klebsiella.** When applying a multivariate model, treatment with vancomycin, both for a full 10-day course and for a short 3-day empirical treatment, remained statistically significant. **Treatment with vancomycin is a risk factor for gastrointestinal colonization with ESBL-producing Klebsiella in premature babies.**

4. Ruppe E, Pitsch A, Tubach F, de L, V, Chau F, Pasquet B, et al. Clinical predictive values of extended-spectrum beta-lactamase carriage in patients admitted to medical wards. Eur J Clin Microbiol Infect Dis. 2012 Mar;31(3):319-25.
PubMed: PM21660500

**We aimed to reassess, through clinical items, populations at risk for extended-spectrum beta-lactamase-producing Enterobacteriaceae (ESBL-E) carriage at admission to hospital and to assess the risk of further positive clinical culture of ESBL-E among carriers.** We performed a 5-month cohort study in a medicine ward of a 500-bed university teaching hospital in the Parisian area of France. All admitted patients were prospectively enrolled for rectal swabbing and clinical data collection, including bacterial infection at admission and during stay. Variables associated with ESBL-E carriage were identified by univariate and multivariate analysis. Five hundred patients were included. **The prevalence of ESBL-E was 6.6% (33/500) upon admission. Only previous carriage of multidrug-resistant bacteria (MDRB) was associated with carriage (odds ratio [OR]: 17.7, 95% confidence interval (CI) 5.8-54.2, p < 0.001), yet, the positive predictive value (PPV) was not higher than 50%. When prior MDRB carriage was not considered in the multivariate analysis, only prior antibiotic consumption was found to be associated with carriage at admission (OR: 2.2 [1.1-4.5], p = 0.02). Two patients had ESBL-E infection at admission, yet, no patient became infected with ESBL-E during their stay.** The clinical prediction of ESBL carriage at admission in our wards was found to be poorly efficient for assessing the at-risk population.

5. Schoevaerdts D, Verroken A, Huang TD, Frennet M, Berhin C, Jamart J, et al. Multidrug-resistant bacteria colonization amongst patients newly admitted to a geriatric unit: A prospective cohort study. J Infect. 2012 Feb 14.
PubMed: PM22343066

   OBJECTIVES: **To determine prevalence, incidence and risk factors of colonization by extended-spectrum beta-lactamase-producing Enterobacteriacae (ESBLE), methicillin-resistant Staphylococcus aureus (MRSA), and vancomycin-resistant Enterococcus (VRE) in aged subjects admitted to an acute geriatric unit at a teaching hospital.** METHODS: During 12 months, 337 patients were screened by nasal, oropharyngeal, groin, axillary and rectal swabs upon admission and at discharge. RESULTS: The prevalence of ESBLE, MRSA and VRE carriage upon admission was 11.6%, 7.5% and 0.6%, respectively. The incidence density of ESBLE and MRSA carriage was respectively of 1.77 and 2.40 new cases for 1000 patient-days. No cases of VRE acquisition were found. **Risk factors for ESBLE colonization on admission were: multiple contacts with the hospital within the previous year, chronic catheter use and a high level of dependency.** For MRSA, risk factors were: chronic wounds, anti-acid use and a high level of dependency. CONCLUSION: **This study shows a high prevalence of asymptomatic colonization of ESBL-producing Escherichia coli in patients admitted to an acute geriatric ward, as high as MRSA carriage. A low functional status is a common risk factor both for ESBLE and for MRSA colonization and it highlights the need to reinforce infection control measures.**

6. Almyroudis NG, Lesse AJ, Hahn T, Samonis G, Hazamy PA, Wongkittiroch K, et al. Molecular epidemiology and risk factors for colonization by vancomycin-resistant Enterococcus in patients with hematologic malignancies. Infect Control Hosp Epidemiol. 2011 May;32(5):490-6.
PubMed: PM21515980

   OBJECTIVE: **To study the molecular epidemiology of vancomycin-resistant**

**Enterococcus (VRE) colonization and to identify modifiable risk factors among patients with hematologic malignancies.** SETTING: A hematology-oncology unit with high prevalence of VRE colonization. PARTICIPANTS: Patients with hematologic malignancies and hematopoietic stem cell transplantation recipients admitted to the hospital. METHODS: Patients underwent weekly surveillance by means of perianal swabs for VRE colonization and, if colonized, were placed in contact isolation. We studied the molecular epidemiology in fecal and blood isolates by pulsed-field gel electrophoresis over a 1-year period. We performed a retrospective case-control study over a 3-year period. Cases were defined as patients colonized by VRE, and controls were defined as patients negative for VRE colonization. Case patients and control patients were matched by admitting service and length of observation time. RESULTS: Molecular genotyping demonstrated the primarily polyclonal nature of VRE isolates. **Colonization occurred at a median of 14 days. Colonized patients were characterized by longer hospital admissions. Previous use of ceftazidime was associated with VRE colonization (P < .001), while use of intravenous vancomycin and antibiotics with anaerobic activity did not emerge as a risk factor. There was no association with neutropenia or presence of colonic mucosal disruption, and severity of illness was similar in both groups.** CONCLUSION: Molecular studies showed that in the majority of VRE-colonized patients the strains were unique, arguing that VRE acquisition was sporadic rather than resulting from a common source of transmission. **Patient-specific factors, including prior antibiotic exposure, rather than breaches in infection control likely predict for risk of fecal VRE colonization.**

7. Altoparlak U, Koca O, Ozkurt Z, Akcay MN. Incidence and risk factors of vancomycin-resistant enterococcus colonization in burn unit patients. Burns. 2011 Feb;37(1):49-53. PubMed: PM20926196

**This study was aimed to identify the incidence of vancomycin-resistant enterococcus (VRE) colonization in burn patients, to collate risk factors for colonization and to determine the VRE resistance profile to different antimicrobial agents.** This prospective study was carried out on the burn unit, during the period from September 2008 to January 2010, in 128 patients who were hospitalized at least 3 weeks or more. Periodic swabs were taken from burn wound, rectal, axillary, umblicaly and throat regions of the patients on admission and 7th, 14th, 21st days of hospitalization. Demographics and known risk factors were retrieved and assessed by statistical methods. Only 20 patients (15.6%) were colonized with enterococci on admission and these strains isolated from rectal, umblical and throat samples were sensitive to vancomycin. Initial VRE isolation was made in the first samples from the rectum of two patients on the 7th day. The rates of rectal, umblical, throat and axillary colonization increased to 21.9%, 3.1%, 3.1% and 3.1% at 28th day, respectively. VRE strains were the first isolated from burn wounds of only one patient (0.8%) on the 14th day and the colonization rate increased to 7.0% at the 28th day. Our study indicated that rectal colonization was seen more than other sites of colonization and was strictly correlate to colonizing enterococci between burn wound and other body regions. **Multivariate analyses showed that glycopeptide use, burn depth and total burn surface area were independent risk factors for acquisition of VRE.** All VSE strains were susceptible to teicoplanin, tigecycline and linezolid. VSE strains were more resistant to gentamicin and streptomycin, and VRE strains were more resistant to penicillin and ampicillin. The present study showed tigecycline and linezolid to be most active agents against VRE strains. **The determined**

**VRE colonization and risk factors of VRE acquisition are expected to be useful in establishing guidelines for preventing VRE infection in burn unit.**

8. Arnan M, Gudiol C, Calatayud L, Linares J, Dominguez MA, Batlle M, et al. Risk factors for, and clinical relevance of, faecal extended-spectrum beta-lactamase producing Escherichia coli (ESBL-EC) carriage in neutropenic patients with haematological malignancies. Eur J Clin Microbiol Infect Dis. 2011 Mar;30(3):355-60. PubMed: PM21052757

**The purpose of this study was to assess the risk factors for, and the clinical relevance of, faecal carriage by extended-spectrum beta-lactamase producing Escherichia coli (ESBL-EC) in neutropenic cancer patients (NCP).** An observational prospective multicentre cohort study was conducted over 2 years at two teaching hospitals. Patients with acute leukaemia or undergoing stem cell transplantation were included during neutropenia episodes. Rectal swabs were obtained at hospital admission and weekly thereafter until discharge or death. ESBL-EC colonized episodes were compared with non-colonized episodes. ESBL-EC strains were studied by PCR and isoelectric focusing, and molecular typing was performed by pulsed field gel electrophoresis (PFGE). **Among 217 episodes of neutropenia, the prevalence of ESBL-EC faecal carriage was 29% (14% at hospital admission). Multivariate analysis identified previous antibiotics as the only independent risk factor for ESBL-EC faecal colonization (OR 5.38; 95% CI 2.79-10.39).** Analysis of ESBL-EC isolates revealed a polyclonal distribution with CTX-M predominance (81.3%). E. coli bacteraemia was mainly caused by non-ESBL producing strains and its rate was similar in both groups (13% vs. 11%). **We found no association between ESBL-EC carriage and an increased risk of ESBL-EC bacteremia or a negative influence on other clinical outcomes, including length of hospitalisation, early and overall mortality rates.** ESBL-EC faecal colonization is frequent in NCP but difficult to identify by epidemiological or clinical features on presentation. **Prior antibiotic therapy is the major associated risk factor. In this setting colonization does not appear to have a significant clinical relevance. Thus, routine testing for ESBL-EC faecal carriage does not seem to be beneficial.**

9. Herindrainy P, Randrianirina F, Ratovoson R, Ratsima HE, Buisson Y, Genel N, et al. Rectal carriage of extended-spectrum beta-lactamase-producing gram-negative bacilli in community settings in Madagascar. PLoS ONE [Internet]. 2011 [cited 2012 Apr 25];6(7):e22738. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3146483 PubMed: PM21829498

BACKGROUND: Extended-spectrum ss-lactamase-producing Enterobacteria (ESBL-PE) emerged at the end of the 1980s, causing nosocomial outbreaks and/or hyperendemic situations in hospitals and long-term care facilities. In recent years, community-acquired infections due to ESBL-PE have spread worldwide, especially across developing countries including Madagascar. OBJECTIVES: **This study aimed to determine the prevalence and risk factors of intestinal carriage of ESBL-PE in the community of Antananarivo.** METHODS: Non-hospitalized patients were recruited in three health centers in different socio economic settings. Fresh stool collected were immediately plated on Drigalski agar containing 3 mg/liter of ceftriaxone. Gram-negative bacilli species were identified and ESBL production was tested by a double disk diffusion (cefotaxime and ceftazidime +/- clavulanate) assay. Characterization of ESBLs were perfomed by PCR

and direct sequencing. Molecular epidemiology was analysed by Rep-PCR and ERIC-PCR. RESULTS: **484 patients were screened (sex ratio = 1.03, median age 28 years). 53 ESBL-PE were isolated from 49 patients (carrier rate 10.1%).** The isolates included Escherichia coli (31), Klebsiella pneumoniae (14), Enterobacter cloacae (3), Citrobacter freundii (3), Kluyvera spp. (1) and Pantoae sp. (1). **In multivariate analysis, only the socioeconomic status of the head of household was independently associated with ESBL-PE carriage, poverty being the predominant risk factor.** CONCLUSIONS: The prevalence of carriage of ESBL in the community of Antananarivo is one of the highest reported worldwide. This alarming spread of resistance genes should be stopped urgently by improving hygiene and streamlining the distribution and consumption of antibiotics.

10. Peirano G, Laupland KB, Gregson DB, Pitout JD. Colonization of returning travelers with CTX-M-producing Escherichia coli. J Travel Med. 2011 Sep;18(5):299-303. PubMed: PM21896092

    BACKGROUND: We previously identified foreign travel as a risk factor for acquiring infections due to CTX-M (active on cefotaxime first isolated in Munich) producing Escherichia coli. **The objective of this study was to assess the prevalence of extended-spectrum beta-lactamase (ESBL)-producing E coli among stool samples submitted from travelers as compared to non-travelers (a non-traveler had not been outside of Canada for at least 6 months before submitting a stool specimen).** METHODS: Once a travel case was identified, the next stool from a non-traveler (not been outside of Canada for at least 6 months) was included and cultured on the chromID-ESBL selection media. Molecular characterization was done using polymerase chain reaction and sequencing for bla(CTX-Ms), bla(TEMs), bla(SHVs), plasmid-mediated quinolone-resistant determinants, O25-ST131, phylogenetic groups, pulsed-field gel electrophoresis (PFGE), and multilocus sequencing typing. RESULTS: **A total of 226 individuals were included; 195 (86%) were negative, and 31 (14%) were positive for ESBL-producing E coli. Notably, travelers were 5.2 (95% CI 2.1-31.1) times more likely than non-travelers to have an ESBL-producing E coli cultured from their stool. The highest rates of ESBL positivity were associated with travel to Africa or the Indian subcontinent.** Among the 31 ESBL-producing E coli isolated, 22 produced CTX-M-15, 8 produced CTX-M-14, 1 produced CTX-M-8, 12 were positive for aac(6')-Ib-cr, and 8 belonged to clone ST131. CONCLUSIONS: **Our study confirms that foreign travel, especially to the Indian subcontinent and Africa, represents a major risk for rectal colonization with CTX-M-producing E coli and contributed to the Worldwide spread of these bacteria.**

11. Schoevaerdts D, Bogaerts P, Grimmelprez A, de Saint-Hubert M, Delaere B, Jamart J, et al. Clinical profiles of patients colonized or infected with extended-spectrum beta-lactamase producing Enterobacteriaceae isolates: a 20 month retrospective study at a Belgian University Hospital. BMC Infect Dis [Internet]. 2011 [cited 2012 Apr 25];11:12. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3023698 PubMed: PM21226923

    BACKGROUND: Description of the clinical pictures of patients colonized or infected by ESBL-producing Enterobacteriaceae isolates and admitted to hospital are rather scarce in Europe. **However, a better delineation of the clinical patterns associated with the carriage of ESBL-producing isolates may allow healthcare providers to identify more rapidly at risk patients.** This matter is of particular concern because of the growing

proportion of ESBL-producing Enterobacteriaceae species isolates worldwide. METHODS: **We undertook a descriptive analysis of 114 consecutive patients in whom ESBL-producing Enterobacteriaceae isolates were collected from clinical specimens over a 20-month period.** Clinical data were obtained through retrospective analysis of medical record charts. Microbiological cultures were carried out by standard laboratory methods. RESULTS: **The proportion of ESBL-producing Enterobacteriaceae strains after exclusion of duplicate isolates was 4.5% and the incidence rate was 4.3 cases/1000 patients admitted. Healthcare-associated acquisition was important (n = 104) while community-acquisition was less frequently found (n = 10). Among the former group, two-thirds of the patients were aged over 65 years and 24% of these were living in nursing homes. Sixty-eight (65%) of the patients with healthcare-associated ESBL, were considered clinically infected. In this group, the number and severity of co-morbidities was high, particularly including diabetes mellitus and chronic renal insufficiency. Other known risk factors for ESBL colonization or infection such as prior antibiotic exposure, urinary catheter or previous hospitalisation were also often found.** The four main diagnostic categories were: urinary tract infections, lower respiratory tract infections, septicaemia and intra-abdominal infections. For hospitalized patients, the median hospital length of stay was 23 days and the average mortality rate during hospitalization was 13% (Confidence Interval 95%: 7-19). Escherichia coli, by far, accounted as the most common ESBL-producing Enterobacteriaceae species (77/114; [68%]) while CTX-M-1 group was by far the most prevalent ESBL enzyme (n = 56). CONCLUSION: **In this retrospective study, the clinical profiles of patients carrying healthcare-associated ESBL-producing Enterobacteriacae is characterized by a high prevalence rate of several major co-morbidities and potential known risk factors. Both, the length of hospital stay and overall hospital mortality rates were particularly high.** A prospective case-control matched study should be designed and performed in order to control for possible inclusion bias.

12. Tumbarello M, Trecarichi EM, Bassetti M, De Rosa FG, Spanu T, Di ME, et al. Identifying patients harboring extended-spectrum-beta-lactamase-producing Enterobacteriaceae on hospital admission: derivation and validation of a scoring system. Antimicrob Agents Chemother [Internet]. 2011 Jul [cited 2012 Apr 25];55(7):3485-90. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3122446
PubMed: PM21537020

    Increases in community-acquired infections caused by extended-spectrum-beta-lactamase (ESBL)-producing Enterobacteriaceae have important implications for hospital infection control and empirical antibiotic therapy protocols. **We developed and validated a tool for identifying patients harboring these organisms at hospital admission.** We retrospectively analyzed chart data for 849 adult inpatients. The derivation cohort included 339 patients admitted to a large hospital in Rome during 2008, with (n = 113) or without (n = 226) culture positivity for ESBL-producing Escherichia coli, Klebsiella spp., or Proteus mirabilis within 48 h after admission. Logistic-regression-based prediction scores were calculated based on variables independently associated with the outcome. The model was validated in a second cohort (n = 510) selected with identical criteria in hospitals in Genoa and Turin during 2009. **Prediction scores were based on the following six variables (reported with odds ratio for study outcome and the 95% confidence intervals in brackets): recent (</= 12 months before admission) hospitalization (5.69 [2.94 to 10.99]), transfer from another health care facility (5.61 [1.65 to 19.08]), Charlson**

**comorbidity score >/= 4 (3.80 [1.90 to 7.59]), recent (</= 3 months before admission) beta-lactam and/or fluoroquinolone treatment (3.68 [1.96 to 6.91]), recent urinary catheterization (3.52 [1.96 to 6.91]), and age >/= 70 years (3.20 [1.79 to 5.70]).** The model displayed good calibration and good-to-excellent discrimination in the derivation and validation sets (Hosmer-Lemshow chi(2) = 15.28 and 14.07; P = 0.17 and 0.23; areas under the receiver-operating characteristic curve, 0.83 and 0.92). **It reliably identified patients likely to be harboring ESBL-producing Enterobacteriaceae at hospital admission who may need special infection control measures.** Further study is needed to confirm this model's potential as a guide for prescribing empirical antibiotic therapy.

13. Azim A, Dwivedi M, Rao PB, Baronia AK, Singh RK, Prasad KN, et al. Epidemiology of bacterial colonization at intensive care unit admission with emphasis on extended-spectrum beta-lactamase- and metallo-beta-lactamase-producing Gram-negative bacteria--an Indian experience. J Med Microbiol. 2010 Aug;59(Pt 8):955-60.
PubMed: PM20413621

**An important risk factor for nosocomial infection in an intensive care unit (ICU) is prior colonization. This study was undertaken to determine the spectrum of bacterial colonization and predisposing risk factors in patients being admitted to an ICU in India, with special emphasis on extended-spectrum beta-lactamase (ESBL)- and metallo-beta-lactamase (MBL)-producing Gram-negative bacteria.** Nasal, oral and rectal swab samples were collected and processed for isolation of ESBL-producing Gram-negative bacteria and MBL-producing Pseudomonas aeruginosa and Acinetobacter species. **Bacterial colonization (of one or more sites) on admission was detected in 51 out of 96 patients included in the study.** Non-fermenters, i.e. P. aeruginosa and Acinetobacter baumannii, were the most common colonizers, present in 37 patients, with simultaneous colonization in 12 patients. A total of 16 patients were colonized with MBL-producing members of the family Enterobacteriaceae, out of which 11 isolates (from 5 patients) were also carrying ESBL-encoding genes. As for MBLs, most of our patients have shown colonization with ESBL-producing bacteria. **On admission, 47 of 51 patients (92 %) have been colonized by ESBL-producing members of the family Enterobacteriaceae, at one or more of the three anatomical sites.** The most common MBL subtype was bla(IMP) (51.56 %), whereas bla(CTX) was the most common gene (84.9 %) identified among ESBL producers. **Risk factors for colonization on admission to the ICU were hospitalization for more than 48 h, use of >or=3 groups of antibiotics, co-morbidities and mechanical ventilation for more than 48 h prior to ICU admission.** There is an increasing incidence of MBLs and ESBLs in the Indian population. The identified risk factors can be used as a guide for empiric antibiotic therapy targeted to these resistant bacteria.

14. Levy SS, Mello MJ, Gusmao-Filho FA, Correia JB. Colonisation by extended-spectrum beta-lactamase-producing Klebsiella spp. in a paediatric intensive care unit. J Hosp Infect. 2010 Sep;76(1):66-9.
PubMed: PM20621392

**A prospective cohort study was performed in order to study the incidence and risk factors for bacterial colonisation with extended-spectrum producing beta-lactamase (ESBL) Klebsiella spp. in children.** The study took place in a paediatric intensive care unit (PICU) in Recife, Brazil over a five-month period in 2008. Rectal swabs were collected during the first 24h of admission and on the 2nd, 5th, 7th and 14th days of PICU stay.

ESBL-producing strains of Klebsiella spp. were detected by Kirby-Bauer disc diffusion and confirmed by double disc synergy testing. A total of 186 children were enrolled with a median age of three years. **The overall colonisation rate with ESBL-producing Klebsiella spp. was 14%, but 13 (7%) children were already colonised upon admission.** The incidence density of colonisation during PICU admission was 14.2 per 1000 patient-days. **On multivariable analysis, the use of third generation cephalosporins (P=0.008) was a risk factor for colonisation. Survival analysis revealed an increase in the accumulated risk of colonisation with an increase in length of stay in the PICU.** The present study provides baseline information to guide improved practices in similar settings and direct future studies in relation to the magnitude of cross-infection and effectiveness of infection control interventions.

15. Lo WU, Ho PL, Chow KH, Lai EL, Yeung F, Chiu SS. Fecal carriage of CTXM type extended-spectrum beta-lactamase-producing organisms by children and their household contacts. J Infect. 2010 Apr;60(4):286-92.
PubMed: PM20144898

OBJECTIVES: **To investigate the epidemiology of fecal carriage of CTX-M type extended-spectrum beta-lactamases (ESBL)-producing organisms among children and their household contacts.** METHODS: Fecal carriage with CTX-M-producing organisms was studied in 53 children and 172 household members. Molecular methods were used to characterize the isolates. RESULTS: The children were mostly healthy and hospitalized for relatively mild febrile illnesses. **Overall, the prevalence of fecal carriage of CTX-M-producing bacteria was 43.5% (admission children, 37.7%; household children, 20.7% and household adults, 50.3%). Household colonization index (defined by number of household carriers/total number of members) was significantly higher among families with at least one individual having a history of prolonged (>3 months) out-of-town residence in the previous year** (mean+/-standard deviation; yes group, 0.67+/-0.36 vs. no group, 0.39+/-0.28, P=0.009) **and was inversely correlated with the living space per person** (R-square=0.139, P=0.006). Among 29 households with at least two carriers of CTX-M-producing enterobacteria, six clusters of clonally related strains were shared by 15 individuals from seven households; with both intra- and inter-household transmission. CONCLUSION: **CTX-M beta-lactamases may spread extensively amongst family members in the home.**

16. March A, Aschbacher R, Dhanji H, Livermore DM, Bottcher A, Sleghel F, et al. Colonization of residents and staff of a long-term-care facility and adjacent acute-care hospital geriatric unit by multiresistant bacteria. Clin Microbiol Infect. 2010 Jul;16(7):934-44.
PubMed: PM19686277

Long-term-care facilities (LTCFs) are reservoirs of resistant bacteria. **We undertook a point-prevalence survey and risk factor analysis for specific resistance types among residents and staff of a Bolzano LTCF and among geriatric unit patients in the associated acute-care hospital.** Urine samples and rectal, inguinal, oropharyngeal and nasal swabs were plated on chromogenic agar; isolates were typed by pulsed-field gel electrophoresis; resistance genes and links to insertion sequences were sought by PCR; plasmids were analysed by PCR, restriction fragment length polymorphism and incompatibility grouping. Demographic data were collected. **Of the LTCF residents, 74.8% were colonized with >/=1 resistant organism, 64% with extended-spectrum**

**beta-lactamase (ESBL) producers, 38.7% with methicillin-resistant Staphylococcus aureus (MRSA), 6.3% with metallo-beta-lactamase (MBL) producers, and 2.7% with vancomycin-resistant enterococci. Corresponding rates for LTCF staff were 27.5%, 14.5%, 14.5%, 1.5% and 0%, respectively. Colonization frequencies for geriatric unit patients were lower than for those in the LTCF.** Both clonal spread and plasmid transfer were implicated in the dissemination of MBL producers that harboured IncN plasmids bearing bla(VIM-1), qnrS, and bla(SHV-12). Most (44/45) ESBL-producing Escherichia coli isolates had bla(CTX-M) genes of group 1; a few had bla(CTX-M) genes of group 9 or bla(SHV-5); those with bla(CTX-M-15) or bla(SHV-5) were clonal. **Risk factors for colonization of LTCF residents with resistant bacteria included age >/=86 years, antibiotic treatment in the previous 3 months, indwelling devices, chronic obstructive pulmonary disease, physical disability, and the particular LTCF unit; those for geriatric unit patients were age and dementia.** In conclusion, ESBL-producing and MBL-producing Enterobacteriaceae and MRSA were prevalent among the LTCF residents and staff, but less so in the hospital geriatric unit. Education of LTCF employees and better infection control are proposed to minimize the spread of resistant bacteria in the facility.

17. Tande D, Boisrame-Gastrin S, Munck MR, Hery-Arnaud G, Gouriou S, Jallot N, et al. Intrafamilial transmission of extended-spectrum-beta-lactamase-producing Escherichia coli and Salmonella enterica Babelsberg among the families of internationally adopted children. J Antimicrob Chemother. 2010 May;65(5):859-65.
PubMed: PM20233775

OBJECTIVES: International adoption from developing countries has become an increasing phenomenon in recent years. **Given the high prevalence of multidrug-resistant (MDR) bacteria in these countries, the adopted children represent a group at risk for both carriage and infection with MDR bacteria. The dynamics of intrafamilial transmission of MDR bacteria after adoption was studied in a prospective study from January 2002 to January 2005.** METHODS: Stool samples, taken at the first visit to the outpatient adoption practice and subsequently every month, from the adopted children of an orphanage of Bamako (Mali) and from all the members of their adoptive families were screened for MDR bacteria and bacterial pathogens. Bacteria were characterized by standard biochemical methods, disc diffusion antibiograms, PFGE and plasmid analysis. beta-Lactamase genes were sought by PCR. RESULTS: **Over the study period, 52 ESBL-producing Enterobacteriaceae (E-ESBL), with Escherichia coli (56%) being the most prevalent, were isolated from 24/25 adoptees at arrival in France. During follow-up, the transmission of ESBL-producing E. coli and Salmonella enterica Babelsberg between the adoptees and their adoptive family members has clearly been demonstrated for 5/22 families (23%). The mean duration of the carriage for the adopted children was 9 months (1-15 months).** CTX-M-15 was the most prevalent resistance gene among the E-ESBLs (93%), while SHV-12 was found among the S. enterica Babelsberg studied. CONCLUSIONS: **International travellers, transfer of patients and now adoption may contribute to the global emergence of MDR bacteria. Thus, in addition to the usual screening of adopted children for infectious diseases, additional screening for MDR bacteria should be recommended, at least for children coming from countries with a high prevalence of MDR bacteria.**

18. Tangden T, Cars O, Melhus A, Lowdin E. Foreign travel is a major risk factor for colonization with Escherichia coli producing CTX-M-type extended-spectrum beta-lactamases: a prospective study with Swedish volunteers. Antimicrob Agents Chemother [Internet]. 2010 Sep [cited 2012 Apr 25];54(9):3564-8. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2934993
PubMed: PM20547788

**Foreign travel has been suggested to be a risk factor for the acquisition of extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae.** To our knowledge, this has not previously been demonstrated in a prospective study. Healthy volunteers traveling outside Northern Europe were enrolled. Rectal swabs and data on potential travel-associated risk factors were collected before and after traveling. A total of 105 volunteers were enrolled. Four of them did not complete the study, and one participant carried ESBL-producing Escherichia coli before travel. **Twenty-four of 100 participants with negative pretravel samples were colonized with ESBL-producing Escherichia coli after the trip.** All strains produced CTX-M enzymes, mostly CTX-M-15, and some coproduced TEM or SHV enzymes. Coresistance to several antibiotic subclasses was common. **Travel to India was associated with the highest risk for the acquisition of ESBLs (88%; n = 7). Gastroenteritis during the trip was an additional risk factor (P = 0.003). Five of 21 volunteers who completed the follow-up after 6 months had persistent colonization with ESBLs.** This is the first prospective study demonstrating that international travel is a major risk factor for colonization with ESBL-producing Enterobacteriaceae. Considering the high acquisition rate of 24%, it is obvious that global efforts are needed to meet the emergence and spread of CTX-M enzymes and other antimicrobial resistances.

19. Cohen MJ, Adler A, Block C, Gross I, Minster N, Roval V, et al. Acquisition of vancomycin-resistant enterococci in internal medicine wards. Am J Infect Control. 2009 Mar;37(2):111-6.
PubMed: PM18986736

BACKGROUND: Our institution experienced an increase in the frequency of vancomycin-resistant enterococci (VRE) clinical isolates, which rose 5-fold from 2004 to 2005. **We sought to measure the prevalence of VRE carriage among medical inpatients in a tertiary hospital in Jerusalem and estimate the rate of acquisition during hospitalization.** METHODS: During 2006, we performed 3 cross-sectional surveys, including 1039 patients, representing 3 phases of hospitalization: admission, hospital stay, and discharge. Perianal/stool samples were cultured for VRE. RESULTS: **VRE carriage was 3.8% (95% confidence interval [CI] = 1.8% to 6.9%) on admission, 15% (95% CI = 9% to 23%) at discharge, and 32% (95% CI = 24% to 40%) among inpatients.** Among inpatient carriers, 60% of the isolates represented a single strain. **Recent previous hospitalization was the most significant predictor for identifying carriers on admission.** CONCLUSIONS: Our study demonstrates that substantial VRE transmission occurred during hospitalization. Identification of carriers on admission should supplement effective application of infection control methods in attempting to decrease VRE nosocomial spread and burden.

20. Friedmann R, Raveh D, Zartzer E, Rudensky B, Broide E, Attias D, et al. Prospective evaluation of colonization with extended-spectrum beta-lactamase (ESBL)-producing enterobacteriaceae among patients at hospital admission and of subsequent colonization

with ESBL-producing enterobacteriaceae among patients during hospitalization. Infect Control Hosp Epidemiol. 2009 Jun;30(6):534-42.
PubMed: PM19419270

OBJECTIVE: **To determine the rates of and risk factors for carriage and acquisition of extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae during hospitalization.** DESIGN: Cohort study. SETTING: Shaare Zedek Medical Center, a 550-bed teaching hospital. METHODS: During a 5-month period (February 1-June 30, 2004), 167 (8%) of 1,985 newly admitted general medical patients were enrolled in our study. Nasal, oropharyngeal, and rectal swab specimens were obtained at admission and every 2-3 days until hospital discharge or death. Enterobacteriaceae isolates were tested for ESBL, and Staphylococcus aureus isolates were tested for methicillin resistance. RESULTS: **Of the 167 patients enrolled in our study, 15 (9%) were identified as nasal carriers of methicillin-resistant S. aureus (MRSA) at admission, and 13 (8%) were rectal carriers of ESBL-producing Enterobacteriaceae at admission. Univariate risk factors for rectal carriage of ESBL-producing Enterobacteriaceae included female sex (odds ratio [OR], 11 [95% confidence interval {CI}, 1.4-238]; P < .05), nursing home residence (OR, 6.9 [95% CI, 1.8-27]; P < .01), recent antibiotic treatment (OR, 9.8 [95% CI, 1.7-74]; P < .05), and concomitant nasal carriage of MRSA and/or ESBL-producing Enterobacteriaceae (OR, 5.8 [95% CI, 1.2-26]; P < .01). Multivariate risk factors were female sex and recent antibiotic treatment.** During hospitalization, 35 (21%) of 167 patients had acquired rectal carriage of ESBL-producing Enterobacteriaceae (P = .002, for trend analysis). **Of the 12 patients who were still in the hospital 2 weeks after admission, 4 (33%) were carriers of ESBL-producing Enterobacteriaceae. Univariate risk factors for acquisition included an age of older than 65 years (P < .005), nursing home residence (OR 2.6, [95% CI, 0.98-2.6]), impaired cognition (OR, 4.8 [95% CI, 1.9-12]), recent antibiotic treatment (OR, 2.7 [95% CI, 0.9-8.3]), respiratory assistance (OR, 4.2 [95% CI, 1.2-14]), and prolonged hospitalization. Multivariate risk factors were an age of older than 65 years and broad-spectrum antibiotic therapy.** CONCLUSIONS: Rectal carriage of ESBL-producing Enterobacteriaceae occurred in 13 (8%) of 167 patients at admission to the medical departments of our hospital and in 4 (33%) of 12 patients still remaining in our hospital after 2 weeks.

21. Nolan SM, Gerber JS, Zaoutis T, Prasad P, Rettig S, Gross K, et al. Outbreak of vancomycin-resistant enterococcus colonization among pediatric oncology patients. Infect Control Hosp Epidemiol [Internet]. 2009 Apr [cited 2012 Apr 25];30(4):338-45. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2900794
PubMed: PM19239375

OBJECTIVE: **To detect the burden of vancomycin-resistant Enterococcus (VRE) colonization among pediatric oncology patients and to determine risk factors for VRE acquisition.** DESIGN: Retrospective case-control study. SETTING: The Children's Hospital of Philadelphia. PATIENTS: Pediatric oncology patients hospitalized from June 2006 through December 2007. METHODS: Prevalence surveys revealed an increased VRE burden among pediatric oncology patients. For the case-control study, the 16 case patients were pediatric oncology patients who had 1 stool sample negative for VRE at screening before having a stool sample positive for VRE at screening; the 62 control patients had 2 consecutive screenings in which stool samples were negative for VRE. Case and control patients were matched on the duration of the interval between screens.

Analyses were performed to determine the association between multiple exposures and VRE acquisition. RESULTS: **The prevalence survey revealed that 5 (9.6%) of 52 patients had unsuspected VRE colonization at the time of hospitalization. Multivariate analysis identified a lack of empirical contact precautions (odds ratio [OR], 17.16 [95% confidence interval {CI}, 1.49-198.21]; P= .02) and the presence of a gastrointestinal device (OR, 4.03 [95% CI, 1.04-15.56]; P= .04) as significant risk factors for acquisition of VRE.** Observations in the interventional radiology department revealed that staff could not access the portions of the electronic medical record in which isolation precautions were documented. Simple interventions that granted access and that trained interventional radiology staff to review the need for precautions, coupled with enhanced infection control practices, interrupted ongoing transmission and reduced the proportion of VRE screens that were positive to 15 (1.2%) of 1,270. CONCLUSIONS: Inadequate communication with regard to infection control precautions can increase the risk of transmission of epidemiologically important organisms, particularly when patients receive care at multiple clinic locations. Adherence to infection control practices across the spectrum of care may limit the spread of resistant organisms.

22. Rooney PJ, O'Leary MC, Loughrey AC, McCalmont M, Smyth B, Donaghy P, et al. Nursing homes as a reservoir of extended-spectrum beta-lactamase (ESBL)-producing ciprofloxacin-resistant Escherichia coli. J Antimicrob Chemother. 2009 Sep;64(3):635-41. PubMed: PM19549667

    BACKGROUND: **To assess the prevalence and risk factors for faecal carriage of fluoroquinolone-resistant, extended-spectrum beta-lactamase (ESBL)-producing, Escherichia coli (MDR E. coli) among residents in nursing homes in Northern Ireland.** METHODS: Between January 2004 and May 2006, retrospective histories of hospital admissions, antimicrobial treatment and co-morbidities were collected. Faecal samples were cultured for MDR E. coli. These isolates and their ESBL genes were typed by a reference laboratory. RESULTS: **Of the 294 patients included in the study, faecal samples from 119 (40.5%) grew MDR E. coli.** The proportion of carriers in the different homes ranged from 0% to 75%. Epidemic strain A belonging to the ST131, O25:H4 lineage with the CTX-M-15 enzyme accounted for 58 (49%) of all isolates; its proportion varied from 0% to 100% among homes. **Fifty-one percent of carriers had no history of recent hospital admission and only 13.5% had a known history of ESBL E. coli colonization or infection. In a multivariate logistic regression model, days of fluoroquinolone use [odds ratio (OR) = 1.33, 95% confidence interval (CI) 1.04-1.69, P = 0.02] and a history of urinary tract infection (OR = 2.56, 95% CI 1.37-4.78, P = 0.003) were the only variables independently associated with the risk of carrying MDR E. coli.** CONCLUSIONS: The high level of faecal carriage of MDR E. coli in nursing home residents demonstrates their importance as a reservoir population. Public health measures to combat spread of these organisms should address the needs of this group.

23. Song JY, Cheong HJ, Jo YM, Choi WS, Noh JY, Heo JY, et al. Vancomycin-resistant Enterococcus colonization before admission to the intensive care unit: a clinico-epidemiologic analysis. Am J Infect Control. 2009 Nov;37(9):734-40. PubMed: PM19188004

    BACKGROUND: **Asymptomatic vancomycin-resistant Enterococcus (VRE) colonization is known to precede actual infection.** Since VRE was first isolated in Korea in 1992, the VRE isolation rate has rapidly increased in tertiary hospitals.

METHODS: **We performed a prospective observational study to estimate the prevalence of VRE colonization among inpatients at the time of intensive care unit (ICU) admission.** From March through December 2007, rectal swab cultures were taken in all patients admitted to the ICU. We aimed to identify the risk factors for VRE colonization on admission. RESULTS: **During the study period, 34 (4.4%) out of 780 patients were already colonized with VRE before ICU admission: 21 out of 323 patients from general wards (6.5%) and 13 out of 437 patients from outside the hospital (2.97%). VRE-colonized patients were more likely than uncolonized patients to have infectious diseases and to have been referred from outside hospitals (P < .01). Previous hospitalization (P = .01) and antibiotic exposure (P < .01) were risk factors for VRE colonization before ICU admission.** Pulsed-field gel electrophoresis patterns were diverse. Initial VRE colonization correlated to poor prognosis. CONCLUSION: VRE colonization rate was not negligible among newly admitted ICU patients, suggesting that an active surveillance program focusing on high-risk groups may be helpful.

24. Souli M, Sakka V, Galani I, Antoniadou A, Galani L, Siafakas N, et al. Colonisation with vancomycin- and linezolid-resistant Enterococcus faecium in a university hospital: molecular epidemiology and risk factor analysis. Int J Antimicrob Agents. 2009 Feb;33(2):137-42.
PubMed: PM19013056

**During a hospital-wide prospective point prevalence survey of faecal carriage and environmental colonisation of vancomycin-resistant enterococci in a tertiary care university hospital in Athens (Greece), five clinical and one environmental isolate from a light switch (all in the haematology ward) were identified as vancomycin- and linezolid-resistant vanA-positive Enterococcus faecium (VLRE).** The studied isolates exhibited a linezolid minimum inhibitory concentration of 12microg/mL and carried at least one mutated copy of the 23S rRNA gene, as shown by polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) analysis to detect the G2576T mutation. The enterococcal surface protein (esp) gene was detected by PCR in all isolates. Molecular typing with pulsed field gel electrophoresis (PFGE) showed that the environmental and four of the five clinical isolates were genetically related. None of the colonised patients were previously exposed to linezolid, although heavy linezolid use was noted in the institution. **A case-control study was performed to assess risk factors for VLRE colonisation. In univariate analysis, immunodeficiency, underlying haematological malignancy, duration of any antimicrobial treatment before VLRE isolation, and hospitalisation in the haematology ward were pointed out as possible risk factors**. A multidisciplinary approach including intensified hand hygiene, patient contact isolation, disinfection of the inanimate environment and antibiotic restriction resulted in early containment of the VLRE colonisation outbreak.

25. Tacconelli E, De AG, Cataldo MA, Mantengoli E, Spanu T, Pan A, et al. Antibiotic usage and risk of colonization and infection with antibiotic-resistant bacteria: a hospital population-based study. Antimicrob Agents Chemother [Internet]. 2009 Oct [cited 2012 Apr 25];53(10):4264-9. Available from:
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2764223
PubMed: PM19667289

**Accurate assessment of risk factors for nosocomial acquisition of colonization by**

**antibiotic-resistant bacteria (ARB) is often confounded by scarce data on antibiotic use. A 12-month, nested, multicenter cohort study was conducted. Target ARB were methicillin (meticillin)-resistant Staphylococcus aureus (MRSA), vancomycin-resistant enterococci (VRE), and ciprofloxacin-resistant Pseudomonas aeruginosa (CR-PA).** Nares and rectal swabs were obtained before and after starting antibiotics. Pulsed-field gel electrophoresis was done to define genetic relatedness of the strains. Primary outcomes were (i) the mean time, in days, for acquisition of target ARB colonization in patients previously not colonized; (ii) the rate of acquisition per 1,000 antibiotic-days according to different classes of antibiotics; (iii) the rate of infection caused by the same bacteria as those previously isolated in screening samples; and (iv) the risk factors for ARB acquisition. In total, 6,245 swabs from 864 inpatients were processed. **The rate of acquisition was 3%, 2%, and 1% for MRSA, VRE, and CR-PA, respectively.** The rate of acquisition of ARB per 1,000 antibiotic-days was 14 for carbapenems, 9 for glycopeptides, and 6 for broad-spectrum cephalosporins and quinolones. The highest rates of acquisition were observed for carbapenems in dialyzed and diabetic patients. **Four risk factors were independently associated with acquisition of target ARB: use of carbapenems, age of >70 years, hospitalization for >16 days, and human immunodeficiency virus infection**. **During the 30-day follow-up, 4 among 42 patients newly colonized by ARB (9%) suffered from an infection due to the same bacteria as those isolated in a previous screening sample.** Colonizing and infecting strains from single patients were genotypically identical. Identifying ARB colonization early during antibiotic therapy could target a high-risk hospitalized population that may benefit from intervention to decrease the risk of subsequent nosocomial infections.

26. Askarian M, Afkhamzadeh R, Monabbati A, Daxboeck F, Assadian O. Risk factors for rectal colonization with vancomycin-resistant enterococci in Shiraz, Iran. Int J Infect Dis. 2008 Mar;12(2):171-5.
PubMed: PM17855141

OBJECTIVES: **In order to determine the risk factors for rectal colonization with vancomycin-resistant enterococci (VRE) at the Shiraz Namazi Hospital, we performed a nested case-control study.** METHODS: From December 2003 to July 2004 rectal swabs were taken from 700 randomly selected hospitalized patients every 5 days. RESULTS: **A total of 99 of the 700 patients (14%) were colonized with VRE (cases) and 59 patients were colonized with vancomycin-sensitive strains (VSE), serving as controls. In the univariate analysis, history of antibiotic use (p=0.04), underlying disease (p=0.013), hemodialysis (p=0.03), use of third generation cephalosporins (p=0.04), use of vancomycin (p=0.04), and duration of vancomycin therapy longer than 7 days (p=0.02) were significantly associated with VRE colonization. In a multivariate analysis, underlying disease and the duration of vancomycin use longer than 7 days were independently associated with VRE colonization.** CONCLUSION: Our study, the first on VRE carriage in Iran, demonstrates that VRE prevalence is high in Shiraz and confirms earlier observations in other countries. The identified risk factor 'use of vancomycin longer than 7 days' may be avoidable, indicating a feasible intervention strategy in the control of VRE.

27. Rodriguez-Bano J, Lopez-Cerero L, Navarro MD, az de AP, Pascual A. Faecal carriage of extended-spectrum beta-lactamase-producing Escherichia coli: prevalence, risk factors and molecular epidemiology. J Antimicrob Chemother. 2008 Nov;62(5):1142-9.
PubMed: PM18641033

OBJECTIVES: **The aim of this study was to investigate the epidemiology of faecal carriage of extended-spectrum beta-lactamase (ESBL)-producing Escherichia coli in the community.** PATIENTS AND METHODS: Faecal carriage with ESBL-producing E. coli was studied in 53 outpatients with urinary tract infection (UTI) due to these organisms, 73 household members, 32 non-household relatives and 54 unrelated patients. Clonal relatedness of the isolates was investigated using repetitive extragenic palindromic-PCR and PFGE, and ESBLs were characterized by PCR and sequencing. **Multivariate analysis was performed to investigate risk factors for faecal carriage.** RESULTS: **The prevalence of faecal carriage was 67.9% in patients with UTI, 27.4% in household members, 15.6% in non-household relatives and 7.4% in unrelated patients. Being a relative of a patient with UTI was independently associated with an increased risk of being a carrier. Among the relatives, multivariate analysis showed that those eating their main meal outside their own home >15 days during the previous month were less likely to be faecal carriers (OR = 0.2; 95% CI: 0.06-0.6; P = 0.007).** The faecal isolates of patients with UTI were CTX-M-producers in 66.6% and SHV-producers in 33.3% of the cases, while the percentages for other population groups were 40% to 55.5% and 50% to 75%, respectively. **Of the 19 families with >1 carrier member, 8 families had 2 members who shared clonally related isolates, 8 families had 2 members carrying different clones producing the same enzymes and there were 3 families where all members had different enzyme-producing clones.** CONCLUSIONS: **Our results suggest that both acquisition from a common source and person-to-person transmission might contribute to ESBL dissemination.**

28. Tian SF, Chen BY, Chu YZ, Wang S. Prevalence of rectal carriage of extended-spectrum beta-lactamase-producing Escherichia coli among elderly people in community settings in China. Can J Microbiol. 2008 Sep;54(9):781-5.
PubMed: PM18772941

The importance of community-acquired infections due to extended-spectrum beta-lactamase-producing (ESBL) Escherichia coli has been increasingly recognized in recent years. **No comprehensive data are available on the prevalence, risk factors, and genotypes of ESBL production in community residents in China.** Rectal samples from 270 elderly people were collected in four communities in Shenyang (China). Colonies were screened by double-disk synergy test for ESBL production and then, ESBLs were characterized by PCR and sequencing. The clonal relatedness of all ESBL-producing isolates was determined by pulsed-field gel electrophoresis. **Potential risk factors for rectal carriage of ESBL producers were examined by multivariate analysis. The prevalence of rectal carriage of ESBL-producing E. coli was 7.0%.** All 19 ESBL-producing isolates produced CTX-M-type ESBLs, including CTX-M-14 (11 strains), CTX-M-22 (3 strains), CTX-M-79 (3 strains), CTX-M-24 (1 strain), and CTX-M-24 and CTX-M-79 together (1 strain). CTX-M-79 ESBL was first detected worldwide. ESBL-producing strains were clonally unrelated. **Appearance of ESBL producers is strongly associated with the use of antibiotics in the past 3 months (odds ratio 3.2, 95% CI 1.1-9.0, P = 0.03).** Our results show the importance of the intestinal tract as a reservoir for ESBL-producing isolates in community settings in China and that the use of antibiotics in the past 3 months is clearly linked to rectal carriage of ESBL producers.

29. Assadian O, Askarian M, Stadler M, Shaghaghian S. Prevalence of vancomycin-resistant enterococci colonization and its risk factors in chronic hemodialysis patients in Shiraz,

Iran. BMC Infect Dis [Internet]. 2007 [cited 2012 Apr 25];7:52. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1894971
PubMed: PM17553129

BACKGROUND: Vancomycin-resistant entrococci (VRE) are increasing in prevalence at many institutions, and are often reported in dialysis patients. **The aim of this cross-sectional prevalence study was to determine the prevalence and risk factors of VRE colonization in chronic hemodialysis patients in two hemodialysis centers in Shiraz, Iran.** METHODS: Rectal swabs were obtained from all consenting patients and were streaked on the surface of Cephalexin-aztreonam-arabinose agar (CAA) and incubated at 37 degrees C in air for 24 h. The vancomycin susceptibility of each isolate was confirmed by disk susceptibility testing. The MICs of vancomycin and teicoplanin were confirmed by the E test. To identify risk factors, a questionnaire was completed for all the studied patients and the data of VRE positive and negative groups were compared using Man-Withney U test for continues data and the Fisher exact test for categorical data. RESULTS: **Of 146 patients investigated, 9 (6.2%) were positive for VRE.** All VRE strains were genotypically distinguishable. **Risk factors for a VRE-positive culture were "antimicrobial receipt within 2 months before culture" (P = 0.003) and "hospitalization during previous year" (P = 0.016).** CONCLUSION: VRE colonization is an under-recognized problem among chronic dialysis patients in Iran. VRE colonization is associated with antibiotic consumption and hospitalization.

30. Hadley AC, Karchmer TB, Russell GB, McBride DG, Freedman BI. The prevalence of resistant bacterial colonization in chronic hemodialysis patients. Am J Nephrol. 2007;27(4):352-9.
PubMed: PM17541264

BACKGROUND: **Hospitalized dialysis patients are at increased risk for colonization and infection with resistant bacterial strains.** METHODS: **We performed a cross-sectional analysis of the prevalence of methicillin-resistant Staphylococcus aureus (MRSA) and vancomycin-resistant Enterococcus (VRE) colonization in 198 hemodialysis outpatients, 75 of whom had longitudinal screening data from prior hospitalization.** Nasal specimens for MRSA, perirectal specimens for VRE, and permanent catheter exit site specimens were collected. RESULTS: MRSA colonization was present in 5.6% and VRE colonization in 3.14%. Univariate analyses revealed that prior exposure (defined as infection/colonization) with MRSA, hospitalization, and low serum albumin were associated with MRSA colonization. **VRE colonization was associated with hospitalization, prior VRE or MRSA exposure, low serum albumin, and low ferritin.** Multivariate analyses revealed MRSA colonization was predicted by prior MRSA exposure and **VRE colonization was predicted by prior VRE exposure and number of hospitalizations.** Among the 75 participants with longitudinal screening data, MRSA colonization was associated with prior MRSA history, and VRE colonization was associated with prior MRSA or VRE. CONCLUSIONS: Generally low rates of MRSA and VRE colonization were observed in hemodialysis outpatients. Prior hospital screening was predictive of future outpatient colonization and may be useful in risk assessment.

31. Harris AD, McGregor JC, Johnson JA, Strauss SM, Moore AC, Standiford HC, et al. Risk factors for colonization with extended-spectrum beta-lactamase-producing bacteria and intensive care unit admission. Emerg Infect Dis [Internet]. 2007 Aug [cited 2012 Apr 25];13(8):1144-9. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2828082

PubMed: PM17953083

Extended-spectrum beta-lactamase (ESBL)-producing bacteria are emerging pathogens. To analyze risk factors for colonization with ESBL-producing bacteria at intensive care unit (ICU) admission, we conducted a prospective study of a 3.5-year cohort of patients admitted to medical and surgical ICUs at the University of Maryland Medical Center. **Over the study period, admission cultures were obtained from 5,209 patients. Of these, 117 were colonized with ESBL-producing Escherichia coli and Klebsiella spp., and 29 (25%) had a subsequent ESBL-positive clinical culture. Multivariable analysis showed the following to be statistically associated with ESBL colonization at admission: piperacillin-tazobactam (odds ratio [OR] 2.05, 95% confidence interval [CI] 1.36-3.10), vancomycin (OR 2.11, 95% CI 1.34-3.31), age > 60 years (OR 1.79, 95% CI 1.24-2.60), and chronic disease score (OR 1.15; 95% CI 1.04-1.27).** Coexisting conditions and previous antimicrobial drug exposure are thus predictive of colonization, and a large percentage of these patients have subsequent positive clinical cultures for ESBL-producing bacteria.

32. Hufnagel M, Liese C, Loescher C, Kunze M, Proempeler H, Berner R, et al. Enterococcal colonization of infants in a neonatal intensive care unit: associated predictors, risk factors and seasonal patterns. BMC Infect Dis [Internet]. 2007 [cited 2012 Apr 25];7:107. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2077867
PubMed: PM17868474

BACKGROUND: During and shortly after birth, newborn infants are colonized with enterococci. This study analyzes predictors for early enterococcal colonization of infants in a neonatal intensive care unit and describes risk factors associated with multidrugresistant enterococci colonization and its seasonal patterns. METHODS: Over a 12-month period, we performed a prospective epidemiological study in 274 infants admitted to a neonatal intensive care unit. On the first day of life, we compared infants with enterococcal isolates detected in meconium or body cultures to those without. We then tested the association of enterococcal colonization with peripartal predictors/risk factors by using bivariate and multivariate statistical methods. RESULTS: Twenty-three percent of the infants were colonized with enterococci. The three most common enterococcal species were E. faecium (48% of isolates), E. casseliflavus (25%) and E. faecalis (13%). Fifty-seven percent of the enterococci found were resistant to three of five antibiotic classes, but no vancomycin-resistant isolates were observed. **During winter/spring months, the number of enterococci and multidrug-resistant enterococci were higher than in summer/fall months (p = 0.002 and p < 0.0001, respectively). With respect to enterococcal colonization on the first day of life, predictors were prematurity (p = 0.043) and low birth weight (p = 0.011). With respect to colonization with multidrug-resistant enterococci, risk factors were prematurity (p = 0.0006), low birth weight (p < 0.0001) and prepartal antibiotic treatment (p = 0.019). Using logistic regression, we determined that gestational age was the only parameter significantly correlated with multidrug-resistant enterococci colonization.** No infection with enterococci or multidrugresistant enterococci in the infants was detected. The outcome of infants with and without enterococcal colonization was the same with respect to death, necrotizing enterocolitis, intracerebral hemorrhage and bronchopulmonary dysplasia. CONCLUSION: In neonatal intensive care units, an infant's susceptibility to early colonization with enterococci in general, and his or her risk for colonization with multidrug-resistant enterococci in particular, is increased in preterm newborns, especially during the

winter/spring months. The prepartal use of antibiotics with no known activity against enterococci appears to increase the risk for colonization with multidrug-resistant enterococci.

33. Yang KS, Fong YT, Lee HY, Kurup A, Koh TH, Koh D, et al. Predictors of vancomycin-resistant enterococcus (VRE) carriage in the first major VRE outbreak in Singapore. Ann Acad Med Singapore. 2007 Jun;36(6):379-83.
PubMed: PM17597959

INTRODUCTION: Until recently, vancomycin-resistant enterococcus (VRE) infection or colonisation was a rare occurrence in Singapore. The first major VRE outbreak involving a 1500-bed tertiary care institution in March 2005 presented major challenges in infection control and came at high costs. **This study evaluates the predictors of VRE carriage based on patients' clinical and demographic profiles.** MATERIALS AND METHODS: Study patients were selected from the hospital inpatient census population during the VRE outbreak (aged 16 years or more). Clinical information from 84 cases and 377 controls were analysed. RESULTS: **Significant predictors of VRE carriage included: age>65 years Odds ratio (OR), 1.98; 95% CI (confidence interval), 1.14 to 3.43); female gender (OR, 2.15; 95% CI, 1.27 to 3.65); history of diabetes mellitus (OR, 1.94; 95% CI, 1.14 to 3.30), and staying in a crowded communal ward (OR, 2.75; 95% CI, 1.60 to 4.74). Each additional day of recent hospital stay also posed increased risk (OR, 1.03; 95% CI, 1.01 to 1.04).** CONCLUSION: Elderly diabetic females with prolonged hospitalisation in crowded communal wards formed the profile that significantly predicted VRE carriage in this major hospital-wide outbreak of VRE in Singapore. It is imperative that active VRE surveillance and appropriate infection control measures be maintained in these wards to prevent future VRE outbreaks.

*Risk of infection in patients who are carriers of VRE and ESBL*

34. Kim YJ, Kim SI, Kim YR, Lee JY, Park YJ, Kang MW. Risk factors for vancomycin-resistant enterococci infection and mortality in colonized patients on intensive care unit admission. Am J Infect Control. 2012 Apr 6.
PubMed: PM22483236

This study examined the incidence of and risk factors for development of vancomycin-resistant enterococci (VRE) infection and death in VRE-colonized patients in a medical intensive care unit. **VRE colonization was identified in 184 patients (17.6%) in whom VRE perianal swab cultures were obtained. Of these, 28 (11.9%) developed VRE infection.** Control of infectious sources is crucial to decrease development of VRE infections and optimize the survival of VRE-colonized patients.

35. Bossaer JB, Hall PD, Garrett-Mayer E. Incidence of vancomycin-resistant enterococci (VRE) infection in high-risk febrile neutropenic patients colonized with VRE. Support Care Cancer. 2010 Feb;19(2):231-7.
PubMed: PM20069435

PURPOSE: **This study seeks to determine the incidence of vancomycin-resistant enterococci (VRE) infection in high-risk neutropenic fever patients colonized with VRE and to determine patient characteristics associated with VRE infection.** METHODS: We conducted a retrospective, single-center, unmatched case-control study.

**Fifty-three VRE-colonized, high-risk patients with neutropenic fever were identified between January 2006 and February 2009. The two most common diagnoses/conditions included acute myeloid leukemia and hematopoietic stem cell transplantation.** Data collected included days of neutropenia, days of fever, demographic data, culture results, and antimicrobial therapy. RESULTS: **Twenty of the 53 patients (38%) with VRE colonization developed a VRE infection.** The most common VRE infections were bacteremias (26%). **The presence of neutropenia lasting longer than 7 days was associated with the development of VRE infection in this high-risk population colonized with VRE.** The timeframe to develop VRE infection varied from 1 day to 2 weeks. CONCLUSION: For patients colonized with VRE, approximately 38% of high-risk neutropenic patients developed a VRE infection. This is the first study to specifically evaluate the incidence of VRE infections in febrile neutropenic patients colonized with VRE. Future research into the use and efficacy of empiric VRE coverage is needed.

36. Blaschke AJ, Korgenski EK, Daly JA, LaFleur B, Pavia AT, Byington CL. Extended-spectrum beta-lactamase-producing pathogens in a children's hospital: a 5-year experience. Am J Infect Control [Internet]. 2009 Aug [cited 2012 Apr 25];37(6):435-41. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2743748
PubMed: PM19155096

BACKGROUND: Pediatric infection with bacteria producing extended-spectrum beta-lactamases (ESBLs) has not been well described. **We sought to determine the proportion of isolates producing ESBLs and the incidence of infection or colonization with these organisms in our tertiary care pediatric facility over 5 years. In addition, we sought to evaluate the characteristics of children affected.** METHODS: We identified all Escherichia coli or Klebsiella spp cultured from children younger than 18 years of age at our facility between January 2003 and December 2007. Medical records were reviewed for affected children. RESULTS: **Of 2697 E coli, K pneumoniae, and K oxytoca cultured, 26 ESBL producers were isolated from 16 children.** Rates of ESBL production among cultured isolates significantly increased, from 0.53% in the first half of the study period to 1.4% in the second. Incidence of a primary ESBL infection also increased significantly, from 0.14/10,000 patient encounters to 0.31/10,000. **The majority of children infected or colonized with ESBL-producing organisms were those with chronic medical conditions, frequent hospitalizations, or a history of recurrent infection. However, 4 affected children were less than 5 months old and evaluated in an outpatient setting.** CONCLUSION: Rates and incidence of ESBL infection increased over the study period. **Whereas most patients belonged to traditional risk groups for antibiotic-resistant infection, infants in the ambulatory setting were also affected, an at-risk population not previously described.**

37. Se YB, Chun HJ, Yi HJ, Kim DW, Ko Y, Oh SJ. Incidence and risk factors of infection caused by vancomycin-resistant enterococcus colonization in neurosurgical intensive care unit patients. J Korean Neurosurg Soc [Internet]. 2009 Aug [cited 2012 Apr 25];46(2):123-9. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2744021
PubMed: PM19763214

OBJECTIVE: **This study was aimed to identify the incidence and risk factors of vancomycin-resistant enterococcus (VRE) colonization in neurosurgical practice of**

**field, with particular attention to intensive care unit (ICU).** METHODS: This retrospective study was carried out on the Neurosurgical ICU (NICU), during the period from January. 2005 to December. 2007, in 414 consecutive patients who had been admitted to the NICU. Demographics and known risk factors were retrieved and assessed by statistical methods. RESULTS: **A total of 52 patients had VRE colonization among 414 patients enrolled, with an overall prevalence rate of 6.1%.** E. faecium was the most frequently isolated pathogen, and 92.3% of all VRE were isolated from urine specimen. **Active infection was noticed only in 2 patients with bacteremia and meningitis.** Relative antibiotic agents were third-generation cephalosporin in 40%, and vancomycin in 23%, and multiple antibiotic usages were also identified in 13% of all cases. **Multivariate analyses showed Glasgow coma scale (GCS) score less than 8, placement of Foley catheter longer than 2 weeks, ICU stay over 2 weeks and presence of nearby VRE-positive patients had a significantly independent association with VRE infection.** CONCLUSION: When managing the high-risk patients being prone to be infected VRE in the NICU, extreme caution should be paid upon. Because prevention and outbreak control is of ultimate importance, clinicians should be alert the possibility of impending colonization and infection by all means available. The most crucial interventions are careful hand washing, strict glove handling, meticulous and active screening, and complete segregation.

38. Apisarnthanarak A, Kiratisin P, Mundy LM. Clinical and molecular epidemiology of healthcare-associated infections due to extended-spectrum beta-lactamase (ESBL)-producing strains of Escherichia coli and Klebsiella pneumoniae that harbor multiple ESBL genes. Infect Control Hosp Epidemiol. 2008 Nov;29(11):1026-34.
PubMed: PM18947321

OBJECTIVES: **To characterize healthcare-associated infections due to extended-spectrum beta-lactamase (ESBL)-producing strains of Escherichia coli and Klebsiella pneumoniae that harbor multiple ESBL genes, as opposed to a single ESBL gene.** METHODS: All patients with a confirmed healthcare-associated infection due to an ESBL-producing strain of E. coli or K. pneumoniae were enrolled in the study. Molecular typing of isolates was performed, and the comparative risks and outcomes of patients were analyzed. RESULTS: **Among 71 patients with healthcare-associated infection due to an ESBL-producing strain of E. coli or K. pneumoniae, the gene for CTX-M, with or without other ESBL genes, was identified in all 51 (100%) of the patients infected with an E. coli strain and in 18 (90%) of the 20 patients infected with a K. pneumoniae strain. Of these 71 patients, 17 (24%) met the definition of healthcare-associated infection due to an ESBL-producing strain that harbored multiple genes; in multivariate analysis, previous exposure to 3 or more classes of antibiotics (adjusted odds ratio, 4.5 [95% confidence interval, 1.7-75.2]) was the sole risk factor for healthcare-associated infection due to an ESBL-producing strain that harbored multiple ESBL genes.** Isolates recovered from patients with healthcare-associated infection due to an ESBL-producing strain that harbored multiple ESBL genes were more resistant to various antibiotic classes, and, compared with patients with healthcare-associated infection due to an ESBL-producing strain that harbored a single ESBL gene, they were more likely to have ineffective initial empirical antimicrobial therapy (52% vs 94%; odds ratio, 5.1 [95% confidence interval, 1.04-14.5]). CONCLUSIONS: CTX-M ESBL is highly prevalent in Thailand. Patients with healthcare-associated infection due to an ESBL-producing strain that harbored multiple ESBL genes were more likely to have had ineffective initial empirical antimicrobial therapy, and, given that antibiotic

selection pressure was the only associated risk, we suggest focused antimicrobial stewardship programs to limit the emergence and spread of healthcare-associated infection due to ESBL-producing strains in this middle-income country.

39. Olivier CN, Blake RK, Steed LL, Salgado CD. Risk of vancomycin-resistant Enterococcus (VRE) bloodstream infection among patients colonized with VRE. Infect Control Hosp Epidemiol. 2008 May;29(5):404-9.
PubMed: PM18419361

BACKGROUND: **Colonization with vancomycin-resistant Enterococcus (VRE) is a risk factor for subsequent VRE bloodstream infection (BSI); however, risk factors for BSI among colonized patients have not been adequately described. We sought to determine the proportion of VRE-colonized patients who subsequently develop VRE BSI and to identify risk factors for VRE BSI among these patients.** METHODS: Records of 768 patients colonized with VRE from January 2002 through June 2005 were reviewed. The proportion of patients who developed VRE BSI was calculated, and the characteristics of these patients were compared, in a 2:1 ratio, with those of patients who did not develop VRE BSI. To identify risk factors for VRE BSI and for death, we used univariate logistic regression analysis and then multivariate logistic regression analysis. Using pulsed-field gel electrophoresis (PFGE), we compared the isolate recovered when the patient was colonized and the isolate recovered when the patient developed VRE BSI. RESULTS: **Of the 768 patients colonized with VRE, 31 (4.0%) developed VRE BSI. Multivariate analysis identified the following independent risk factors for developing VRE BSI: infection of an additional body site other than blood (adjusted odds ratio [aOR], 3.9; P = .04), admission to the hospital from a long-term care facility (aOR, 12.6; P = .04), and receipt of vancomycin (aOR, 10.6; P = .001).** The independent risk factors for death among patients colonized with VRE were immunosuppression (aOR, 12.9; P = .001) and VRE BSI (aOR, 9.1; P = .002). Of the 31 patients who developed VRE BSI, 23 (74%) had a pair of isolates representing VRE colonization and VRE BSI. For 19 (83%) of these 23 patients, the isolate representing BSI was genetically related to the isolate representing VRE colonization: 12 pairs of isolates (52%) had identical banding patterns, 5 had closely related patterns, and 2 had possibly related patterns. CONCLUSION: Of the 768 patients colonized with VRE, 31 (4.0%) usually developed VRE BSI due to a related strain. Independent risk factors for BSI among colonized patients were admission from a long-term care facility, infection of an additional body site, and exposure to vancomycin. Independent risk factors for death were immunosuppression and VRE BSI.

*Risk of long term-carriage of VRE or ESBL in patients who are colonized or infected with these organisms*

40. Tham J, Walder M, Melander E, Odenholt I. Duration of colonization with extended-spectrum beta-lactamase-producing Escherichia coli in patients with travellers' diarrhoea. Scand J Infect Dis. 2012 Jan 31.
PubMed: PM22292796

Background: Resistant Enterobacteriaceae have become a worldwide epidemic during the last decade and are a great threat to health care worldwide. **International travel is a major risk factor for becoming colonized with extended-spectrum beta-lactamase (ESBL)-producing bacteria. Data on the persistence of colonization with ESBL-**

**producing bacteria in the faecal flora are limited.**Methods: A prospective cohort study was performed between October 2007 and October 2010. **Fifty-eight patients with faecal carriage of ESBL-producing Escherichia coli from a previous study of patients with travellers' diarrhoea were included.**Results: Forty-one of the patients had a complete follow-up. **Ten of these patients (24%) carried ESBL-producing E. coli at the first follow-up point (3-8 months), of whom 4 had a new ESBL strain. At the 3-y follow-up, 4 patients carried ESBL (10%), of whom 1 had 2 new ESBL strains.**Conclusions: The long duration of ESBL carriage is worrisome. These carriers may be an important source of the spread of ESBLs in the population and this has implications for the clinical management of patients.

41. Yoon YK, Lee SE, Lee J, Kim HJ, Kim JY, Park DW, et al. Risk factors for prolonged carriage of vancomycin-resistant Enterococcus faecium among patients in intensive care units: a case-control study. J Antimicrob Chemother. 2011 Aug;66(8):1831-8. PubMed: PM21652622

    OBJECTIVES: **The aim of this study was to identify the risk factors for prolonged carriage of vancomycin-resistant Enterococcus faecium (VREF) in intensive care units (ICUs).** METHODS: A retrospective case-control study was performed in the ICUs of a university hospital in Korea from September 2006 to July 2009. VREF carriage was identified through weekly active surveillance rectal cultures. Clinical characteristics and the risk factors for VREF acquisition were compared between cases with prolonged VREF carriage (>/= 5 weeks, n = 58) and controls with shorter VREF carriage (<3 weeks, n = 36) in a multivariate logistic regression model. The effect of vancomycin consumption on vancomycin-resistant enterococci (VRE) colonization pressure was investigated using time-series analysis with an autoregressive error model. RESULTS: Out of a total of 6327 rectal swab cultures examined, 1915 (30.3%) specimens from 266 patients were positive for VREF. The weekly VRE colonization pressure ranged from 0.77% to 42.42%. **Vancomycin use after VREF acquisition significantly increased VREF carriage (adjusted odds ratio = 4.09; 95% confidence interval = 1.32-12.65). The case group had higher in-hospital mortality than the control group [21 (36.2%) versus 4 (11.1%), P = 0.007]. Increment of VRE colonization pressure was significantly associated with vancomycin consumption of 1week before (i.e. time t - 1) (P = 0.0028) and moderately associated with that of the corresponding week (i.e. time t) (P = 0.0595).** CONCLUSIONS: Vancomycin use in patients with VREF colonization might prolong the duration of carriage. Restriction of vancomycin use should be strengthened in these patients through infection control measures.

*Length of time patients remain carriers of VRE and ESBL*

42. Alsterlund R, Axelsson C, Olsson-Liljequist B. Long-term carriage of extended-spectrum beta-lactamase-producing Escherichia coli. Scand J Infect Dis. 2012 Jan;44(1):51-4. PubMed: PM21736509

    In 2009 we described an outbreak caused by extended-spectrum beta-lactamase (ESBL)-producing Escherichia coli in southern Sweden that occurred during 2005-2006. **An important finding from the investigation was the long carriage times of the ESBL-producing E. coli in several of the patients, which in some cases exceeded 30 months.** Here we report findings from the continued follow-up of bacterial carriage. **In September 2010, 5 of the 42 patients still carried the bacteria after a median of 58**

**months (range 41-59 months), 18 had had repeatedly negative cultures after shedding bacteria for a median of 7.5 months (range 0-39 months), 16 had died while still shedding the bacteria for a median of 9 months (range 0-38 months), and 3 had been lost to follow-up.**

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## APPENDIX – FURTHER INFORMATION:

### Review Articles

*Risk factors for patient carriage of VRE and ESBL*

43. Crivaro V, Bagattini M, Salza MF, Raimondi F, Rossano F, Triassi M, et al. Risk factors for extended-spectrum beta-lactamase-producing Serratia marcescens and Klebsiella pneumoniae acquisition in a neonatal intensive care unit. J Hosp Infect. 2007 Oct;67(2):135-41.
PubMed: PM17884248

**We investigated the molecular epidemiology of gentamicin-resistant, extended-spectrum beta-lactamase (ESBL)-producing Klebsiella pneumoniae and Serratia marcescens, and risk factors associated with their acquisition in a neonatal intensive care unit (NICU) of a university hospital in Italy. During the study period (April-November 2004), S. marcescens was responsible for six infections and 31 colonisations, while K. pneumoniae was responsible for six infections and 103 colonisations. Concurrent isolation of both organisms occurred in 24 neonates.** Molecular typing identified one major pulsed-field gel electrophoresis pattern each for S. marcescens and K. pneumoniae strains isolated during the study period. An 80 kb plasmid containing bla(SHV-12), bla(TEM-1) and aac(6')-Ib genes, isolated from both S. marcescens and K. pneumoniae strains, and showing identical restriction profiles, transferred resistance to third-generation cephalosporins to a previously susceptible Escherichia coli host. **Birthweight, gestational age and use of invasive devices were significantly associated with S. marcescens and K. pneumoniae acquisition on univariate analysis, while empiric antimicrobial treatment with ampicillin and gentamicin, and duration of hospital stay, proved to be the only independent risk factors.** In conclusion, conjugal plasmid transfer and empiric antimicrobial therapy with ampicillin and gentamicin might have contributed to the selection and spread of gentamicin-resistant ESBL-producing Enterobacteriaceae in the NICU.

*Risk of infection in patients who are carriers of VRE and ESBL*

44. Salgado CD. The risk of developing a vancomycin-resistant Enterococcus bloodstream infection for colonized patients. Am J Infect Control. 2008 Dec;36(10):S175-S178.
PubMed: PM19084155

EPIDEMIOLOGY: Between 2 to 4 million patients each year develop health care-acquired infections in the United States. Infection resulting from vancomycin-resistant Enterococcus (VRE) is now the second to third most common cause of nosocomial infections in the United States. VRE is most often transmitted by the contaminated hands, clothing, and equipment of health care workers. Patients with VRE bloodstream infections (BSIs) have increased rates of recurrent BSI (16.9% vs 3.7%, respectively, P < .0001), increased crude case fatality rates (relative risk [RR], 2.57; 95% confidence interval [CI]: 2.27-2.91), increased mortality because of bacteremia (RR, 1.79; 95% CI: 1.28-2.50), and increased hospital costs of $27,000 per episode of BSI (P = .04) compared with those with vancomycin-susceptible BSI. Additionally, transfer of the gene responsible for vancomycin resistance to S aureus has been demonstrated in vitro, and reports of clinical infections because of vancomycin-resistant Staphylococcus aureus have been reported from many

areas of the world, including the United States. **Risk factors for VRE colonization and infection include prolonged length of hospital stay, use of broad-spectrum antibiotics, having an indwelling invasive device, and close proximity to another VRE-colonized or -infected patient; however, risk factors for developing VRE BSI among colonized patients have not been fully described.** INFECTION CONTROL: Infection control measures for VRE include antibiotic-usage control, reducing contamination of the environment with proper cleaning and disinfection, and reducing contamination of health care workers by use of contact precautions. Health care-acquired BSIs can also be effectively controlled by closely following central venous line prevention guidelines and complying with the central venous line bundle. Control and prevention of VRE colonization and thus infection would be expected to reduce morbidity, reduce health care costs, and save lives.