Hospital infection Control

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Abstract- Previous different studies in India reported that**,** transmission of infection to patients occurs through two general routes, airborne and contact. Air is a major source of infection because air within the hospital may act as a reservoir of pathogenic microorganisms. The present study was carried out to determine the degree of "Hospital Infection Control" in different locations of Indraprastha Apollo Hospital New Delhi including OT, IPD, CSSD, MICU, NICU, Kitchen, using different clinical specimens mainly Air sample, Environmental swabs and Hands swabs, from Jan 09 to Jun 09.

Index Terms- WHO: World Health Organisation, HAI: Hospital Acquired Infection, OT: Operation Theatre, CDC: Centre for Diseases Control

I. INTRODUCTION

Hospital infection is defined as "an infection occurring in a patient in a hospital or other health care facility in whom the infection was not present or incubating at the time of admission". The infection is completely asymptomatic as well as appearing after discharge and also occupational infections among staff of the facility. If the exact status of the patient is not clearly known of his first visit in a medical unit, a period of 48 hours (or superior to the incubation period if it is known) is considered to separate Hospital Acquired Infection (HAI) are typically exogenous, the source could be any part of the Hospital ecosystem, including people, objects, food, water and air in the Hospital.

II. MATERIALS AND METHODS

Sample Size:

Amongst 671 (Air Sample 161, Environmental Swabs 363, Hand swabs 147)Samples used in this study were collected from different locations of Indraprastha Apollo Hospital New Delhi including OT, IPD, CSSD, MICU, NICU, Kitchen, using different clinical specimens mainly Air sample, Environmental swabs and Hands swabs, over the period of Jan 09 to Jun 09.

Sample collection

Sterile swabs were collected from each location Intensive Care Unit (ICU), Medical Intensive Care Unit (MICU), Operation Theatres (OT), Neonatal Intensive Care Unit (NICU), Central Sterile Supply Department (CSSD) on the dependent of accessibility, physical inspection of equipment and staff concerns about specific aspects of cleaning. curtains, water taps, door handle, mobile phone, chair, bed, cardiac monitor, cardiac table, O_2 humidifier, suction bottle, cupboard , infusion pump, Intra vesicular stand, stethoscope, radiant warmer, intra vesicular cannulation tray , ventilator, refrigerator, thermometer, syringe, pump, anaesthesia trolley, iodine solution and chlorohexidine solution and the 90 mm of diameter sterile nutrient agar plate were used.

Isolation of Microorganisms –

Swabs were taken from Hands and different items, and the bottom of the plates was marked with the date, time and the name of the sample to be inoculated. . Swab samples were inoculated on plate of Nutrient agar & MacConkey agar. All the plates were incubated overnight to 48 hr at 37°C. For air samples, 90 mm of diameter Nutrient agar plates were used. The plates were put on the table, floor and corridor. The lids from the culture plates were removed and allowed them to sit uncovered for 45 minutes, then after replacing the lid incubated at 37°C for 24 hours to 48 hours.

Morphological observation of microorganisms-

Examine the overnight incubated plates and count the total number of organisms per plate and determine the number of different organisms based on characteristics of colony like colour size, shape, margin or edge.

Microscopic Observation of Microorganisms

Differentiating bacterial species into two large groups Gram-positive and Gram-negative, by Gram staining and examine under oil immersion using Microscope.

Identification of Microorganisms-

The biochemical tests used for the identification of Gram negative bacteria was as follows:- TSI Test - The Triple Sugar Iron (TSI) test was performed to test the ability of microorganisms those were able to ferment sugars and to produce hydrogen sulfide. It has been often used in the selective identification of enteric bacteria including but not limited to Salmonella and Shigella.

Urease test- The Urease test determined the ability of an organism to split urea, through the production of the enzyme Urease. Two units of ammonia were formed with resulting alkalinity in the presence of the enzyme and the increased pH was detected by a pH indicator. Christensen's urea contains the pH indicator phenol red which under acid conditions (pH 6.8) was yellow. In alkaline conditions (pH 8.4) the indicator turned the media rose pink.

Citrate test- The citrate test utilized Simmon's citrate media to determine if a bacterium could grow utilizing citrate as its sole carbon and energy source. Simmon's media contained bromthymol blue, a pH indicator with a range of 6.0 to 7.6. Bromthymol blue was yellow at acidic pH's (around 6), and gradually changed to blue at more alkaline pH's (around 7.6). Uninoculated Simmon's citrate agar had a pH of 6.9, so it was an intermediate green colour.

Indol test- The test organism was inoculated into tryptone broth, a rich source of the amino acid tryptophan. Indole positive bacteria such as *Escherichia coli* produced tryptophanase, an enzyme that cleaved tryptophan, producing indole and other products. When Kovac's reagent (p-dimethylaminobenzaldehyde) was added to a broth with indole in it, a dark pink colour developed.

MR-VP test- Methyl red-positive organisms produced high levels of acid during fermentation of dextrose, overcome the phosphate buffer system and producing a red colour upon the addition of the methyl red pH indicator. In the Voges-Proskauer test, the red colour produced by the addition of alpha naphthnol and potassium hydroxide to cultures of certain microbial species was due to the ability of the organisms to produce a neutral end product, acetoin (acetylmethylcarbinol), from the fermentation of dextrose. The acetoin is oxidized in the presence of oxygen and alkali to produce a red colour. This was a positive Voges-Proskauer reaction.

Bacterial identification done on the basis of all above biochemical reactions and in case of gram positive bacteria, *Staphylococcus and Streptococcus* were differentiated on the basis of catalase test and *Staphylococcus aureus* and *Coagulase negative staphylococcus* were differentiated on the basis of coagulase test.

		CONS	*Acinetobacter species*	*P.aeruginosa*	*S.aureus*	*K.aerogenosa*	*E.coli*	Enterobacter *species*	*Citrobacterspecie*
AIR SAMPLE	OT	11.80 %	1.24%						
	IPD	1.24%			0.62%				
	CSSD	1.8%							
	MICU	0.62%							
	NICU	3.10%							
	KITCHEN								
ENVIRONMENTAL SWAB	OT	3.03%		0.55%					
	IPD			0.27%		0.27%			
	CSSD	0.27%							
	MICU	1.65%	0.27%						
	NICU	2.20%	0.82%		0.82%				
	KITCHEN			0.27%	0.27%	0.37%	0.27%	1.10	1.10%
HAND SWAB	OT	3.40%	0.68%		3.40%				
	IPD	2.04%			2.72%	0.68%			
	CSSD								
	MICU	2.04%				0.68%			
	NICU								
	KITCHEN	13.60 %			4.08%	0.68%	1.36%		0.68%

Catalase test- The catalase test was used to detect the presence of catalase enzymes by the decomposition of Hydrogen peroxide to release oxygen and water. Hydrogen peroxide was formed by some bacteria as an oxidative end product of the aerobic breakdown of sugars. If allowed to accumulate it was highly toxic, to bacteria and can result in death. Catalase either decomposed hydrogen peroxide or oxidized secondary substrates, but it has no effect on other peroxides.

Coagulase test. - The free coagulase secreted by *S.aureus* reacts with coagulase reacting factor (CRF) in plasma to forma complex, which was thrombin. This converted fibrinogen to fibrin resulting in clotting of plasma.

Oxidase test –This test used in microbiology to determine if a bacterium produced certain cytochrome c oxidases. It used disks impregnated with a reagent such as *N, N, N′, N′*-tetramethyl-*p*-phenylenediamine (TMPD) or *N, N*-Dimethyl-*p*-phenylenediamine (DMPD), which was also a redox indicator. The reagent was a dark blue to maroon colour when oxidized, and colourless when reduced.

III. Experimental Results

The Hand swabs, Environmental swabs and Air samples were collected between Jan 09 to Jun 09 from different locations of Indraprastha Apollo Hospital. The data are as follows-

1. HAND SWABS- Total 147 hand swabs were collected from different locations, OT (49), IPD (24), CSSD (7), MICU (10), NICU (14) and Kitchen (42). In which 39.45% results positive and 60.54% were negative for growth.

2. Air samples- Total 161 Air samples were collected from different locations OT (119), IPD (4), CSSD (11), MICU (13) and NICU (14). In which 44.0% positive and 56.0% were negative for growth.

3. Environmental swabs

Total 363 Environmental swabs were collected from different locations, OT (134), IPD (36), CSSD (13), MICU (42), NICU (94) and Kitchen (44), of Indraprastha Apollo Hospital, New Delhi In which 30.85% swab items were positive and 69.14 % were negative;

The microorganisms isolated and identified are – *Coagulase negative staphylococcus, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella aerogens, Acinetobacter species, Citrobacter species, Escherichia coli and Enterobacter specie.*

The no. of times organisms isolated were as follows-

S. No	Specimen types	OT	IPD	CSSD	MICU	NICU	KITCHEN
1	Air sample	*CONS(19) Acinetobacterspecies (2)*	*S.aureus (1),CONS (2)*	*CONS (3)*	*CONS (1)*	*CONS (5)*	-
2	Environmental swabs	*CONS(11) P.aeruginosa(2)*	*CONS(9) S.aureus(1),K.aerog inosa(1),Acinetobac ter(1)*	*CONS (1)*	*CONS (6), Acineto-bacter species(1)*	*CONS (8),S.aureus(3), Acinetobacte rspe cies(3)*	*CONS(3), Esch.coli(1), P.aerugin-osa(1),S.aureus(1),K.aer ogenosa(5),Enterobacter species(4),Citrobactersp ecies(4).*
3	Hand swabs	*CONS(5), S.aureus(5),Acineto bacter species(1)*	*S.aureus (4),CONS(3), K.aerogenosa(1)*	-	*CONS (3),K.aerog inosa(1),*	-	*S.aureus (6), CONS (20), Esch.coli (2), K.aerogenos (1),Citrobacter species(1)*

IV. Discussion

In this study, we collected 147 Hand swabs from different staff of Indraprastha Apollo Hospital in which 39% swab samples were positive.In positive cultures 58% were nonpathogenic i.e. Coagulase negative staphylococcus (CONS) and 42% are pathogenic organisms (S.aureus-28%, Klebsiella aerogens-6%, Esch.coli-4%, Citrobacter species 2% and Acinetobacter species 2%) isolated. But the Hand swabs collected from NICU and CSSD, no growth were obtained. The result shows that proper hand hygiene can reduce the rate of nosocomial infection. At the University of Geneva, hospital-wide program promoting hand hygiene helped lower the hospital-acquired infection rate from 17 percent to 10 percent between 1994 and 1998[2,3].

Total 161 Air samples were collected in which 56% samples positive and 44% negative. In positives cultures 91% are non pathogenic Coagulase negative staphylococcus i.e. CONS and 10% pathogenic organisms (S.aureus 3% and Acinetobacter species 6%) are isolated. In one study 344 samples taken from seven different operation theatres were processed and the isolates were *Staph aureus* (16%), *Coagulase negative Staph* (26.7%), *Acinetobacter* spp. (2.03%) and *Klebsiella* spp. (0.3%) [4].

Total 363 Environmental samples were collected in which 30% samples positive and 70% samples are negative. In positive samples 59% are non pathogenic i.e. CONS and 41% pathogenic organisms (Pseudomonas aeruginosa 4% , S. aureus-7% , Klebsiella aerogens 8% ,Acinetobacter species 8% , Citrobacter species 6%, Enterobacter species 6% Escherichia coli 2%), are isolated. But we were not found multidrug resistant organisms like MRSA.

V. Conclusion

In "Developing countries like India understand that hospital-acquired infections are a major cause of death and disability for patients as per study done by WHO. Today over 1.4 million people worldwide are suffering from infections acquired in

hospitals. Global and collective efforts by the health-care community are dearly needed today more than ever to limit the number of hospital acquired infections cases," said Dr. Rosenthal[5].

Figures coming from India are alarming with hospital infections rate at over 25 per cent. Here hospital acquired infections kill more people than any other form of accidental death and In Italy , in the 2000s, about 6.7 % of hospitalized patients were infected· In Switzerland, about 70,000 hospitalized patients are affected by nosocomial infections (between 2 and 14% of hospitalized patients).Nosocomial infections are estimated to more than double the Mortality and Morbidity risks of any admitted patient[7].

Nearly One-third of nosocomial infections can be prevented by a well organized infection Control Program. But only less than 10% are actually prevented[8].

The research team identified more than 120 studies linking infection to the built environment of the hospital. Transmission of infection to patients occurs through two general routes*: airborne and contact*. The research literature shows that the design of the physical environment strongly impacts hospital-acquired infection rates by affecting both airborne and contact transmission routes[9].

The goals of Hospital infection control programs are: Monitoring of hospital-associated infections; Training of staff in prevention and control of HAI; Investigation of outbreaks; Controlling the outbreak by rectification of technical lapses, if any; Monitoring of staff health to prevent staff to patient and patient to staff spread of infection; Advice on isolation procedures and infection control measures; Infection control audit including inspection of waste disposal, laundry and kitchen, and Monitoring and advice on the safe use of antibiotics[10].

Infection control organizations in the hospital:

- Infection Control Committee (ICC)
- Infection Control Team (ICT)
- Infection Control Officer (ICO)
- Infection Control Nurse (ICN)
- Infection Control Manual (ICM)

The prevention of Hospital Acquired Infection (HAI) is a real challenge so specific prevention programs are developed in most of the countries.

Nosocomial infections are a major healthcare problem in Europe, Japan, and the developing world. Many of these infections are linked to the use of indwelling medical devices such as endotracheal tubes, central venous catheters and urinary catheters[11].

The Center for Disease Control and Prevention (CDC) released new guidelines that advise the use of alcohol-based hand rubs to protect patients in health care settings. "Clean hands are the single most important factor in preventing the spread of dangerous germs and antibiotic resistance in health care settings," said Dr. Julie Gerberding, director of the CDC. "More widespread use of these products that improve adherence to recommended hand hygiene practices will promote patient safety and prevent infections."[12].

Infections acquired in hospitals are becoming more virulent and more resistant to the antibiotics typically used to fight them. Data indicate up to 70% of acquired infections are antibiotic resistant[13]. One of the deadliest types of antibiotic-resistant bacteria is methicillin-resistant Staphylococcus aureus, commonly referred to as MRSA. The percentage of Staph infections that are resistant to antibiotics has risen from 22 percent in 1997 to over 60 percent in 2007[14].

The Centers for Disease Control (CDC) estimates that MRSA kills approximately 19,000 people per year. Prevalence of other multidrug-resistant bacteria, or "superbugs", is also increasing, including that of vancomycin-resistant enterococci (VRE) which, in 1997, was found in approximately 15 percent of hospital patients (up from less than 1 percent in 1990). Clostridium difficile (C. diff), another dangerous superbug, is also on the rise; CDC estimates there are 5, 00, 000 cases annually in the U.S., up from 1, 50,000 cases in 2001[15].

24 July 2006, The Journal of Hospital Infection showed that 38% of the research sample of 71 health professionals failed to wash their hands after contact with MRSA patients, while 25% failed to wash their hands after contact with faeces and 38% failed to wash their hands after contact with blood[16].

The hospital environment also harbours methicillin-resistant Staphylococcus aureus (MRSA) but is not generally regarded as a major source of MRSA infection. One study has taken in surgical wards of a London teaching hospital affected by MRSA. In this, MRSA contamination, measured by surface swabbing, taken before and after terminal cleaning that complied with UK national standards, or hydrogen peroxide vapour decontamination. Seventy-four percent of 359 swabs taken before cleaning yielded MRSA, 70% by direct plating. After cleaning, all areas remained contaminated, with 66% of 124 swabs yielding MRSA, 74% by direct plating. In contrast, after exposing six rooms to hydrogen peroxide vapour, only one of 85 (1.2%) swabs yielded MRSA, by enrichment culture only. The hospital environment can become extensively contaminated with MRSA that is not eliminated by standard cleaning methods[17].

Hands are the most common routes for transmission of infections. Efforts to improve hand hygiene involve more than the duration of hand washing-they should address disinfectants used, fingernail cleanliness, jewelry worn, and shirtsleeve length. Several low-cost interventions help minimize the spread of infections; alcohol-based hand rubs are especially effective. Improvement programs should address hand hygiene compliance[18].

At the University of Geneva, hospital-wide program promoting hand hygiene, helped lower the hospital-acquired infection rate from 17 percent to 10 percent between 1994 and 1998[19].

A 2007 study from John Hopkins showed that using simple checklists as reminders about basic hygiene such as hand washing and about proper draping, gloving and masking reduced the central intravenous line infection rate by 66 percent in ICUs[20].

The absolute indications for hand washing with plain soaps and detergents versus hand washing with antimicrobial-containing products are not known because of the lack of well-controlled studies comparing infection rates when such products are used. However In one study, hospital-acquired infections were reduced 25% by hand washing with soap plus antiseptic compared to a control group who washed with soap alone[21].

Comparison of Two Paediatric Wards contaminated with Gastro enteric Viruses over a Winter Season- this study was

taken 27 January 2006 to 17 February 2006,in one ward total 90% results were positive within this period in which 41% of swabbing samples positive for one of the three enteric viruses. During the same period, another ward also had its peak of enteric virus environmental contamination, with 70% of all the positive swabs were detected during this time in which 36% of swabs positive for enteric viruses; however, only. In both wards during this period (76%) of the swabs were positive for Rotavirus[22].

Contamination of the air by fungi at the Transplant Intensive Care Unit (ICU) of the University Hospital in Hradec KrálovÈ was investigated in 2004. Air samples were taken from the patient's breathing zone in the single rooms. The majority of the air samples (64%) from the Transplant ICU were free of fungi and 36% samples were positive in which Only Cladosporium spp., Penicillium spp. and Mucor spp. were found though rarely with the load ranging from 2 to 26 CFUám[23].

Air bacterial isolations from operation theatres in a tertiary care hospital in India- in these study 344 samples taken from seven different operation theatres were processed and the isolates were *Staph aureus* (16%), *Coagulase negative Staph* (26.7%), *Acinetobacter* spp. (2.03%) and *Klebsiella* spp. (0.3%). Term 'contaminants' is used for isolates other than Pathogens[24].

One study in a US teaching hospital, samples taken from rooms and ICU revealed pathogens i.e. *Pseudomonas aeruginosa*, *Stenotrophomonas maltophilia*, *Serratia marcescens*, *Sphingomonas paucimobilis* and *Citrobacter amalonaticus*[25].

Different studies show that in hospitals**,** Transmission of infection to patients occurs through two general routes*: airborne and contact*. Air is a major source of infection Because Air within the hospital may act as a reservoir of pathogenic microorganisms which are transmitted by the patients.

Frequent agents those are found in air are Staphylococcus aureus, Streptococcus pneumoniae, Pseudomonas aeruginosa, Enterobacter, Klebsiella, Escherichia coli and Haemophilus influenzae. Other less frequent agents are enterococci, streptococci other than S. pneumoniae, Serratia marcescens, Citrobacter freundii, Acinetobacter sp. and Xanthoomnas sp.

In this study we find out different species, 90% are non pathogenic Coagulase negative staphylococci i.e. CONS and 10% pathogenic organisms in which S.aureus 3% and Acinetobacter species 6% are isolated. But in another study S. aureus 16% and 2.03% Acinetobacter species were isolated.

Hands are also the major source of transmission of infections between patient to patient and health care workers to patients but basic hygiene such as hand washing, gloving and masking can reduced the nosocomial infections.

The frequent organisms those are found in hands are Staphylococcus aureus, Escherichia coli, Coagulase negative staphylococcus, Klebsiella, Acinetobacter species etc.

The prevention of nosocomial infections requires a systematic, multidisciplinary approach. This is usually achieved under the leadership of an institutional infection-control program. The principle activities of such a program include surveillance, outbreak management, policy development, and expert advice. An optimal program may decrease the incidence of nosocomial infections by 30 to 50 percent.

The final analysis prevention of HAI rests on a proper understanding of aseptic practices and meticulous attention to hygienic principles. Sir Willium Osler's aphorism that '*Soap, water, and commonsense are the best disinfectants'* applies even today in the context of the hospital acquired infection[26].

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