Incidence of Central Line Associated Blood Stream Infection in Intensive Care Units in a Private Hospital –Cairo

Thesis

Submitted as Partial Fulfillment of Master Degree in

Public Health

By

Amira Moustafa Malek

(M.B., B.Ch)

Supervised by

Professor Hoda Ibrahim Fahim

Professor, Department of Community, Environmental and Occupational Medicine

Faculty of Medicine, Ain Shams University

Professor Khaled Mahmoud Abd Elaziz

Professor, Department of Community, Environmental and Occupational Medicine

Faculty of Medicine, Ain Shams University

Dr. Hasnaa Abdel Al Abouseif

Associate Professor, Department of Community, Environmental and Occupational Medicine

Faculty of Medicine, Ain Shams University

Faculty of medicine

Ain Shams University

2015

بسم الله الرحمن الرحيم

وَمَا تَوْفِيقِي إِلاَّ بِاللّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ

(هود, ٨٨)

ACKNOWLEDGEMENT

First and foremost, I am deeply thankful to God, without his grace, this work would never have been accomplished. I wish to express my deepest appreciation and gratitude to Professor Dr. ***Hoda Ibrahim Fahim****, Professor of Public Health, Faculty of Medicine, Ain Shams University, for her direct supervision, valuable advices and continuous support and encouragement during the course of this study.*

I am deeply thankful to Professor Dr. ***Khaled Mahmoud Abd Elaziz*** *Professor of Public Health, Faculty of Medicine, Ain Shams University, for supervising this work and for his critical insights and continuous guidance.*

My sincere appreciation goes to Dr. ***Hasnaa Abdel Al Abouseif****, Associate Professor of Public Health, Faculty of Medicine, Ain Shams University, for her valuable help, continuous supervision, guidance and support throughout the conduction of this work.*

Thanks and appreciation also goes to all staff members and residents in the Dar Alfouad Hospital Infection Control Unit for their valuable help during the various phases of this work, especially, Professor Dr. Amani El-Kholy the head of Infection Control Unit in the Dar Alfouad Hospital.

Finally, I would like to thank my husband who was very helpful, supportive and encouraging during the course of this study. I am deeply thankful to my mother and my kids for their love and support.

Contents	*Page*
▪ List of abbreviations	II
▪ List of tables	III
▪ List of figures	V
▪ Abstract	VI
▪ Introduction	1
▪ Objectives	4
▪ Review of literature : ➢ Central Line Associated Blood Stream Infection Overview ➢ Central Line Associated Blood Stream Infection Prevention Strategies	 5 27
▪ Subjects and methods	45
▪ Results	53
▪ Discussion	77
▪ Summary	91
▪ Conclusion	93
▪ Recommendations	94
▪ References	95
▪ Annex	114
▪ Protocol	VII
▪ Arabic summary	VIII

LIST OF ABBREVIATIONS

APACHE II	Acute Physiology and Chronic Health Evaluation II
BSI	Blood Stream Infection
CCU	Coronary Care Unit
CDC	Centers of Disease Control and Prevention
CL	Central Line
CLA-BSI	Central Line Associated Blood Stream Infection
COPD	Chronic Obstructive Pulmonary Disease
CRBSI	Catheter Related Blood Stream Infection 3
CVCs	Central Venous Catheters
CVCR BSI	Central Venous Catheter Related Blood Stream Infection
DCL	Disturbed Conscious Level
HAIs	Health care–Associated Infections
ICU	Intensive Care Unit
INICC	International Nosocomial Infection Control Consortium
IV	Intravenous
MICU	Medical Intensive Care Unit
MRSA	Methicillin-resistant Staphylococcus aureus
NHSN	National Healthcare Safety Network
NICU	Neonatal Intensive Care Unit
PICCs	Peripherally Inserted Central Catheters
SICU	Surgical Intensive Care Unit
WHO	World Health Organization

LIST OF TABLES

No.	*Name*	*Page*
Table (a)	Types of Central Catheters	**12**
Table (b)	CLA-BSI Rates per 1.000 Line Central Line Days in Limited-Resources Countries (2002-2011).	**25**
Table (c)	Interpretation of APACHE II score	**50**
Table (1)	Characteristics and length of stay of the studied ICU patients	**54**
Table (2)	Frequency distribution of the studied ICU patients according to their diagnosis on admission	**55**
Table (3)	Incidence Rate of CLA-BSI per 1000 CL- days among studied Surgical ICU patients in the studied months of follow up (April 2014-September 2014)	**56**
Table (4)	Incidence Rate of CLA-BSI per 1000 CL- days among studied Medical/Coronary ICU patients in the studied months of follow up (April 2014-September 2014)	**58**
Table (5)	Incidence Rate of CLA-BSI per 1000 CL- days in both ICUs in the study months of follow up (April 2014-September 2014)	**60**
Table (6)	Relation between gender and occurrence of CLA-BSI in studied ICUs	**62**
Table (7)	Relation between type of ICU and occurrence of CLA-BSI	**62**
Table (8)	Comparison between cases with and without CLA-BSI as regards to risk factors in both ICUs	**63**
Table (9)	Relation between occurrence of CLA-BSI and risk factors among studied ICU patients	**64**
Table (10)	Relation between occurrence of CLA-BSI and presence of inserted medical devices on admission of studied ICU patients	**65**
Table (11)	Relation between CLA-BSI in studied ICUs and place of admission to the hospital	**66**
Table (12)	Relation between occurrence of CLA-BSI in the studied patients and ICU length of stay	**66**
Table (13)	Relation between CLA-BSI in the studied ICU patients and APACHE II scoring risk	**67**
Table (14)	Relation between occurrence of infection in studied ICU patients and site of CVC insertion	**67**

Table (15)	Relation between occurrence of infection and mean CVC days	**68**
Table (16)	The final fate of the ICU patients	**68**
Table (17)	Comparison of mortality in both ICU types	**69**
Table (18)	Relation between occurrence of infection and mortality in studied ICU patients	**69**
Table (19)	Logistic regression model analysis for risk factors of CLA-BSI in ICU patients of the study hospital	**70**
Table (20)	Percentage distribution of causative organisms of CLA-BSI in studied ICU patients	**71**
Table (21)	Comparison of causative organisms in both ICUs	**72**
Table (22)	CLA-BSI six month pattern in both ICUs during last five years (2009-2013)	**73**
Table (23)	CLA-BSI yearly trend in both ICUs during last five years (2009-2013)	**75**

LIST OF FIGURES

No.	*Name*	*Page*
Figure (a)	Routes for ventral venous catheter contamination with microorganisms	**16**
Figure (b)	World health organization's "My 5 Moments for Hand Hygiene"	**30**
Figure (1)	Incidence Rate of CLA-BSI per 1000 CL- days among studied Surgical ICU patients in the studied months of follow up (April 2014 - September 2014)	**57**
Figure (2)	Incidence Rate of CLA-BSI per 1000 CL- days among studied Medical/Coronary ICU patients in the studied months of follow up (April 2014 - September 2014)	**59**
Figure (3)	Incidence Rate of CLA-BSI per 1000 CL- days in both ICUs in the studied months of follow up (April 2014 - September 2014)	**61**
Figure (4)	Percentage distribution of causative organisms of CLA-BSI in studied ICU patients	**71**
Figure (5)	CLA-BSI six monthly pattern in both ICUs during last five years (2009-2013)	**74**
Figure (6)	CLA-BSI yearly trend in both ICUs during last five years (2009- 2013)	**76**

ABSTRACT

OBJECTIVE: This study aimed to measure central line associated blood stream infection (CLA-BSI) incidence density rate, study its risk factors and to identify pathogen specific incidence rates of CLA-BSI in patients of Intensive Care Units (ICUs). The study also aimed to examine the trend of CLA-BSI rates among patients in ICUs throughout the last five years; from 2009 to 2013 at Dar-alfouad Hospital.

DESIGN of study: A prospective cohort epidemiological study was carried out in Medical/coronary and Surgical ICUs at Dar-alfouad Hospital in order to estimate the rate of CLA-BSI, most common pathogens causing it and factors related to its occurrence. To examine the trend of CLA-BSI, a retrospective study revising the ICU records of last five years was applied.

PATIENTS and METHODS: A total of 499 patients were enrolled in the current study. The patients were prospectively followed throughout the study period (6 months) from April 2014 to September 2014, at the Surgical and Medical/Coronary ICUs for detection of CLA-BSIs. The observation was performed after admission until removal of catheter, patient death or discharge. Data collection sheets were filled by infection control staff to collect and record preoperative data for ICU patients with central venous catheters (CVCs).

RESULTS: The study revealed that nearly forty four percent of all patients admitted to ICUs had CVC insertion (43.7%), nineteen patients developed CLA-BSI at the end of the study period and 480 patients were not infected. The overall incidence density rate of CLA-BSI was 6 cases per 1000 CL-days. The central line utilization ratio was 0.94 (94.0 device are used per 1000 patient days). Our CLA-BSI rate increased from 1.6 in year 2009 to 5.6 in 2013. There was a high percentage of mortality among cases with CLA-BSI (47.4%) during the study period. Risk factors of CLA-BSI which were detected by univariate analysis includes associated co-morbidities as heart failure, high APACHE II scores >15, length of ICU stay 5 days or more, duration of CVC placement, subclavian insertion of CVCs, and mechanical ventilation. However; there were no statistical significant association between age, gender, length of hospital stay before the ICU admission, type of the ICU, place of admission to ICU and occurrence of CLA-BSI. Risk factors which were detected by multivariate logistic regression analysis includes a long ICU stay 5 days or more, Mechanical ventilation and presence of heart failure.

Gram-negative bacteria, especially Enterobacter (36.8%) and *Pseudomonas aeruginosa* (21.1%) were the predominant organisms detected in CLA-BSI cases in the current study.

CONCLUSION: CLA-BSI is an important cause of mortality in ICU patients. Nearly, half of the infected cases died in the current study. The incidence rate of CLA-BSI in the studied ICU patients increased from 1.6/ 1000 CL-days in 2009 to 6/ 1000 CL-days in 2014. The infection rate is considerably higher than in recent studies from developed counties, but is the same as in developing countries. Nevertheless, it was still lower than the rates reported in comparable published studies in Egypt. Length of ICU stay ≥ 5 days, heart failure and mechanical ventilation were independent risk factors for CLA-BSI.

Keywords: Adults; Central Line Associated Blood Stream Infection; cohort study; Intensive Care Unit; Incidence density rate; Risk factors.

INTRODUCTION

INTRODUCTION

Use of vascular catheters is common in both inpatient and outpatient care. In the United States, it is estimated that almost 300 million catheters are used each year; nearly 3 million of these are central venous catheters (CVCs), also known as central lines ***[Edgeworth, 2009].***

CVCs play an integral role in modern health care, allowing for the administration of intravenous fluids, blood products, medications, and parenteral nutrition, as well as providing hemodialysis access and hemodynamic monitoring. However, their use is associated with a risk of bloodstream infection caused by microorganisms colonizing the external surface of the device or the fluid pathway when the device is inserted or in the course of its use ***[Mermel, 2011]*** CVC is the most frequent cause of health care–associated bloodstream infections ***[Maki et al., 2006].***

Central line–associated bloodstream infection (CLA-BSI) is the term used to describe intravascular catheter–related infections. A CLA-BSI is a primary bloodstream infection (that is, there is no apparent infection at another site) that develops in a patient with a central line in place within the 48-hour period before onset of the bloodstream infection that is not related to infection at another site ***[CDC, 2012]***

Infections that patients develop while they are receiving care in a health care setting for another condition are termed ***health care–associated infections*** (HAIs). HAIs occur throughout the world, affecting hundreds of millions of patients each year ***[WHO, 2011].*** These infections are not only costly to individuals and health care systems; they can significantly increase morbidity and mortality in developed countries and in developing countries ***[Higuera et al., 2007].*** Seriously ill patients are particularly vulnerable to serious complications due to HAIs, likely due to factors such as progressively more invasive medical technology and complex medical procedures, increasing immunocompromised status and elderly age, and the rising incidence of antimicrobial resistance ***[Weinstein, 1998]***.

In the United States the CDC estimates that 5% to 10% of hospitalized patients develop an HAI ***[CDC, 2010].*** There were an estimated 1.6 million to 3.8 million infections occuring in long term care facilities each year. The percentage of patients who develop HAIs in Western Europe is similar to that in the United States with about 4.1 million patients developing HAIs. HAIs result in 16 million

added hospital days and 37,000 attributable deaths, and they contribute to 110,000 additional deaths in Europe each year ***[European Commission, 2008].*** The pooled density of HAIs in adult intensive care units (ICUs) per 1,000 patient-days (from electronic databases and reference lists of relevant papers for articles published 1995-2008 in developing countries) is estimated to be 47.9, which is more than 3 times the estimated incidence of 13.6 per 1,000 patient-days in US ICUs ***[Allegranzi et al., 2011].***

In the United States, 75% of all HAIs are due to four types of infections: urinary tract infections, surgical site infections, bloodstream infections, and pneumonia. These infections are a significant patient safety concern in health care today and are among the leading causes of morbidity and mortality in US hospitals ***[US Department of Health and Human Services, 2012].***

CLA-BSI is the most common cause of HAI to the bloodstream, according to the US CDC. There are approximately 80,000 CLA-BSIs cases occuring in ICUs in the United States each year. CLA-BSIs are serious but often preventable infections when evidence-based guidelines are followed for the insertion and maintenance of central lines. They can considerably reduce the risk of infection and mortality in patients ***[Mermel, 2000].*** As with other HAIs, CLA-BSIs also increase the cost of health care and prolong hospital lengths of stay by up to three weeks ***[Edgeworth, 2009].*** A single incident of CLA-BSI can cost as much as US$ 56,000 to treat according to some studies, once the cost of pharmacy charges, catheter changes, lab tests and an additional day in the ICU are added up ***[WHO, 2013].*** In the United States the estimated annual number of deaths associated with HAIs was 98,987. Nearly one third of these HAIs were due to CLA-BSIs, with an associated case fatality rate of 12.3% ***[Klevens et al. 2007]***.

In developing countries, mortality rates may be as high as 50% ***[Gupta et al., 2011].*** In Egypt (for example) a study was done in ICUs in 3 hospitals of Cairo University applying the US Centers for Disease Control and Prevention's National Healthcare Safety Network case definitions for central-line associated bloodstream infection between March 2009 and May 2010. CLA-BSI rates ranged widely, from 2.9 to 14.3 per 1,000 central line days, with an overall rate of 9.1/1,000 central line-days ***[El-Kholy et al., 2012].***

In adult and pediatric intensive care units of member hospitals of the International Nosocomial Infection Control Consortium (INICC) in Egypt, the CLA-BSI rate was 22.5 in the Respiratory ICU and 18.8 in the Pediatric ICUs with an overall rate of 20.8 per 1000 line-days ***[Rasslan et al., 2012].***

Available data on the global impact of HAIs have been more limited, particularly in many resource-constrained areas. Countries of low and middle income generally do not have adequate resources to conduct surveillance of HAIs. Researchers who have attempted to quantify HAI rates in developing countries have found rates to be much higher than in developed countries, and their impact on patients and health care delivery systems is both severe and underestimated ***[Rosenthal et.al, 2011], [Allegranzi et al., 2011]*** *and* ***[Raza et al., 2004].***

Based on the previously mentioned facts, the current study was done to detect the incidence, risk factors and the most frequent causative organisms of CLA-BSIs in Medical/Coronary and Surgical ICUs at Dar Alfouad Hospital. In order to minimize the occurrence of CLA-BSIs.

OBJECTIVES