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ORIGINAL ARTICLE

Hospital Building and Healthcare Associated Infections (HAIs) in terms of total contamination data and cases grouped by department/areas

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ABSTRACT

Objective: This study includes investigations on hospital building and healthcare associated infections (HAIs) in terms of total contamination data and cases grouped by department /areas.

Methods: The paper contains two parts; i) a literature background study on the importance of keeping hospital buildings within the healthcare standards, and ii) a survey accomplished in the period from January 2015 to January 2016 on total contamination data and cases grouped by department/areas in a local hospital. To include; Department of Burns, General Operating Theatres, Accident and Emergency, Kitchen, Orthopedic, ENT, Urology, Intensive Care, Medical Instruments Manufacturing College, Cardiac, Dermatology, Endoscopy, General Surgery and Neurosurgery.

Results: From the literature study, 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. Healthcare Associated Infections (HAI), affect 1 in 10 UK hospital admissions who spend on average 2.5 times longer in hospital and cause 5000 per annum deaths at a cost of a billion pounds.

From this study, the investigations provide microbiology swipes data to include the types of bacteria, which caused HAIs. The highest contamination rates in descending order were found in Department of Burns (52), the general operating theatres (42), Accident and Emergency wards and theatres (36), and the kitchen (22). By organism, *Staph. aureus* (46), followed closely by *Staph. epidermidis* (42), were the two most commonly isolated contamination organisms from the swipes. The data regarding contaminated swipe locations identifies the patient bed (46) and ventilation (31) as the two most contaminated areas in the hospital.

Conclusion: In hospitals, professionally & technically skilled medicine doctors and health team members apply their knowledge and skill with the help of technology to provide quality care for the patients; therefore, more measures need to be implemented to minimize the contamination rates in the departments and area where the rate is high..

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INTRODUCTION

Hospitals are a place for the diagnosis and treatment of human ills and restoration of health and well-beings of those temporarily deprived of these. Professionally & technically skilled people apply their knowledge and skill with the help of technology to provide quality care for the patient[1].

Functions of hospitals: The University of Mosul Nursing Department lists the following as functions of a hospital[1]:

a. **Patient Care:** Primary function (Curative function) refers to any type of care given to patients by the health team members, e.g. Physicians; Nurses, Physical Therapists, Dietitians, etc. It also includes health teaching to patients.
b. **Health Personnel Education:** Secondary function (Educational function). Refers to the education of professional and technical personnel who provide health services, e.g. Physicians, Nurses, Dentists, Therapists, Technicians, etc.
c. **Health Promotion:** Secondary function (Preventive function) as a community health center taking an active role to improve the health of the population it serves. Hospitals as major community health centers can sponsor programs of environmental and occupational health, home care services, etc.
d. **Health Related Research**: Secondary function (Research function) where research focuses on the improvement of health and/or prevention of disease.

Healthcare associated infections (HAIs): Healthcare Associated Infections (HAIs), known as nosocomial infections if contracted in hospital, are defined as those occurring within 48 hours of hospital admission, with 3 days of discharge or 30 days of an operation. They affect 1 in 10 patients admitted to hospital in the UK. Annually, this results in 5000 deaths with a cost to the National Health Service 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[2] .

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[3]. The survey identified the main type of Healthcare Associated Infections in hospitals in England in 2006 and the types of bacteria which caused them are; Urinary Tract Infections; Lower Respiratory Tract Infections Gastrointestinal Infections; Surgical Site Infections; Bloodstream Infections (Bacteraemia); Skin & Soft Tissue Infections. Two examples of these types of bacteria which cause the infection are explain below. These are; i) Urinary Tract Infections and ii) Lower Respiratory Tract Infections.

i) Urinary Tract Infections

Most urinary tract infections are caused by gram negative bacteria, especially *Escherichia coli* (*E. coli).* These occur when bacteria (or sometimes fungi) enter the urinary tract and infect the bladder. Urinary tract infections are usually treatable with antibiotics but antibiotic resistant strains can be a problem in patients with long term catheters. 80% of healthcare associated urinary tract infections are associated with urine catheters. Risk is affected by the method and duration of catheterisation and the susceptibility of the patient.

Fig. 1 ***Escherichia coli* (*E. coli)* in urinary tract infections**[7]

ii) Lower Respiratory Tract Infections

Lower respiratory tract infections affect the breathing tubes (trachea and bronchi) and the lungs. Pneumonia is the most severe and life threatening of all respiratory tract infections. Bacteria such as *Staphylococcus aureus (Staph. aureus)* are well known for 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.

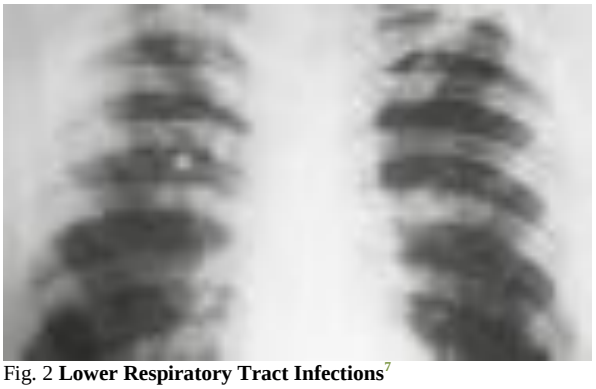

Fig. 2 **Lower Respiratory Tract Infections**[7]

Routes of infection

Endogenous infection from the patient occurs when bacteria present in the normal flora cause infection because of transmission to sites outside the natural habitat (urinary tract), damage to tissue (wound) or inappropriate antibiotic therapy that allows overgrowth (*C. difficile*). For example, Gram-negative bacteria in the digestive tract frequently cause surgical site infections after abdominal surgery or urinary tract infection in catheterized patients.

Exogenous cross-infection occurs from another patient or hospital staff. Bacteria are transmitted between patients[4]:

a) through direct contact between patients (hands, saliva droplets or other body fluids),

b) in the air (droplets or dust contaminated by a patient's bacteria),
c) via staff contaminated through patient care (hands, clothes, nose and throat) who become transient or permanent carriers, subsequently transmitting bacteria to other patients by direct contact during care,
d) via objects contaminated by the patient (including equipment), the staff's hands, visitors or other environmental sources (e.g. water, other fluids, food)

Several types of microorganisms survive well in the hospital environment:

- in water, damp areas, and occasionally in sterile products or disinfectants (*Pseudomonas*, *Mycobacterium*)
- in items such as linen, equipment and supplies used in care
- in food and,
- in fine dust and droplets generated by coughing or speaking (bacteria smaller than 10 µm in diameter remain in the air for several hours and can be inhaled in the same way as fine dust).

All people admitted to hospital are at some risk of contracting an HAI, but the severity of infection's effects can be vary according to the patient's susceptibility**.**

Table 1. **Factors that increase the risk of infection to susceptible person attending the hospital**[2]

Underlying Health Status	**Acute Disease Process**
Advanced age	Surgery
Malnutrition	Trauma
Alcoholism	Burns
Heavy smoking	
Chronic lung disease	
Diabetes	
Invasive Procedures	**Treatments**
Endotracheal or nasal intubation	Blood transfusion
Central venous catheterisation	Recent antimicrobial therapy
Extracorporeal renal support	Immunosuppressive treatments
Surgical drains	Stress-ulcer prophylaxis
Nasogastric tube	Recumbent position
Tracheostomy	Parenteral nutrition
Urinary catheter	Length of stay

Ultimately, people are at the center of the infection phenomenon. They are the:

- main reservoir and source of microorganisms
- main transmitter, notably during treatment
- receptor for microorganisms, thus becoming a new reservoirs.

Hosptal design and infection control

Sick Building Syndrome is attributed to air quality problems within buildings and is thought to cause sickness and headaches, dizziness, wheezing, eye irritation, respiratory infections, and fatigue. Approximately 20 percent of the American workforce is affected by sick building syndrome[5]. The US Environmental Protection Agency lists the key factors of sick building syndrome as:

- Inadequate ventilation
- Pollutants emitted inside buildings
- Contaminations from outside sources
- Biological Contamination (i.e. mould growth due to excess hu¬midity)
- Inadequate temperatures
- Excess humidity
- Poor Lighting

The effects of the syn¬drome include reducing productivity, performance, and well-being of building users. Cur¬rently many hospitals in the indus¬trialized world can be characterized as prone to sick building syndrome. These impacts are extreme in hospi¬tals where the spread of diseases are possible. In Germany, about 1,500 people die annually from diseases they contract in the hospital[6]. Bensalem quotes Houghton et al as suggesting ''the underlying motivations for healthcare facilities to pursue sustainable building designs are moral, but they should also be seen as financial and as part of health treatments'' [6]. A hospital should not be a place that people go and get sick in.

Prevention of nosocomial infections is the responsibility of all individuals and services providing health care. Everyone must work cooperatively to reduce the risk of infection for patients and staff. This includes personnel providing direct patient care management, training of health workers, physical plant, provision of materials, and products, and commissioning and management of the built environment. It is this latter part which lead to that this project is designed to seeks ; i) to investigate in greater depth in regard to first considering one of the Hospital in Karbala with regards to the number of HAIs and ii) in the future to further exploring, the measures that the particular hospital and other hospitals had already undertaken as common practices to try to minimize the impact of the building environment on nosocomial infections.

MATERIALS AND METHDS

Results of microbiology swipe sample results were collected to serve the aim of this study, namely providing an insight into the scale of infection transmission within hospital. The microbiology swipe sample results were where normally collected by the relevant hospital in charged section and produced for the Iraqi Ministry of Health. The authors uses 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 authors were provided with two sets of data, one being the monthly microbiology laboratory results and the other being the monthly microbiology summary sheet of all microbiology swipes undertaken within the hospital. The microbiology laboratory results identified the organisms, departments and specific areas from which the swipes were taken. The summary sheets identified the total number of swipes undertaken in that period and the number and percentage that were contaminated, along with which organism, the location

and what action if any was undertaken to sterilise the area.

RESULTS AND DISCUSSION

Following review of the microbiological swipes, the authors looked at the following groups of results:

A. Total contamination data from January 2015 to February 2016, Table 2
B. Contamination cases grouped by department, Table3.

Data was collated from laboratory reports and report summaries of microbiology swipe results for the January 2015 to February 2016 period. Here are examples of two such reports, for April 2015, figure 7 and August 2015, Figure 8.

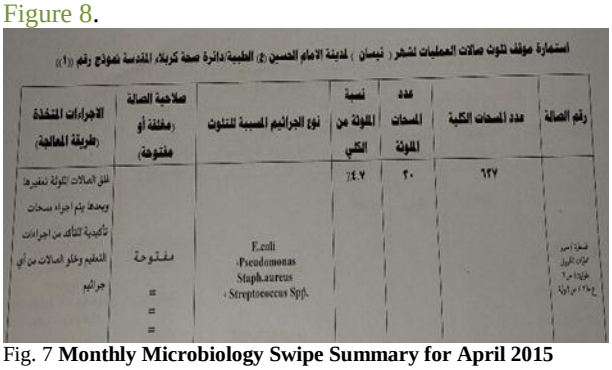

Fig. 7 **Monthly Microbiology Swipe Summary for April 2015**

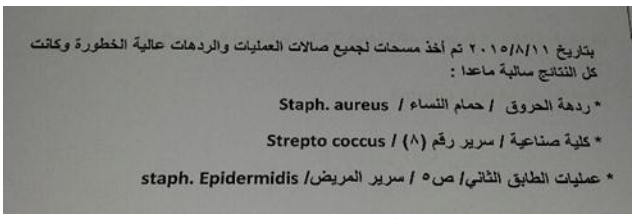

Fig. 8 **Weekly Microbiology Swipe Results for August 2015**

A. 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. These results also are plotted in Figure 9. Where the vertical axis presents the ccontamination percentage and the horizontal axis shows the months in 2015 and 2016 where these information are taken. 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 was between 2.4 – 6.8%.

Table 2. **Microbiology swipes and level of contamination Jan 2015 to February 2016**

Month-Year	Total Swipes	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%

Table 3. **Contaminated microbiology swipe cases grouped by Department**

Department with Contamination	Cases
Department of Burns	52
General Operating Theatres	42
Accident and Emergency	36
Kitchen	22
Orthopaedic	18
ENT	13
Urology	12
Intensive Care	6
Medical Instruments Manufacturing College	4
Cardiac	3
Dermatology	2
Endoscopy	1
General Surgery	1
Neurosurgery	1

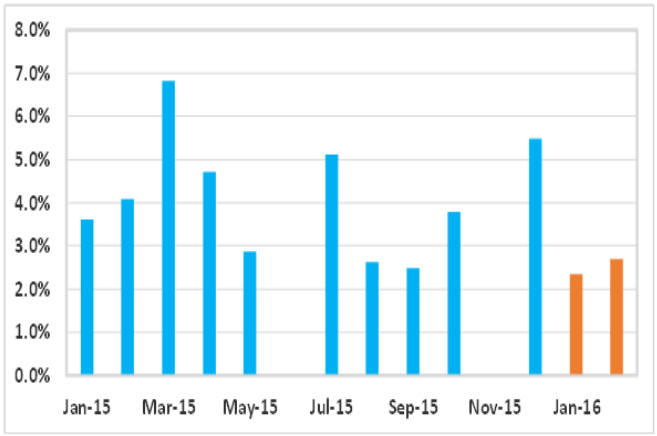

Fig. 9 **Contamination information from Hospital for January 2015 February 2016**

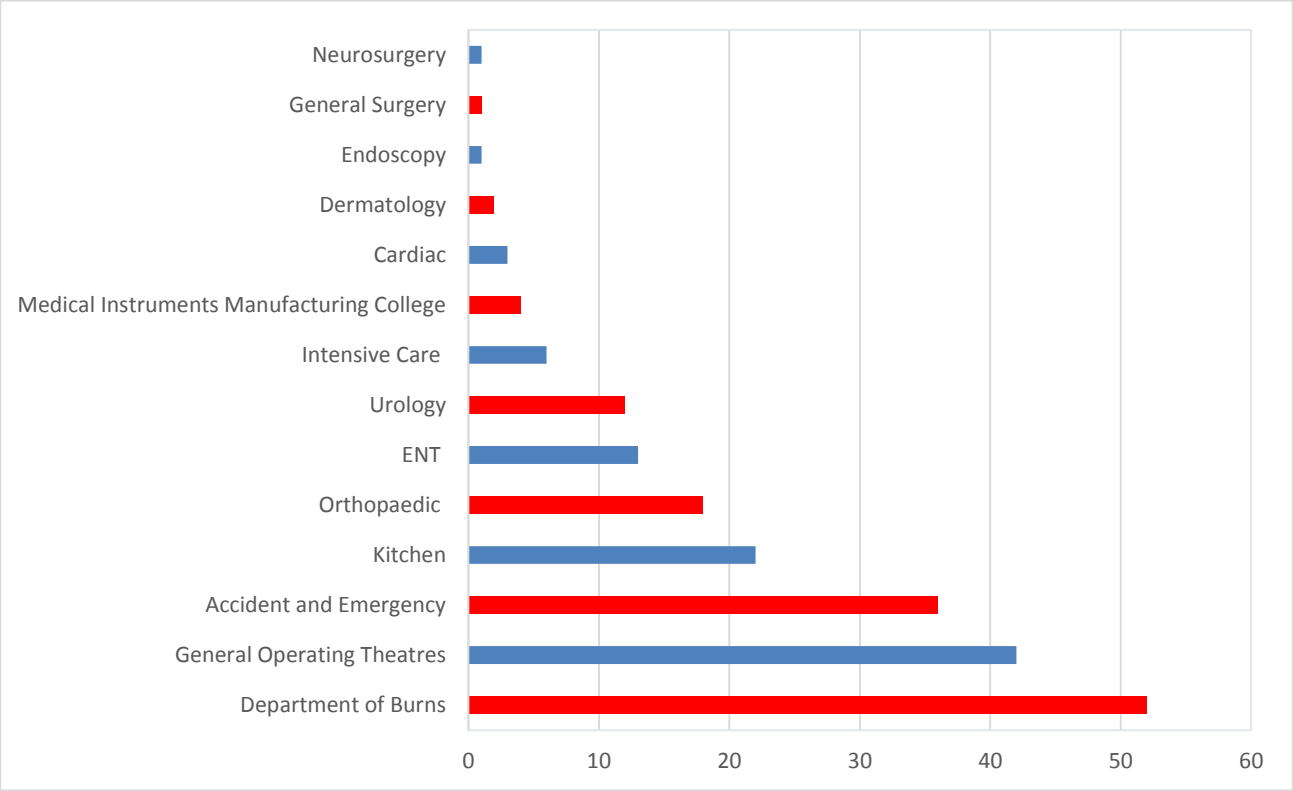

Fig. 10 **Contaminated microbiology swipe cases grouped by Department**

B. 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 Table 2 and Figure 9, 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.

In a second paper the author is completing information for investigating in greater depth the measures that the particular hospital had already undertaken as common practices to try to minimize the impact of the building environment on nosocomial infections.

CONCLUSION

1. Literature survey revealed that;
   a. Sick Building Syndrome is attributed to air quality problems within buildings and is thought to cause sickness and headaches, dizziness, wheezing, eye irritation, respiratory infections, and fatigue. Approximately 20 percent of the American workforce is affected by sick building syndrome[5]. The US Environmental Protection Agency lists the key factors of sick building syndrome 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. Thus it is attributed to Healthcare Associated Infections (HAI).
   b. Healthcare Associated Infections (HAI) is important in transmitting illness and diseases. HAI affect 1 in 10 UK hospital admissions who spend on average 2.5 times longer in hospital and cause 5000 per annum deaths at a cost of a billion pounds.
   c. 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'.
   d. In 2006, a national prevalence survey (NPS) in England found that eight per cent of patients had an infection that was not present or incubating at the time of their admission[3].
   e. The NPS identified the main type of Healthcare Associated Infections in hospitals in England and the types of bacteria which caused them are; Urinary Tract Infections; Lower Respiratory Tract Infections Gastrointestinal Infections; Surgical Site Infections; Bloodstream Infections (Bacteraemia); Skin & Soft Tissue Infections. Two examples of these types of bacteria which cause the infection are explain in this paper. These are; i) Urinary Tract Infections and ii) Lower Respiratory Tract

Infections. Both of bacteria [*E. coli and Staph. Aureus respectively*] are found in the Monthly Microbiology Swipe Summary for April 2015, Figiurte 1.

f. Most urinary tract infections are caused by gram negative bacteria, especially *Escherichia coli* (*E. coli*). 80% of healthcare associated urinary tract infections are associated with urine catheters. Risk is affected by the method and duration of catheterisation and the susceptibility of the patient.

g. Lower respiratory tract infections affect the breathing tubes (trachea and bronchi) and the lungs. Pneumonia is the most severe and life threatening of all respiratory tract infections. Bacteria such as *Staphylococcus aureus (Staph. aureus)* are well known for 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.

h. Endogenous infection from the patient occurs when bacteria present in the normal flora cause infection because of transmission to sites outside the natural habitat (urinary tract), damage to tissue (wound) or inappropriate antibiotic therapy that allows overgrowth (*C. difficile*).

i. Exogenous cross-infection occurs from another patient or hospital staff. Bacteria are transmitted between patients. Five possible route for contaminations are reported in the papers.

2. The study shows that several types of microorganisms are 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.

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