

Incidence and Risk Factors of Hospital-Acquired Infections in Ain Shams University Hospital

Thesis submitted for partial fulfillment of the
MD degree in Public Health

By

Lamyaa Mohammed Saied Salem Al Bagoury

Assistant lecturer of Community, Environmental and Occupational Medicine
Faculty of Medicine – Ain Shams University

Under supervision of

Professor/ Mohsen Abdel Hamid Gadallah

Professor of Community, Environmental and Occupational Medicine
Faculty of Medicine – Ain Shams University

Professor/ Aisha Aboul Fotouh Al Gamal

Professor of Community, Environmental and Occupational Medicine
Faculty of Medicine – Ain Shams University

Professor/ Hadia Hussein Bassim

Professor of Clinical Pathology
Faculty of Medicine – Ain Shams University

Doctor/ Maha Mohammed Al Gaafary

Assistant Professor of Community, Environmental and Occupational Medicine
Faculty of Medicine – Ain Shams University

Faculty of Medicine
Ain Shams University

٢٠١٠

ABSTRACT

Background: Hospital- acquired infections (HAIs) are among the major causes of excess morbidity and mortality among hospitalized patients. **Objectives:** This study aimed to estimate the incidence and identify the risk factors of HAIs in Ain Shams University Hospital. In addition, the direct cost of the detected HAIs was calculated. **Method:** A prospective surveillance of patients admitted to 4 surgical wards and 2 intensive care units (ICUs) for a period of one year starting from 1 September 2008 to 31 August 2009. **Results:** A total of 1416 patients had their surgical operations being performed in the selected surgery wards. Among these patients, 121 in-hospital surgical site infections (SSIs) have occurred with an incidence rate of 8.5%. In ICUs, a total of 822 patients were admitted for 7722 days. Of these patients, 144 patients acquired 222 HAIs with an overall patient infection rate of 28.3% and an overall patient day rate of 34.7 per 1000 ICU-days. The overall device-associated infection rate is 21.6 per 1000 ICU-days. The independent risk factors revealed by multivariate analysis for SSI were: diabetes mellitus, multiple interventions performed through the same incision, unclear preoperative wound class, lengthy operation, smoking, and obesity, for hospital acquired pneumonia: presence of chest diseases and/or infections, mechanical ventilation, trauma, coma, and repeated intubation, for bloodstream infection: long duration of central vascular catheterization, and long-term steroid therapy, and for urinary tract infection: long duration of urinary catheterization, presence of renal disease, and old age. HAIs increased patients' length of stay by 4 days in ICUs and 10 days in surgery wards. The cost of stay for patients with HAI was 2 to 3 times higher compared to patients who did not acquire an infection. Gram-negative microorganisms of the multidrug-resistant type were the most common pathogens isolated from infected patients either in surgery wards or ICUs. **Conclusion:** HAIs represent a serious health problem in Ain Shams University Hospital, justifying the need to maximize proper infection control measures to prevent these infections.

Table of Contents

	Page
-Introduction	۱
-Objectives	۵
-Review of literature	
<i>Chapter I:</i> Epidemiology of hospital acquired infection	۶
<i>Chapter II:</i> Surgical site infection	۱۵
<i>Chapter III:</i> Hospital acquired pneumonia	۴۵
<i>Chapter IV:</i> Catheter-associated bloodstream infection	۶۱
<i>Chapter V:</i> Urinary tract infection	۷۶
<i>Chapter VI:</i> Skin and soft tissue infections	۸۶
<i>Chapter VII:</i> Other hospital acquired infections	۸۹
<i>Chapter VIII:</i> Multidrug-resistant organisms	۹۱
<i>Chapter IX:</i> Surveillance of hospital acquired infection	۱۰۱
<i>Chapter X:</i> Infection control program	۱۱۰
-Methodology	۱۱۵
-Results	۱۳۳
-Discussion	۱۸۲
-Conclusions	۲۱۹
-Recommendations	۲۲۱
-References	۲۲۳
-Appendix	
<i>Appendix I:</i> Worksheet I (A)	۲۶۰
<i>Appendix II:</i> Worksheet I (B)	۲۶۲

<i>Appendix III:</i>	Worksheet II	٢٦٤
<i>Appendix IV:</i>	Worksheet III	٢٦٥
<i>Appendix V:</i>	Worksheet IV	٢٦٦
<i>Appendix VI:</i>	Antibiogram of microorganisms isolated from surgery wards	٢٦٨
<i>Appendix VII:</i>	Antibiogram of microorganisms isolated from intensive care units	٢٦٩
-Summary		٢٧٠
-Protocol		٢٧٧

List of Tables

	Page
Table (١) Demographic characteristics of patients subjected to surgical operations in the selected surgery wards	١٣٥
Table (٢) Clinical characteristics of patients subjected to surgical operations in the selected surgery wards	١٣٦
Table (٣) Percent distribution of general and specific surgeries according to degree of preoperative wound contamination	١٣٧
Table (٤) Distribution and patient infection rates of hospital acquired infections (HAIs)	١٣٨

according to surgery specialty

Table (٥)	Incidence rate of post-discharge surgical site infections (SSIs) among general surgical procedures (n=٢٨٦) from ١ March till ٢١ August ٢٠٠٩	١٤٠
Table (٦)	Percent distribution of surgical site infections (SSIs) according to Centre for Disease Control and Prevention (CDC) definition by type of surgery	١٤٠
Table (٧)	Percent distribution of microorganisms isolated from patients with hospital-acquired surgical site infections (SSIs) according to surgery specialty	١٤٢
Table (٨)	Patient characteristics in relation to risk of surgical site infection (SSI)	١٤٤
Table (٩)	Preoperative factors in relation to risk of surgical site infection (SSI)	١٤٥
Table (١٠)	American Society of Anesthesiologists (ASA) score and degree of preoperative wound contamination in relation to risk of surgical site infection (SSI)	١٤٦
Table (١١)	Preoperative preparation items in relation to risk of surgical site infection (SSI)	١٤٧
Table (١٢)	Operative risk factors of surgical site infection (SSI)	١٤٨
Table (١٣)	Multivariate logistic regression analysis for risk factors of surgical site infection (SSI)	١٤٩

Table (١٤)	Impact of surgical site infection (SSI) on postoperative length of stay (LOS) in days, and cost of stay in L.E.	١٥٠
Table (١٥)	Cost of antimicrobials prescribed for patients with hospital acquired infections (HAIs) in the selected surgery wards	١٥١
Table (١٦)	Demographic and clinical characteristics of patients admitted to ICUs	١٥٣
Table (١٧)	Patient infection rate (PIR) and patient day rate of hospital acquired infections (HAIs) by type of ICU	١٥٤
Table (١٨)	Patient day rates of hospital acquired infections (HAIs) by site according to type of ICU	١٥٥
Table (١٩)	Device utilization (DU) ratios for mechanical ventilation (MV), central vascular catheter (CVC) and urinary catheter (UC) by type of ICU	١٥٩
Table (٢٠)	Device-associated infection (DAI) rates by type of ICU	١٦٠
Table (٢١)	Percent distribution of microorganisms isolated from patients with hospital acquired infections (HAIs) in intensive care units according to site of infection	١٦٢
Table (٢٢)	Percent distribution of hospital acquired infections (HAIs) in intensive care units according to number of different microorganisms isolated	١٦٣
Table (٢٣)	Host factors in relation to risk of hospital acquired pneumonia (HAP)	١٦٥

Table (٢٤)	Factors enhancing colonization of the oropharynx and/or stomach by microorganisms in relation to risk of hospital acquired pneumonia (HAP)	١٦٦
Table (٢٥)	Factors favoring aspiration into the respiratory tract in relation to risk of hospital acquired pneumonia (HAP)	١٦٧
Table (٢٦)	Exposure to mechanical ventilation (MV) in relation to risk of hospital acquired pneumonia (HAP)	١٦٨
Table (٢٧)	Multivariate logistic regression analysis for risk factors of hospital acquired pneumonia (HAP)	١٦٩
Table (٢٨)	Age and sex of patients in relation to risk of hospital acquired bloodstream infection (BSI)	١٧٠
Table (٢٩)	Risk factors of hospital acquired bloodstream infection (BSI)	١٧١
Table (٣٠)	Central vascular catheterization (CVC) in relation to risk of hospital acquired bloodstream infection (BSI)	١٧٢
Table (٣١)	Multivariate logistic regression analysis for risk factors of hospital acquired bloodstream infection (BSI)	١٧٣
Table (٣٢)	Age and sex of patients in relation to risk of hospital acquired urinary tract infection (UTI)	١٧٣
Table (٣٣)	Risk factors of hospital acquired urinary tract infection (UTI)	١٧٤

Table (٣٤)	Urinary catheterization (UC) in relation to risk of hospital acquired urinary tract infection (UTI)	١٧٥
Table (٣٥)	Multivariate logistic regression analysis for risk factors of hospital acquired urinary tract infection (UTI)	١٧٦
Table (٣٦)	Impact of hospital acquired infections (HAIs) on length of stay (LOS) for patients admitted to intensive care units (ICUs)	١٧٧
Table (٣٧)	Impact of hospital acquired infections (HAIs) on crude mortality rate (CMR) for patients admitted to intensive care units (ICUs)	١٧٨
Table (٣٨)	Impact of hospital acquired infections (HAIs) on cost of ICU stay (in L.E.)	١٧٩
Table (٣٩)	Impact of hospital acquired infections (HAIs) on cost of laboratory and radiological investigations in general surgery ICU (in L.E.).	١٨٠
Table (٤٠)	Cost of antimicrobials prescribed for patients with hospital acquired infections (HAIs) in the selected ICUs.	١٨١

List of Figures

		Page
Figure (١)	Monthly surgical site infection (SSI) rates over a one year surveillance period	١٣٩
Figure (٢)	Percent distribution of surgical site infections (SSIs) according to Centre for Disease Control and Prevention (CDC) definition by type of	١٤١

surgery

Figure (۳)	Selected antimicrobial-resistant pathogens associated with hospital acquired infections in surgery wards	۱۴۳
Figure (۴)	Crude mortality rate (CMR) of patients with surgical site infection (SSI) and those without hospital acquired infections (HAIs).	۱۵۲
Figure (۵)	Percent distribution of hospital acquired infections (HAIs) in general surgery ICU	۱۵۶
Figure (۶)	Percent distribution of hospital acquired infections (HAIs) in neurosurgery ICU	۱۵۷
Figure (۷)	Monthly patient day rates of hospital acquired infections (HAIs) in intensive care units over a one year surveillance period.	۱۵۸
Figure (۸)	Monthly patient day rates of hospital acquired pneumonia (HAP) in intensive care units over a one year surveillance period.	۱۵۸
Figure (۹)	Onset of ventilator-associated pneumonia (VAP) in intensive care units	۱۶۱
Figure (۱۰)	Selected antimicrobial-resistant pathogens associated with hospital acquired infections in intensive care units	۱۶۴

List of Abbreviations

AK	Amikacin	CRO	Ceftriaxone
AMC	Amoxycillin + Clavulanic acid	CTX	Cefotaxime
ASA	American Society of Anesthesiologists	CVC	Central vascular catheter
BMI	Body Mass Index	DAI	Device associated infection
BSI	Bloodstream infection	DU	Device utilization
CAUTI	Catheter-associated urinary tract infection	G	Gentamycin
CAZ	Ceftazidime	HAI	Hospital acquired infection
CDC	Center for Disease Control and Prevention	HAP	Hospital acquired pneumonia
CI	Confidence Interval	ICU	Intensive care unit
CIP	Ciprofloxacin	IPM	Imipenem
CLABSI	Central line-associated bloodstream infection	IQR	Interquartile range
CMR	Crude mortality rate	LE	Livre Egyptienne (Egyption pound)

COPD	Chronic obstructive pulmonary disease	LEV	Levofloxacin
LOS	Length of stay	SAM	Sulbactam + Ampicillin
LRI	Lower respiratory tract infection other than pneumonia	PU	Pressure ulcer
MEM	Meropenem	RCT	Randomized controlled trial
MRSA	Methicillin-resistant <i>Staphylococcus aureus</i>	RR	Relative risk
MV	Mechanical ventilation	SD	Standard deviation
NHSN	National Healthcare Safety Network	SE	Standard error
NNIS	National Nosocomial Infections Surveillance	SSI	Surgical site infection
OR	Odds ratio	TZP	Tazocin
PDS	Post discharge surveillance	UC	Urinary catheter
PIR	Patient infection rate	UTI	Urinary tract infection
PNEU	Pneumonia	VAP	Ventilator-associated pneumonia

Chapter I

Epidemiology of Hospital Acquired Infection

Patient care is provided in facilities which range from highly equipped clinics and technologically advanced university hospitals to front-line units with only basic facilities. Despite progress in public health and hospital care, infections continue to develop in hospitalized patients, and may also affect hospital staff (*WHO, १००१*).

Definitions :

The term "***nosocomial infection***" is derived from two Greek words "nosos" (disease) and "komeion" (to take care of). Refers to any infection that develops during or as a result of an admission to an acute care facility (hospital) and was not incubating at the time of admission (*Siegel et al, १००१*).

A "***hospital-acquired infection***" or "***healthcare-associated infection***" (***HAI***) is an infection acquired in hospital by a patient who was admitted for a reason other than that infection. An infection occurring in a patient in a hospital or other health care 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. Infections occurring more than 48 hours after admission are usually considered nosocomial (*WHO, 2002*).

Definitions to identify healthcare-associated infections have been developed for specific infection sites (e.g. urinary, pulmonary). These are derived from those published by the Centers for Diseases Control and Prevention (CDC) in the United States of America and are used for surveillance of HAIs. They are based on clinical and biological criteria, and include approximately 10 potential infection sites (*Horan et al, 2002*).

Hospital-acquired infections may also be considered either endemic or epidemic. Endemic infections are most common. Epidemic infections occur during outbreaks, defined as an unusual increase above the baseline of a specific infection or infecting organism (*WHO, 2002*).

Eighty-five percent (85%) of HAIs comprise surgical site, pneumonia, bloodstream, and urinary tract infections. Others are skin infections, meningitis, endometritis, etc... (*Weinstein, 1992*).

Factors influencing the development of nosocomial infections

The microbial agent

The patient is exposed to a variety of microorganisms during hospitalization. Contact between the patient and a microorganism does not by itself necessarily result in the development of clinical disease — other factors influence the nature and frequency of nosocomial infections. The likelihood of exposure leading to infection depends partly on the characteristics of the microorganisms, including resistance to antimicrobial agents, intrinsic virulence, and amount (inoculum) of infective material (*WHO, 1997*).

Before the introduction of basic hygienic practices and antibiotics into medical practice, most hospital infections were due to pathogens of external origin (foodborne and airborne diseases, gas gangrene, tetanus, etc.) or were caused by microorganisms not present in the normal flora of the patients (e.g. diphtheria, tuberculosis). Progress in the antibiotic treatment of bacterial infections has considerably reduced mortality from many infectious diseases. Most infections acquired in hospital today are caused by microorganisms which are common in the general population, in whom they cause no or milder disease than among hospital patients (*Staphylococcus aureus*, coagulase-negative *Staphylococci*, *Enterococci*, *Enterobacteriaceae*) (*WHO, 1997*).

Patient susceptibility

Important patient factors influencing acquisition of infection include age, immune status, underlying disease, and diagnostic and therapeutic interventions. The extremes of life — infancy and old age — are associated with a decreased resistance to infection. Patients with chronic disease such as malignant tumours, leukaemia, diabetes mellitus, renal failure, or the acquired immunodeficiency syndrome (AIDS) have an increased susceptibility to infections with opportunistic pathogens. The latter are infections with organism(s) that are normally innocuous, e.g. part of the normal bacterial flora in the human, but may become pathogenic when the body's immunological defences are compromised. Immunosuppressive drugs or irradiation may lower resistance to infection. Injuries to skin or mucous membranes bypass natural defence mechanisms. Malnutrition is also a risk. Many modern diagnostic and therapeutic procedures, such as biopsies, endoscopic examinations, catheterization, intubation/ventilation and suction and surgical procedures increase the risk of infection. Contaminated objects or substances may be introduced directly into tissues or normally sterile sites such as the urinary tract and the lower respiratory tract (*WHO, 1997*).

Environmental factors

Health care settings are an environment where both infected persons and persons at increased risk of infection congregate. Patients with infections or carriers of pathogenic microorganisms admitted to hospital are