# POTENTIAL SOURCES OF TRANSMISSION OF HOSPITAL ACQUIRED INFECTIONS IN THE VOLTA REGIONAL HOSPITAL IN GHANA

**D. N. A. TAGOE[1,2], S.E BAIDOO[1,2], I. DADZIE[1,2], D. TENGEY[1,2] and C. AGEDE[3]**
**[1]Department of Laboratory Technology, University of Cape Coast, PMB, Cape Coast, Ghana**
**[2]Medical Laboratory Section, Department of Laboratory Technology, University of Cape Coast, Cape Coast, Ghana [3]Microbiology Laboratory, Volta Regional Hospital, Ho, Volta Region, Ghana**

***Corresponding Author:*** *Daniel N.A. Tagoe* ***E-mail:*** *carte5000@yahoo.com*

***Conflict of Interest:*** *None declared*

## SUMMARY

**Background:** The study was undertaken to assess potential sources that might transmit Hospital Acquired Infections in the Volta Regional Hospital of Ghana.

**Method:** A total of 218 swabs were taken over a six month study period of two weeks sampling bi-monthly from 33 different door handles, taps, desk surfaces and lavatories and 15 different surfaces in the theatre before and after cleaning on each sampling day. The swabs were cultured on Blood, Chocolate and MacConkey agars and incubated for 24hrs at 35±2ºC after which isolates were identified morphologically and biochemically.

**Results:** A total of 187 (88.8%) bacterial isolates were obtained from the swabs ($P$<0.0017) made up of 55.5% non-pathogenic isolates, 33.3% pathogenic isolates and 14.2% no bacteria growth. There was significant difference between pathogenic isolates and no bacterial growth ($P$=0.0244). The largest pathogenic isolates were *S. aureus* (57.6%) and *E. coli* (39.4%) whilst *Bacillus spp*. was the only non-pathogenic isolate. Door handles of the various wards and theatre had the highest total bacterial isolates (25.7%), followed by the lavatories (24.6%); whereas the lavatories recorded the most pathogenic isolate (21), followed by taps. There was no change in *S. aureus* isolate numbers after cleaning whereas *E. coli* decreased by (26.7%) and *Bacillus spp.* increase by (32.7%).

**Conclusion:** The high percentage of pathogenic isolates of *S. aureus* and *E. coli* as well as *Bacillus spp*. on fomites at the Volta Regional Hospital indicates a high potential risk of HAI in the hospital.

**Keywords**: Fomites, Hospital Acquired Infections, *E. coli*, *S. aureus*, *Bacillus spp*.

## INTRODUCTION

Nosocomial infections also known as Hospital Acquired Infections (HAIs) are infections acquired in hospitals by patients who are admitted for a reason other than that infection and first appear 48 hours or more after hospital admission or within 30 days after-discharge.[1-2] HAIs could be in the form of cross-infection, endogenous infection and or environmental infection (from an inanimate objects or substances recently contaminated from another human source.[2] A prevalence survey in 2002 conducted under the auspices of the World Health Organization (WHO) in 55 hospitals in 14 countries representing four WHO Regions (Europe, Eastern Mediterranean, South-East Asia and Western Pacific) showed an average of 8.7% of hospital patients had HAIs.[3]

Some of the factors that influence the nature and frequency of HAIs include resistance to antimicrobial agents, intrinsic virulence, and amount (inoculum) of infective material.[4] Nosocomial infections are the most common complications affecting hospitalized patients, with 5% to 10% of patients admitted to US acute care hospitals acquiring one or more infections.[5] Estimate of the annual cost of treatment for HAIs ranges from $4.5 billion to $11 billion and upwards contributing to 88,000 deaths in the U.S. in 1995.[6-8] HAIs add to the imbalance between resource allocation for primary and secondary health care by directing scarce funds to the management of potentially preventable conditions.[9-11]

This is particularly important in developing countries where very little amount of resources are available for use for an unbearable number of patients. It is believed that one third of nosocomial infections are considered preventable and that as many as 92 percent of deaths from hospital infections could be prevented.[12]

In South Africa it is estimated that approximately 1 in 7 patients entering South African hospitals are at high risk of acquiring an HAI of which lower respiratory tract infections, urinary tract infections, bloodstream infections and post-surgical infections account for the majority (about 80%) of HAIs.[13] It is extrapolated that the rate of incidence of HAI infections in Ghana is approximately 152, 000 out of 20.7million people.[14] In spite of the health risks and financial burden associated with HAIs, not much has been done by government

and hospital authorities to arrest the situation in Ghana. This study therefore evaluated the potential of the transmission of HAIs in the Volta Regional Hospital, Ho in Ghana.

## MATERIALS AND METHODS

The study was undertaken at the Volta Regional Hospital, a referral hospital that serves the people of Ho and the entire Volta region in Ghana as well as clients from the neighbouring country, Togo between September, 2009 and April, 2010. Samples were taken from the hospital and bacteriological analysis undertaken in the Microbiology laboratory of the same hospital.

### Sampling

The Experimentation technique was used to isolate organisms from fomites of which taps, nurse's desks, main door handles, and door surfaces of lavatories and the various theatres that might serve as sources for transmission of HAIs within the hospital were selected based on their contact frequency with both patients and healthcare practitioners.

A swab stick was used to do swabs of taps, nurses' desks, main door handles, and door surfaces of lavatories and the various theatres of the hospital. Samples were taken in a six month period, bi-monthly, two weeks in each sampling month leading to the same surface being sampled thrice. One sample was taken just before cleaning and the other after cleaning of the same surface. The cleaning solution used in the hospital consisted of a mixture of dichloro-meta-xylenol and ethanol in water. A total of 218 swabs were obtained.

### Isolation of Organisms

Standard isolation techniques were employed in isolation of organisms. Swabs were immediately transported to the laboratory and incubated in peptone water overnight at 35±2˚C to encourage growth. Growth in peptone water was observed and streaked on Blood, MacConkey and Chocolate Agars for 24hrs at 35±2˚C for colony isolation and morphological identification.

### Identification of Organisms

Pure isolated colonies were Gram differentiated and then biochemically identified using Indole, Catalase, Citrate, Oxidase, Coagulase, and Urease tests.[15]

### Statistical Analysis

Data obtained in the study were statistically analyzed using Statview from SAS Version 5.0. The means were separated using double-tailed Paired Means Comparison. $P \leq 0.05$ was considered significant.

## RESULTS

Results from the study showed 88.8% bacterial isolates from the surfaces sampled made up of 55.5% Non-pathogenic bacteria, 33.3% pathogenic bacteria and 14.2% No Bacteria Growth (NBG). First sampling had the highest pathogenic bacteria of (32.9%) whilst the third sampling had the highest Non-pathogenic bacteria (58.3%).

Figure 1 shows that the first sampling had the highest No Bacteria Growth (NBG) (16.4%). *S. aureus* was the highest pathogenic isolate (57.6%), followed by *E. coli* (39.4%) and *P. aureginosa* (3%). *Bacillus spp*. was the only Non-pathogenic and highest isolate (121) as well as the largest colonizer of all the surfaces such as door handles (42), desks (32), lavatories (25), taps (14), doors of laboratories (6) and theatre (2). *S. aureus* followed with (12) isolates each on taps and lavatories, (7) in the theatre, (4) on door handles and (3) on the desks.

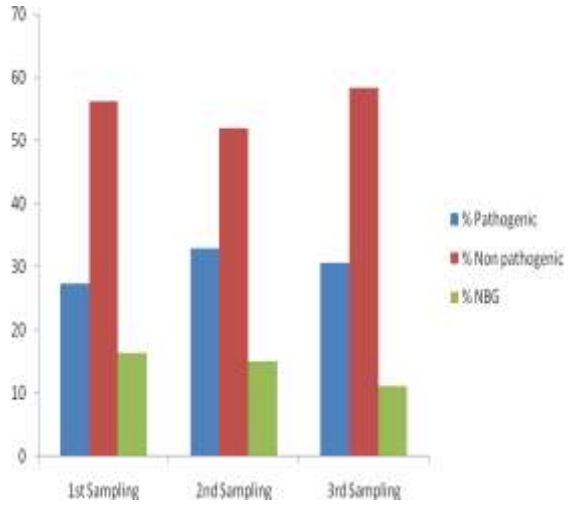


**Figure 1** Distribution of culture results at each sampling period

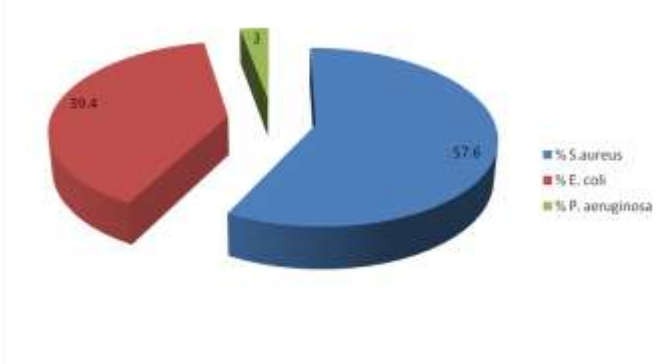


**Figure 2** Distribution of pathogenic isolates of total sample

The largest number of *E. coli* was isolated from the desks (10), followed by the lavatories (8), taps (5) and one each from door handles, theatre and door of the laboratory (Figure 3).

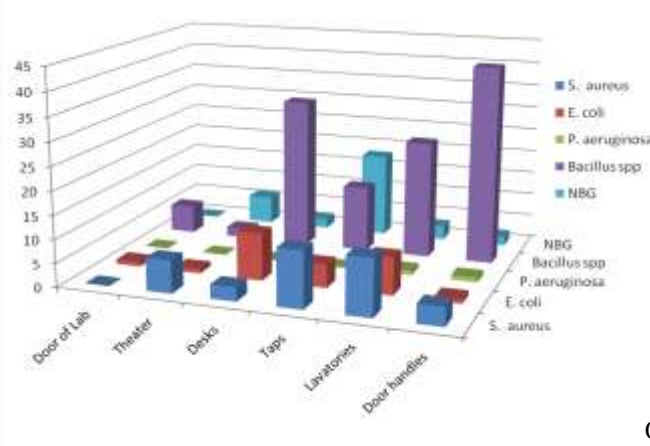


**Figure 3** Distribution of culture outcomes over all the sampled surfaces

About a third (31.8%) of the pathogenic isolates were obtained from the lavatories, followed by 25.8% from taps, 19.7% from desks, 12.1% theatre, and 9.1% door of handles and 1.5% door of laboratory.

*Bacillus spp*. increased from 52 to 69 bacteria isolates after cleaning, *E. coli* decreased from 15 to 11 whilst *S. aureus* and *P. aureginosa* remained unchanged before and after cleaning (Figure 4).

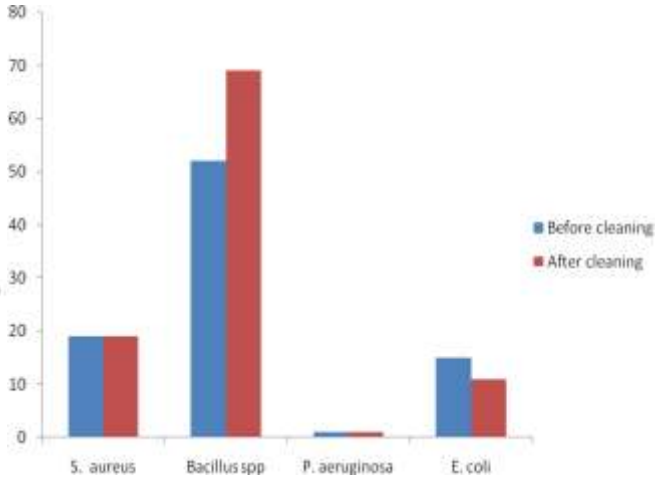


**Figure 4** Distribution of isolates before and after Cleaning

The theatre had the most pathogenic isolates of 7 of 9 (77.8%), followed by medical ward 10 of 20 (50%), the male ward 10 of 23 (43.5%), female ward 9 of 23 (39.1%), children's ward 9 of 25 (36%), Lab 8 of 25 (32%), maternity ward 5 of 22 (22.7%), accident/emergency ward 5 of 21 (23.8%) and gynaecology ward 4 of 19 (21%) in that order (Table I).

**Table I** Bacterial isolates from the different wards of the hospital

| Isolates | Male Ward | Female Ward | Children Ward | Maternity Ward | Gynae Ward | A&E Ward | Medical Ward | Theatre | Laboratory | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| *S. aureus* | 6 | 5 | 4 | 3 | 2 | 2 | 3 | 7 | 6 | 38 |
| *E. coli* | 4 | 3 | 5 | 2 | 2 | 3 | 6 | 0 | 2 | 26 |
| *P. aeruginosa* | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 |
| *Bacillus spp.* | 13 | 14 | 16 | 17 | 15 | 16 | 10 | 2 | 17 | 121 |
| Total Isolates | 23 | 23 | 25 | 22 | 19 | 22 | 20 | 9 | 25 | 187 |
| No bacteria growth | 1 | 2 | 0 | 3 | 5 | 3 | 4 | 6 | 5 | 29 |

## DISCUSSION

Results from the study showed a marked significant number of bacterial isolates 88.8% (*P*-0.0017) from the surfaces sampled made up of 55.5% non-pathogenic bacteria, 33.3% pathogenic bacteria and 14.2% No Bacteria Growth (NBG). There was a significant difference between pathogenic bacteria isolates and NBG (*P*-0.0244). This indicates the potential transmission of pathogenic bacteria to patients and staff in the hospital and confirms research by[12] that a low of 15% pathogenic isolates in a hospital ward result in a 10% chance of patients acquiring HAIs.

There was no significant difference (*P*-0.8740) between number and type of isolates over the three sampling periods (Figure 1). *S. aureus* was the highest pathogenic isolate (57.6%) although not significantly different from *E. coli* (39.4%) with *P*=0.2254 (Figure 2).

This confirm work in which *S. aureus* and *E. coli* have been found to be among the predominant organisms that are isolated in hospitals and among the leading causes of HAIs.[2,16]

Bacillus spp. was the only non-pathogenic bacteria isolate and its distribution over the sampled surfaces showed that *it* was the most predominant organism colonising these surfaces (Figure 3). The extent of colonisation could be explained by the fact that *Bacillus spp.* are ubiquitous in nature with their spores able to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods.[16]

The colonisation of many surfaces by *Bacillus spp.* is therefore justified especially before cleaning however since the hospital is an environment with a lot of immuno-compromised patients; aseptic techniques should be able to deal with even non-pathogenic bacteria since they can cause infection in immuno-compromised individuals. The lavatory (31.8%), tap (25.8%), and writing desks (19.7%) recorded the highest pathogenic isolates.

The tap and the lavatory had the highest isolate of *S. aureus* confirming earlier research that showed that *S. aureus* colonises such areas as the sink and the lavatory.[17] The 25.8% pathogenic isolates from taps also confirms earlier works that found taps to usually have the most pathogenic isolates but the least total bacterial colonisation as a result of their persistent contact with detergents during washing.

Results from the study showed a marked significant number of bacterial isolates 88.8% ($P$=0.0017) from the surfaces sampled made up of 55.5% non-pathogenic bacteria, 33.3% pathogenic bacteria and 14.2% No Bacteria Growth (NBG). There was a significant difference between pathogenic bacteria isolates and NBG ($P$=0.0244). This indicates the potential transmission of pathogenic bacteria to patients and staff in the hospital and confirms research by[12]hat a low of 15% pathogenic isolates in a hospital ward result in a 10% chance of patients acquiring HAIs.

There was no significant difference ($P$=0.8740) between number and type of isolates over the three sampling periods (Figure 1). *S. aureus* was the highest pathogenic isolate (57.6%) although not significantly different from *E. coli* (39.4%) with *P*-0.2254 (Figure 2). This confirm works in which *S. aureus* and *E. coli* have been found to be among the predominant organisms that are isolated in hospitals and among the leading causes of HAIs.[2,16] *Bacillus spp.* was the only non-pathogenic bacteria isolate and its distribution over the sampled surfaces showed that it was the most predominant organism colonising these surfaces (Figure 3). The extent of colonisation could be explained by the fact that *Bacillus spp.* are ubiquitous in nature with their spores able to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods.[16]

The colonisation of many surfaces by *Bacillus spp.* is therefore justified especially before cleaning however since the hospital is an environment with a lot of immuno-compromised patients; aseptic techniques should be able to deal with even non-pathogenic bacteria since they can cause infection in immuno-compromised individuals. The lavatory (31.8%), tap (25.8%), and writing desks (19.7%) recorded the highest pathogenic isolates. The tap and the lavatory had the highest isolate of *S. aureus* confirming earlier research that showed that *S. aureus* colonises such areas as the sink and the lavatory.[17]

The 25.8% pathogenic isolates from taps also confirms earlier works that found taps to usually have the most pathogenic isolates but the least total bacterial colonisation as a result of their persistent contact with detergents during washing and thus would only be colonised by bacteria that are resistant to the detergent or one that was left there just before swabbing was done.[17] There was no significant difference in occurrence of isolates before cleaning (87) and after cleaning (90) ($P$>0.8820). *S. aureus* had a moderate reduction from 19 isolates before cleaning to 14 after cleaning whereas Isolates of *Bacillus spp*. actually increased after cleaning to 66 compared with 52 before cleaning (Figure 4).

This means that the cleaning of the facilities did not have any effect at all on the surfaces swabbed. Across the various wards, the predominant organism isolated was *Bacillus spp.* with a total of 121 isolates whilst the area with the most pathogenic isolate was the theatre (77.9%) (Table I). This contrasts sharply with the expectation of the theatre to be the most sanitized area in the hospital due to the high potential of transmission of HAIs. The reason for the high presence of pathogenic bacteria could be as a result of the cleaning regimen which is able to get rid of the non-pathogenic bacteria but not the pathogenic ones making them the dominant colonizing bacteria in that environment.

The incidence of HAIs in the theatre during surgery varies from 0.5 to 15% and is dependent on the type of operation and underlying patient status.[18] The medical ward had 50% pathogenic isolates, followed by the male ward (43.5%), female ward (39.1%), children's ward (36%), Lab (32%), maternity ward (22.7%), accident/emergency ward (23.8%) and gynaecology ward (21%) in that order.

All the wards had greater than the 15% pathogenic isolates required in a hospital ward to result in a 10% chance of patients acquiring HAIs.[12] This clearly indicates a very high potential of HAIs transmission in the hospital.

## CONCLUSION

This study demonstrates that fomites at the Volta Regional Hospital are highly contaminated with pathogenic *S. aureus* and *E. coli* and non-pathogenic *Bacillus spp.* and also have a high potential of transmitting HAIs.

## ACKNOWLEDGEMENT

We express our gratitude to the management and staff of the Volta Regional Hospital, Ho, Ghana, for consenting to the study and especially to staff of the Microbiology Laboratory for the space to undertake this study.

## REFERENCES

1. Benenson AS. *Control of communicable diseases manual*, 16th edn. Washington, American Public Health, Association 1995. ISBN: 0875532225
2. Ducel G, Fabry J, Nicole L. *Prevention of hospital-acquired infections, a practical guide*, 2nd edition, WHO, 2002
3. WHO/CDS/CSR/EPH/2002.12
4. Siegel JD, Rhinhert E, Jackson M, Chiarello L. *Management of Multidrug resistant organisms in Healthcare settings*. CDC, 2006; USA.
5. Burke JP. Infection control - a problem for patient safety. *N Engl J Med* 2003;348:651-6.
6. Ponce-de-Leon S. The needs of developing countries and the resources required. *J Hosp Infect* 1991; 18 (Supplement A):376–381.
7. Klevens RM, Edwards JR, Richards CL Jr., *et. al*. Estimating healthcare-associated infections and deaths in U.S. hospitals, 2002. *Public Health Rep.* 2007;122(2):160-166.
8. Stone PW, Larson E, Kawar LN. A systematic audit of economic evidence linking nosocomial infections and infection control interventions: 1990-2000. *Am J Infect Control* 2002;30:145-52.
9. Wenzel RP. The economics of nosocomial infections. *J Hosp Infect* 1995;31:79-87.
10. Kirkland KB, Briggs JP, Trivette SL, Wilkinson WE, Sexton DJ. The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. *Infect Control Hosp Epidemiol*. 1999;20:725-730.
11. Plowman R, Graves N, Griffin M, *et al*. The socio-economic burden of hospital acquired infection. London: Public Health Laboratory Service, 1999.
12. Ricks, Delthia. "Germ Warfare". *Ms. Magazine* 2007*;* 43–5.
13. Brink A, Feldman C, Duse A, *et al*., Guideline for the Management of Nosocomial Infections in South Africa. *S Afr Med J* 2006; 96: 642-652.
14. US Census Bureau, International Data Base, 2004
15. Harrigan WF and McCance ME. Laboratory Methods in Food and Dairy Microbiology. Academic Press, London.
16. Brooks GF, Carrol KC, Butel JS, Morse SA. Jawetz, Melnick, and Adelberg's Medical Microbiology, 24th Ed. McGrawHill, 2007; USA.
17. Hota B. Contamination, Disinfection, and Cross-colonization. Are hospital surfaces reservoirs for Nosocomial infections? *Clinical infectious diseases* 2004; 39:1182-1189.
18. Horan TC, Culvar DH, Gaynes RP, Jarvis WB, Edwards JR, Reid CR. Nosocomial infections in surgical patients in the United States, 1986–1992 (NNIS). *Infect Control Hosp Epidemiol* 1988; 14:73–80