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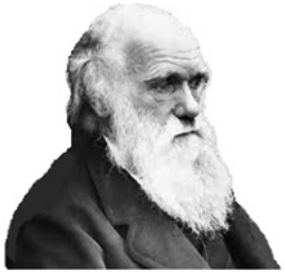

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Infection Control in the Post-Antibiotic Era

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ABSTRACT

Antibiotic resistance by pathogenic microorganisms has become a major clinical and public health problem in the 21st century. Countries across the world are faced with restricted healthcare resources, high demand for modern drugs and increasing antimicrobial resistance. This escalation in antibiotic resistance is attributed to the misuse and overuse of antibiotics, poor isolation practices and long hospital stay of patients who then become susceptible to nosocomial infection. The misuse and overuse of antibiotics is now generating resistance to almost all classes. However, it is pertinent to emphasize that even with the pervasive nature of antibiotic resistance worldwide, infections acquired by patients in the hospital must be treated. Thus, this review article proposes some control options and recommendations to protect us against resistant bacterial strains.

***Keywords*:** Infection control, antibiotic resistance, hand hygiene, nosocomial infection, transposons, teratogenic infection

INTRODUCTION

The discovery of antibiotics by Alexander Fleming in 1920s was one of the most important weapons in the fight against bacterial infections and has saved millions of lives. However, over the past decades, health benefits of these important drugs are waning down as more strains of bacterial pathogens are now resistant to varieties of antibiotics and chemotherapeutic agents (Nayan and Shukla, 2011). Antibiotics resistance currently threatens the efficacy of treatment of pathogenic bacterial infections. Consequently, common infectious

diseases remain untreated and spread rapidly in most hospitals. The widespread antibiotic resistance also inhibits the effective treatment and management of specific health conditions such as cancer, organ transplant, diabetes, surgeries and other medical procedures (WHO, 2016). Existing literatures have attributed the widespread of antibiotic resistance to the overuse and misuse of antibiotics or medication (Ventola, 2015; Okeke, 2014). The overuse of antibiotic drugs has been linked to the increase availability and the uncontrolled sales and dispersion of drugs, especially in third world countries, where people can easily access antibiotics without any formal prescription from a health care professional. Countries with uncontrolled sales of drugs may probably lack an effective regulatory body to checkmate the distribution of drugs and ensure drug standardization. Even in developed countries, livestock animals are fed with low doses of antibiotics which have also contributed substantially to heighten the level of resistance (Ferber, 2002; Mathew, Cissell & Liamthong, 2007). Wrong usage of antibiotics or drug misuse or inappropriate prescription has been reported to be largely responsible for bacterial drug resistance (Arnold & Straus, 2005). For instance, McNulty *et al.,* (2007) observed that one-third of people believed that antibiotics can be used for common cold and as such becomes the major reason for most antibiotic prescription. Non-adherence to prescription guidelines on the part of the prescriber may lead to excessive usage of antibiotics.

In the hospital setting or infirmaries, antibiotic resistance exacerbates the health outcome of patients propelling the rapid spread of untreated bacterial strains. The transmission of such infection can occur from divergent routes, that is, from patient to health care workers and vice versa, air droplet, body contacts, use of unsterilized equipment, etc. Poor medical procedures and longer stay in the hospital could further propel the spread of infections in infirmaries. Nicolle (2014) documented that the health care facility is a hub for anti-microbial resistance and its prevalence varies across hospitals. According to Nicolle (2014) tertiary health care facilities present a greater proportion of antimicrobial resistance as compared to smaller health care facilities such as health post, comprehensive health centers and primary health centers. This may be associated with the fact that most perception or prescribers are found in tertiary health facilities and there is greater influx of patients in most giant hospitals than the community-based infirmaries.

Nicole (2014 further affirmed that anti-microbial resistance within the hospital setting is much higher in specific units, such as intensive care units, burns units and transplant units. This is because 30-50% of patients admitted to these units are administered anti-microbial therapy which is usually a broad spectrum. The elderly and premature neonates constitute the most-at-risk hospital population for increase rate of acquired nosocomial infections. This is because of their immune-comprised state which consequently affects their resistance level to infection. Some anti-microbial agents are naturally resistant, usually because of their impermeability and molecular properties. Acquired resistance can equally be gotten via mutation or by acquiring new genetic strains which are converged by mobile materials such as plasmids and transposons (Lim *et al*., 2005). Four distinctive mechanisms have been discovered to aid the free exchange of genetic materials across microbial agents thereby fuelling acquired resistance which includes: target modification, drug efflux pumps, drug inactivation, and reduced permeability (Lim *et al.*, 2005).

These mechanisms work in close synergy to produce a resistance of which a single mechanism may not be adequate. Furthermore, selective pressure could also result in the ‘bundling’ in proximity of various resistance genes in a single package of exchangeable genetic

material. This is specifically common in Gram-negative organisms that are highly resistant to antibiotic.

However, it is pertinent to emphasize that even with the widespread wave of antibiotic resistance around the globe, infections acquired by patients in the hospital must be treated. To achieve this, scholars have raised concern over the impact of antibiotic resistance and spread of infection on the outcome of patient care, alternative methods of treating bacterial infection in hospitals and measures or workable strategies to mitigate the spread of bacterial infection in hospitals of which this paper principally seeks to explore.

Transmission or Spread of untreatable bacterial strains in hospitals

Transmission of nosocomial infection is principally via air droplets, direct or indirect contact with infected persons or objects either from patients to healthcare workers or from health workers to immuno-comprised patients. Non-adherence to treatment guidelines and medical procedures can propagate the spread of teratogenic infections in the hospital. This occurs in a situation where the health professional uses unsterilized equipments or neglect the use of medical gadgets (also called Medial Safety Devices) such as hand gloves, mask, gown, etc., during medical operations. It has also been observed that transmission of infection in the hospital can equally occur when the strain of an endogenous resistance results in an epidemic or continual endemicity of colonized resistant organism. Dirty or untidy environment can also catalyze the transmission of infection in the hospital. In this case, the dirty environment becomes the hub for microbes to strive, breed, and proliferate, and thereafter transmits and infects a susceptible host. One way to control such spread is by the use of disinfectants to disinfect the environment and suppress the microbial activities from transmitting infections. It is important to highlight that in-patients who are often hospitalized and stay longer in infirmaries are twice more likely at risk of acquiring nosocomial infection than their out-patient counterparts (Mehta, *et al*., 2014).

Impact of the spread of infection in the hospital on patient care

The impact of microbial resistant infection is usually accompanied by negative consequences on the patients and healthcare facilities. Such negative impacts include: increase morbidity, increase death rates, longer stay in hospital, increase out-of-pocket expenditure on treatment and purchase of drugs, possible epidemic outbreak, increased risk of nosocomial infection. These consequences exert substantial pressure on the existing health system and increase patients' susceptibility to poor health outcome. While antibiotic resistance in infirmaries is seen to have a negative impact on patient care, concerns have been raised to understand the methodologies of measuring outcomes.

Measures of controlling the spread of infections in hospitals

The World Health organization (2014) stated that antibiotic resistance can be dealt with by using only prescribed antibiotics given by a healthcare professional, adherence to treatment regimen and using quality antibiotic products. The healthcare providers also have a role to play in tackling antibiotic resistance by giving prescription only when it is needed and prescribing and dispensing the right antibiotic(s) to treat the illness. Institutionalizing the regulation and appropriate use of medication, strengthening an efficient surveillance structure, fostering innovation and research, and establishing an efficient mechanism for information sharing

among relevant stakeholders are vital roles health policy makers, must play to fight against antibiotic resistance in the contemporary world.

Unarguably, antibiotics are usually used most often to control the spread of infection in infirmaries. However, with the emergence of antibiotic resistance to certain microbes, there is a great need to re-strategize in order to control, mitigate and antagonize the proliferation and spread of infectious diseases in hospitals. Evidence-based researches have confirmed some alternative measures which have been applied to control nosocomial infections.

Production of vaccine

It is a known fact that micro-organism does not develop resistance to vaccine. This may be linked to the fact that vaccines, when introduced in the body system, boost the immune system to fight against infection, whereas antibiotics tend to operate in isolation from the body's defense system. Vaccines are also highly needed because they prevent the occurrence of infections and consequently diminishe the use of antibiotics (Mishra *et al*., 2012).

Alternative therapy

This is a situation, where a combination of 2 to 3 antibiotics is taken at once. The logic behind this strategy is that once the microbes develop resistant to one antibiotic, the other antibiotics would still act to suppress the activities of the microorganism and treat the patient. According to Kim *et al.*, (2014) this method has proven to be effective to tackle antibiotic resistance and enhance better health outcome.

Hand hygiene practice

The lack of hand washing by healthcare workers remains a worldwide problem, and this could pose a threat in the spread of infections in the hospital from staff, patients and visitors. Poor hand hygiene is one of the most common cause of the spread of infection in the hospitals (Wester *et al*., 1999). It increases the chance of spread the drug resistant organisms such as Methicilline resistance, *Staphylococcus aureus* and *Clostridium difficile* infection. The hands have been identified as the most important vehicle for microbial transmission and hand hygiene, on the other hand, is one major approach to prevent the transmission of infections especially from healthcare personnel to patients in the hospital (horizontal transmission) (WHO, 2014). According to World Health Organisation, hand hygiene should be practiced before and after touching a patient, before and after aseptic procedures, and after exposure to body fluids and blood products. It is recommended that the washing of hands should be with soap and water. Care for the finger nails is also encouraged, to prevent the infestation of germs.

Adherence to medical procedures

Standard operation procedures must dully be followed to mitigate the spread of infection in hospitals. This involves the use of personal protective equipment, such as sterile gloves, gown, mask, face shield, shoe and head coverings, and sterilized equipments by healthcare personnel during medical operations (Mehta *et al.*, 2014). The use of personal protective equipment, protects both the staff and patient from cross infection. The use of personal protective equipment is important to healthcare workers because it protects their skin from contact to potential infectious body fluids. Hand gloves should be used at all times when attending to patient, as it prevents cross-contamination especially when touching body fluids

(Garner, 2012). All personal protective equipment should be removed and discarded after usage and fresh one be worn before attending to new patient, this will prevent infection from spreading. Although hand gloves are not 100% protective as it may be torn during usage and this could easily lead to contamination of hand at the point of removal (Larson, 2011), then hand hygiene is important before using another pair of gloves. Various types of face masks, protective eye wears are used to provide barrier protection. A surgical face mask is worn to protect a patient against pathogenic human bacteria from the wearer and also protects the healthcare worker from particle droplet splash that could be created during surgical operation.

Environmental hygiene

Ensuring optimal environmental hygiene is crucial to effectively prevent the spread of infections. Dirty environmental surfaces are possible vehicle for the transmission of microbial infection. Certain microbes are capable of surviving on the environmental surface for a long time. When hospital patients or healthcare providers come in contact with these contaminated surfaces with their skin, the bacteria can then be transmitted from one person to another. Hence, it is in this light that the hospital environment be kept clean, sanitary and regularly disinfected.

Surveillance

Surveillance provides clues to the patterns of spread of infectious diseases and how they can be controlled effectively. Surveillance is also use to assess current infection prevention protocols. Having a robust infection surveillance programme helps organizations to measure outcomes, assess processes of care, and promote patient safety.

Antimicrobial stewardship

They should be a coordinated interventions put in place to improve and measure the use of antibiotic appropriately by promoting the selection of antibiotic in a most desirable manner, duration of therapy and the route of administration in order to get the most out of clinical cure as well as prevention of infection, while limiting the widespread of resistance, adverse drug incidence, and the cost of treatment. Dellit *et al*., (2007), affirm that antimicrobial stewardship has shown to limit the inappropriate consumption of antibiotic, thereby reducing antibiotic resistance and has lead to proper antimicrobial treatment outcomes from patients.

Recommendations

Based on empirical evidence, the following recommendations are made:

(1) Effective monitoring and surveillance system should be institutionalized to checkmate the quality of antibiotic drugs manufactured, control the pattern of drug distribution and ensure adherence to prescription guidelines.
(2) While an efficient method of treating and managing microbial infections is highly anticipated, vaccines should be developed to act as a second therapeutic approach so as to mitigate the rate of morbidity and mortality from infectious diseases.
(3) Health education should be used as a tool to increase awareness level of the populace on the consequences of antibiotic overuse, misuse and rampant practice of self-medication.

(4) Healthcare professionals should be trained and retrained intermittently to keep them abreast with current health events, dynamism in disease occurrence, ensure continual adherence to perception guidelines and medical procedures, as well as improve the standard of patient care and promote international best practices.
(5) Isolate patients with highly infectious communicable disease.
(6) Perform procedures under maximum aseptic condition.
(7) Patient should be counseled on self medication.
(8) Discrete use of antibiotics in human and animal population.

Future directions for research and practice

In order to understand the connection between antimicrobial use and resistance, a successful program aimed at regulating antimicrobial use should be designed. A better understanding of this connection would allow clinicians to decide of the type of antibiotic that is restricted to the user because some people react differently to different antibiotics. This would determine whether there is a threshold volume of antibiotic use that is required before the existence of ubiquitous antimicrobial resistance, and the expected time between antimicrobial use and changes in resistance. One technique that can be used to understand the time dependence of antimicrobial resistance changes in response to antimicrobial use is autoregressive integrated moving average (ARIMA) (Lopez *et al*., 2000, Monnet *et al*., 2001).

Although, this is an emerging area of research that is used outside the hospital environment. This is because some common disease causing microbes, such as methicillin resistant *Staphylococcus aureus*, that were limited or restricted to the hospital, are now becoming prevalent in various communities around the hospital environment or even far from the hospital environment (Conan and Ron, 2005). All healthcare professionals should come together and design an electronic antibiotic prescribing system that has an in-built antibiotic alert system with a formal management and a proper surveillance. Robot healthcare delivery space suits to protect all medical staff attending to patients who are infected should be introduced in the future as a means of tackling the problem of antibiotic resistance in the near future (Dancer, 2013).

CONCLUSION

The emergence of antibiotics resistance obviously threatens the overwhelming benefits that have been achieved with antibiotics. However, the contemporary healthcare system suffers a major setback because of its substantial impact on patient care and economies of countries. The widespread overuse of antibiotics and the non-availability of new and effective antibiotic agents pose substantial health risks to the vulnerable population and further exacerbate the issue globally.

To control the development of antibiotic resistance by microorganisms, it is advisable to use antibiotic in the right way, and to use the right drug, at the appropriate time, for the right period, and should be taken as prescribed by the doctor, and antibiotic should never be saved for later or shared with others. Hence, concerted efforts to establish new policies, re-enforce research efforts, and devise formulae to control the crisis are highly desirable.

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