Ventilator Associated Pneumonia: Incidence, Risk Factors and Etiological Agents

Thesis

Submitted for partial fulfillment of M.Sc. degree in

Medical Microbiology and Immunology

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2015

Acknowledgement

All praise, thanks and gratitude are due to ALLAH, the Cherisher and Sustainer of the worlds, for always bestowing countless bounties upon us.

I'd like to express my warm appreciation and cardinal thanks to Dr. Basma H. Gomaa; Professor of Medical Microbiology and Immunology, Cairo University, for her enthusiastic encouragement, persistent effort and support.

I owe special thanks to Dr. Lamiaa A. Madkour, Lecturer of Medical Microbiology and Immunology, Cairo University for her generous effort, honest advice, critical insight, meticulous supervision and patience.

I'd like to express my sincere gratitude and appreciation to Dr. Youssef M. Amin, Lecturer of Chest diseases, Cairo University, for his highly-valued help and cooperation.

Words truly stand short when they come to express my deep thankfulness to my family, to whom I owe a debt of gratitude.

Abstract

Background:

Ventilator-associated pneumonia (VAP) is a type of nosocomial pneumonia associated with increased morbidity and mortality. Knowledge about the incidence and risk factors is necessary to implement proper preventive measures.

Objectives:

To estimate the incidence and risk factors of VAP, as well as the most common etiological agents.

Methodology:

A prospective cohort study was conducted from March 2014 to February 2015 at Kasr El-Aini University Hospital, Chest Intensive Care Unit. Hundred patients who were on mechanical ventilation (MV) for more than 48 hours were monitored for the development of VAP.

Results:

Out of the 100 patients, 34 patients developed VAP. Univariate analysis showed that the duration of MV and trauma were significant risk factors for VAP. Multivariate analysis revealed that the duration of MV, trauma, diabetes mellitus, smoking and some comorbidities were also independent risk factors for VAP. The most common isolated pathogens were *Klebsiella* spp., *Pseudomonas* spp. and *Acinetobacter* spp.

Key Words

VAP; risk factors; nosocomial pneumonia; nosocomial pathogens

Contents

List of Abbreviations

Abbreviation	Full name
AmpC	AmpC β- lactamase
ARDS	Acute Respiratory Distress Syndrome
ATS	American Thoracic Society
BAL	Broncho-alveolar Lavage
CC-10	Clara Cell protein 10
CDC	Centers for Disease Control and Prevention
CFU	Colony Forming Unit
CHF	Congestive Heart Failure
CHX	Chlorhexidine
CK	Creatine Kinase
CLSI	Clinical and Laboratory Standards Institute
CoNS	Coagulase Negative Staphylococci
COPD	Chronic Obstructive Pulmonary Disease
CPIS	Clinical Pulmonary Infection Score
CRP	C- Reactive Protein
CT-proAVP	C-Terminal provasopressin-copeptin
DM	Diabetes Mellitus
DVT	Deep Vein Thrombosis
EN	Enteral Nutrition
ESBL	Extended Spectrum β lactamase
ETA	Endotracheal Aspirate
ETT	Endotracheal Tube
H2	Histamine-2
HAIs	Healthcare Associated Infections
HAP	Hospital-Acquired Pneumonia
HOB	Head Of the Bed
ICU	Intensive Care Unit
IDSA	Infectious Diseases Society of America
IHI	Institute for Health Improvement
IL-1	Interleukin-1
IL-6	Interleukin-6

Abbreviation	Full name
IL-8	Interleukin-8
LOS	Length Of Stay
LTB4	Leukotriene B4
MBL	Metallo-β-lactamase
mcg	Microgram
MDR	Multi-Drug Resistant
MHA	Mueller-Hinton Agar
MIF	Macrophage migration Inhibitory Factor
MIO	Motility Indole Ornithine
MR-proANP	Mid-Regional pro-Atrial Natriuretic Peptide
MRSA	Methicillin-Resistant *Staphylococcus aureus*
MSA	Mannitol Salt Agar
MSSA	Methicillin-Susceptible *Staphylococcus aureus*
MV	Mechanical Ventilation
N	Number
NA	Not Applicable
NHSN/CDC	National Healthcare Safety Network at Centers for Disease Control and Prevention
NIV	Non-Invasive Ventilation
PCT	Procalcitonin
PF ratio	Arterial oxygenation (PO_2)/Fraction inspired oxygen (FiO_2) ratio
PMNL	Polymorphonuclear Leukocyte
PSB	Protected Specimen Brush
PTC	Plugged Telescoping Catheter
SBT	Spontaneous Breathing Trial
SD	Standard Deviation
SDD	Selective Digestive Decontamination
SOD	Selective Oropharyngeal Decontamination
SPSS	Statistical Package for the Social Science
sTREM-1	soluble Triggering Receptor Expressed on Myeloid cells-1
suPAR	soluble urokinase-type Plasminogen Activator Receptor
TNF	Tumor Necrosis Factor

Abbreviation	Full name
TSI	Triple Sugar Iron
VAP	Ventilator Associated Pneumonia
WHO	World Health Organization

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Introduction and Aim of the Study

Ventilator associated pneumonia (VAP) is considered the most common nosocomial infection among the critically ill patients admitted in the intensive care units (ICUs) **(Juneja *et al.*, 2011).** It is defined as pneumonia occurring more than 48 h after patients have been intubated and mechanically ventilated **(Koenig & Truwit, 2006).**

VAP is associated with significant morbidity and mortality; including prolongation of mechanical ventilation (MV) **(Rello *et al.*, 2002)** and ICU stay **(Fagon *et al.*, 1993 and Heyland *et al.*, 1999),** increased risk of death **(Fagon *et al.*, 1993),** as well as increased hospital costs **(Safdar *et al.*, 2005b).**

Several risk factors have been reported to be associated with VAP, including the duration of MV, the presence of chronic pulmonary disease, sepsis, acute respiratory distress syndrome (ARDS), neurological disease, trauma, prior use of antibiotics and blood transfusions **(Tejerina *et al.*, 2006).**

Study of these factors offer prognostic information about the probability of developing VAP in individual patients and populations, help us to understand the mechanisms that may predispose to VAP and may allow risk stratification to target high risk patients for prevention strategies **(Cook & Kollef, 1998).**

The incidence of VAP ranges from 8-68%. Mortalities can range from 24-50% and even up to 76% when the infection occurs with certain microorganisms **(Chastre &Fagon, 2002).** The etiological agents vary from common organisms to multidrug resistant (MDR) pathogens that are difficult to treat **(Charles *et al*., 2013a).** The diagnosis of VAP requires a high clinical suspicion combined with bedside examination, radiographic examination and microbiologic analysis of respiratory secretions **(Koenig & Truwit, 2006).** Detection of the causative organisms and their antibiotic susceptibility is crucial for diagnosis of VAP in order to initiate the appropriate antibiotic treatment; thereby reducing the adverse effects of inadequate antibiotic treatment on the patient prognosis **(Dey & Bairy, 2007).**

Aim of this study:

1- Estimation of the incidence of VAP among mechanically-ventilated patients in Kasr Al-Aini hospitals.
2- Assessment of the relation between different risk factors and the incidence of VAP.
3- Detection of the most common etiological agents of VAP.

Epidemiology of VAP

Nosocomial pneumonia is an infectious process which develops within 48 hours after admission to the hospital and that was not incubating at the time of hospitalization. Ventilator-associated pneumonia (VAP) is considered as a subgroup of nosocomial pneumonia that develops 48 hours after the presence of an artificial airway and mechanical ventilation (MV) **(Ferrer *et al*., 2008).**

From another point of view, VAP is defined as a pneumonia where the patient is on MV for >2 calendar days on the date of event, with day of ventilator placement being day 1, and the ventilator was in place on the date of event or the day before. If the patient is admitted or transferred into a facility on a ventilator, the day of admission is considered day 1 **(CDC, 2014).**

- ***Incidence of VAP:***

VAP is the most frequent ICU-acquired infection **(Morehead & Pinto, 2000 and Joseph *et al*., 2009)**. However; the incidence of VAP varies in different regions of the world, depending on the criteria used for diagnosis, the type of ICU, hospital resources and study population **(Joseph *et al*., 2009).**

To facilitate and foster benchmarking between units and hospitals, the National Healthcare Safety Network at Centers for Disease Control and Prevention (NHSN/CDC) recommends expressing VAP as the number of infectious episodes per 1,000 ventilator-days. In its report

covering the period from January 1995 to June 2001, VAP ranged from 4.9 episodes per 1,000 ventilator-days in pediatric, 7.3 episodes per 1,000 ventilator-days in medical and 8.4 episodes per 1,000 ventilator-days in coronary to 13.2 episodes per 1,000 ventilator-days in surgical ICUs **(NHSN, 2002).** On the other hand, the WHO **(2011)** revealed that the incidence of VAP ranged from 5 to 24 episodes per 1,000 ventilator days. Meanwhile; data from developing countries reveal an incidence which ranges from 15.8-30.6 per 1000 ventilator-days **(Joseph *et al.*, 2009).** The rate of VAP in developing countries is higher than NHSN benchmark rates, and is associated with a significant impact on patient outcome **(Arabi *et al.*, 2008).**

In the United States, VAP was proposed as a quality-of-care indicator for ICUs **(Melsen *et al.*, 2009).** Between January 2006 and December 2007 in the United States, NHSN/CDC reported that VAP accounted for approximately 17% of the Healthcare Associated Infections (HAIs) in the ICU **(Edwards *et al.*, 2009).** Another study concluded that the incidence of VAP worldwide was 10-28% **(Safdar *et al.*, 2004)**. However; the incidence of VAP in Egypt ICUs was about 2.5 times more. The highest incidence, 75% was noted in Ain Shams University and the lowest incidence, 16% was in Alexandria University, while the incidence in Mansoura University was 22.6% (**Fathy *et al.*, 2013).**

- ***Classification and etiological agents of VAP:***

VAP can be divided into early-onset and late-onset disease. Early-onset VAP occurs during the first 4 days in which the patient receives MV **(Craven, 2000).** It is usually less severe, has a better prognosis and is more likely to be caused by antibiotic-sensitive bacteria. On the other

hand, late-onset VAP is often caused by MDR pathogens and is associated with increased morbidity and mortality **(Niederman & Craven, 2005).**

The common and unusual microbial causes of VAP documented by several investigators are listed in table 1 **(Niederman & Craven, 2005; Park, 2005 and Joseph *et al*., 2010b).** These agents may be part of the host's endogenous flora, or may be acquired from other patients, health care workers, devices or the hospital environment **(Craven, 2000).**