Clinical Microbiology: Reemphasizing the Role of Anaerobic Bacteria in Human Infections

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Introduction

Life in the absence of air is known as anaerobiosis. Oxygen free environment is suitable for growth of bacteria which are termed as anaerobic bacteria was first observed by Antony Van Leeuwenhoek. Clostridium butyricum was the first anaerobic bacteria discovered by Louis Pasteur in 1862 and he coined the term anaerobes for those bacteria which grow in the absence of air. First report of infection in human by anaerobic bacteria was attributed to Bacteroides fragilis by Veillon and Zuber way back in 1893 [1]. Anaerobic bacteria that cannot grow in the presence of more than 0.5% oxygen are termed as strict anaerobes and those that can sustain 2-8% of oxygen are called as facultative anaerobes [2]. Anaerobic bacteria live in the oxygen free pockets of human body including the interiors of plaques on the surfaces of teeth, gums and in the gastrointestinal tract. It is really astonishing to know that anaerobic bacteria outnumber the aerobic bacteria as flora being present even on skin. Most of the anaerobic infections in human are endogenous in origin ever since they were recognized as being responsible for various infections in human as well as animals [3]. More than hundred years since anaerobes and the infections caused by anaerobic bacteria were recognized, lest very less progress has been achieved that can be attributed to complacency, negligence and ignorance among the clinicians and clinical microbiologists.

Identification of Anaerobic Bacteria

From the time since discovery of anaerobic bacterial infections, very less progress has been achieved which included anaerobic apparatus like gas paks, Coy anaerobic chambers, pre-reduced anaerobically sterilized media (PRAS) and sodium azide selective medium for selective culture of anaerobes were used in clinical laboratories [4-6]. Identification of Anaerobic bacterial isolates from various clinical isolates was studied based morphological characters like pigment production and their susceptibilities to six antibiotics including penicillin, erythromycin, rifampicin, kanamycin, vancomycin and colistin [7-8]. Due to more turnaround time for their culture, identification and sensitivity and the cost, routine anaerobic bacteriology of various clinical isolates was not considered in many clinical laboratories. The fact that anaerobic infections are normally polymicrobial makes it even more difficult for their culture as clinical samples are processed routinely for aerobic bacteria. Anaerobic bacteria were considered to act synergistically with coexisting aerobic pathogens to produce specific lesions which otherwise would have developed typical infections independently [9-11]. Bacteremia due to anaerobic microorganisms though has been reported frequently, blood for culture of anaerobes is still not regularly performed in many clinical laboratories [12]. Developing countries face cost constraints in acquiring and processing clinical samples for both aerobic and anaerobic bacteria. Clinically relevant anaerobic bacteria include Bacteroides fragilis group (Bacteroides fragilis, B thetaiotamicron, B ureolyticus, B stercolis, B caccae, B merdae, B distasonis, B uniformis, B ovatus and B vulgatus). Pigmented anaerobic gram negative bacteria (Prevotella melaninogenica, P dentica and P nigrescens) and non-pigmented prevotella (P oralis) [3]. Other anaerobic bacteria that are isolated frequently in clinical samples include Clostridium difficile, Peptostreptococcus micros, Peptostreptococcus magnus, Porphyromonas asacharolytis, Fusobacterium nucleatum, F necrophorum, F varium, F russii and Bilophila wadsworthia. Bifidobacterium, Eubacterium, Lactobacillus, Propionibacterium and Actinomyces spp. form a part of indigenous flora of humans [5,10,13].

Pathology of Anaerobic Bacterial Infections

Anaerobic infections most often present as abscesses. Very little has been understood about the pathogenesis of anaerobic bacterial infections. Though many anaerobic bacteria do not possess biologically active endotoxins, capsular polysaccharide, synergistic association with other bacteria (poly microbial infections), action of anaerobic bacteria on living and dead tissue to form gas, impairment of defence mechanism due to anoxia, various conditions that reduce oxidation- reduction potential may produce characteristic anaerobic infections. From skin and soft tissue infections, periodontal infections, bite wound, traumatic wounds, anaerobes can involve head and neck, lungs, GIT and genito-urinary tract [3,14-16]. Anaerobic infections are normally localized near mucus membranes and involve degenerating tissue either due to bacterial action or with enzymatic action. Predisposing factors for anaerobic bacterial infections include tissue anoxia either due to trauma or because of surgery, malignancy and vascular abnormalities. Endocrine disorders including Diabetes mellitus, spleenectomy, immunosuppression either due to cytotoxic drugs or because of HIV and other infections [3,10].

Therapeutic Management of Anaerobic Infections

Antibiotic prophylaxis is often practiced in clinical practice to combat anaerobic bacterial infections. Clindamycin for respiratory infections, metronidazole and fluoroquinolones for GIT and other surgeries are some of the antibiotics employed to eliminate anaerobic infections [17]. Resistance to antibiotics though is not common, reports of resistance of anaerobic bacteria to many commonly used drugs has been on the rise [18,19]. Carbapenem and 5-nitroimidazoles are the two groups of antibiotics which still show a lot of promise [10]. Aminoglycosides are ineffective in anaerobic infections due to absence of oxygen and nitrogen electron transport system which is required for uptake [10]. Molecular mechanisms of resistance include inter or intra generic transfer of resistance by conjugation and transformation under anaerobic
environment. Plasmids also were found responsible for drug resistance in anaerobic bacteria [20-22].

Current Perspective and Future Implications

Interest on anaerobic microbiology has taken a new upsurge due to increasing reports of infections with anaerobic bacteria including Bacteroides group, Clostridium difficile and animal infection outbreaks caused by Clostridium botulinum [16]. Bacterial therapeutics, use of bacteria for drug delivery, a new area of research concentrating on treatment of cancers with use of anaerobic bacteria to carry the antibiotics or anti-cancer reagents to the hypoxic, low pH and microenvironments inside the cancerous tissue has been instrumental in generating some interest in anaerobic bacteria [23,24]. Thermophilic anaerobic bacteria are a cause of concerns in food industry that brings about spoilage of non or semi-acid canned foods and can be responsible for outbreaks [6]. The main drawback for reduced isolation of anaerobic bacteria from various clinical samples was improperly collected and transported specimen. Developing countries are ill supported financially to establish a separate clinical section in diagnostic laboratory. Though many aerobic blood cultures are negative, no efforts are made to process blood for anaerobic bacteria. Previous reports have suggested significance of anaerobic blood cultures in ICU’s and a 3% positivity of obligate anaerobes among the study group [25,26]. No adequate data is available either on the frequency of anaerobic bacterial infections, predisposing factors or on the in vitro antimicrobial susceptibility patterns of anaerobic bacteria isolated from clinical specimens. Interest on anaerobic bacterial identification and their susceptibility towards various antimicrobial agents can only be attained if clinicians suspect anaerobic bacterial infections and availability of trained paramedical staff on the necessary precautions to be taken for proper collection and transport of specimens where ever anaerobic bacteria are to be suspected. Clinical microbiologists should work in synergy with clinicians, Conduct Continuing Medical Education (CME) programmes on anaerobic bacteria and their role in infections, give necessary training for paramedical staff and establish necessary laboratory facilities for identification of anaerobes in the suspected clinical specimens.

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