



Hospital Acquired Infections-A Review

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ABSTRACT

A nosocomial infection is defined as any infection occurring in a patient during hospital stay or receiving any healthcare facility in which the infection was not present at the time of hospital admission or acquired during hospitalisation. Malhotra S et al research findings reflected the prevalence of hospital acquired infections was highest in ICUs (33.3%) followed by paediatric wards (12.5%) and surgical wards (10.3%). The most common hospital acquired infections were urinary tract infection (UTI 31.1%) followed by respiratory tract infections (RTI- 24.3%), surgical site infection (SSI- 20.3%) and blood stream infection (BSI- 18.2%). According to Mythri H and Kashinath KR et al the mean duration of stay of the patients in the hospital was 8.1 days. The distribution of nosocomial infections in MICU were UTI (34.8% - 8/130), pneumonia (21.7% - 5/130), soft tissue infections (17.4% - 4/130), gastrointestinal (13.0% - 3/130), blood stream infections (8.7% - 2/130) and meningitis (4.3% - 1/130). According to Sugata Dasgupta research study the outcome of this research study concluded there was no statistically significant difference between the hospital mortality rates among the patients with and without nosocomial infection ($P = 0.181$). According to Ozgur Ak research study the incidence rate of nosocomial infection was 21.6 in 1000 patient-days, and the rate of nosocomial infection was 25.6% Length of ICU stay, central venous catheterisation, mechanical ventilation and tracheostomy were statistically significant risk factors for nosocomial infection. According to Michael Behnke research study concludes that the prevalence of nosocomial infection has not changed since 1994,

but the prevalence of antibiotic use has increased in hospital acquired infections.

Keywords: Nosocomial, Infection, Hospital, Acquired

According to World Health Organization (WHO) a nosocomial infection (NI) is defined as “An infection occurring in a patient in a hospital or other healthcare facility in whom the infection was not present or incubating at the time of admission. This includes infections acquired in the hospital but appearing after discharge and also occupational infections among staff of the facility”. NIs are a major source of morbidity, mortality and also monetary burden on patients. Immune-compromised patients are at the threat of NIs when they undergo surgery or have any underlying disease. They are the worse affected when admitted in intensive care unit (ICU) as the rate of NIs is almost three times higher than any other department of hospital. According to a survey conducted by WHO in 4 Regions (Europe, Eastern Mediterranean, South-East Asia and Western Pacific), 8.7 % of patients prevailed with NIs. The survey also showed that the sites at which NIs are most prone to attack are infections of surgical wounds, urinary tract infections and lower respiratory tract infections. The NIs is caused by both gram positive, gram negative, and also by other microorganisms like fungi and viruses. NIs is also being caused by resistant strains of bacteria like MRSA, VRSA, and VRE².

Hospital-acquired infections add to the functional disability and emotional stress of the patient and may, in some cases, lead to disabling conditions that reduce the quality of life. Nosocomial infections are also one

of the leading causes of death. The economic costs are also considerable. The increased length of stay for infected patients is the greatest contributor to cost. One study revealed that the overall increase in the duration of hospitalization for patients with surgical wound infections was 8.2 days, ranging from 3 days for gynaecology to 9.9 for general surgery and 19.8 for orthopedic surgery. Prolonged stay not only increases direct costs for patients or payers but also indirect costs due to lost work. The increased use of drugs, the need for isolation, and the use of additional laboratory and other diagnostic studies also contribute to the costs. Hospital-acquired infections add to the imbalance between resource allocation for primary and secondary health care by diverting scarce funds to the management of potentially preventable conditions.

The advancing age of patients admitted to health care settings, the greater prevalence of chronic diseases among admitted patients, and the increased use of diagnostic and therapeutic procedures which affect the host defenses will provide continuing pressure on nosocomial infections in the future⁶.

COMMON CAUSES OF HOSPITAL ACQUIRED INFECTION

Urinary Catheterization: A urinary tract infection (UTI) when acquired in any healthcare setup due to cross transmission of pathogens is referred to as nosocomial UTI (NUTI). Among all other sites of Nis, UTI approximately accounts for 40 % of NIs. In more than two thirds of the cases patient's flora is responsible for origin of infection. Usually the common etiology of NUTI is due to catheter which is also called as Catheter Associated Urinary Tract Infection (CA-UTI). The main mechanism of infection in non catheterized patients is the ascending way and in the catheterized patients the mechanism is of four types: Acquisition on insertion of the urinary catheter, acquisition through the endoluminal way, acquisition through the extra luminal or periurethral way, acquisition through the lymphatic or haematogenous way. Among gram negative bacteria *E. coli* was the most commonly reported gram-negative pathogen, followed by *Pseudomonas aeruginosa*. Other isolated strains were *K. pneumoniae* and *Acinetobacter sp*².

Surgery: Surgical site infections are also frequent: the incidence varying from 0.5 to 15% depending on the type of operation and underlying patient status. These

are a significant problem which limits the potential benefits of surgical interventions. The impact on hospital costs and postoperative length of stay (between 3 and 20 additional days) is considerable. The definition is mainly clinical: purulent discharge around the wound or the insertion site of the drain, or spreading cellulitis from the wound. Infections of the surgical wound (whether above or below the aponeurosis), and deep infections of organs or organ spaces are identified separately. The infection is usually acquired during the operation itself; either exogenously (e.g. from the air, medical equipment, surgeons and other staff), endogenously from the flora on the skin or in the operative site or, rarely, from blood used in surgery. The infecting microorganisms are variable, depending on the type and location of surgery, and antimicrobials received by the patient. The main risk factor is the extent of contamination during the procedure (clean, clean-contaminated, contaminated, dirty), which is to a large extent dependent on the length of the operation, and the patient's general condition. Other factors include the quality of surgical technique, the presence of foreign bodies including the drains, the virulence of the microorganisms, concomitant infection at other sites, the use of preoperative shaving and the experience of the surgical team.

Mechanical Ventilation: Nosocomial pneumonia occurs in several different patient groups. The most important are the patients on ventilators in intensive care units, where the rate of pneumonia is 3% per day. There is a high case fatality rate associated with ventilator-associated pneumonia, although the attributable risk is difficult to determine because patient co-morbidity is so high. Microorganisms colonize the stomach, upper airway and bronchi, and cause infection in the lungs (pneumonia): they are often endogenous (digestive system or nose and throat), but may be exogenous, often from contaminated respiratory equipment. The definition of pneumonia may be based on clinical and radiological criteria which are readily available but non-specific: recent and progressive radiological opacities of the pulmonary parenchyma, purulent sputum, and recent onset of fever. Diagnosis is more specific when quantitative microbiological samples are obtained using specialized protected bronchoscopy methods. Known risk factors for infection include the type and duration of ventilation, the quality of respiratory care, severity of the patient's condition (organ failure), and previous use of antibiotics¹ might occur as a result of

the entry of pathogenic microorganisms to the bloodstream via four different routes: local insertion site colonization, catheter hub contamination, haematogenous seeding and infusion of contaminated fluids. The spread of infection from the insertion site has been widely recognized as the main cause of CRBSI. On the other hand, microorganism colonization may occur due to the contamination of the catheter hub, its lumen, and its guide wire during insertion, the catheter, and the connectors to the infusion lines when handling them, or the infusion administered through the catheter. Once the microorganism has access to the CVC, infection occurs as a result of the capacity of bacteria to adhere to the catheter surface, colonize and develop bio-film, which is formed when the microorganisms are irreversibly attached to the external or internal surface of the catheter and produce extracellular polymers that facilitate their adherence and form a structural

matrix.

Catheter related bloodstream infection: Vascular access poses significant potential risks of iatrogenic complications in general, but in particular, of catheter related bloodstream infections (CRBSIs). Insertion of central line, a very common procedure in critical care settings is associated with infectious complications such as local colonization of organisms eventually leading to bacteraemia and sepsis. The definitive diagnosis of catheter related infection can be made by using a combination of clinical signs and symptoms together with the quantitative culture techniques. CRBSI and central line associated blood stream infection (CLABSI) were used interchangeably in various studies. For reporting purpose, the term "CRBSI" has been used for CLABSI. CRBSI

Common pathogens and sites of infection

Site of Infection	Common pathogens	Less common pathogens
Blood stream	<i>Coagulase negative staphylococci,</i>	<i>Enterococci,</i>
	<i>S. aureus</i>	<i>Klebsiella sp</i>
		<i>Serratia marcescens</i>
Pneumonia		<i>Enterobacter sp</i>
	<i>CoNS,</i>	<i>Enterococci</i>
	<i>S. aureus,</i>	<i>Klebsiella sp</i>
	<i>P. aeruginosa,</i>	<i>Serratia marcescens</i>
Skin/soft tissue/surgical site	Respiratory syncytial virus	<i>Influenza</i>
	<i>CoNS,</i>	<i>Enterococci</i>
	<i>S. aureus</i>	<i>Serratia,marcescens</i>
Gastrointestinal tract		<i>Aspergillus sp.</i>
	Rotavirus	Anaerobic bacteria
Conjunctivitis/ocular	<i>CoNS,</i>	<i>Serratia marcescens</i>
	<i>P. aeruginosa</i>	
Urinary tract	Gram negative bacilli,	<i>Candida sp</i>
	<i>Enterocooci</i>	
Endocarditis	<i>CoNS,</i>	<i>Candida sp</i>
	<i>S.aureus</i>	
Central Nervous System	<i>CoNS,</i>	<i>Candida sp</i>
	<i>S.aureus</i>	<i>Serratia marcescens</i>
		<i>Enterobacter sp</i>
Osteoarthritis	<i>S. aureus,</i>	<i>Candida sp.,</i>
	Group B <i>streptococci</i>	Gram negative bacilli ²

PREVIOUS STUDIES

The research findings of older research studies carried out on Hospital Acquired

Infections were reflected in the following:

The point prevalence study was conducted by **Malhotra S et al** in a tertiary care hospital on 20th November 2013. The aim of this point prevalence study was to estimate the burden of various hospital acquired infections in the hospital and the major related risk factors for acquiring HAIs. Of 660 patients included in the survey, there were 372 (56.4%) males and 288 (43.6%) females. 257 patients were from medical wards, 242 from surgical wards, 80 from paediatric wards, 42 from obstetrics and gynaecology and 39 from ICUs. Of 660 evaluated patients, 58 patients acquired 77 hospital acquired infections. The prevalence of HAI was highest in ICUs (33.3%) followed by paediatric wards (12.5%) and surgical wards (10.3%). Out of 660 patients included in the study, 576 (87.2%) patients had peripheral intravenous catheters (PVC), 110 (16.6%) underwent surgery, 88 (13.3%) had indwelling urinary catheters (UC), 54 (8.1%) had central venous catheters (CVC) and 35 (5.3%) were on mechanical ventilator. While the overall HAI prevalence was 8.78%. The presence of specific devices was associated with higher HAI prevalence: CVC (22.2%), PVC (12.6%), urinary catheter (19.3%) and intubation (25.7%). The most common HAI category was urinary tract infection (UTI 31.1%) followed by respiratory tract infections (RTI- 24.3%), surgical site infection (SSI- 20.3%) and blood stream infection (BSI- 18.2%). At least one antibiotic was taken by 572 patients, which represents prevalence of 86.6%. The most frequently administered antibiotics were amoxicillin clavulanic acid, ceftazidime, ciprofloxacin, metronidazole and piperacillin-tazobactam. Common organisms isolated were *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Staphylococcus aureus*, *Escherichia coli* and *Klebsiella pneumoniae*⁷

This prospective study was carried out by **Patel Disha A et al** on patients admitted in the general surgical wards at one of the largest tertiary care centre hospital in Ahmedabad, Gujarat, West India, from January 2006 to June 2006. The study was carried out to find out rate of various hospital acquired infections. A total of consecutive 100 patients admitted in the

surgical wards were taken as a study group and assessed for any kind of nosocomial infection. For SSI patients were excluded from the study by following criteria: deficient medical records; having undergone surgical intervention at another hospital and then referred to the respective hospital; or death after surgery or within the following 30 days. Among the 100 patients the prevalence rate of hospital acquired infections in surgical wards was about 21.90%. 55 patients were operated among which 6 patients developed SSI during prevalence study, thus prevalence of SSI was 10.9%. Local blood stream infection (i.e. thrombophlebitis) was 8%, UTI was 2% and only 1% was of the other infection (like bed sore). Investigating about microbiological reports of wound, organism, *Klebsiella* spp. was found in the most of the patients who were operated at Major Operation Theater and organism, *Staphylococcus* was found in the patients who were operated at emergency OT⁹.

Dileep Kumar Sharma et al conducted a cross-sectional study in a tertiary care hospital in north India. The patients admitted in the ICU, without evidence of initial infection, were included in the study. Blood and urine specimen among study patients was taken after 48 hours of admission who developed fever after 48 hours of admission and followed till discharge from the hospital. Bacterial strains were identified with the help of gram staining and biochemical tests. Out of the total 185 patients enrolled, 89 (48.1%) patients had fever. Thus, 89 blood and urine specimen were collected. A total of 46 patients were found to be positive for NI by any of the two specimens. Hence, incidence of NI was 24.9% (95%CI=18.6-31.1%. The incidence of NI was significantly higher ($p=0.04$) among the patients of age 40 years (30.2%, 95%CI=21.4-38.9) than <40 (17.7%, 95%CI=9.3-26.1). Females (28.7%, 95%CI=19.2-38.2) were found to be significantly ($p=0.03$) more infected as compared to males (19.4%, 95%CI=11.6-27.2). The incidence of NI was significantly higher among illiterates than literates ($p=0.02$). The *Acinetobacter baumannii* (83.2%) was the most common organism found followed by *Pseudomonas aeruginosa* (73.5%) *Escherichia coli* (72.5%), *Staphylococcus aureus* (53.3%), *Klebsiella pneumoniae* (41.3%), Coagulase-negative staphylococcus (33.4%) and *Eterococcus faecalis* (22.2%)¹⁰.

Rello J et al conducted a retrospective matched cohort study was carried out in patients admitted to an

ICU between January 1998 and June 1999 who received mechanical ventilation for >24 h. the aim of the study was to evaluate risk factors for ventilator-associated pneumonia. Data for this study were obtained from the **MediQual Profile** database, which is maintained by the Cardinal Information Corporation (CIC). Risk factors for Ventilator Associated Pneumonia (VAP) were examined using crude and adjusted odds ratios (AORs). Out of the total 9,080 patients, VAP was developed in 842 patients (9.3%). The mean interval between intubation, admission to the ICU, hospital admission, and the identification of VAP was 3.3 days, 4.5 days, and 5.4 days, respectively. The identified independent risk factors for the development of VAP were male gender, trauma admission, and intermediate deciles of underlying illness severity (on admission) [AOR, 1.58, 1.75, and 1.47 to 1.70, respectively]. Patients with VAP were matched with 2,243 control subjects without VAP. Hospital mortality did not differ significantly between cases and matched control subjects (30.5% vs 30.4%, $p = 0.713$). Nevertheless, patients with VAP had a significantly longer duration of mechanical ventilation (14.3 ± 15.5 days vs 4.7 ± 7.0 days, $p < 0.001$), ICU stay (11.7 ± 11.0 days vs 5.6 ± 6.1 days, $p < 0.001$), and hospital stay (25.5 ± 22.8 days vs 14.0 ± 14.6 days, $p < 0.001$). Development of VAP was also associated with an increase of >\$40,000 in mean hospital charges per patient ($\$104,983 \pm \$91,080$ vs $\$63,689 \pm \$75,030$, $p < 0.001$)¹¹.

Olivier Leroy et al conducted a combined observational and validation cohort study was conducted by in the Urban Teaching Hospital of Lille University from January 1994 to March 2001. The objectives of the study was to determine factors associated with antimicrobial-resistant hospital-acquired pneumonia (AR-HAP), to build an algorithm evaluating the risk for such a pneumonia, and to test this algorithm. A total of 172 episodes of HAP was collected in which one or more causative pathogens were identified in 124 episodes. Among them, 39 pathogens were antimicrobial-resistant bacteria, which were incriminated in 37 episodes of HAP (30%). They were methicillin-resistant *Staphylococcus* ($n=11$), *Acinetobacter* species ($n=9$), *S maltophilia* ($n=8$), ticarcillin-resistant *P aeruginosa* ($n= 5$), ESBL - producing *Enterobacteriaceae* ($n= 4$), and penicillin-resistant *S pneumoniae* ($n=2$). There were 21 men and 5 women; mean \pm SD age was 63.8 ± 15.7 years. When characteristics of patients included

in this cohort were compared with those of patients included in the observational cohort, there were only few statistically significant differences. In the validation cohort, mean albumin concentration on ICU admission was higher (30.6 ± 6.4 g/L vs 21.3 ± 7.2 g/L, $p=0.03$) and prevention of GI bleeding during ICU stay was less frequent used (13 of 26 patients vs 94 of 124 patients, $p=0.008$). All patients with HAP without prior antimicrobial treatment ($n=5$) and patients with HAP with prior antimicrobial treatment and either exhibiting neurologic disturbances on ICU admission and an early onset HAP ($n=1$) or aspiration on ICU admission without neurologic disturbances ($n= 2$) had antimicrobial-susceptible HAP¹².

Mythri H and Kashinath KR conducted a retrospective analytical study in patients admitted to ICU of a tertiary health center, Tumkur, Karnataka during August 2012 to May 2013. The aim was to study was to identify the current status of nosocomial infection, rate of infection and distribution of infection among patients admitted in Medical Intensive Care Unit (MICU). A total of 130 records were considered and out of these 23 belonged to medical (nonsurgical) cases. This tertiary health center covers a population of Tumkur District, with approximately 1000 patients input per day. The data of nosocomial infections were collected from patient records, analysis of infections, and their causes. Among the total of 130 patients admitted in MICU, 23 patients (23/130-17.7%) admitted to the MICU suffered from nosocomial infection, there were 18 males, five females. The age ranged from 43 to 72 years, mean age being 56 years. The mean duration of stay of the patients in the hospital was 8.1 days. The distribution of nosocomial infections in MICU were UTI (34.8% - 8/130), pneumonia (21.7% - 5/130), soft tissue infections (17.4% - 4/130), gastrointestinal (13.0% - 3/130), blood stream infections (8.7% - 2/130) and meningitis (4.3% - 1/130)¹³.

Sugata Dasgupta et al study was conducted a study in a 12 bedded combined medical and surgical ICU of a medical college hospital. It was a prospective observational to determine the incidence of nosocomial infections acquired in the ICU, their risk factors, the causative pathogens and the outcome. The study group comprised 242 patients admitted for more than 48 h in the ICU. Intensive care unit acquired nosocomial infections were detected in 29 patients (11.98%; 95% CI: 7.89–16.07%). These 29 patients developed one type of nosocomial infection each. The

most frequently diagnosed nosocomial infection was nosocomial pneumonia. Combining both ventilator associated pneumonia (VAP) and non-VAP, nosocomial pneumonia was found in 18 (62.07%; 95% CI: 44.41–79.73%) of the 29 infected patients. Taken separately, VAP was diagnosed in 10 (34.48%) and non-ventilator associated nosocomial pneumonia was diagnosed in 8 (27.59%) of the infected patients. Urinary tract infection was diagnosed in 8 (27.59%) out of the 29 infections and central venous catheter related blood stream infection was detected in 3 (10.34%) patients. A total of 40 pathogens were isolated on culture and accounted for the nosocomial infections in 29 patients. Some infections were polymicrobial. Gram-negative Enterobacteriaceae were the most frequently isolated pathogens ($n = 15$; 37.5%) closely followed by *Pseudomonas* species ($n = 14$; 35%, *Pseudomonas aeruginosa* = 13, *Burkholderia cepacia* = 1). There was no statistically significant difference between the hospital mortality rates among the patients with and without nosocomial infection ($P = 0.181$)¹⁴.

A prospective observational study was conducted by **Dilara Inan et al** in Akdeniz University Hospital in Antalya, Turkey. The aim was to determine the daily antibiotic cost of nosocomial infections per infected adult patient. Among 8460 adult patients admitted in the ICU between January 1, 2000 and June 30, 2003, 817 patients developed 1407 episodes of nosocomial infections, accounting for an infection rate of 16.6%. Among them, 233 patients (mean age: 50.1; sex ratio female:male 0.49) had only one nosocomial infection. Mean daily antibiotic cost was found \$89.64 per infected patient (\$8.56 to \$359.28). Among the sites of nosocomial infections, urinary tract infections had the lowest daily antibiotic cost per infected patient. The mean daily antibiotic cost for pneumonia was the highest of all sites, but patients with bloodstream infection reached the highest range of daily cost (\$31.31 to \$359.28). *Pseudomonas aeruginosa* was the most prevalent bacteria followed by *Klebsiella* spp. and *Acinetobacter* spp. *P. aeruginosa* infections had the highest overall daily antibiotic cost per infected patient than other pathogens⁵.

A prospective cohort study of nosocomial infection surveillance was conducted by **Oznur Ak et al** in a total 25-bed combined medical and surgical ICU of the Kartal Teaching and Research Hospital, which is a 700-bed teaching hospital in Istanbul, Turkey from January 1, 2008, to December 31, 2008. The aim of

the study was to evaluate the incidence, risk factors and etiology of nosocomial infections (NIs) in the intensive care unit (ICU). Out of 1134 patients hospitalized in the ICU for a period of 6257 days, 115 patients acquired a total of 135 NIs distributed as follows: 36.3% bacteremia, 30.4% ventilator-associated pneumonia (VAP), 18.5% catheter-associated urinary tract infection, 7.4% central-line infection, 5.9% cutaneous infection, and 1.3% meningitis. The incidence rate of NI was 21.6 in 1000 patient-days, and the rate of NI was 25.6% Length of ICU stay, central venous catheterisation, mechanical ventilation and tracheostomy were statistically significant risk factors for NI. Of all NI, 112 (83%) were microbiologically- confirmed and 68.8% of the isolates were Gram-negative, 27.6% were Gram-positive, and 3.6% were fungi. 23 (17%) were clinically-defined infections. The most frequently isolated organism was *P. aeruginosa* (25%), followed by *S. aureus* (21.4%), *E. coli* (18.7%) and *A. baumannii* (16.9%)¹⁵.

An observational prospective study was conducted by **Burcin Ozer et al** in patients admitted to the 10 bed mixed ICU for more than 48 hours during period of study from March 2007 to August 2007. A total of 250 patients were admitted during this 6-month period. 149 patients (61 female and 88 male) with a mean age of 61.1 ± 18.1 (min 15 – max 94) were involved in this study. They stayed a mean of 6.6 ± 5.9 (min 2– max 30) days in ICU. 20.1% ($n=30$) of the patients developed a total of 40 ICU-acquired infections for a total of 988 patient-days. The infection sites were the lower respiratory tract (40%), urinary tract (40%), bloodstream (10%), wound (7.5%), and the central nervous system (CNS) infection (2.5%). A total of 52 patients had ischemic heart disease, 32 (21.5%) had undergone surgery before admission whom 23 (15.4%) emergency, 9 (6%) had elective surgery, 29 (19.5%) had cerebrovascular disease, 19 (12.8%) had diabetes mellitus and 13 (8.7%) chronic obstructive pulmonary disease, 13 (8.7%) had gastrointestinal hemorrhage. Based on the exposure, 116 patients (77.9%) had a urinary catheter, 37 (24.8%) had a nasogastric tube, 28 (18.8%) were being mechanically ventilated, 25 (16.8%) were being intubated, 8 (5.4%) had a tracheostomy, 7 (4.7%) had an arterial catheter, 6 (4%) had a central venous catheter, 6 (4%) had drainage catheter. The most common pathogens found were as follows: Enterobacteriaceae (26.1%), *Staphylococcus aureus* (21.7%), *Candida* species

(16.7%), *Pseudomonas aeruginosa* (10.9%), *Enterococcus* species (10.9%), and *Acinetobacter* species (8.7%). The most frequently prescribed antibiotics were third generation cephalosporins (32.9%), quinolones (17.4%), metronidazole (15.4%), first generation cephalosporins (8.7%), and aminoglycosides (8.7%)¹⁶.

A prospective study was conducted by **Mark Melzer** and **Catherine Welch** at Barking, Havering and Redbridge University Hospitals NHS Trust (BHRUT) to determine the association between catheter-associated bacteraemic UTIs and likelihood of death. A clinical and microbiological data were collected on patients with hospital-acquired bacteraemia from October 2007 to September 2008. Patients were followed until death, hospital discharge or recovery from infection. Risk factors for 7-day mortality were determined and multivariate logistic regression was used to define the association between catheter-associated bacteraemic UTIs and likelihood of death. 559 bacteraemic episodes occurred in 437 patients. Overall, there were 90 deaths (20.6%) at 7 days and 153 deaths (35.0%) at 30 days. Among patients with catheter-associated bacteraemic UTIs, 7-day and 30-day mortalities associated with each bacteraemic episode were 25/83 (30.1%) and 33/83 (39.8%), respectively. Within this subgroup, the commonest isolates were *Escherichia coli*, 36 (43.4%), *Proteus mirabilis*, 11 (13.3%) and *Pseudomonas aeruginosa*, 9 (10.8%). There were 22 (26.5%) multiple drug-resistant isolates and, of the *E coli* infections, 6 (16.7%) were extended spectrum β -lactamase producers. In univariate analysis, the variables found to have the strongest association with 7-day mortality were age, Pitt score, Charlson comorbidity index (CCI), medical speciality and site of infection. Compared with CVC-associated bacteraemic infections, there was a significant association between catheter associated bacteraemic UTIs and 7-day mortality (OR 4.16, 95% CI 1.86 to 9.33). After adjustment for age and CCI, this association remained significant (OR 2.90, 95% CI 1.19 to 7.07)¹⁷

A survey of the prevalence of nosocomial infections was conducted by **Wei-Ping Liu et al** in target hospitals using the combination of a bedside survey and medical record review. In total, 101,907 inpatients were surveyed from 2012 to 2014. There were 1,997 cases of nosocomial infections, accounting for an average prevalence of 1.96%. The infection site was mainly the lower respiratory tract. Higher

prevalence of nosocomial infections occurred in the comprehensive intensive care unit (ICU), Neurosurgery Department, and Hematology Department. The average rate of antibiotic use was 33.72%, and the average submission rate for bacterial cultures for patients who received therapeutic treatment with antibiotics was 28.26%. The most common pathogens associated with nosocomial infections were Gram-negative (G-) bacteria, and frequently detected bacterial pathogens included *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, and *Staphylococcus aureus*¹⁸.

A prospective study was conducted by **Amer Custovic et al** to determine the rate, the site and causative organisms of NIs in the surgical ICU at University Clinical Center, Tuzla. All patients admitted to the surgical ICU were followed prospectively, for the development of NIs from January-December 2010. Determination of NIs was performed using standardized the Centers for Disease Control and Prevention (CDC) criteria. Out of total 834 patients, 94 patients (11.27%) developed NIs. Respiratory tract infections were seen in 56 (60%), urinary tract infections in 15 (16%) and gastrointestinal tract infections in 8 (9%) patients. Other infections identified were surgical site, bloodstream and skin infections. Gram-negative organisms were reported in approximately 75% of cases (78.7% extended-spectrum beta-lactamase (ESBL)-producers). *Klebsiella pneumoniae* was the commonest (51.0%), followed by *Proteus mirabilis* (21.3%) and *Pseudomonas aeruginosa* (10.6%). Methicillin-resistant *Staphylococcus aureus* (MRSA) (16%), and *Clostridium difficile* (9.6%) were the commonest among gram-positive bacteria. The study indicates respiratory and urinary tract infections made up the great majority of NI's, ICU patients are more susceptible to NI's, emphasizing the importance of continuous surveillance and enforcement of specific infection control measures¹⁹

Michael Behnke et al conducted a second national prevalence study according to the specifications of the European Centre for Disease Prevention and Control (ECDC). The ECDC protocol, containing uniform surveillance definitions and ascertainment methods, was implemented. The aim was to estimate the prevalence of nosocomial infections (NIs) and antibiotic use in acute care hospitals in Germany. A total of 132 hospitals participated in the study, with 41

539 patients included. This represents approximately 8% of acute care hospitals in Germany. The representative sample included 46 hospitals with 9626 patients. 53.8% of the 132 hospitals were routine care hospitals, and 16.7% were tertiary hospitals. 2248 nosocomial infections (NIs) in 2109 patients were recorded, reflecting 1.07 NIs per patient with nosocomial infection. 1666 NIs in 1560 patients had been acquired during the current hospital stay. The number of patients receiving antibiotics on the day of the study was 10 607. By type of ward, the highest prevalence rates of nosocomial infections (18.6%) and antibiotic use (50.5%) were observed in intensive care units. Surgical wound infections (24.3% of the total), urinary tract infections (23.2%), and lower respiratory tract infections (21.7%) were the most common nosocomial infections, followed by *Clostridium difficile* infections (6.4%) and primary sepsis (5.7%). The most common pathogens causing nosocomial infections were *E. coli* (18.0%), enterococci (*E. faecalis* and *E. faecium*) (13.2%), *S. aureus* (13.1%), and *C. difficile* (8.1%). The five most commonly used classes of antibiotics were second-generation cephalosporins (15.1%), followed by fluoroquinolones (13.8%), penicillins with beta-lactamase inhibitors (12.5%), third-generation cephalosporins (10.4%), and carbapenems (5.9%). This study concludes that the prevalence of nosocomial infection has not changed since 1994, but the prevalence of antibiotic use has increased. In interpreting these findings, one should bear in mind that confounders may have influenced them in different directions²⁰.

Micha Scherbaum et al conducted a prospective case study over a period of six months at the Albert Schweitzer Hospital, Lambaréné, Gabon. All patients admitted to the departments of surgery, gynecology/obstetrics and internal medicine were screened daily for signs and symptoms of hospital-acquired infections. Among the total 2925 patients screened, 46 nosocomial infections (1.6%) were diagnosed. These comprised 20 (44%) surgical-site infections, 12 (26%) urinary-tract infections, 9 (20%) bacteraemias and 5 (11%) other infections. High rates of nosocomial infections were found after hysterectomies (12%) and Caesarean sections (6%). Most frequent pathogens were *Staphylococcus aureus* and *Escherichia coli*. Eight (40%) of 20 identified *E. coli* and *Klebsiella* spp. strains were ESBL-producing organisms.²¹

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