A STUDY OF THE BACTERIAL COLONIZATION AND INFECTION OF THE TRACHEOBRONCHIAL TREE IN INTUBATED PATIENTS IN RESPIRATORY INTENSIVE CARE UNIT

THESIS

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in Chest Diseases

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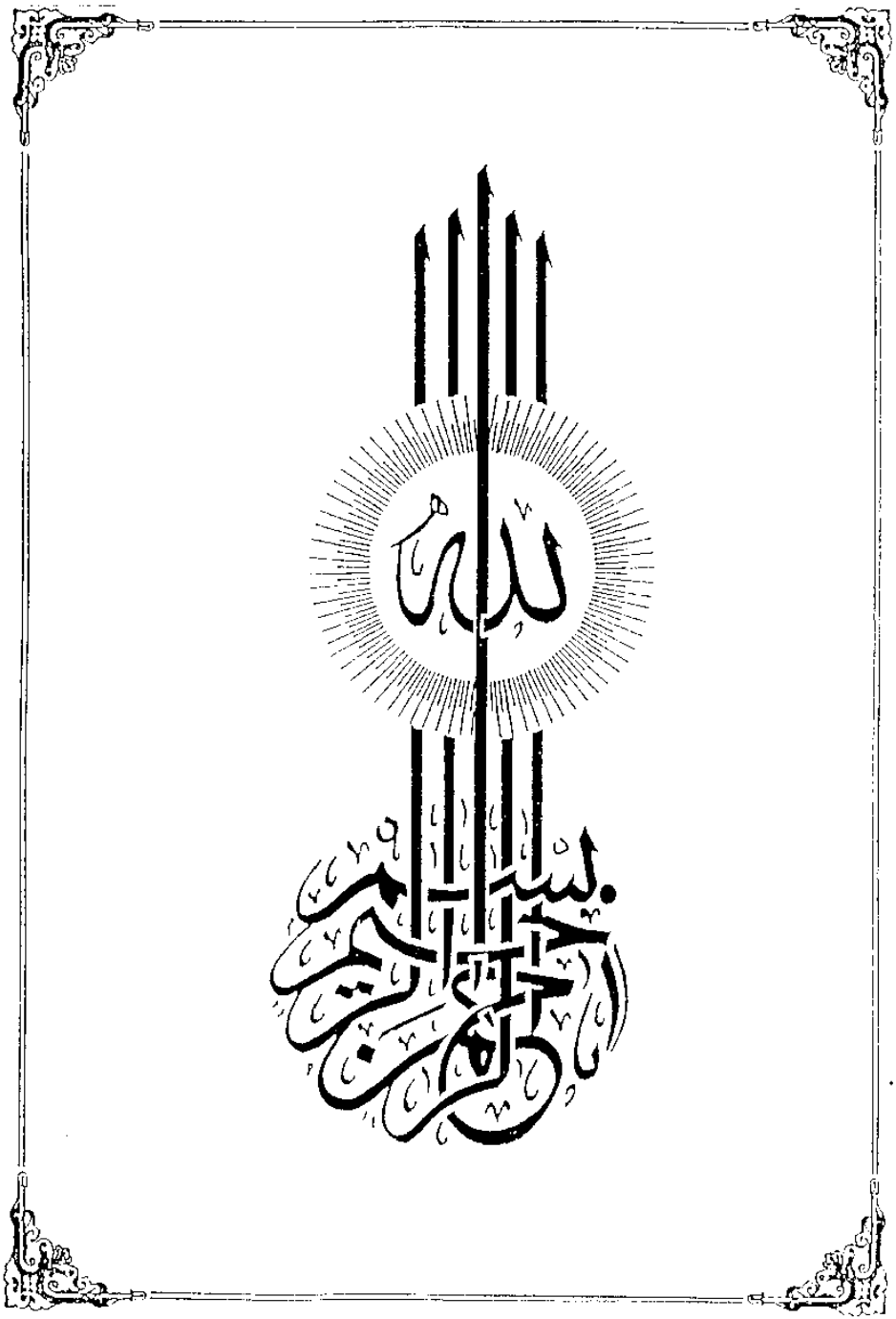

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CONTENTS

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INTRODUCTION

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Introduction

The relationship between oropharyngeal colonization, especially with gram negative bacilli, and the subsequent development of nosocomial infection of the lower respiratory tract, has been well established. Pneumonia most often develops after the failure of lung defenses to clear or kill an aspirated challenge (Johanson et al, 1969).

Patients with endotracheal tubes are particularly at high risk for colonization and subsequent pneumonia, because of disrupted local clearance mechanisms, underlying immunosuppression, the frequency of invasive procedures, the use of respiratory therapy equipment and location in an intensive care environment with exposure to numerous nosocomial pathogens (Stevens et al, 1974) (Sanford & Pierce, 1979) (LaForce, 1981).

Patients treated with endotracheal intubation and mechanical ventilation have enhanced in-hospital morbidity when they develop nosocomial pneumonia. A complication with an incidence of 10 to 70 percent, paralleling the severity of a given patient's illness (Ashbaugh & Petty, 1972) (Stevens et al, 1974) (Schwartz et al, 1978) (Gross & Van Antwerpen, 1983).

The understanding of gram-negative bacillary pneumonia has increased considerably during the past 2 decades. Difference between the clinical and epidemiological features

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of community - acquired and nosocomial gram-negative bacillary pneumonia have been delineated. Identification of risk factors, early determination of the specific microbial cause; and prompt, specific antimicrobial therapy are now realistic goals to which efforts are directed.

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Aim of Work

Screening, detection of the most prevalent bacteria in the tracheobronchial tree and searching for the factors which may affect the dynamics of colonization of these bacteria and the development of actual respiratory infections, in intubated patients, in respiratory intensive care unit, are the aims of this work.

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BACTERIAL COLONIZATION

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BACTERIAL COLONIZATION

Definition:

Colonization describes the behaviour of organisms when they grow on the surface or lining of the host without invasion, alteration of tissue, or any host response to toxin, this includes mutual and commensal relationships (Couperus & Elder, 1984).

Colonization of the respiratory tract :

Colonization is defined as the appearance of any potential pathogen in tracheal cultures in the absence of purulent tracheobronchial secretions or clinical evidence of infection (Demers & Irwin, 1985).

When a potentially pathogenic microorganism (PPM), normally not present in the microflora of an individual, penetrates and grows either among the existing flora or in a normally sterile site, without signs of infection , this new situation is called "Colonization". Many microorganisms penetrate several body sites during the daily contact with the environment. However, defense mechanisms will prevent them from setting up residence at those sites, colonization will not take place and the PPMs will not remain for more than a few hours. It is then possible to culture PPMs in occasional samples taken from a given site. therefore, colonization with PPMs will only be considered to occur when the same microorganism is isolated from at least 2 consecutive samples from that site taken over a 2 days interval (Miranda & Langrehr, 1988). Thus colonization can

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be defined as the persistence of bacteria at a body site, without evidence of a host response (Johanson, 1989).

Pathogenesis:

Microbial colonization begins immediately after birth, depending mostly upon the flora existing in the environment. Within a few weeks colonization of the neonate becomes qualitatively and quantitatively remarkably similar to that observed in adults (Mackowiak, 1982).

Holdeman et al (1976), studying the faecal flora of astronauts have shown that, there were only small daily variations in the flora of each of them, even when submitted to different diets or environments. Although there might be difference in the representation of microbiological species between individuals the pattern of colonization will remain almost constant for any single individual (Miranda & Langrehr, 1988). Although the upper respiratory tract is bathed with secretions which are in constant motion towards the pharynx, the resident bacterial flora of this region is not uniformly distributed, rather certain bacterial species exhibit a definite predilection for specific sites (Liljemark & Gibbons, 1971) (Liljemark & Gibbons, 1972). It has been found that the microbial composition of a region is proportional to the relative abilities of the individual species to attach to the epithelial cells of that region (Liljemark & Gibbons, 1972) (Gibbons & Van Houte, 1975) (Gibbons et al, 1976). Evidence has accumulated to suggest that, the initial event in colonization and invasion is the

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adherence of the microorganisms to epithelial cells of mucosal surfaces (Gibbons & Van Houte, 1975) (Gibbons, 1977). Organisms that are unable to adhere to mucosal surfaces, fail to colonize because they are removed by the secretions that bathe the mucosal surfaces (Mandel, 1976).

Colonization of the respiratory tract of seriously ill patients by gram-negative bacilli is, in every case, accompanied by in vivo adherence of the colonizing species to epithelial cells of the upper respiratory tract (Johanson et al, 1979). Thus a selective bacterial adherence to mucosal surfaces of the respiratory tract seems to be a major determinant of the endogenous bacterial flora. The colonization of the mucosal surfaces by newly acquired pathogenic bacteria may also be mediated by bacterial adherence, and appears to involve both host and microbial factors (Woods, 1983).

Bacteria may gain access to the pulmonary parenchyma by at least three routes. Organisms may enter the lung via the blood stream from an extrapulmonary source, they may also enter by inhalation of aerosolized bacterial particles (Pierce & Sanford, 1973). However, the majority of bacterial pulmonary infections are thought to follow endogenous aspiration of oropharyngeal bacteria. Inhaled bacteria are cleared by the lung much more efficiently than those introduced by aspiration. Aerosol deposition of 10^6 Streptococcus pneumoniae into the lungs of experimental animals, causes no evident illness and the organsims are cleared rapidly. In contrast, intratracheal instillation of

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10^3 of the same organism reproducibly causes pneumonia (Ansfield et al, 1977).

Huxley et al (1978) have investigated that nocturnal aspiration of the oropharyngeal secretions is a common event. They found that approximately 50% of normal subjects and 70% of subjects with impaired consciousness aspirate during sleep. As nonaspirating subjects were noted to sleep poorly during the study, the investigators proposed that every one probably aspirates during deep sleep. It should be noted that oropharyngeal secretions contain approximately 10^7 organisms per milliliter, a significantly large challenge if presented to the lung by aspiration. Thus, the bacterial composition of aspirated oropharyngeal secretion may be an important determinant of the etiology of pneumonia (Woods, 1983).

However, before an infection arises, one or more of the following events of colonization tends to occur:

1- Overgrowth of one microorganism, upsetting the previous equilibrium with other microorganisms in the local flora.

2- The appearance and growth of microorganisms normally not present in the normal flora.

3- The penetration and growth of microorganisms into sites normally sterile.

(Miranda & Langrehr, 1988).

Factors Affecting Colonization:

1- Defense mechanisms:

Aside from the nonspecific cleansing mechanisms operating to remove bacteria from the mucosal surfaces,

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certain specific factors may influence the adherence of particular organisms to these surfaces. Oral secretions contain IgA antibodies, which have been shown to coat various bacteria and prevent their adherence (Williams & Gibbons, 1972).

2- Physiochemical factors:

Gibbons & Van Houte (1975), have reviewed factors which have been postulated to account for the selection of the resident bacterial flora of the mouth, many of these factors including pH, temperature, nutrient supply, inhibitory substances such as lysozymes and bacterial products such as bacteriocins, might be expected to influence the outcome of the selection process. However, because of the large variety of species in the oral cavity which coexist with each other in high proportions, they concluded that both the physical and chemical conditions existing in the mouth probably exert relatively weak selective influences.

3- Microbial factors:

Long and Swenson (1976), found a selective adherence of oral Streptococci over Escherichia coli, in studies of oral epithelial cells obtained from normal newborn infants.

4- Physical state of the host:

In prospective studies of patients at high risk of colonization of the upper respiratory tract, it was demonstrated that colonization rapidly follows an apparent alteration in the epithelial cell surface which allows the

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adherence of gram-negative bacilli, thus the physical state of the host is also an important determinant (Johanson et al, 1980) (Woods et al, 1981 [a]) (Woods et al, 1981 [b]).

5- Epithelial cell associated factors:

Since the resistance of the normal respiratory epithelial cells to colonization has been shown to persist in vitro, the mechanism appears to involve cell associated factors. Using in vitro methods, it was also shown that attachment of gram-negative bacilli to buccal epithelial cells of colonized subjects was markedly greater than to cells of non-colonized subjects (Woods, 1983).

6- Bacterial interference:

Bacterial interference refers to the phenomenon in which one bacterial species inhibits the growth of another. It may involve competition for receptors or binding sites on host cells, competition for nutrients, mutual inhibition by metabolic or toxic products, mutual inhibition by antibiotic materials or bacteriocins, or other mechanisms. Suppression of the normal flora clearly creates a partial local void that tends to be filled by organisms from the environment or from other parts of the body. Such organisms behave as opportunists and may become pathogens (Jawetz et al, 1984). Antimicrobial drugs kill normal flora, allowing new microbes to colonize (microbes that are resistant to the antimicrobial agent), for example Alpha haemolytic Streptococci in the mouth, normally block Pseudomonas multiplication, and are part of the system against Candida

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