ISSN: 2520-5234

Available online at http://www.sjomr.org

Scientific Journal of Medical Research
Vol. 1, Issue 4, pp 119 - 124, Autumn 2017

SCIENTIFIC JOURNAL
OF MEDICAL RESEARCH

ORIGINAL ARTICLE

An Investigation into the Type of Bacteria causing Healthcare Associated Infections (HAIs) in Hospital Departments and Areas- In Karbala

Shadha M. Abbas Al Asadi
Environmental Health Department, Applied Medical Sciences College, Karbala University, Iraq.

ARTICLE INFORMATIONS

Article History:
Submitted: 12 October 2017
Revised version received:
14 November 2017
Accepted: 17 November 2017
Published online: 1 December 2017

Key words:
Sustainable Healthcare Hospital Buildings
Sick Building Syndrome
Healthcare Associated Infections (HAIs)
Nosocomial infections
Measures to minimise HAIs

Corresponding author:
Shadha M. Abbas Al Asadi
Email: shadha4@yahoo.co.uk
Environmental Health Department
Applied Medical Sciences College
Karbala University
Iraq.

ABSTRACT

Objective: This paper compliments that published in Scientific Journal of Medical Research Vol. 1, Issue 2, pp 57 - 62, Spring 2017[1], which presented the results of an investigation at an Iraqi hospital of Healthcare Associated Infections (HAIs) in terms of total contamination data and contamination cases grouped by departments/areas.

Methods: The survey was accomplished in the period from January 2015 to January 2016, and provided microbiology swipes data which identified the types of bacteria most commonly associated with HAIs.

The hospital departments/area having contaminated swipes percentages more than 10% contamination were: Department of Burns 52, General Operating Theatres 42, Accident and Emergency wards 36, Kitchen 22, Orthopaedics 18, ENT 13, Urology 12.

Results: The main organism identified in the most contaminated swipes was Staph. Aureus (46), followed closely by Staph. Epidermidis (42). Fungal 28, *E. coli* 27, *Pseudomonas* 27 and *Streptococcus* 25 were all found in similar quantities. Other isolated organisms were significantly less prevalent. This paper aims to educate about the health problems associated and or caused by the highest prevalent organisms of the aforementioned research, namely i) *Staph. aureus*, *Staph. epidermidis* and Fungal (46%, 42% and 28% respectively of total contaminated swipes). The measures that the particular hospital and other hospitals had already undertaken as common practices which are already minimizing the impacts of the building environment on nosocomial infections are reported in this paper too.

Conclusion: The design of sustainable healthcare buildings, such as hospitals are important to avoid Sick Building Syndrome (SBS) and they should be seen as financial and as part of health treatments. A hospital should not be a place that people go and get sick in.

Citation: Al Asadi, S.M.A. "An Investigation into the Type of Bacteria causing Healthcare Associated Infections (HAIs) in Hospital Departments and Areas- In Karbala". Sci. J. Med. Res. 2017, 1 (4): 119-124.

INTRODUCTION

In 2006, a national prevalence survey in England found eight per cent of patients had an infection that was not present or incubating at the time of their admission. The survey identified the main type of Healthcare Associated Infections (HAIs) in hospitals in England at the time, and the bacteria that caused them, as being a) Urinary Tract Infections b) Lower Respiratory Tract Infections, c) Gastrointestinal Infections, d) Surgical Site Infections, e) Bloodstream Infections (Bacteraemia) and f) Skin & Soft Tissue Infections[2]. Inweregbu *et. al*[3], also reported in 2006 that annually, this results in 5000 deaths with a cost to the National Health Service (NHS) of a billion pounds. On average, a patient with a nosocomial infection spent 2.5 times longer in hospital,

incurring additional costs of £3000 (approx. $4500) more than an uninfected patient. Intensive care units (ICU) have the highest prevalence of acquired infections in the hospital setting. The European Prevalence of Infection in Intensive Care Study (EPIC), involving over 4500 patients, demonstrated that the nosocomial infection prevalence rate in ICU was 20.6%. ICU patients are particularly at risk from nosocomial infections as a result of mechanical ventilation, use of invasive procedures and their immune compromised status[3].

The author has reported two examples of these types of bacteria which cause the infections, namely i) Urinary Tract Infections and ii) Lower Respiratory Tract Infections[1]. In this study Gastrointestinal Infections; Surgical Site Infections; Bloodstream Infections (Bacteraemia); Skin & Soft Tissue Infections will be included. The paper will make reference to the measures used in developing countries to minimize their existence[4-8], and the scale of their existence in the hospital in which the author conducted original study and survey.

1. Gastrointestinal Infections

Most nosocomial gastrointestinal infections arise from *Clostridium difficile (C. difficile).* This organism releases spores in faeces that can contaminate the environment. The organism is then acquired by ingestion through contact with an infected person or from the contaminated environment. Norovirus is another common pathogen, that causes vomiting and diarrhoea and can be highly contagious. The gut may become colonised with *C. difficile*, which may establish infection if the normal gut flora is disrupted by broad spectrum antibiotics or immune-suppressive states. The elderly are particularly at risk of developing this infection.

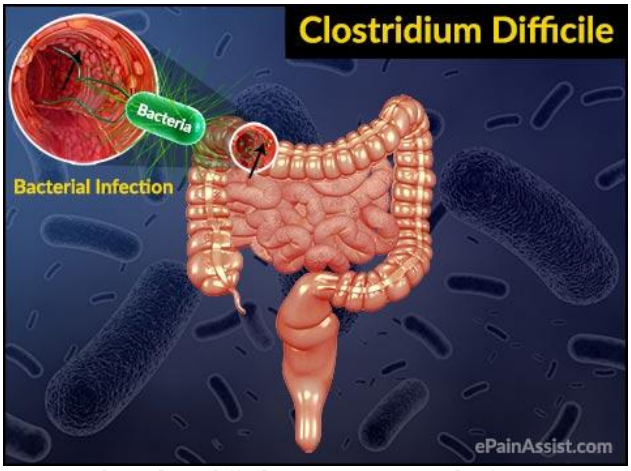

Figure 1. ***Clostridium difficile*** **in gastrointestinal infection.** (*https://www.epainassist.com/abdominal-pain/intestine/clostridium-difficile-or-c-difficile-infection*)

2. Surgical Site Infections

Surgical site infections are wound infections that occur after an invasive (surgical) procedure. *Staphylococcus aureus* (around 50 per cent of surgical site infections), *Pseudomonas aeruginosa*, and other gram negative bacteria are common causes of surgical site infections. Ranging from limited wound excretions to post-operative life-threatening complications, such as endocardial infarction after open-heart surgery. Risk factors for infection include duration of surgery, surgical technique and preparation, presence of foreign material, length of hospital stay and antibiotic prophylaxis.

Figure 2.**Surgical Site Infections – Sternal infection after open-heart surgery.**(*https://www.slideshare.net/eyeofmekhael/surgerysurgical-infections-12*)

3. Bloodstream Infections (Bacteraemia)

Bacteria enter the bloodstream through the insertion device into the artery or vein, or as a result of an infection elsewhere in the body. They can cause sepsis, the body's overwhelming and life-threatening response to infection that can lead to tissue damage and organ failure, and result in septic shock and death. They have high patient mortality. Around 44 per cent of bloodstream infections in England are associated with invasive devices, with two thirds of these due to intravenous access devices such as peripheral and central line catheters. *E. coli*, and other gram-negative bacteria and *Staph. aureus*. Around 13 per cent of bloodstream infections are caused by *Staph. aureus,* four per cent are MRSA- Methicillin-resistant *Staph. aureus* (MRSA) infection, was caused by a type of cluster bacteria that became resistant to many of the antibiotics used to treat normal Staphylococcus infections.

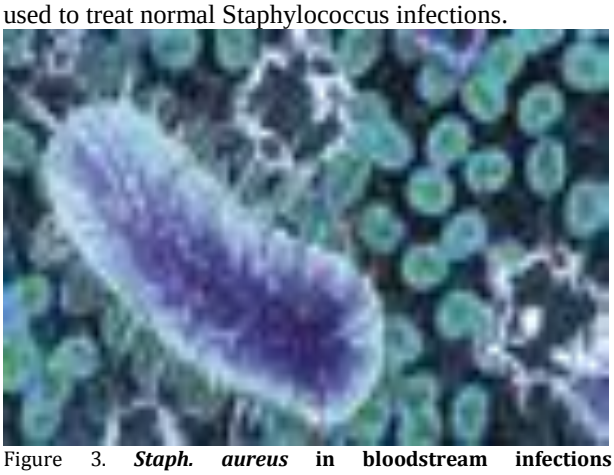

Figure 3. ***Staph. aureus*** **in bloodstream infections (bacteraemia).**
(Source: National Audit Office in England 2009)[4]

4. Skin & Soft Tissue Infections

Staph. aureus is commonly found in skin and soft tissue infection. Its severity is usually determined by how deeply the skin is infected. Deep soft tissue infections may require surgical intervention and can result in significant morbidity for the patient, which in the worst cases can lead to loss of limbs and death. Open wounds and pressure sores are particularly at risk of becoming infected due to already present break in the skin.

Figure 4. ***Staph. aureus*** **in skin and soft tissue infections. (Source: National Audit Office in England 2009)**[4]

MATERIALS AND METHDS

Results of microbiology swipe sampling were collected to provide an insight into the scale of infection transmission within the hospital. The microbiology swipe sample results were normally collected by the relevant hospital department and produced for the Department of Health Office. The author used these results of microbiology swipes to provide an insight into the scale of infection transmission at the Hospital between the period of January 2015 and February 2016.

The author was provided with two sets of data, the first being the monthly microbiology summary sheet of all microbiology swipes. These summary sheets of all microbiology swipes results identified the departments, organisms and specific areas from which the swipes were taken, the number and percentage of departments/areas that were contaminated, along with which organism, the location and what action if any was undertaken to sterilise the area. An example of the monthly microbiology summary sheet of all microbiology swipes is shown in Table 1. The second set of data included the monthly microbiology laboratory results in Table 2, undertaken within the hospital. These laboratory results identified the total number of swipes undertaken in that period, contaminated swipes and percentage contamination.

Table 1. ***Representative*** **Sample of The Monthly Microbiology Swipe Summary for April 2015, at the Hospital produced by the Health Office of the City where the study was conducted.**

Area	Total swipes taken	Total contaminated swipes	Percentage of total contaminated swipes	Type of Bacteria	Action taken (closing the area or not)	Action taken / methods of contamination treatment
Heart surgery bed	637	30	4.7%	*E. coli*	Open	All contaminated areas closed and treated, then swipes taken to ensure they are free from contamination and safe to operate in.
Burns Operation Theatre				*Pseudomonas*	Open	
Accident and Emergency				*Staph aureus*	Open	
Operation Theatre				*Strep* Spp.	Open	

RESULTS

Following review of the laboratory reports and report summaries of microbiology swipe results for the January 2015 to February 2016, the following groups of results were looked at:

a. Total contamination data, Table 2.
b. Contamination cases grouped by Department, Figure 5.
c. Contaminated microbiology swipe cases grouped by organism, Table 3 and Figure 6.

Total Contamination Data from January 2015 to February 2016.

From Table 2, the greatest number of total swipes 815 were taken in February 2016 and the lowest 293 in March and July 2015. There were no results available for June and November 2015. The range of results for most months was between 637-815 total swipes. Therefore, both March and July 2015 results are significantly lower than other months at 293. The highest percentage of contaminated swipes (6.8%) was in the month of March 2015 and the lowest (2.4%) in January 2016. The ranges of percentage contamination were between 2.4 – 6.8%.

Contamination Cases Grouped By Department

When looking at the number of contaminated swipe cases by Department for the whole period of study [January 2015-January 2016], as shown in Figure 5, the highest are found in the Department of Burns 52. This includes both the wards and the operating theatres. This is followed by the general operating theatres that have not been allocated to any particular department 42. Accident and Emergency wards and theatres came in third 36. The kitchen brought back 22 incidences of contaminated swipes. Orthopaedics 18, ENT 13 and Urology 12 were also had contaminated swipes. There is then a significant dip in the number of swipes found in the rest of the departments. The range of contaminated swipes fell within three distinct groups, which were 1-6, 12-22 and 36-52 contaminated swipes.

Table 2. **Microbiology Swipes and Level of Contamination Jan 2015-February 2016.**

Month-Year	Total Swipe	Contaminated Swipe	% Contamination
Jan-15	637	23	3.6%
Feb-15	757	31	4.1%
Mar-15	293	20	6.8%
Apr-15	637	30	4.7%
May-15	800	23	2.9%
Jun-15	No Data	No Data	No Data
Jul-15	293	15	5.1%
Aug-15	688	18	2.6%
Sep-15	808	20	2.5%
Oct-15	790	30	3.8%
Nov-15	No Data	No Data	No Data
Dec-15	638	35	5.5%
Jan-16	638	15	2.4%
Feb-16	815	22	2.7%

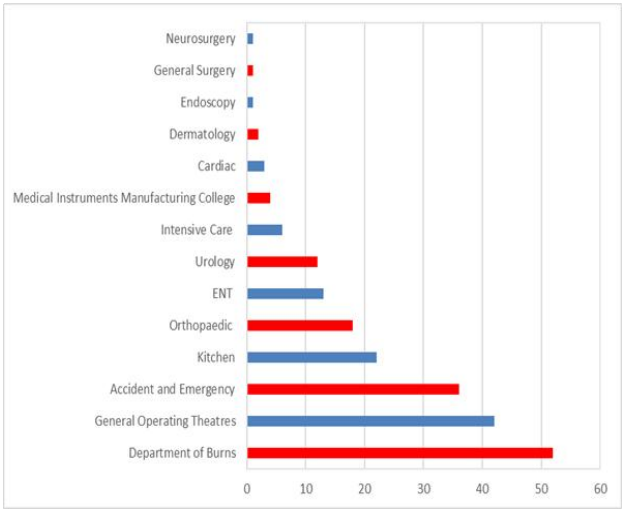

Figure 5. **Contaminated Microbiology Swipe Cases Grouped by Department.**

Contamination Cases Grouped by Organism

In Table 3 and Figure 6, it can be seen that the organism identified in the most contaminated swipes was *Staph. aureus* 46, followed closely by *Staph. epidermidis* 42. Fungal 28, *E. coli* 27, *Pseudomonas* 27 and *Streptococcus* 25 were all found in similar quantities, whereas the rest of the organisms isolated were significantly less prevalent. There were three distinct ranges of data, between 1-4, 25-28 and 42-46 cases.

Table 3. **Contaminated Microbiology Swipe Cases Grouped by Organism**

Contamination Organism	Cases
Staph. aureus	46
Staph. epidermidis	42
Fungal	28
E. coli	27
Pseudomonas	27
Streptococcus	25
Enterobacter	4
Gram +ve Bacilli	4
Bacillus	3
Serratia	3
Klebsiella	2
Moraxella	1
Pantoea	1

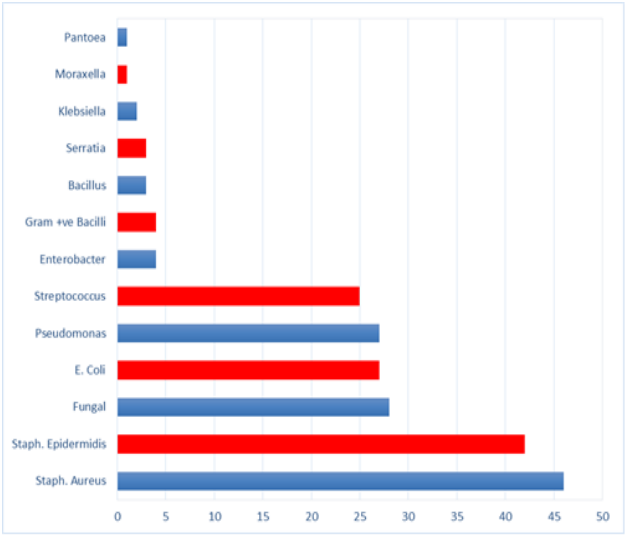

Figure 6. **Contaminated Microbiology Swipe Cases Grouped by Organism.**

This paper has reported the health problems associated with or causes by the main organisms Staph. aureus and Staph. and epidermidis as they are the highest prevalent in this survey, 46%, 42% respectively. Together with the health problems associated with and or caused by the organism; *E. coli* 27 and *Streptococcus* 25 were found in similar quantities. The measures that this and other hospitals have undertaken are already preventing and/or minimizing the health problems associated and/or caused by the main organism and the impacts of the building environment on nosocomial infections are summarized below.

DISCUSSION

Measures to minimise healthcare associated infections in hospitals and improve the health the environment.

Key measures of infections control include but are not limited to;

1. Identifying patients at risk of nosocomial infections.

2. Observing hand hygiene[5].
3. Following standard precautions to reduce transmission of diseases.
4. Adapt strategies to reduce VAP [Ventilator-Associated Pneumonia], CR-BSI [Catheter Related Blood Stream Infection] which is the commonest cause of nosocomial bacteraemia, and CAUTI [Catheter Associated Urinary Tract Infection], the most prevalent healthcare associated infection (HAI) worldwide[6-9].
5. Environmental factors and architectural layout of the hospitals. Compare with best practices.
6. Infection prevention in special subsets of patients e.g. burns patients, including sources identification of living organism, identification of organisms, isolation if necessary, prevention using antibiotics to selectively use early removal of dead tissue, tetanus prevention, early nutrition and control.
7. Immunodeficiency and organ transplant recipients are at a higher risk of opportunistic infections. The post transplant timetable is divided into three time periods for determining risk of infections.
8. Room ventilation, cleaning and decontamination.
9. Protective clothing with food handling requires special consideration.
10. Monitoring and surveillance are prioritized depending upon the needs.
11. Designated infection control teams should supervise the process and help in collection and compilation of data.
12. Antibiotic Stewardship Recommendations include constituting a team, close coordination between teams, audit, formulary restriction, de-escalation, optimizing dosing, active use of information technology amongst other measures.

Hospital policy of prevention should be supported by evidence that indicates the strength and quality of evidence supporting the application of these measures, so that hospital directors/managers can ascertain how best to apply the measure in their practice environments[8-11].

CONCLUSIONS

This study has revealed the following conclusions:

From literature survey, the following has been gleaned:

a. In 2006, a national prevalence survey in England found that eight per cent of patients had an infection that was not present or incubating at the time of their admission. The survey identified the main type of Healthcare Associated Infections (HAIs) and the types of bacteria that caused them, namely a) Urinary Tract Infections, b) Lower Respiratory Tract Infections c) Gastrointestinal Infections, d) Surgical Site Infections, e) Bloodstream Infections (Bacteraemia) and f) Skin & Soft Tissue Infections. All of these can contribute to the phenomenon known as Sick Building Syndrome, whereby the design of a building can compromise user health, though such factors as: inadequate ventilation, pollutants emitted inside buildings, contaminations from outside sources, biological contamination (i.e. mould growth due to excess humidity), inadequate temperatures, excess humidity and poor lighting.
b. The European Prevalence of Infection in Intensive Care Study (EPIC) demonstrated that Intensive Care Unit (ICU) patients are particularly at risk from nosocomial infections because of mechanical ventilation, use of invasive procedures and their immune compromised state.
c. Most nosocomial gastrointestinal infections are caused by *Clostridium difficile (C. difficile).* This organism forms spores, which are released in faeces and can contaminate the environment.
d. Surgical site infections are wound infections that occur after an invasive surgical procedure.
e. *Staphylococcus aureus* (around 50 per cent of surgical site infections), Pseudomonas aeruginosa, and other gram negative bacteria are common causes of surgical site infections. Ranging from limited wound excretions to life-threatening postoperative complications, such as endocardial infarction after open heart surgery. Risk factors for infection include duration of surgery, surgical technique and preparation, presence of foreign material, length of hospital stay and antibiotic prophylaxis.
f. *Staph. aureus* is commonly found in skin and soft tissue infection. Their severity is usually determined by how deeply the skin is infected.
g. Bacteria such as *Staphylococcus aureus (Staph. aureus)* are well known for Lower respiratory tract infections that affect the trachea, bronchi and lungs. This type of infection and pneumonia has a case fatality rate approaching 40 per cent. Mechanical ventilation is the main risk factor for healthcare associated pneumonia. The cumulative risk of infection increases with duration of ventilation.

The study demonstrated that several types of microorganisms were identified in the hospital building environment. Microbiology swipes data provided in this paper reported the existence of infections that could be transmitted to occupants and visitors at the hospital between the period of January 2015 and February 2016.

Important measures to minimize and/or prevent some healthcare associated infections in hospitals and improve the health environment are reported. Stringent monitoring and rapid remedial systems need to be undertaken in hospitals for effective resolution of the report findings.

REFERENCES

1. Al Asadi S. "Hospital Building and Healthcare Associated Infections (HAIs) in terms of total contamination data and cases grouped by department/areas". Scientific Journal of Medical Research, Spring 2017; 1(2):57 – 62. Available at http://www.sjomr.org Accessed: 01/10/17.
2. The Hospital Infection Society, 2007. "The Third Prevalence Survey of Healthcare Associated Infections in Acute Hospitals in England 2006". Available at: http://webarchive.nationalarchives.gov.uk/20081105143757/http://dh.gov.uk/en/Publicationsandstatistics/Publications/Publications

PolicyAndGuidance/DH_078388?IdcService=GET_FILE&dID=148408&Rendition=Web Accessed: 05/04/16.
3. Inweregbu K. "Nosocomial infections, Continuing Education in Anaesthesia, Critical Care & Pain". The British Journal of Anaesthesia, 2006; 5(1): 14-17. Available at: http://ceaccp.oxfordjournals.org/content/5/1/14/T1.expansion.html Accessed: 14/03/16.
4. National Audit Office (NAO), 2009. "Reducing Healthcare Associated Infections in Hospitals in England". Available at: https://www.nao.org.uk/report/reducing-healthcare-associated-infections-in-hospitals-in-england/ Accessed: 01/05/16.
5. Mayo Clinic Staff, 2017. "Staph infections – Self Management". Available at: http://www.mayoclinic.org/diseases-conditions/staph-infections/basics/prevention/con-20031418 Accessed: 02/07/17.
6. Maselli D.J., Restrepo M.I."Strategies in the prevention of ventilator-associated pneumonia". Ther Adv Respir Dis. 2011;5(1): 31–41.
7. Coffin S.E., Klompas M., Classen D., Arias K.M., Podgorny K., Anderson D.J. "Strategies to prevent ventilator-associated pneumonia in acute care hospitals". Infect Control Hosp Epidemiol. 2008; 29 (Suppl 1):S31–40.
8. Ducel G. 2002. "Prevention of hospital-acquired infections. World Health Organization Department of Communicable Disease, Surveillance and Response". Available at: http://apps.who.int/medicinedocs/documents/s16355e/s16355e.pdf , Accessed: 01/04/16.
9. Levin H. 1989. "Sick Building Syndrome: Review and Exploration of Causation Hypotheses and Control Methods". The Human Equation: Health and Comfort. ASHRAE/SOEG Conference IAQ 89, p263-275. Available at: http://www.buildingecology.com/articles/sick-building-syndrome-review-and-exploration-of-causation-hypotheses-and-control-methods/at_download/file Accessed: 01/05/16.
10. World Health Organization, 2004. "Standards for Health Promotion in Hospitals". Available at: http://www.euro.who.int/__data/assets/pdf_file/0006/99762/e82490.pdf . Accessed: 12/04/16.
11. Bensalem S., 2014. "Sustainable Healthcare Architecture: Designing a Healing Environment". Available at: https://soa.utexas.edu/sites/default/disk/munpaper1/munpaper1/10_02_su_bensalem_sara.pdf Accessed: 06/05/16.