

Emerging Pathogens

1. A Nationally-Coordinated Laboratory System for Human Avian Influenza A (H5N1) in Thailand: Design, Analysis, and Program Evaluation

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Background: The first phase of national surveillance for avian influenza (H5N1) among people in Thailand occurred over a four-month period that began on 1 December, 2003. Subsequently, a nationally-coordinated laboratory system (NCLS) for avian influenza (H5N1) was created to assess surveillance, specimen procurement, case detection, and reporting at the national level.

Methods: A pre- post study was conducted to evaluate the NCLS designed during the six-week interval of 1 April through 15 May, 2004. In the pre-intervention period (1 December, 2003 to 31 March, 2004), 12 cases of avian influenza (H5N1) were confirmed and the NCLS was not yet established. In the post-intervention period (16 May 16, 2004 through 31 December, 2006), NCLS interventions were implemented for avian influenza (H5N1) surveillance, case detection and expedited, computer-based reporting.

Results: In the pre- and post-intervention periods, 85% (N = 777 of 915) versus 95% (N = 10,434 of 11,042) of clinical respiratory specimens were adequate for confirmatory testing ($P < 0.001$), the median time from procurement to results declined from 17 days (range, 14-24) to 1.8 days (range, 0.25 -4; $P < 0.001$), and specimen shipment decreased from 46.5 to 21.1 hours ($P < 0.001$). Thirteen cases of avian influenza (H5N1) were detected during the 31-month post-intervention period. The H5N1 RT-PCR and real-time RT-PCR sensitivity and specificity were 100% and 99%, respectively.

Conclusions: The NCLS exemplifies a systematic approach to national surveillance for avian influenza A (H5N1). This NCLS program in Thailand serves as a model for avian influenza (H5N1) preparedness that can be adopted or modified for use in other countries.

2. Emergence of Fluoroquinolone Resistance in Outpatient Urinary *Escherichia coli* Isolates

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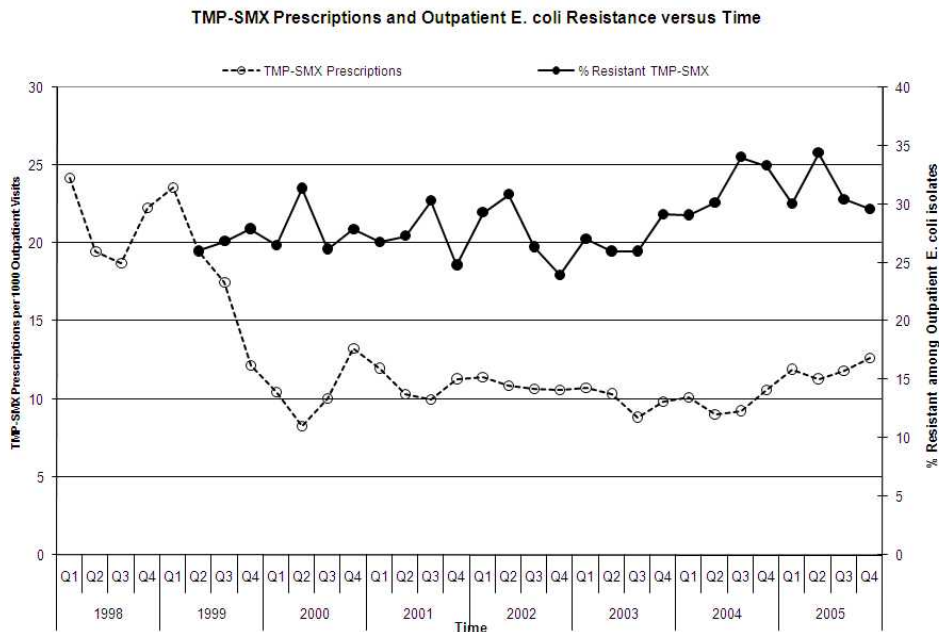
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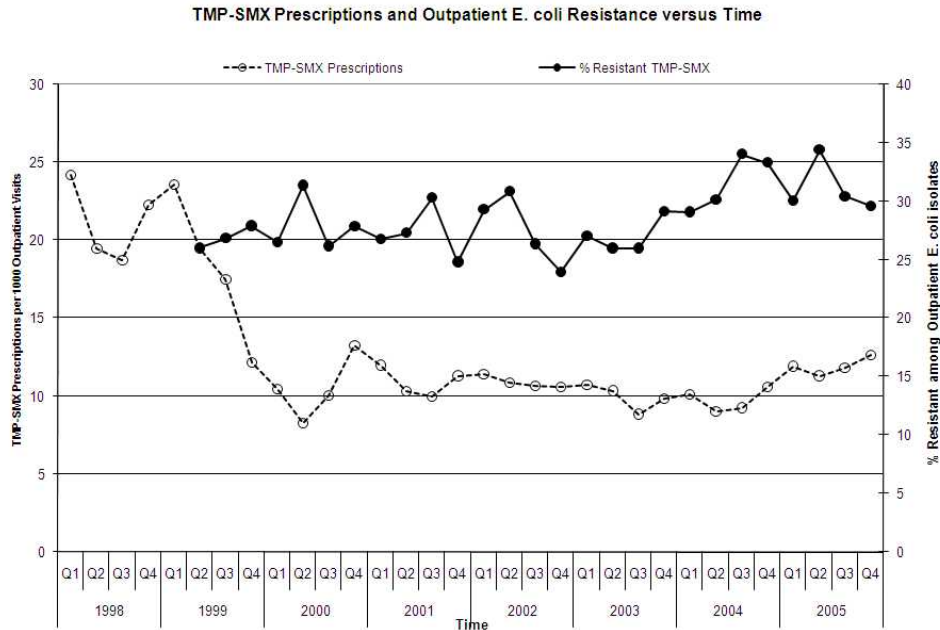
Background: Due to high rates of trimethoprim-sulfamethoxazole resistance in *Escherichia coli*, our institution switched to levofloxacin as initial therapy for urinary tract infections (UTI) in 1999.

Objective: We evaluated the effects of that switch 6 years later. Methods: Levofloxacin prescriptions /1000 outpatient visits and levofloxacin resistance in outpatient *E.coli* were evaluated over time. *E.coli* isolated in 2005 were further characterized by specimen source and antimicrobial susceptibilities. Risk factors for levofloxacin-resistant *E.coli* UTI among non-pregnant adult outpatients were evaluated in a case-control study.

Results: Between 1998- 2005, levofloxacin use increased from 3.1 to 12.7 prescriptions /1000 visits ($p < 0.01$) and levofloxacin resistance among outpatient *E. coli* increased from 1% to 9% ($p < 0.01$). Even though prescriptions for sulfonamide antibiotics decreased by half during same time period, *E. coli* resistance to trimethoprim-sulfamethoxazole increased from 26.1% to 29.6%. Levofloxacin-resistant *E.coli* were more likely to be resistant to other antibiotics used to treat UTI than levofloxacin-susceptible isolates (90% vs. 43%, $p < 0.0001$). Risk factors for levofloxacin-resistant *E. coli* UTI were hospitalization (odds ratio for each week of hospitalization, 2.0, 95% confidence interval 1.0 - 3.9) and use of levofloxacin (odds ratio, 5.6, 95% confidence interval 2.1, 27.5) within the prior year.

Conclusions: Fluoroquinolone prescriptions increased markedly after an institutional policy change for empirical treatment of UTI, and a rapid rise in fluoroquinolone resistance among outpatient *E.coli* followed. Risk factors for infection with resistant *E.coli* were recent hospitalization and levofloxacin use. Risk factors should be considered before initiating empiric treatment with a fluoroquinolone.





Molecular Epidemiology

3. Indoor Air Contamination by Multiresistant *Serratia marcescens*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* Genetically Related to Nosocomial Infection Strains

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Background: Bacterial contamination in indoor air has been related to airborne spread of multiresistant organism, mainly *Staphylococcus aureus* and *Acinetobacter baumannii*. The relationship between bacterial air contamination and nosocomial infection, however, has not been well defined yet.

Objective: This study has the purpose of investigating multiresistant (MDR) bacteria in the air and also in inpatient clinical samples during the same period for comparing their genetic profiles.

Methods: A total of 48 air samples were collected weekly over February-2003 at 12 sites (Surgical Center, 6 Intensive Care and Kidney Transplant Units) in a federal tertiary public hospital in Rio de Janeiro, Brazil. Five air samples were also collected during an epidemic caused by MDR *P. aeruginosa* in the adult ICU in August-2003. 500L of air from each point were collected using the MAS-100 air sampler (MERCK, Germany). The number of CFU/m³ was determined in plate count agar (PCA, Difco) and the brain heart infusion agar with sheep blood (BHI-S agar), Mac Conkey agar

(MCA, Merck), cetrimide agar (CA, Merck) and mannitol salt agar (MSA, Merck) plates were used for the pathogen research. Microorganisms were identified by conventional methods and MicroScan technology. The genetic relationship of MDR bacterial strains was determined by PFGE. Band patterns were analyzed using GelCompar II (Applied Maths).

Results: Most airborne bacterial counts were below 500cfu/m³, although counts above 500cfu/m³ could be found. The largest total heterotrophic bacteria count detected were mostly coincident with floor cleaning activities, handling of patients including linen change, or the presence of a large number of persons during the air sampling. Eleven airborne and 4 patients` strains of *S. marcescens* showed an identical genetic pattern, although they were isolated from hospital sectors of different floors of the same building or in the other building for even six months later. *P. aeruginosa* airborne cultures (n=5) also showed identical profiles by PFGE which were practically identical to those isolated from two patients. The clonal complexes of MRSA strains from the environment (n=1) and infected patients (n=4) were also closely related.

Conclusions: Airborne persistence of different species of MDR organisms that are genetically similar suggests that these strains can survive for long periods in adverse conditions. The potential of air dissemination of multiresistant pathogens involved in nosocomial infection is confirmed, however it cannot be evidenced which one happened first. This study indicates that bacterial indoor air quality and the standardization of routine activities for minimizing the dispersion of particles are probable parameters for nosocomial infection control.

Quality Assessment

4. Measuring Adherence to Hand Hygiene Guidelines: A Collaborative Project to Identify Consensus-Based Approaches

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Background: The importance of hand hygiene (HH) in preventing healthcare-associated infections is well established, but there is little consensus on recommended methods for assessing adherence to guidelines. The multiplicity of approaches makes it difficult to compare across organizations and to determine if performance is improving overall.

Objective: Survey the field for examples of effective practices for measuring adherence with HH guidelines.

Methods: In fall 2006, The Joint Commission, World Health Organization World Alliance for Patient Safety, Association for Professionals in Infection Control and Epidemiology, Centers for Disease Control and Prevention, Society for Healthcare Epidemiology of America, Institute for Healthcare Improvement, and National Foundation for Infectious Diseases began work on the Consensus Measurement in Hand Hygiene Project (CMHH). An expert advisory panel identified criteria for

evaluating the accuracy and usefulness of submitted measurement approaches and tools for possible inclusion in a monograph. To gather standardized information from organizations that considered their approaches to be potential examples of effective practice, a field survey was implemented electronically in Feb. 2007.

Results: 242 responses from various settings and 20 countries were submitted; 15 voluntarily withdrew, 7 contained no identifiers and 117 did not submit required materials. 65% of all respondents measure when HH is done; 45% measure product consumption; less than 30% measure thoroughness, glove use, satisfaction or other aspects. Most data is collected manually (72%) or with some technology (17%). 40 of 103 (38.8%) complete submissions met basic inclusion criteria and were reviewed by the expert panel. Three major measurement approaches (observe, measure product, survey) were identified for the domains related to HH adherence: HH occurrence and associated characteristics of who, when, how, thoroughness and appropriate glove use; HH indication or opportunity; product consumption; nail policy adherence; knowledge; attitudes/beliefs; competence; satisfaction; structural considerations. Practical examples, strengths/weaknesses and recommendations for implementation are described.

Conclusions: Organizations should determine their measurement goals then select methods with appropriate levels of detail. Multiple measurement approaches and different domains allow staff to create a dashboard for identifying problematic areas and tracking improvement. The tools, case studies and references will be published in a free educational monograph to provide consensus-based recommendations to infection control and quality improvement professionals searching for effective and efficient strategies to measure organizational adherence to guidelines. Project supported in part by unrestricted grant from GOJO Industries, Inc., Akron OH.

Communicable Diseases

5. Contact Investigation in a Healthcare Worker with Cavitory Pulmonary Tuberculosis

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Background: Healthcare workers with pulmonary tuberculosis have the opportunity to infect multiple contacts, including vulnerable patients. Large scale contact investigations often stress local resources and likely require significant coordination and communication within the involved healthcare system and with the public.

Objective: To share our recent experience with a large scale investigation of a healthcare worker with pulmonary tuberculosis.

Methods: Contact investigation by employee health nurses and the State Department of Health in Texas required a prolonged and concerted effort. The hospital identified all healthcare workers who might have been in this outpatient surgery unit during a two month period prior to the index case presentation. In addition, all patients and family members who might have accompanied a patient were contacted. Finally,

general public announcements via local media were made to inform the public and encourage testing.

Results: The index case was a registered nurse with cavitary tuberculosis who worked in an outpatient surgery unit and had multiple contacts with other healthcare workers, patients, and family members. Sputum specimens were smear positive and the isolate was drug sensitive. She had had symptoms for at least two months prior to presenting for clinical evaluation. Chest x-ray and CT of the chest revealed bilateral disease with multiple cavities. Three members in the patient's immediate family were PPD positive. The husband had a minimally abnormal chest x-ray with negative cultures. Sixteen nurses were tested; 0 were PPD positive. Twenty physicians were tested; 0 were PPD positive. 164 hospital staff members were tested; 1 was PPD positive. 1261 patients were tested; 60 were PPD positive. 1027 indirect contacts (friends and families of contact patients) were tested; 32 were PPD positive. Only two potential contacts had an abnormal chest x-ray and received active treatment. 12 contacts received isoniazid prophylaxis. No contacts had a positive sputum culture for *Mycobacterium tuberculosis*.

Conclusions: This patient had extensive cavitary pulmonary tuberculosis with smear positivity. However, her infectivity seemed low, and no proven cases with positive sputum cultures were identified in this investigation. The approach to this contact investigation was demanding in terms of personnel resources. A better approach might have involved a more intensive screening of family and close coworkers first to gain a better estimate of infectivity of this source case.

Critically Ill Patients (Adults)

6. Central Venous Catheter (CVC) Insertion Practices in the Emergency Department (ED)

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Background: Preventing CVC-associated bloodstream infections is an important quality improvement initiative in many healthcare organizations. CVC insertion is commonly performed in the ED. However, there are no published data on infection control practices during CVC insertion in the ED.

Objective: To assess compliance with best practices for CVC insertion.

Methods: A prospective observational cohort study was performed between November 2006 and March 2007 in two EDs of a tertiary care referral center. Observations were conducted by nurses assisting with the procedure. Observers were trained and used a standardized audit tool. Data were collected for each new site attempted and for each new operator.

Results: 33 central line insertions on 29 patients were observed. CVC insertions were performed by staff physicians (30%) or residents (70%) from Emergency Medicine (45.5%), Intensive Care (45.5%) or Medicine (9%) services. Ultrasound was used 42% of the time. Most insertions were considered emergent (42%) or urgent (45%).

The femoral vein, internal jugular vein, and the subclavian vein were used in 45%, 33% and 21% of cases, respectively. The femoral vein was more likely to be used in emergent insertions (71.4%; $p=0.01$). All recommended infection control practices were followed in only 27% of observations. The most common breaches were failure to cover the patient with a sterile gown (36%), to maintain a sterile field (15%), to use a sterile drape (12.1%), or to wear a hat (12.1%). Hand hygiene was performed before the procedure by 58% of operators and 57% of assistants. A mask was not worn in 6% of cases. Compliance with infection control procedures was lowest among Emergency Medicine physicians (15% vs 39%; $p=.05$). There were no statistical differences in compliance between staff vs residents, urgency of the procedure or time of day.

Conclusions: Compliance with CVC insertion best practices is low in the ED and is not correlated with the urgency of the procedure. Improving outcomes related to CVC insertion will require educational strategies targeting physicians, and should focus on the importance of sterile technique and hand hygiene.

Critically Ill Patients (Neonates and Children)

7. An Increased Rate of Healthcare-Associated Bloodstream Infections in a Neonatal Intensive Care Unit

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Background: An increased rate of bloodstream infections (BSIs) in the neonatal intensive care unit (NICU) of Helsinki University Central Hospital, Finland, was noted in 2004 as a result of prospective hospital-wide laboratory-based BSI surveillance, performed since 1999 as a part of the Finnish Hospital Infection Program. The NICU had earlier suffered from outbreaks.

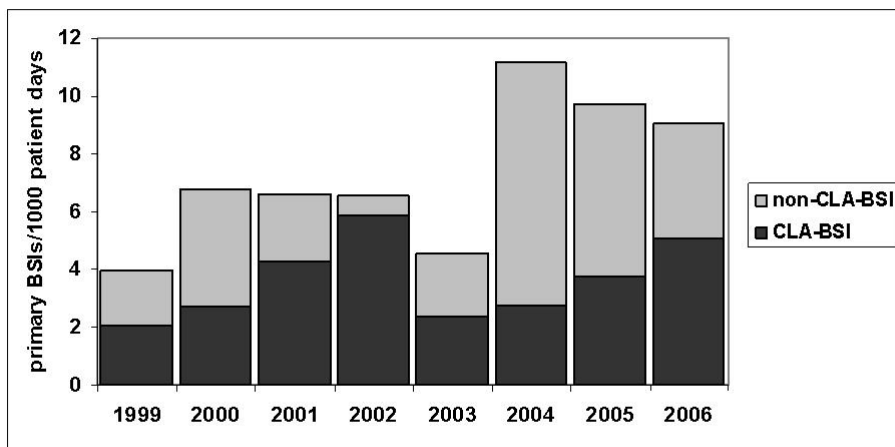
Objectives: To investigate the epidemiologic features of healthcare-associated BSIs in the NICU during 1999-2006.

Methods: All infants admitted to the NICU were included. Infection-control nurses regularly reviewed the laboratory database for positive blood culture results. Clinical information and microbiological data of each BSI case were recorded on a standardized case-record form. CDC definitions for nosocomial laboratory-confirmed BSIs were utilized. Microbiology laboratory data were reviewed for determining the culturing activity in the NICU and for confirmation of secondary BSI foci. The central line (CL) use status for BSI cases was completed from the NICU database; the ward staff estimated the CL utilization ratio in the NICU to be 20%. An 'early-onset' BSI referred to an infection with a positive blood culture during the first 6 days of life, and a 'late-onset' BSI to one diagnosed thereafter.

Results: We identified 345 BSIs (7.6 BSIs/1000 patient days; range by year, 4.5-12.0), including 330 primary BSIs (7.3 BSIs/1000 patient days; range by year, 3.9-11.1) (Figure). No association was found between the annual rates of blood cultures and BSIs detected. A 4-fold increase in early-onset infections occurred from 2003 to

2004. Of the primary BSIs, 260 (79%) were late-onset infections. Of the patients with primary BSIs, 170 (52%) had a CL at the time of the positive culture. The estimated CL-associated BSI (CLA-BSI) rate was 18 per 1000 CL-days (range by year, 10-29; range by month, 0-72). An outbreak of *Candida parapsilosis*, including 20 BSIs, during 1999-2002; and three *Serratia marcescens* clusters, including 5 BSIs, during 1999-2002 were detected. The main causative pathogens in early-onset BSIs were coagulase-negative staphylococci (CoNS) (30%) and *Streptococcus agalactiae* (27%). CoNS were cultured in 64% of the late-onset BSIs. In CLA-BSIs, CoNS (55%) and *Candida* species (16%) were the most prevalent pathogens.

Conclusions: The BSI rates, including the estimated CLA-BSI rate, were alarming. The increase in the BSI rate in 2004 could not be explained by increased CLA-BSI rate or a single pathogen. The data on birth weights were not available, and the role of variation in the patient population could not be assessed. Surveillance did not favorably affect the BSI rate, likely reflecting a failure in feeding back the surveillance data to the NICU staff.



Healthcare-Acquired Pneumonia

8. Development of Quality Indicators to Measure Adherence to Guidelines in Intensive Care Patients with Ventilator-associated, Hospital-acquired, and Healthcare associated Pneumonia: the IMPACT-HAP Project

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Background: ATS/IDSA recently published guidelines for hospital-acquired pneumonia (HAP), including healthcare-associated pneumonia (HCAP) and ventilator-associated pneumonia (VAP). An ICU HAP performance improvement project (PIP) was implemented at 4 academic hospitals and quality indicators (QIs) were developed to measure adherence to the local and ATS/IDSA guidelines.

Objective: To assess compliance with local and ATS/IDSA guidelines in 4 institutions.
Methods: QIs were based on management principles within ATS/IDSA guidelines. Data were collected prospectively and reviewed by the investigators prior to submission to a central database.

QI1: Proportion who met criteria for diagnosis of HAP, VAP or HCAP.

QI2A: Proportion with sputum Gram stain and culture results available within 72 hrs

QI2B: Proportion with blood culture results available within 72 hrs

QI3: Proportion with antibiotic selection compliant with local and ATS/IDSA guidelines

QI4: Proportion with short course therapy performed

QI5: Proportion of patients with de-escalation of therapy performed

Results: 164/169 patients (97%) met criteria for the diagnosis of pneumonia (QI-1). Respiratory cultures were obtained in 94% (QI-2A) and blood cultures were obtained in 88% of patients (QI-2B). In 129 candidates who received empiric therapy, empiric therapy was compliant with local guidelines in 50% of patients and compliant with the ATS/IDSA guidelines in only 31% of the patients, (QI-3); with failure to use a 2nd agent to cover multi-drug resistant Gram negatives in 55% of these patients. De-escalation occurred in 80/106 (75%) of the candidates who met criteria (QI-5). Only 12% were candidates for short course therapy. Clinical improvement and/or cures were seen in 70% (110/158) of patients.

Conclusion: The ATS/IDSA guideline was used to develop quality indicators to measure adherence to local and ATS/IDSA guidelines for pneumonia. Initial work-up was appropriately performed in the majority of patients. Initial antibiotic selection can be improved, as most of the variance was unjustified. De-escalation was effectively performed in a high percentage of candidates who met criteria. Correlating QIs with outcomes will help refine treatment strategies.

9. Pathogens, Treatment, and Outcomes of Patients with Healthcare-Associated and Community-Acquired Pneumonia and Bacteremia

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Background: The characteristics, treatment patterns, clinical outcomes and resource utilization of patients with pneumonia (P) or bacteremia (B) that are community-acquired (CA) or healthcare-associated (HCA) have not been well documented.

Objective: To compare pathogens, treatment patterns, and outcomes of patients with HCA and CA infections.

Methods: This study analyzed data from 3 of 8 sites participating in a multicenter, retrospective, chart review of patients (randomly selected within the infection type) hospitalized in 2006 with a microbiologically confirmed CA or HCA P or B. Patients had an HCA infection if they were hospitalized within the past 6 months, receiving dialysis, immunocompromised, or residing in a nursing home. Empiric treatment was appropriate if received within 24 hours of admission and the identified pathogen was susceptible to the treatment.

Results: A total of 630 P and 297 B patients were included in the analysis. HCAP (n=515; 81.7%) or HCAB (n=225; 75.8%) patients were far more common than CAP (n=115; 18.3%) or CAB (n=72; 24.2%) patients. The most common classes of pathogens identified were MRSA (17.5%), *P. aeruginosa* (14.3%), and MSSA (12.5%) for P. and *S. pneumoniae* (17.2%), MRSA (17.2%), and MSSA (16.2%) for B. MRSA and *P. aeruginosa* infections were primarily HCA (96.4% of MRSA and 93.3% of *P. aeruginosa* Ps were HCAP; 94.1% MRSA and 94.1% of *P. aeruginosa* Bs were HCAB). HCA infections were less likely to be treated appropriately than CA infections (77.9% vs 88.7% for P, p=0.0097; 80.0% vs 86.1% for B, p=0.2972 respectively). HCAP length-of-stay was longer than CAP (13.9 vs 9.9 days; p=0.0001) and HCAB than CAB (13.9 vs 10.1 days; p=0.0061). Compared to CAP patients, HCAP patients were more likely to be admitted in the ICU (54.8% vs 34.8%; p=0.0001) and more likely to be placed on mechanical ventilation (41.0% vs 30.4%; p=0.0443). Patients who were treated inappropriately had higher mortality than those treated appropriately both in P (19.7% vs 11.9%, p=.0287) and B (30.9% vs 12.4%, p=0.0017).

Conclusions: HCA infections appear to have distinct characteristics and are treated inappropriately more often than CA infections. The majority of MRSA and *P. aeruginosa* infections were HCA. Improved identification and appropriate treatment of HCA infections may lead to improved clinical and economic outcomes.

10. First Results of Ventilator-associated Pneumonia Surveillance in Five Dutch Hospitals

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Background: Since 2005 Dutch hospitals can participate in the PREZIES surveillance of ventilator-associated pneumonia (VAP), in which the incidence of VAP as well of that of several risk factors are registered.

Objective: Surveillance data are analyzed to assess the most important risk factors in order to feedback case mix-adjusted data to the hospitals.

Methods: Data are collected and infections diagnosed based on the PREZIES-protocol, which is based on the CDC-definitions. Surveillance ended when a VAP was diagnosed or after a maximum of 28 ventilation days per period. Data were analyzed with Cox regression.

Results: Five hospitals collected data on 457 ventilation periods (3098 ventilation days) with 411 patients. The average VAP incidence was 6.3% per ventilation period (9.4/1000 ventilation days). In univariate analysis neurosurgery compared to general surgery (HR 4.1), position in bed (supine compared to semirecumbent, HR 0.3) and SDD (HR 0.18) were significantly associated with the risk of VAP. Infection frequencies differed significantly per hospital. Therefore in multivariate analysis these data were adjusted for hospital and also for non significant risk factors with a p-value < 0.2 (age group).

In multivariate analysis the VAP risk was significantly higher for patients with a mean daily sedation score of four or higher (HR 6.4, 95% CI 2.6-15.7) and for patients on oropharyngeal prophylaxis (HR 16.7, CI 2.3-118). The risk for patients who were treated with multiple dose inhalers was lower, compared to those patients not treated with inspiratory medication (HR 0.36, 0.15-0.91). The interpretation of the results is hampered by the frequent presence of collinearity.

Most frequent organisms were *Klebsiella pneumoniae* (24%), *Pseudomonas aeruginosa* (13%), *Haemophilus influenzae* (11%) and *Staphylococcus aureus* (11%). In 9 of 29 cases two micro-organisms were cultured.

Conclusions: Oropharyngeal prophylaxis, the use of multiple dose inhalers and the average daily sedation score were significantly associated with the VAP incidence.