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RESEARCH ARTICLE

Antimicrobial Sensitivity of Bacterial Isolates of Patients attending the Bingham University Teaching Hospital, Jos, North Central, Nigeria

Sensibilité aux Antimicrobiens des Isolats Bactériens de Patients Fréquentant l'Hôpital Universitaire de Bingham, Jos, North Central, Nigéria

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ABSTRACT

BACKGROUND: **Antibiotics are among the most frequently prescribed classes of medicines. It is estimated that about 50% of antibiotic use is inappropriate. The emergence of antimicrobial resistance has contributed to the morbidity, mortality and increased healthcare cost resulting from treatment failures and longer hospital stay. However, antibiotic resistance can be controlled by appropriate measures. This study aimed to determine the sensitivity pattern of pathogenic bacteria to various antimicrobial compounds used in a resource limited setting in order to assist physicians in selecting treatment options for patients.**

METHODS: **Faecal, urinary and wound swab specimens were collected from patients attending the Binghan University Teaching Hospital (BhUTH) Jos, North Central Nigeria over a period of four months. Specimens were tested for bacterial culture and sensitivity using standard techniques.**

RESULTS: **During the period of study, 379 faecal, 192 urinary and 195 wound specimens were tested. Significant growths of pathogenic bacteria were isolated from 680 specimens. The commonest isolates were *Salmonella* (33.2%), *S. aureus* (31.5%) and *E. coli* (15.0%). The isolates were mostly sensitive to ciprofloxacin (75.4%), Augmentin® (65.9%), co-trimoxazole (71.6 %), ampicillin (75.7%), ofloxacin (65.9%), cefuroxine (69.8%), and Cloxacillin (70.4%) while lesser susceptibility was recorded for ceftazidine , gentamicin, and nitrofurantoin . Stool cultures showed significantly more growths than either urine or wound swabs (p<0.001).**

CONCLUSION: **While *Salmonella* is the most common faecal isolate, *Staphylococcus aureus* and E. *coli* appear to be the most common wound and urinary isolates respectively in Jos. Thus, the results of this study should be of interest to the prescribing physician as a guide. BJM 2020; 2(1): 3–7.**

Keywords: ***Salmonella, E.coli* etc urine, stool, wound swabs, antimicrobial resistance, sensitivity pattern, Jos, Nigeria.**

ABSTRAIT

CONTEXTE: Les antibiotiques font partie des classes de médicaments les plus fréquemment prescrites. On estime qu'environ 50% de l'utilisation d'antibiotiques est inappropriée. L'émergence de la résistance aux antimicrobiens a contribué à la morbidité, à la mortalité et à l'augmentation du coût des soins de santé résultant des échecs de traitement et des séjours hospitaliers plus longs. Cependant, la résistance aux antibiotiques peut être contrôlée par des mesures appropriées. Cette étude visait à déterminer le profil de sensibilité des bactéries pathogènes à divers composés antimicrobiens utilisés dans un contexte de ressources limitées afin d'aider les médecins à choisir les options de traitement pour les patients.

METHODES: Des prélèvements sur écouvillon fécaux, urinaires et de plaies ont été prélevés sur des patients fréquentant l'hôpital universitaire de Binghan (BhUTH) Jos, centre-nord du Nigeria sur une période de quatre mois. Les échantillons ont été testés pour la culture bactérienne et la sensibilité en utilisant des techniques standard.

RESULTATS: Au cours de la période d'étude, 379 échantillons fécaux, 192 échantillons urinaires et 195 plaies ont été testés. Des croissances significatives de bactéries pathogènes ont été isolées à partir de 680 échantillons. Les isolats les plus courants étaient Salmonella (33,2%), S. aureus (31,5%) et E. coli (15,0%). Les isolats étaient principalement sensibles à la ciprofloxacine (75,4%), à Augmentin® (65,9%), au cotrimoxazole (71,6%), à l'ampicilline (75,7%), à l'ofloxacine (65,9%), à la céfuroxine (69,8%) et à la cloxacilline (70,4%).) tandis qu'une moindre sensibilité a été enregistrée pour la ceftazidine, la gentamicine et la nitrofurantoïne. Les cultures de selles ont montré beaucoup plus de croissances que les écouvillons d'urine ou de plaie (p <0,001).

CONCLUSION: Bien que Salmonella soit l'isolat fécal le plus courant, Staphylococcus aureus et E. coli semblent être les isolats de plaie et d'urine les plus courants respectivement à Jos. Par conséquent, les résultats de cette étude devraient intéresser le médecin prescripteur à titre indicatif. **BJM 2020; 2(1): 3–7.**

Mots clés: Salmonella, E. coli, etc. urine, selles, écouvillons de plaie, résistance aux antimicrobiens, schéma de sensibilité, Jos, Nigéria.

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Abbreviations: BhUTH, Binghan University Teaching Hospital.

INTRODUCTION

Due to significant changes in microbial genetics, as a result of indiscriminate use of antimicrobials, the spread of resistance that can be controlled is now a global problem.[1–3] In Nigeria and other developing countries, several studies have shown that resistance to antimicrobials is widespread.[4–6] However, resistance to antibiotics can be controlled by appropriate antimicrobial prescribing, infection control, new treatment alternatives and continued surveillance.[7 9] The overuse and misuse of antimicrobials coupled with bacterial world disability to adapt under selective pressure has led to an increase in the number of organisms that are resistant to the effects of antibiotics.[9–11] Currently, the Clinical Laboratory Standards Institute (CLSI) is responsible for updating and modifying the original procedure of Kirby and Bauer through a global consensus process. This ensures uniformity of technique and reproducibility of results as pathogens develop new mechanisms of resistance and new antimicrobials are developed to fight these organisms.[12] The increase in resistance among a wide range of bacteria has caused some people to speculate that there is a danger of seeing an end to the antibiotic era.[13,38] According to the CDC 2015 report the current estimated number of deaths worldwide due to drug-resistant infections is already approximately 700,000 each year. This figure is likely to reach 10 million per year by 2050 if antimicrobial resistance remains unchecked.[14,15,17]

Pseudomonance aerugenosa, *Staphylococcus aureus*, Proteus spp, *Klebsiella pneumonia* and *Escherichia coli* are highly prevalent in urine, stool and wound specimens of Nigerian residents.[2,3,16-19] The success of antibiotic chemotherapy may often depend on the isolation and the determination of the susceptibility pattern of the causative organisms but due to the lack of facilities and personnel, this practice is rare in many health institutions in developing countries.[18,19] Hence the choice of antibiotics is often made and treatment started empirically before laboratory report of susceptibility of the causative organisms is available.[20,21] The emergence and spread of antimicrobial resistance has contributed to the morbidity, mortality and increased healthcare costs resulting from treatment failure and longer hospital stays.[21,22] Bacterial infections continue to be important causes of morbidity and mortality in developing countries.[23,24] However, there is a phenomenal increase in antibiotic resistant bacterial pathogens which is one of the major problem facing medicine and science today.[25,26] Various researchers and organisations cite multiple interrelated factors that influence the development and spread of AMR due to antimicrobial misuse in humans and agriculture especially in resource limited countries due to health system weaknesses, poor pharmaceutical management and regulation and inadequate infection control practices.[27–29] The original methods of determining susceptibility to antimicrobials was based on broth dilution methods which although still remain the gold standard today, and are time consuming to perform, this prompted the development of a disk diffusion procedure for the determination of susceptibility of bacteria to anti-microbials. Thus, sensitivity tests measure antimicrobial activity against bacteria under laboratory conditions *[in vitro]* not in the patient *[in vivo]*.[20,31,39]

The purpose of this study was to evaluate the sensitivity or resistance of pathogenic bacteria to various antimicrobial compounds in order to assist physicians in selecting treatment options at a tertiary hospital. Specifically we set out to determine the prevalence of bacterial isolates in urine, stool and wound specimens and the antimicrobial sensitivity pattern of bacteria isolated.

MATERIALS AND METHODS

This study was carried out among patients suspected to have bacterial infections attending Bingham University teaching Hospital between December 2013 and March 2014. Ethical approval was obtained from the BhUTH ethical committee. Cultural examinations of stool, urine and wound specimens were done directly onto the following media (CLED, Blood, Chocolate, SSA agars) after sterilization at interval. Biochemical testing was also carried out using coagulase, and catalase for gram positive organisms while TSIA, citrates and urease for gram negative organisms respectively. Antimicrobial susceptibility test was performed using Kirby-Bauer disk diffusion protocol on the bacteria isolates and incubated at 37°C overnight in the following antibiogram Ciprofloxacin (5µg), Augmentin (30 µg), Co-trimoxazole (25 µg), Ampicillin (10 µg) Ofloxacin (5 µg), Cefuroxine (30 µg), Ceftazidine (30 µg), and Cloxacillin (5 µg), Gentamicin (10 µg) and Nitrofuratoin (300 µg) from Abtek Biological LTD, Liverpool L97AR UK. The diameter of zone of inhibition around the disc was measured to the nearest millimeter using plastic meter rule while the isolates were classified as sensitive or resistant to the antibiotics.[32 34]

RESULTS

A total of 680 isolates were made from the three categories of specimens. Figure 1 and Table 1 compare the frequency of significant growths of pathogenic bacteria isolated from the three sources. Stool cultures showed significantly more growths than either urine or wound swabs ($p<0.001$).

Table 1 shows the impact of specimen on the frequency and type of bacterial isolates. The three commonest isolates were *Salmonella* (33.2%), *Staphylococcus* spp. (31.5%) and *E. coli* (15.0%). *Salmonella* spp were the predominant isolates from stool accounting for 65.2% of the 229 stool isolates. In the urine, *S. aureus* was the most common accounting for 32.2% of the urinary isolates followed by *E.coli* (25.9%). *Staph aureus* was also the predominant isolate from wound specimens constituting 76(41.5%) of them.

Bacterial Sensitivity to Antibiotics

The isolates were mostly sensitive to Ampicillin (75.7%), Ciprofloxacin (75.4%), Co-trimoxazole (71.6%), Cloxacillin (70.4%), Cefuroxime (69.8%), Augmentin^R (65.9%), Ofloxacin (65.9%) and Ceftazidine (48.1%), while lesser susceptibility was recorded to Gentamicin (40.4%) and Nitrofuratoin (38.2%). 49.4%, 26.7% and 23.9% bacteria isolates were frequently isolated from stool, urine, and wound specimens.

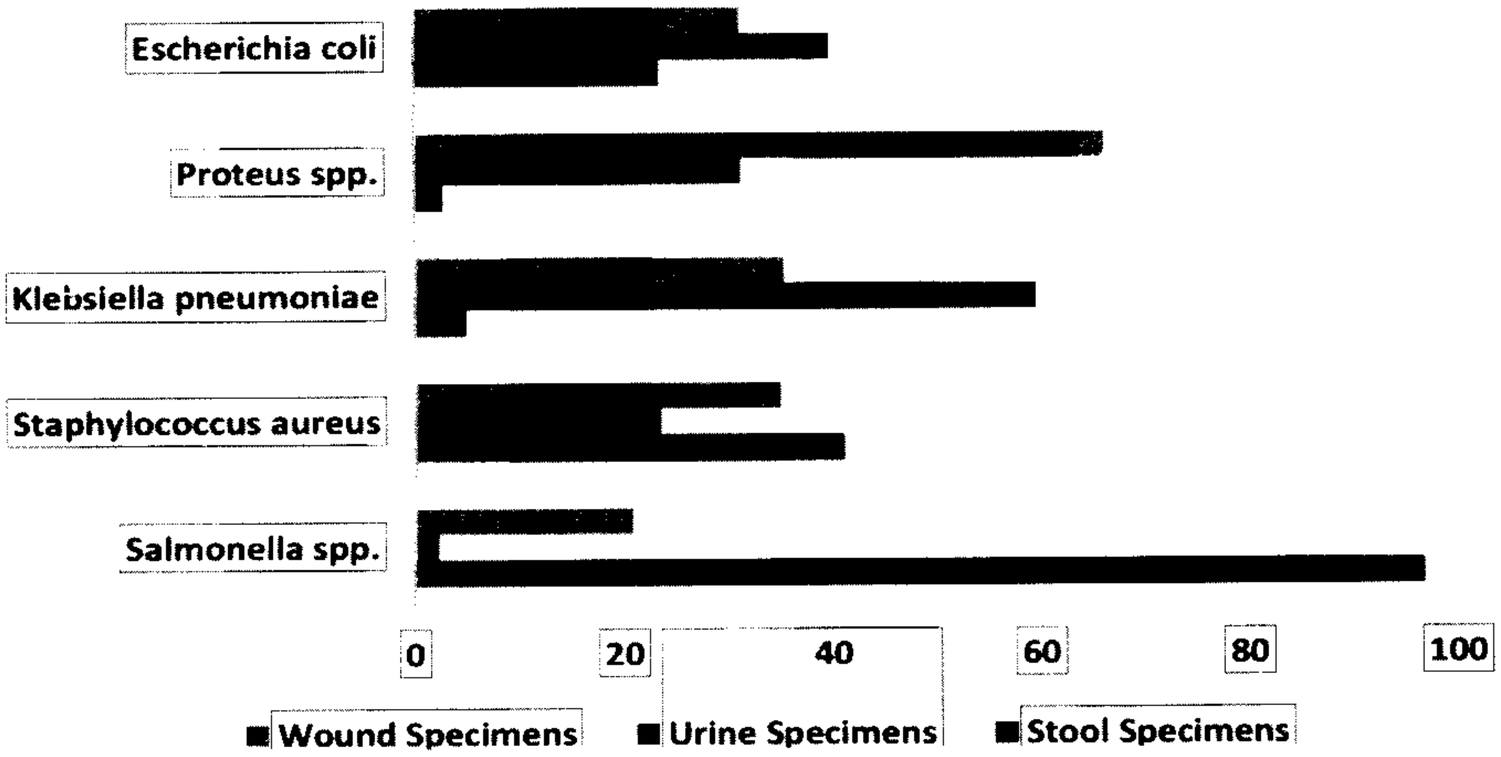

Fig. 1: Frequency of Bacterial Isolation. The predominant isolates were *Salmonella* spp (33.2%), *S. aureus* (31.5%) and *E. coli* (14.3%) while less predominant were *Klebsiella* spp (9.1%) and Proteus spp (11.2%) respectively from stool, Urine and Wound Swabs.

Table 1: Impact of Specimen Source on Frequency and Type of Bacterial Isolated

Specimen	Organism Isolated [Number (%)]					
	All	*Salmonella* spp.	*Staph. aureus* i	K. *pneumonia*	Proteus spp.	E. *coli*
Stool	339 (49.9)	221 (65.2)	89 (41.2)	3 (4.8)	2 (2.6)	24 (24.7)
Urine	158 (23.2)	5 (2.2)	51 (23.6)	37 (59.7)	24 (31.2)	41 (42.3)
Wound	183 (26.9)	2 (0.9)	76 (35.2)	22 (35.5)	51 (66.2)	32 (32.9)
All	680 (100)	228 (33.5)	216 (31.8)	62 (9.1)	77 (11.3)	97 (14.3)

Chi square statistics 391.0626, p-value is <0.0001. The result is significant at p<0.05.

Table 2: Bacterial Sensitivity to Antibiotics

Antibiotics	Bacterial Sensitivity									
	Salmonella spp		***Staphylococcus aureus***		***Klebsiella pneumonia***		**Proteus spp**		***Escherichia coli***	
N = 686	228		216		62		77		97	
CPR (No.) (%)	189	39	163	53	44	18	62	15	64	33
	82.9	17.1	76.5	24.5	71.0	29.0	80.5	19.5	66	34
AUG (No.) (%)	86	142	155	61	40	22	63	14	72	25
	37.7	62.3	71.8	28.2	64.5	35.5	81.8	18.2	74	26
GENT (No.) (%)	49	179	48	168	40	22	63	14	58	39
	21.5	78.5	22.2	77.8	64.5	35.5	81.8	18.2	60	40
AMP (No.) (%)	193	35	168	48	45	17	65	12	57	40
	84.6	15.4	77.8	22.2	72.6	27.4	84.4	15.6	59	41
COTR (No.) (%)	102	126	176	40	12	50	68	98	41	56
	44.7	55.3	81.5	18.5	19.4	80.6	8.3	11.7	42.3	57.7
NIT (No.) (%)	38	190	132	84	24	38	20	57	44	53
	16.7	83.3	61.1	38.9	38.7	61.3	26	74	45.4	54.6
OFL (No.) (%)	193	35	168	48	15	47	65	12	56	41
	84.6	15.4	77.8	22.2	24.2	75.8	84.4	15.6	57.7	42.3
CRX (No.) (%)	169	59	125	91	43	19	68	98	57	40
	74.1	25.9	57.9	42.1	69.4	30.6	8.3	11.7	59	41
CAZ (No.) (%)	45	183	131	85	11	51	58	19	65	32
	19.7	80.3	60.6	39.4	17.7	82.3	75.3	24.7	67	33
CLOX(No.) (%)	172	56	150	66	41	21	63	14	57	40
	75.4	24.6	69.4	30.6	66.1	33.9	81.8	18.2	59	41

AUG, Amoxyclillin/Clavulanate; GEN, Gentamicin; CO-TRI (co-trimoxazole), CPR (Ciprofloxacin), AMP (Ampicillin), OFL (Ofloxacin), NIT (Nitrofuratoin), CRX (Cefuroxine), CAZ (Ceftazidine) and CLOX (Cloxacillin, S= susceptibility, R= resistant.

DISCUSION

In our study, *S. aureus* was found in about a third of the specimens, which could be as a result of either food poisoning or an increased post contamination risk for hospitalised patients with 30.8% chances as reported by Bhalla et al (37). *Salmonella* isolated in wound is an uncommon manifestation due to post contamination as our study recorded about 1%, while in urine it is as a result of bacteria or invasive illness reported by others[38,39] of which our study also found a prevalence of 3.0%. However, *Salmonella* can sometimes be isolated in urine and other samples such as blood and tissues apart from stool.[38,39]

Although *Proteus* spp. are opportunistic pathogens commonly responsible for urinary and septic infections often nosocomial, we found that a 0.6%of this isolate was as a result of contamination which may occur during sample collections. *Klebsiella pneumoniae* was found to be 0.9% in our study. This as reported by CDC may be a co-infection among sick patients receiving treatment for other conditions in a healthcare setting.[40] ReAct[41] reported resistance rates from bacteria resistance strains of *E.coli* (32%), *K. pneumonia* (43.8%) and *S. aureus* (23.6%); our study presented a resistance rate of 40.7%, 49.2% and 34.4% for *E. coli*, *K. pneumonia* and *S. aureus* respectively.[41]

While *Salmonella* is the most common faecal isolate, *Staphyloccus aureus* and *E. coli* appear to be the most common wound and urinary isolates respectively in Jos. The results of this study should be of interest to the prescribing physician as guide.

REFERENCES

1. Zhanel GG, Decorly M, Laing N, Weshnoweski B, Vashiht R, Tailor F. Antimicrobial-resistant pathogen is intensive care units in Canada: results of the Canadian National intensive care unit (CAN-ICU) study, 2005- 2006. antimicrobAgents Chemotherapy. 2008; 52:1430-7 [PMC free article] Pubmed.doi:10.1128/AAC.01538-07. Accessed 4th April 2013.
2. Arora D, Pooja G, Gurpreet G, Rajiv C, Ritesh S. Changing trends in the antibiogram of salmonella isolates in Northern Area of Punjab. *Int J*

Pharmacy and Pharm Sci. 2010; vol 2, issue 3, 135 – 137. www.ijpps. Accessed 4th April 2013.
3. Nutanbala NG, Hiren RT, Alpesh PPG, Tejas KP, Tipathi CB. Antibiotic sensitivity profile of bacterial pathogens in postoperative wound infections at a tertiary care hospital in Gujarat, India. *J Pharmacol Pharmacother.* 2011; Jul – Sep; 2 (3): 158–164. Doi 10. 4103/0976 – 500X. 83279. PMCID: PMC3157123. Accessed 4th April 2013.
4. Center for Disease Control and Prevention – Salmonella: Outbreak, symptoms and diagnosis. 19 Mar. 2013. www.cdc.gov/salmonella. Accessed 4th April 2013.
5. Ehinmidu JO. Antibiotics susceptibility patterns of Urine bacterial isolates in Zaria, Nigeria. *Trop J Pharm Res.* December 2003; 2 (2) [Ehinmid 2003]. Accessed 8th April 2013.
6. Esiegbe EE, Iriah S, Ibok S, Anyanwu F, Esiegbe P, Adama SJ, *et al.* Bacteria isolates from the stool of children aged less than 5 years with acute diarrhea in Kaduna North western Nigeria. *Ann Trop Med Public Health*. 2013; **6:** 452
5. Available from http://www.atmph.org/tect.asp?2013/6/452/127798.
7. Nwadioha SI, Nwokedi EOP, Ikeh I, Egesie J, Kashibu E. Antibiotic susceptibility pattern of Uro – pathogenic bacteria isolates from AIDS patients in a Nigerian tertiary hospital. *J Med and Med Sci.* December 2010; **1:** 530 – 534. Accessed 8th April 2013.
8. Okwori EE, Nwadioha SI, Nwokedi EOP, Odimayo M, Jombo GTA. Bacterial Pathogens and their antibiotic susceptibility pattern in Idoma community, Benue State of Nigeria. [Enedpub – international infectious diseases: 2001; vol 1:5]. ISSN 2231 – 6019. Accessed 8th April 2013.
9. Bolaji AS, Akande IO, Iromini FA, Adewoye SO, Opasola OA. Antibiotic resistance pattern of bacteria spp isolated from Hospital waste water in Ede South Western Nigeria. *Euro J Exp Bio*. 2011, **1:** 66–71. www.pelagia researchlibrary.com. Accessed 8th April 2013.
10. Skov R, Jensen ET, Molbak K. MRSA: New guidelines and mandatory notification 2006. http:/www.ssi.dk/graphics/en/news/epinews/44,2006pdf. Accessed 8th April 2013.
11. Onile BA, Odugbemi TO, Nwofor C. Antibiotic susceptibility of Bacterial agents of septicemia in Ilorin, Nigeria. *Med Pract.* 1985; **9:** 16–18. Accessed 8th April 2013.
12. Clinical Laboratory Standards Institute. Performance standards for antimicrobial disk susceptibility tests; Approved standard – 9th ed. CLSI document M2-A9. 2006; 26:1. Accessed 26th May, 2014.
13. Jombo GTA, Opajobi SO, Egah DZ, Banwat EB, Denen P Akaa. Symptomatic vulvovaginal candidiasis and genital colonization by candida species in Nigeria. *J Pub Hlth and Epidem.* 2010: **2:** 147–151. Accessed 8th April 2013.
14. Asghar HA, Faidah SH. Saudi Med J. 2009; vol. **30:** 179–185. Accessed 8th April 2013.
15. Ummu K, Mustafa A, Zainab MA. Antimicrobial resistance pattern of pathogenic bacteria isolates from four Hospital environments in Sokoto metropolis, Northwestern Nigeria. *J Microbial Biotec Res.* 2013, **3:** 120–124. JMB – 2013 – 3 – 1 – 120 – 124. www.scholarsreeaschlibrary.com. Accessed 8th April 2013.
16. American Society for Microbiology, Antibiotic Resistance. An Ecological perspective on an old problem. Report from the American Academy of microbiology. American Society for Microbiology, Washington, DC, 2009.
17. CDDEP. President's Council of Advisors on Science and Technology 2014–2015.
18. Tiawo SS, Bamidele M, Omonigbehin EA, Akinsinde KA, Smith SI, Onile BA, Olowe AO. Molecular epidemiology of methicillin resistant staphylococcus aureus in Ilorin, Nigeria. *West Afr J Med.* 2005 Apr – Jun; **24:** 100 – 6. [Pub Med]. Accessed 8th April 2013.
19. Ikeh EI. Methicillin resistant staphylococcus aureus at Jos University Teaching Hospital (JUTH). *Afr J Clin Exp Microbial.* 2003; **4:** 52–55. Accessed 8th April 2013.
20. Center for Disease Control and Prevention. National antimicrobial resistance monitoring system for Enterobacteria (NARMS); 2003 human isolates final report. Atlanta, US Dept of Health and Human Services. 2006 Category: emedpud-international infectious Disease Tagged as Africa-antibiotic resistance, bacteria isolates, clinical specimens Nigeria.
21. O'Neill O. Review on Antimicrobial Resistance. Antimicrobial Resistance: Tackling a Crisis for the Health and Wealth of Nations 2014.
22. Emmanuel ONM, Magaji SN. Antibiotic sensitivity pattern of Staphylococcus aureus from clinical isolates in a tertiary health institution in Kano, Northwestern Nigeria. *Pan Afr Med J.* 2011: PMCID: PMC3201603. Accessed 8th April 2013
23. Arora D, Seetha KS, Rajiv K. The changing scenario of the salmonella serotypes and its drug resistance pattern. *Journal of Clinical and Diagnostic Research.* 2009; **3:** 1754–1759. Accessed 8th April 2013.
24. Neopane A, Singh SB, Bhatta R, Dhital DB. Changing spectrum of antibiotic sensitivity in enteric fever. *Kathmandu University Medical Journal.* 2008; **1:** 12–15. Accessed 8th April 2013.
25. Esposito S, Leone S, *et al.* 2007: Antimicrobial treatment for intensive care unit (ICU) infections including the role of the infectious disease specialist. *Int J Antimicrob.* Agents 29: 494 – 500. Accessed 8th April 2013.
26. Levin PD, Fowler RA, Guest C, Shibbald WJ, Kiss A. Risk factors associated with resistance to ciprofloxacin in clinical bacterial isolates from intensive care unit patients. *Infect Control Hosp Epidemiol.* 2007; **28:** 331–336. Accessed 8th April 2013.
27. Rhomberg PR, Fritsche TR, Sader H, Jones RN. Antimicrobial susceptibility pattern comparisons among intensive care unit and general ward gram-negative isolate from meropenen yearly susceptibility test information collection program (USA). *Diagn Microbial Infect Dis.* 2006:56: 57 – 62. Accessed 8th April 2013.
28. Bauer AW. Antibiotic susceptibility testing by a standardized single disk method. *Am J Clin Pathol.* 1966; **36:** 493–496. Pub Med. Accessed 5th May 2013.
29. Olusola V,Odetoku IA. Antibiogram Profiles of Escherichia coli, Salmonella and Listeria Species Isolated Along the processing line of sale of frozen poultry foods. Research Journal of Microbiology, 2012;7:235 - 241. **Doi:** 10.3923/jm.2012.235.241. **URL:**http:/scialert.net/abstract/?doi=jm.2012.235.241. Accessed 5th May 2013.
30. Lalitha MK: Manual on Antimicrobial Susceptibility Testing; under the auspices of Indian Association of Medical Microbiologists. Printed 17th Jul. 2013.
31. Kirby WMM, Yoshihara, GM, Sundsted, KS, Warren JH. Clinical usefulness of a disc method for antibiotics sensitivity testing. Antibiotics Annu. 1956 – 1957; 1957:892. Accessed 26th May, 2014.
32. Jorgensen JH, Turnidge, JD. Susceptibility test methods: dilution and disk

diffusion methods, 2007; p. 1152–1172. In P.R Murray, EJ. Baron, JH Jorgensen, ML Landry, and MA Pfaller (ed.), Manual of clinical microbiology, 9th ed. ASM Press, Washington, DC. Accessed 26th May, 2014.

33. Bauer AW, Perry DM, Kirby WMM. Single disc antibiotic sensitivity testing of Staphylococci. A.M.A Arch. Intern. Med. 1959:104:208 – 216. Accessed 26th May, 2014.
34. Cheesbrough M. Antimicrobial sensitivity testing; District Laboratory Practice in Tropical Countries Part 2; Cambridge University Press. 2000; 7. **16:** 132–136.
35. Re-Karen C Carroll. Diagnostic Medical Microbiology and Clinical correlation: Laboratory aids in te selection of antimicrobial therapy. *Medical Microbiology* 25ed. Pp.703–715.
36. Global action plan for antimicrobial resistance (World Health Assembly document A68/20, 27 March 2015) (http://www.who.int/drugresistance/global_action_plan/en/).
37. Bhalla A, Aron DC, Donskey CJ. Staphylococcus aureus intestinal colonization is associated with increased frequency of S. aureus on skin of hospitalized patients. *BMC infectious diseases*. 2007: 7, 105. doi:10.1186/1471-2334-7-105
38. Miller *S.*, Pegues, D. *Salmonella* Species, Including *Salmonella* Typhi, in Mandell, Douglas, and Bennett's Principles And Practice of Infectious Diseases, Sixth Edition, 2005; Chap. 220, pp. 2636-650.
39. Tauxe R. Emerging Foodborne Diseases: An Evolving Public Health Challenge. Emerging Infectious Diseases, 1997; Vol. 3, No. 4, pp. 425-34. http://www.ncbi.nlm.nih.gov/pmc.
40. CDC 2012: Klebsiella. CDC/HAI/cdc.gov/hai/organism/klebsiella.htmi.
41. ReAct – Action on Antibiotic Resistance 2012: President's, councils of Advisors on Science and Technology 2014. (http://www.reactgroup.org/uploads/who-weare/africa/ReAct-Africa-Champions-Workshop-Report-2014.pdf).