British Microbiology Research Journal
15(1): 1-11, 2016, Article no.BMRJ.25895
ISSN: 2231-0886, NLM ID: 101608140

SCIENCEDOMAIN *international*
www.sciencedomain.org

A Review of Nosocomial Infections in Sub-Saharan Africa

Elizabeth N. Mbim[1], Clement I. Mboto[1] and Bassey E. Agbo[1*]

[1]Department of Microbiology, Faculty of Biological Sciences, University of Calabar, P.M.B. 1115, Calabar, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BMRJ/2016/25895
Editor(s):
(1) Gyanendra Singh, Gene Therapy & Louisiana Vaccine Center, School of Medicine, LSU Health Sciences Center, Louisiana, USA.
Reviewers:
(1) Akobi Oliver Adeyemi, Federal Medical Centre, Nigeria.
(2) Cucunawangsih, University of Pelita Harapan, Indonesia.
Complete Peer review History: http://sciencedomain.org/review-history/14797

Review Article

Received 25th March 2016
Accepted 13th May 2016
Published 27th May 2016

ABSTRACT

Nosocomial infections are a major public health problem globally and are on the increase despite efforts in hospital infection control measures and contribute significantly to morbidity and mortality. Naturally, any micro-organism has the potential to cause infection in hospitalized patients however, only a few including *Staphylococci, Escherichia coli*, *Pseudomonas aeruginosa, Enterococci,* fungi and to a lesser extent, viruses and parasites are responsible for the majority of nosocomial infections. In sub-Saharan Africa, data available show that the incidence of nosocomial infections ranges from 2-49% with patients in intensive care units having the highest rate ranging from 21.2-35.6%. The prevalence of nosocomial infections have been reported to vary between 1.6%-28.7% in Burkina Faso, United Republic of Tanzania, Ghana, Mali, Cameroon, Gabon, Uganda, Burundi, Democratic republic of Congo and Senegal. In Nigeria and Ethiopia, the total accruing occurrence in surgical wards has been reported to vary from 5.7%-45.8% with the later having an incidence as high as 45.8% and an incidence density equal 26.7 infections per 1000 patient days in paediatric surgical patients. In addition, 3.4 -10.9% of hospital-associated infections often result to mortality in most developed countries though these figures are suspected to be higher in developing countries of sub-Saharan Africa including Nigeria. However, simple and effective control programmes together with effective training of healthcare workers will go a long way in reducing the endemic nature of

**Corresponding author: E-mail: profbaseadeone@gmail.com;*

nosocomial infections in sub Saharan Africa. This paper highlights the natural history, distribution, risk factors of nosocomial infections especially in sub Saharan Africa as well as its contributory factors.

Keywords: Natural history; distribution; nosocomial infections; Sub-Saharan Africa; burden.

1. INTRODUCTION

The history of nosocomial infections can be traced to the origin of hospitals themselves and have been defined by the WHO as infections that develop in a patient during his/her stay in a hospital or other types of clinical facilities which were not present at the time of admission [1,2]. According to Samuel et al. [1], these infections usually become clinically apparent either during hospitalization or after discharge and as such, organisms that cause these infections are termed nosocomial pathogens [2]. Furthermore, Samuel et al. [1], Saka et al. [3] and Amoran et al. [4] reported that infections acquired by staff or visitors to the hospital or other health care settings may also be considered as nosocomial.

Usually, when pathogenic microorganisms are found in body fluids or at body sites that are normally believed to be sterile, such as the cerebrospinal fluid or blood of asymptomatic patients, this may be considered as an infection. Also, Samuel et al. [1] and Bereket et al. [5], stated that an infection is not considered nosocomial if it is already present on admission. However, such infections can be termed nosocomial if there is a change in symptoms or pathogen which may indicate the acquisition of a new infection.

According to Nejad et al. [6], 'patient care is provided in facilities which range from front-line units with only basic facilities 'to University teaching hospitals and clinics with well-equipped technologically advanced medical facilities. These facilities have been implicated in nosocomial infections ranging from superficial infections to necrotizing soft tissue infections. Both add to the cost of patient care, extend period of hospitalization and contribute significantly to mortality [3,7].

Studies have revealed that nosocomial infections are becoming more alarming in the present century (21st century) which is due to the increased use of outpatient treatment meaning that people who are in hospitals are averagely sick coupled with the fact that hospitals admit large number of sick people and whose immune systems are often compromised [1]. Several reports including the WHO, [8] revealed that the frequent use of antibiotics in hospitals has created selective pressure which has caused most micro-organisms to develop resistance coupled with some medical procedures especially those that bypass the body's natural protective barriers and cross contamination from medical staff to patients as well as inadequate cleaning procedures concerning uniforms, washing, sterilization of equipment and other preventive measures that may be ignored thus providing a route for pathogens to spread.

This review is aimed at contributing to our understanding of the natural history of nosocomial infections, distribution most especially in sub Saharan Africa. Most importantly, this paper also aims to highlights the risk and contributory factors of these agents as it relate to disease burden: morbidity and mortality.

2. AETIOLOGY OF NOSOCOMIAL INFECTIONS

Studies including that conducted by Jain et al. [9] and Sherifa and Moataz [10] revealed that nosocomial pathogens often come from the patient's own body (endogenous flora) while a great number of them come from contact with staff (cross contamination), contaminated needles, environment and instruments (exogenous flora). In practice, almost any organism has the potential to initiate infections in hospitalized patients [5] because these patients may be more prone to infections due to diminished immunity. Though globally, bacteria, fungi, viruses and some parasites are frequently indicted in the majority of nosocomial infections [5,7]. Among them: *Staphylococci* [11], *Pseudomonas aeruginosa* [12], *Escherichia coli* [13], *Enterococci* [14], *Candida albicans* [15] and *streptococci* [6] take the lead. Other pathogens include; *Bacillus cereus* [5], *Acinetobacter spp., Clostridium defficile, Legionella* [16] and other members of the *Enterobacteriaceae* family such as *Bacetroides* [1], *Haemophilus influenzae* [17], *Klebsiella pneumoniae* [18], *Serratia marcescens*

[19], *Proteus mirabilis, Salmonella spp.* [5,20], *Enterobacter spp*. [2,21], *Citrobacter spp.* [13], *Acinetobacter spp*. [22] as well as mycobacterial, fungal, viral agents [14] and protozoan agents which are less commonly involved [5].

The major diseases associated with these organisms ranges from nosocomial respiratory site infections [23], urinary tract infections [1,18] meningitis [17], surgical site infections [24,25] blood stream infections [26], gastroenteritis [16] to a host of other symptoms which are induced by reduced immune resistance of individual patients and severity of underlying illness [10,27].

3. EPIDEMIOLOGY OF NOSOCOMIAL INFECTIONS

According to the World Health Organization (WHO) [8], hospital acquired infections are one of the major infectious diseases and has a huge economic impact worldwide. These infections affect about 2 million people annually resulting in 5% to 15% of them requiring hospitalization [28]. In addition, a WHO study conducted in 55 hospitals of 14 countries representing four WHO Regions (Europe, Eastern Mediterranean, South-East Asia and Western Pacific) showed that an average of 8.7% of hospitalized patients contracted nosocomial infections with the highest frequencies noted from patients in the South-East Asian and Eastern Mediterranean Regions (10.0 and 11.8%) respectively. The report revealed that in the European and Western Pacific Regions, prevalence rates of 7.7 and 9.0% respectively were recorded. Samuel et al. [1] reported prevalence rates of 6.9% -7.5%, 6.7% and 10% from France, Italy, and United Kingdom respectively.

Some studies have revealed disparity in hospital acquired infections due to their income status. In a national and multicentre study, WHO, [29] reported that the prevalence of hospitalized patients who contracted hospital acquired infections varied from 3.5% to 12% in high-income countries. In a meta-analysis studies conducted in mixed population with pooled healthcare associated infections revealed 7.6 episodes per 100 patients. Furthermore, the report gave the healthcare associated infections prevalence figures from 1995-2010 from the following countries to include: Germany 3.6%, France 4.4%, Slovenia 4.6%, Norway 5.1%, Italy 6.7%, Belgium 6.9%, Netherlands 7.2%, Greece 7.9%, Spain 8.1%, Switzerland 8.8%, United Kingdom 9%, Finland 9.1%, Canada 11.6% and New Zealand 12%.

However, the prevalence of Healthcare Associated Infections in developing countries varied from 5.7% to 19.1% with a pooled prevalence of 10.1 per 100 patients and most reported researches noted proportions of infected patients higher than 10% with pooled prevalence of affected patients being 10.2 per 100 patients [29]. In line with this, various prevalence rates have been recorded for the following countries: Mongolia 5.4%, Latvia 5.7%, Thailand 6.5%, Lebanon 6.8%, Indonesia 7.1%, Cuba 7.3%, Islamic Republic of Iran 8.8%, Lithuania 9.2%, Tunisia 9.4% Turkey 12.5%, Brazil 14%, Malaysia 14% Algeria 16.2%, Serbia 17.4%, Morocco 17.8%, Tunisia 17.9% and Albania 19.1% [29].

4. DISTRIBUTION OF NOSOCOMIAL INFECTIONS IN SUB SARAHAN AFRICA

In sub-Saharan Africa, majority of the reports on infectious diseases and drug resistance are limited to the pressing problems associated with Human Immune Virus, Tuberculosis, Malaria and other emerging and re- emerging resistant pathogens [30]. However, as reported by Azeez-Akande, [31], limited data available shows that nosocomial infection rates range from 2-49%. He further revealed that different locations show considerably high figures of 21.2-35.6% which occurs in intensive care units (ICU). Complicating the scenario is the fact that most recorded nosocomial prevalence rates are from university teaching hospitals who merely admit referred patients thus making the determination of national prevalence rates in these countries difficult [6]. Generally, data suggest that nosocomial infections are widespread in sub Saharan Africa with surgical sites being the most common. The prevalence rates of the infections reported varied between 2.5% - 14.8% in Burkina Faso, United Republic of Tanzania and Senegal [6,29]. In Ghana and Mali, prevalence rates of 6.7% and 9.6-18.7% respectively have been recorded [29,32] while Senegal recorded 10.9% [6,29]. Similarly, Kensah et al. [33] reported 2.1% in Cameroon while Scherbaum et al. [34] and Kareem et al. [35] recorded a prevalence range of 1.6% -11% in Gabon. Prevalence rates of 1.7% and 10.4% were reported for Democratic republic of Congo and Burundi respectively [36].

Furthermore, Greco and Magombe, [37] recorded 28% in Uganda. The peak of this report is the finding of5.7-45.8% in Nigeria and Ethiopia [31,38] with the former having an incidence as high as 45.8% and an incidence density equal 26.7 infections per 1000 patient days in paediatric surgical patients [31]. However, there is significant disparity in variation in the regional distribution of nosocomial infections in Nigeria. In a report by Samuel et al. [1], rates of 2.7%, 3.8% and 4.2% were recorded from Ife, Lagos and Ilorin respectively. Neglecting the high prevalence rates reported in Nigeria and variations in geographical distribution, data on the risk factors and measures on risk reduction and control activities are limited [1]. Significant degree of mortality has been associated with nosocomial infections. Azeez-Akande, [31] reported a rate of 0.7- 2.5% in Nigeria and a range of 3.4 -10.9% in most developed countries and added that these figures may be higher in developing countries of Asia and sub Saharan Africa. A summary of the regional distribution of nosocomial infections in Sub Saharan countries is represented in Fig. 1.

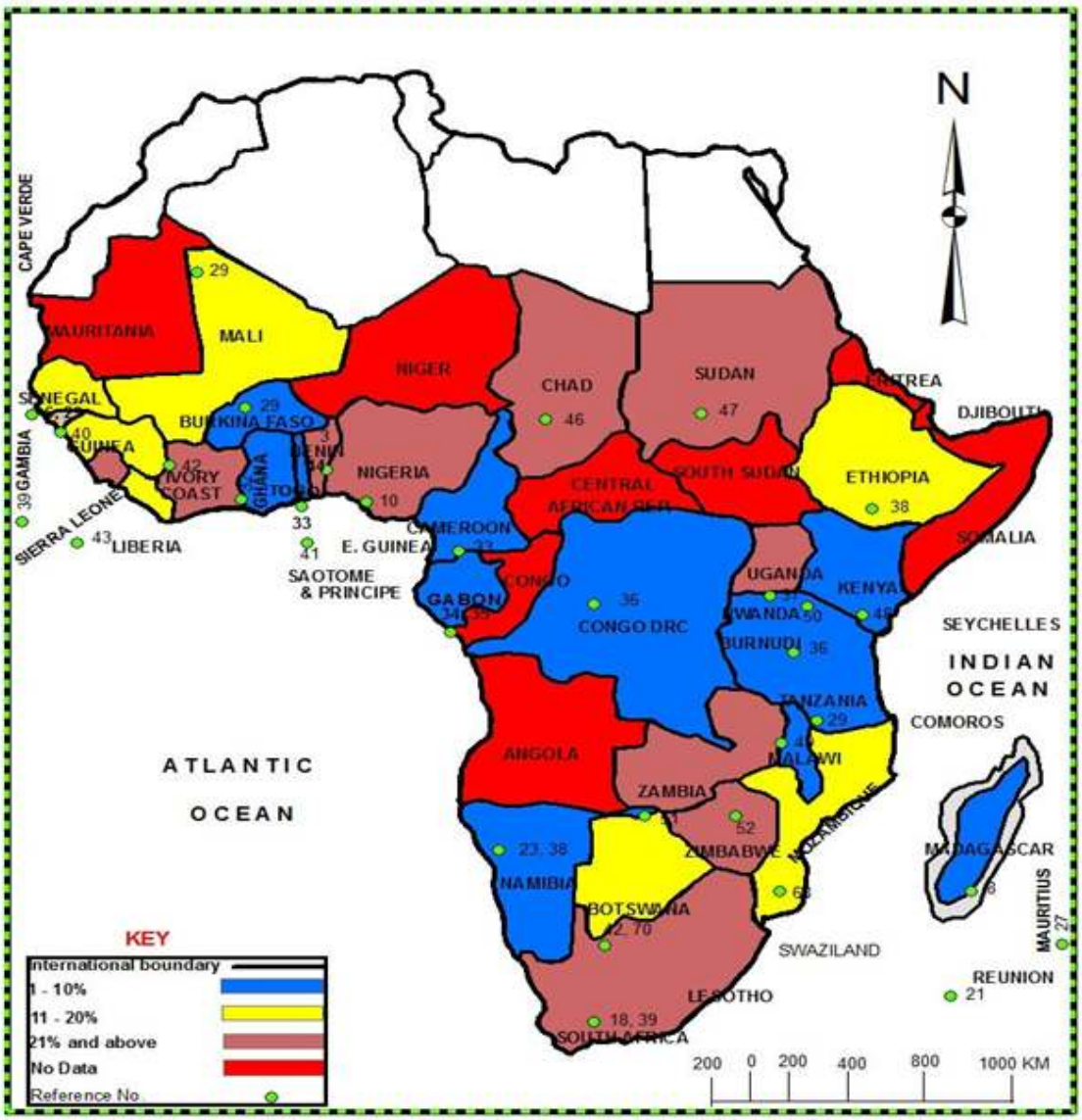

Fig. 1. Map sub Saharan Africa showing the percentage distribution of nosocomial infections

5. MODES OF TRANSMISSION OF NOSOCOMIAL PATHOGENS

Nosocomial infections developments are characterized by series of events and are often influenced by the microbe (inoculums size and virulence), transmission route, micro-environment and the patient's immune system [1] [3]. The primary entry points for microorganisms are compromised skin, mucosal surfaces (such as the respiratory, gastrointestinal, genitourinary tracts) [62]. Main routes of transmission range from contact (which could be direct or indirect), droplets, airborne, common vehicles such as medications, food, equipment, water, vector-borne transmission as well as devices [5]. The vulnerability of patients to nosocomial infections may be due to reduction in patient's immune resistance [10,13]. Patil et al. [15] have identified these to include; urinary catheters, intravenous catheters, haemodialysis, cortisone therapy, respirators, complicated operationsamong others.

6. RISK FACTORS ASSOCIATED WITH NOSOCOMIAL INFECTIONS

Several studies have revealed that patients who are admitted into the hospital are usually at a high risk of infections. Akingbade et al. [14] and Jose et al. [63] observed that patient's skin and openings are colonized by prevailing nosocomial agents. This colonization is enhanced by several factors such as intrinsic (factors inherent in the patient such as age, chemotherapy or underlying disease, disrupters of the natural barrier such as lesions/injury), extrinsic (factors which reside in the health care worker (practices of an individual care giver). Bereket et al. [5] also observed that the practices and conditions in an entire hospital significantly enhance colonization by nosocomial agents. Furthermore, Samuel et al. [1] listed other prevailing conditions to include contaminated water systems, air conditioning systems, and resistance to antimicrobial agents as well as invasive devices. They added that patients who were previously colonized on admission are often put at a high risk especially when subjected to invasive routines.

The most significant factor for acquisition of nosocomial infections has been documented as the length of hospital stay. At significant disadvantage are newborns admitted into neonatal intensive care units that may possess several host factors that not only make them more prone to infections but also maximize their risk of contracting even more fatal illnesses [1,64].

7. BURDEN OF NOSOCOMIAL INFECTIONS

The burden of nosocomial infections has long been recognized globally and about 1.4 million people suffer from infections acquired in hospitals [1,3]. Uneke and Ijeoma, [65] estimated the range of nosocomial infections to vary from 25-40% in resource poor settings. In other words, the prevalence of nosocomial infections is two-three folds higher in developing countries [6,27]. An estimated 2.5 million cases reported each year in the United States alone and responsible for about 99000 deaths annually [31,66]. Further studies revealed that 'approximately 10% of hospitalized patients in America (about 2 million every year) acquire clinically significant nosocomial infections with an annual aggravated cost [1]. In addition, Pollack, [66] reported that gram negative nosocomial transmitted infections account for two-thirds of the 25,000 deaths each year in Europe.

In sub Saharan Africa, Nejad et al. [6] described that overall burden of nosocomial infections to range from 2.5% -14%. This they described as twice the average in European prevalence rate of 7.1%. They added that this rate revealed an estimated pooled accruing incidence and density of intensive care unit contracted infections ranging from 34.7 - 49.9 per 1000 patient days. A figure considerably much higher than the estimated 13.6 per 1000 patient days reported in the United States.

Currently, nosocomial infections has become one of Africa's great challenge and what is even more threatening is the discovery of both emerging and re-emerging multidrug-resistant strains of infectious organisms in the hospitals which has further reduced the efficacy of the available therapy and care with an associated deadly outcomes [14,31]. Most developed countries of the world possess surveillance systems that give regular reports on national trends of endemic Hospital-associated infections, such as the German hospital infection surveillance system and the National Healthcare Safety Network of the United States of America [1,5]. However, some studies have revealed that in developing countries, inefficient social and health care systems that are often complicated by economic bottlenecks enhanced by underlying

challenges including overcrowding, poor infection control policies, inadequate staff, ineffective guidelines resulting in poor infection control practices and lack of trained professionals adds considerably to the extent of the problem [1,6,67].

8. DIAGNOSIS OF NOSOCOMIAL INFECTIONS

Significant variations exist in the diagnosis of nosocomial infections. The method employed is often influenced by the nature and type of sample. Generally, effective and recommended methods are employed to identify the aetiological agents of nosocomial infections. A summary of the common nosocomial infections, their clinical and laboratory features are summarized in Table 1. The diagnostic procedures must take cognizance of proper sample collection, use of appropriate media and methods, radiologic techniques as well as use of molecular techniques [5,26,31,63]. This must in totality enhance the isolation, identification and characterization of nosocomial agents.

According to Samuel et al. [1], phenotypic characterization of pathogens including culture, biochemical techniques and serotyping has been important in the isolation and characterization of pathogens, they however have limitations as they cannot be used for highly discriminatory identification of microorganisms and demonstrates poor reproducibility and standardization. On the other hand, molecular methods for characterization of isolates including Amplified fragment length polymorphism (AFLP), Plasmid Analysis, Polymerase Chain Reaction (PCR), Southern Blot Analysis, Ribotyping, Pulse-field gel Electrophoresis (PFGE) which generally involve lysis, extraction and purification of nucleic acid, nucleic acid amplification by PCR and identification methods are powerful tools in fighting the spread of pathogens in the hospital environment [1,26].

Generally, the incorporation of molecular typing into phenotypic and surveillance methods has been noted to be an effective approach in the diagnosis of nosocomial infections. This has resulted in an observed reduction in the number of nosocomial infections. The incorporation of molecular typing into phenotypic and surveillance methods promises to be an aid in the development of treatment regimen. In addition, employing an integrated system of diagnosis coupled with a basic assessment of drug resistant pathogens is essential for creating disease epidemiology which often leads to reduction in nosocomial infections as well as improved patient health and economic benefits [1,26,68].

Table 1. Common nosocomial infections, their clinical and laboratory features

Types of nosocomial infections	Clinical features	Laboratory features
Pneumonia	Decreased intensity of breath sounds, increase in rales, fever and pleuritic chest pain	Leukocytosis, positive sputum culture, sputum for Gram's stain and positive chest X-ray
Gastroenteritis	Fever, change in consistency of stool, increased frequency of stool and dehydration.	Leukocytosis, positive stool culture.
Blood stream infections (BSI)	Tenderness or purulent drainage at the site of insertion of IV access of CVP catheter, Unusual fever with chills and rigor.	Leukocytosis, positive blood culture, positive CVP catheter culture (after catheter removal).
Urinary tract infections (UTI)	Lower abdominal pain, fever, changes in characteristics of urine.	Leukocytosis, positive urine culture.
Meningitis	Headache, fever altered sensorium, neck stiffness, vomiting.	Leukocytosis, CSF-cell count, cell type culture, sugar, protein.
Skin and soft tissue infection (SSI)	Swelling, pain, fever, tenderness or inflammation and warmth of skin, purulent drainage from skin.	Smear for Gram's reaction, leukocytosis and positive swab culture.

Source: [63]

9. PREVENTION AND CONTROL

Generally, as recorded by Samuel et al. [1], control measures are aimed at protecting possible infection sites, interrupting transmission routes, boosting host defences and discouraging selection of hospital strains of organisms. However, effective prevention and control of nosocomial infections require scientific, professional, technical and administrative leadership [31]. The prevention of nosocomial infections is considered everyone responsibility including health care givers and this assertion has been generally accepted [5,6,8]. As a rule, this is often done through stratifying risk, management, making available all essential materials and products as well as training of health workers [1,6].

Several researches has pointed to the fact that for an infection control programme in any hospital to be viable, setting up an infection control committee is usually the first step and a basic criterion for effective control of nosocomial infections [1,69]. 'Infection control committee should always give authority to infection control policies that are comprehensive and include surveillance and prevention activities and ensure implementation' as well as ensure adequate training and re-training of staff [1,6]. In line with this trend, many researchers have advocated the inclusion of infection control into student nurses, medical students and other paramedical curriculum with adequate support at both national and regional levels [1,6,8].

Generally, effective preventive actions should be geared towards identifying the reservoirs of the agents that cause nosocomial infections [63]. Samuel et al. [1] and Bereket et al. [5] have observed that the principles of infection control employ practices and procedures which are safe and minimize the possibility of infections being transmitted from a source to a susceptible host. Effective infection control principle therefore, range from hand washing or hand hygiene which remains one of the most significant measure for the control and prevention of such infections to good personnel and hospital hygiene which entails the use of protective clothing, ensuring aseptic techniques in theatres, wards and delivery suites, good specimen handling, adequate management and disposal of waste generated within the hospital, effective handling of inoculation and contaminated incidents, preventing specimen spills on container during collection, effective use of antiseptics / disinfectants in sterilization processes, efficient management of soiled linen coupled with effective antibiotics usage, daily surveillance of infection within the hospital by the infection control team and carrying out quarantine processes on highly contagious patients will effectively prevent the spread of nosocomial infections [1,5,6,70].

10. BOTTLENECKS IN THE MANAGEMENT OF NOSOCOMIAL INFECTIONS

As observed by researchers, 'an effective infection control programme is important in reducing cost, morbidity and mortality resulting from nosocomial infections' [1,5]. Several factors are militating against infection control activities in developing countries including Nigeria. These range from lack of adequate infection control programmes, ignorance of the burden to understaffing enhanced by limited infrastructure. These limitations include lack of basic amenities such as water and electricity supply, poor antibiotic policies that do not accommodate antibiotic resistance profile of bacterial isolates within the locality. Others include inadequate essential materials like disinfectants, masks and gloves.

This situation is further complicated by absence of antibiotic resistance surveillance programmes as well as a host of other deficiencies ranging from poor funding, poor laboratory facilities and poor knowledge of the responsibilities of the infection control team. Inadequate facilities for quarantining patients that require isolation [1,3,6]. Routine hand washing is a norm in any health care setting however, in developing countries including Nigeria these inadequacies such as running water makes hand washing a difficult programme to effect.

Several bodies are responsible for the routine monitoring of nosocomial infections. These include National Nosocomial Infections Surveillance (NNIS) in the USA, Centre for Disease Control (CDC) and at local levels, individual hospital infection control committees [1]. In developing countries including Nigeria, monitoring of nosocomial infections is poorly handled or may not even exist. This inadequacy may be a contributory factor to the high rate of nosocomial infections documented [1,5].

It is therefore imperative that effective reduction in nosocomial infections will mandatorily require the establishment of effective infection control committees neglecting their size [71]. These

committees must have a national body similar to CDC that will ensure wide consultations, review of the existing practices, formulation and implementation of policies [1]. Furthermore, the health budgeting system of each country should be made to accommodate the hospital infection control Programmes cost [1,26]. In addition, the individual health care administrators must ensure the implementation of effective control policies [31,72].

As the struggle in the management of nosocomial infections deepens worldwide due to the varying but increasing resistance pattern of the organisms, the regional and geographical variations in their prevalence and antimicrobial susceptibility patterns need to be established as this would offer a guide towards prompt management of infections most especially as it relates to it sources [1,5].

11. CONCLUSION

Nosocomial infections are endemic in sub Saharan Africa and are further enhanced by emerging and re- emerging resistant agents. Simple and effective control programme together with computer-based epidemiological surveillance carried out as a global project with considerable inputs from developing countries for monitoring will enable the development of nosocomial infections to be halted if not eliminated. In addition, it is necessary to review the current infection control practices in all hospitals particularly in developing countries including Nigeria so as to incorporate molecular techniques which have been proven to be effective in keeping the spread of nosocomial infections under check. The training and re-training of health care givers on principles of infection control is strongly recommended. Also, the principles of infection control should be incorporated into student nurses, medical students, and other paramedical curriculum as well as employment of adequately competent health workers to avoid over labour which sometimes cause workers to be inefficient resulting in disease outbreaks. Finally, hand washing and other standard infection control practices should be adhered to so that nosocomial infections can be controlled effectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Samuel SO, Kayode OO, Musa OI, Nwigwe GC, Aboderin AO, Salami TAT, Taiwo SS. Nosocomial infections and the challenges of control in developing Countries. Afr. J. Clin. Exp. Microbiol. 2010;11:102-110.
2. Caini S, Hajdu A, Kurcz A, Böröcz K. Hospital-acquired infections due to multidrug-resistant organisms in Hungary, 2005-2010. Eurosurveillance. 2013;18.
3. Saka MJ, Saka AO, Adebara VO. Prevention of nosocomial infections in the new born: The Practice of Private Health Facilities in Rural Communities of Nigeria. Int. Infect. Dis. 2011;1:9.
4. Amoran OE, Sogebi AO, Fatugase OM. Rates and risk factors associated with surgical site infections in a tertiary care center in South- Western Nigeria. Int. J. Trop. Dis. & Health. 2013;3:25-36.
5. Bereket W, Hemalatha K, Getenet B, Wondwossen T, Solomon A, Zeynudin S, Kannan S. Update on bacterial nosocomial infections. Eur. Rev. Med. Pharmacol. Sci. 2012;16:1039-1044.
6. Nejad SB, Allegranzi B, Syed SB, Benjamin EB, Pittet D. Health-care-associated infection in Africa: A systematic review. Bull. World Health Organ. 2011; 89:757-765.
7. Sikka R, Mann JK, Vashist MG, Chaudhary U, Antriksh A. Prevalence and antibiotic sensitivity pattern of bacteria isolated from nosocomial infections in a surgical ward. Indian J. Clin. Pract. 2012;22:519-521.
8. Wood SM, Shah SS, Bafana M, Ratner AJ, Meaney PA, Malefho KCS, Steenhoff AP. Epidemiology of methicilin resistance *Staphylococcus aureaus* bacteremia in Gaborone, Botswana. Infect. Control Hosp. Epidemiol. 2009;30:782-785.
9. Jain A, Agarwal A, Verma RK, Awasthi S, Singh KP. Intravenous device associated blood stream Staphylococcal infection in paediatric patients. Indian J. Med. Res. 2011;134:193-199.
10. Sherifa MS, Moataz MA. Epidemiological and microbiological profile of nosocomial infection in Taif Hospitals, KSA (2010-2011). World J. Med. Sci. 2012;7:01-09.
11. Iyer AP, Baghallab I, Albaik M, Kumauni T. Nosocomial infections in Saudi Arabia caused by Methicillin resistance *Staphylococcus aureus* (MRSA). Clin. Microbiol. 2014;3:146.

12. Hongsuwan M, Srisamang P, Kanoksil M, Luangasanatip N, Jatapai A, Day NP, Nicholas PD, Peacock SJ, Cooper BS, Limmathurotsakul D. Increasing incidence of hospital-acquired and healthcare-associated bacteraemia in Northeast Thailand: A multi-center surveillance study. PLoS ONE. 2014;9:e109324.
13. Pradhan NP, Bhat SM, Ghadage DP. Nosocomial infections in the medical ICU: A retrospective study highlighting their prevalence, microbiological profile and impact on ICU stay and mortality. J. Asso. Physicians India. 2014;62:18-21.
14. Akingbade OA, Ojo DA, Okerentugba PO, Adejuwon AO, Okonko IO. Antibiotic resistance profile of bacteria isolated from Septicaemia cases in a tertiary health Care in Abeokuta, Nigeria. Nat. & Sci., 2013; 11:107-112.
15. Patil A, Patil K, Pankaj Pawar P, Maheshwari V. Isolation and survey of antibiotic sensitivity in nosocomial infections in North Maharashtra Region. Journal of the Association of Physicians of India. 2013;61:454-458.
16. Polage CR, Solnick JV, Cohen SH. Nosocomial diarrhea: Evaluation and treatment of causes other than clostridium difficile. Clin. Infect. Dis. 2012;55:982–989.
17. Van-de Beek D, Drake JM, Tunkel AR. Nosocomial Bacterial Meningitis. New Eng. J. Med. 2010;362:146-154.
18. Jombo GTA, Emanghe UE, Amefule EN, Damen JG. Urinary tract infections at a Nigerian University Hospital: Causes, patterns and antimicrobial susceptibility profile. J. Microbiol. Antimicrob. 2011;3: 153-159.
19. Sonia ICM, Jorge ACL. Nosocomial urinary tract infections in: Clinical management of complicated urinary tract infection. New York: Intech publishers. 2011;210-280.
20. Saint S, Kowalski CP, Kaufman SR, Hofer TP, Kauffman CA, Olmsted RN, Forman J, Banaszak-Holl J, Damschroder L, Krein SL. Preventing hospital- acquired urinary tract infection in the United States: A national study. Clin. Infect. Dis. 2008;46: 243-50.
21. Saha JC. Nosocomial infections as a preventable burden for health care delivery. Faridpur Med. Coll. J. 2010;5:1-2.
22. Singh R, Singla P, Chaudhary U. Surgical site infections: Classification, risk factors, pathogenesis and preventive management. Int. J. Pharm. Res. Health Sci. 2014;2:203-214.
23. Kieninger AN, Lipsett PA. Hospital – Acquired pneumonia: Pathophysiology, diagnosis, and treatment. Surg. Clin. North Am. 2009;89:439-461.
24. Donald E, Rosemary V. Surgical site infection: The host factor. AORN J. 2007; 86:801-809.
25. Merdaw MA. 2011 postoperative wound infections and the antimicrobial susceptibility in Baghdad Hospitals. Iraqi J. Pharm. Sci. 2007;20:59-65.
26. Afshari A, Schrenzel J, Ieven M, Harbarth S. Bench-to-bedside review: Rapid molecular diagnostics for bloodstream infection - a new frontier? Critical Care. 2012;16:222.
27. Naidu K, Nabose L, Ram S, Viney K, Stephen M, Graham SM, Bissell K. A Descriptive Study of Nosocomial Infections in an Adult Intensive Care Unit in Fiji 2011-12. J. Trop. Med. 2014;10:1-5.
28. Apanga S, Adda J, Issahaku M, Amofa J, Mawufemor KRA, Bugr S. Post-operative surgical site infection in a surgical ward of a tertiary care hospital in Northern Ghana. Int. J. Res. Health Sci. 2014;2: 207-212.
29. World Health Organization (WHO) Report on the Burden of Endemic Health Care-Associated Infection Worldwide. (NLM classification: WX 167) Geneva: WHO. 2011;1-34.
30. Bello AI, Asiedu EN, Adegoke BOA, Quartey JNA, Appiah-Kubi KO, Bertha Owusu-Ansah B. Nosocomial infections: knowledge and source of information among clinical health care students in Ghana. Int. J. Gen. Med. 2011;4:571–574.
31. Azeez-Akande O. Emerging and re-emerging infectious agents of nosocomial diseases – The need for review of hospital policy and control strategies. Bayero J. Pure App. Sci. 2012;5:19–25.
32. Newman MJ. Nosocomial and community acquired infections in Korle Bu Teaching Hospital, Ghana. West Afr. J. Med. 2009; 28:300-303.
33. Kensah NF, Vincent KP, Chrysanthus N. Healthcare associated infections in three hospitals in Dschang, west region, Cameroon. Ann. Trop. Med. Pub. Health, 2013;6:23-29.
34. Scherbaum M, Kösters K, Mürbeth RE, Ngoa UA, Kremsner PG, Lell B, Alabi A. Incidence, pathogens and resistance

patterns of nosocomial infections at a rural hospital in Gabon. BMC Infect. Dis. 2014; 14:124-126.
35. Kareem AM, Mohammed AI, Wijdan AH. Perceptions of Medical students towards nosocomial infections at college of medicine-Babylon. J. Edu. Pract. 2014;5: 73-83.
36. Chu K, Maine R, Trelles M. Cesarean section surgical site infections in Sub-Saharan Africa: A multi-country study from Medecins sans Frontieres. World J. Surg. 2014;35:1169–1172.
37. Greco D, Magombe I. Hospital acquired infections in a large north Ugandan hospital. J. Prev. Med. Hyg. 2011;2:55-58.
38. Mulu W, Kibru G, Beyene G, Damtie M, Post-operative nosocomial infections and antimicrobial resistance pattern of bacteria isolates among patients admitted at FelegeHiwot Referral Hospital, Bahirdar, Ethiopia. Ethiopian J. Health Sci. 2012;22: 7-18.
39. Vergnano S, Sharland M, Kazembe P, Mwansambo C, Health PT. Neonatal sepsis; An international perspective. Arch. Dis. Child fetal neonatal. 2005;90:220-224.
40. Fischer TK, Aaby P, Melbak K, Rodrigues A. Rotory virus disease in Guinea- Bissau, West Africa: A review of longitudinal community and hospital studies. J. Infect. Dis. 2010;202:239-242.
41. Aleksey S. Prevalence and antibiotic resistance pattern of *Escherichia coli* and *Klebsiella pneumonia* in urine tract infections at the La Paz Medical Centre, Malabo, Equitorial Guinea. Open J. Med. Microbial. 2015;5:177-183.
42. Moroh JLA, Fleurg Y, Tia H, Bahi C, Lietard C, Coroller L, Edoh V, Coulibaly A, Labia R, Leguerinel I. Diversity and antimicrobial resistance of uropathogenic bacteria from Abijan. Afr. J. Uro. 2014;20: 18-24.
43. Kilmarx PH, Clarke KR, Dietz MP, Hamel MJ, Hasain F, Mcfadden JD, Park BJ, Sugerman DE, Bresee JS, Mermin J, McAuley J, Jambai A. Ebola virus in health care workers in Sierra Leone. MMWR, 2014;63:1168-1171.
44. Ahoyo AT, Baba-Musa L, Anago AE, Avogbe P, Missihoun TD, Loko F, Prevost G, Sanni A, Dramane K. Incidence of infections due to *Escherichia coli* strains producing extended spectrum betalactamase, in the Zou/Collines Hospital Centre (CHDZ/C) in Benin. Medicine et Maladies Infectieuses. 2007; 37:746-752.
45. Khamis WB, Wambura CM, Verma A. Compliance to infection prevention and control guidelines among health care workers at Mnazi Mmoja Hospital Zanzibar. IMTU Med. J. 2014;4:34-38.
46. Nadlaou B, Abdelsalam T, Guelmbaye N, Clement KH, Nicholas B. Prevalence of multi-resistant bacteria in Hospital Ndjamena, Chad. Chemotherapy: Open Access. 2015;4:170.
47. Ahmed MI. Prevalence of nosocomial wound infection among post-operative patients and antibiotics pattern at Teaching Hospital in Sudan. Nat. Am. J. Med. Sci. 2012;4:29-34.
48. Dinda V, Gunturu R, Kariuki S, Hakeem A, Raja A, Kimanga A. Pattern of pathogens and their sensitivity isolated from surgical site infections at the Aga Khan University Hospital Nairobi, Kenya. Ethiopian J. Health Sci. 2013;23:141-149.
49. Kanyerere HS, Salaniponi FM. Tuberculosis in healthcare workers in a central hospital in Malawi. Int. J. Tuber. Lung Dis. 2003;7:489-492.
50. Petroze RT, Byiringio JC, Kyamanywa P, Ntakiyiruta G, Calland JF, Sawyer RG. Infectious outcomes assessment for health system strengthening in low-resource settings: the novel use of trauma registry in Rwanda. Surg. Infect. 2014;15:382-386.
51. Mwamungule S, Chimana MH, Malama S, Mainda G, Kwenda G, Muma JB. Contamination of health care workers coats at the University Teaching Hospital in Lusaka, Zambia: The nosocomial risk. J. Occup. Med. Toxicol. 2015;10:34.
52. Maruta A. Surveillance of surgical site infections following caesarean section at Two Central Hospital in Harare, Zimbabwe; 2015.
53. Van-derMeeren BT, Millard PS, Scacchetti M, Hermans MH, Hilbink M, Concelho TB, Ferro JJ, Wever PC. Emergence of methicillin resistance and panton-valentine leukocidin positivity in hospital and community-acquired *Staphylococcus aureus* infections in Beira, Mozambique. Trop. Med. Int. Health. 2014;19:169-176.
54. Mudzikati L, Dramowski S. Neonatal septicaemia: Prevalence and antimicrobial susceptibility patterns of common pathogens at Princess Marina Hospital, Botswana. Afr. J. Infect. Dis. 2014;30: 108-113.

55. Hauri AM, Armstrong GL, Hutin YJ. The global burden of disease attributed to contaminated injectionsgucin in health care settings. Int. J. STD AIDS. 2004;15:7-16.
56. Massoud MR, Barry D, Vaid S, Kuhlase NM, Haumba SM. The role of improvement science in infection control. AMR Control. 2015;5:81-87.
57. Duse AG, Doherty L, Mcllvenny G, Rahman A, Smyth ETM. Health Care Associated Infection (HCAI) prevalence survey: The South African Pilot. Sixteenth Annual Scientific Meetings of the Society of Healthcare Epidemiology of America, Chicago, IL: USA; 2006.
58. Melony C, Fortuin-de S, Singh-Moodley A. *Staphylococcus aureus* bacteraemia in Gauteng Academic Hospitals, South Africa. Int. J. Infect. Dis. 2015;30:41-48.
59. Andriatahina T, Randrianirina F, Hariniana ER, Talarmin A, Raobijaona H, Buisson Y, Richard V. High prevalence of fecal carriage of extended-spectrum β-lactamase-producing Escherichia coli and *Klebsiella pneumoniae* in paediatric unit in Madagascar. BMC Infect. Dis. 2010;10: 204.
60. Gomard Y, Silai R, Hoarau G, Bon K, Gonneau F, Yssouf A, Michault A, DellagiK, Tortosa P. Nosocomial drug-resistant Bacteremia in 2 cohorts with cryptococcal meningitis, Africa. Emerg. Infect. Dis. 2014;20:722-724.
61. Jepsen OB, Jensen LP, Zimakoff J, Friis H, Bissoonauthsing CN, Kasenally AT, Fareed D, Johansen KS, Worning AM. Prevalence of infections and use of antibiotics among hospitalized patients in Mauritius. A nationwide survey for the planning of a national infection control programme. The J. Hosp. Infect. 1993;25: 271-278.
62. Manikandan C, Amsath A. Antibiotic susceptibility of bacterial strains isolated from patients with respiratory tract infections. Int. J. Pure App. Zool. 2013;1: 61-69.
63. José P, Sandra A, de OcaRaúl M. A Study on nosocomial infections – Is elderly people at risk? Nurse's perspectives. Int. J. Comm. Health Nur. 2014;1:7-11.
64. Polin RA, Denson S, Brady MT. Epidemiology and diagnosis of health care– Associated infections in the NICU: A technical report of the committees on fetus and newborn and infectious diseases 2011–2012. Am. Academy Pedia. 2013;4: 23-26.
65. Uneke CJ, Ijeoma PA. The potential for nosocomial infection transmission by white coats used by physicians in Nigeria: Implications for Improved Patient- Safety Initiatives. World Health & Pop. 2010;11.
66. Pollack A. Rising threat of infections unfazed by antibiotics. New York Times, February, 27; 2010.
67. Allegranzi B, Bagheri–Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, Pittet D. Burden of endemic health-care-associated infection in developing countries: Systematic review and meta-analysis. Lancet. 2011;377:228-241.
68. Burillo A, Bouza E. Use of rapid diagnostic techniques in ICU patients with infections. BMC Infect. Dis. 2014;14:593-600.
69. Felsdman C, Brink A, Duse, A. Infection control in developing countries with particular emphasis on South Africa. The South African J. Epidemiol. Infect. 2005; 20:37-41.
70. Uwaezuoke SN, Obu HA. Nosocomial infections in neonatal intensive care units: Cost-effective control strategies in resource-limited countries. Nig. J. Paedia. 2013;40:125-132.
71. Togo A, Traore A, Kante L, Coulibaly Y, Diango D, Keita M, Diallo S, Dembele BT, Diakite I, Diani N, Samake B, Traore BA, Diallo G. Fighting nosocomial infection rates in the general surgery department of the Teaching Hospital Gabriel Toure in Bamako, Mali. The Open Bio. J. 2010;3: 87-91.
72. World Health Organization (WHO). Prevention of hospital-acquired infections: A Practical guide; WHO/CDS/CSR/EPH/ 2002.12, 2nd Edition Geneva. 2002;1-88.

Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/14797