IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Medical Device-Associated Microbiological Infections At A Tertiary Care Teaching Hospital In North India"

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ABSTRACT

Introduction: Health care associated infections (HCAIs) or hospital acquired infections (HAIs) are infections that occur after 48 hours of hospitalization but are neither present nor incubating upon hospital admission. Health care-associated infections (HAIs) have become a global patient safety concern. Device-associated infections (DAIs) like ventilator-associated pneumonia (VAP), central line-associated blood stream infections (CLA-BSIs) and catheter-associated urinary tract infections (CA-UTIs) together account for the majority of these infections.

Aims and objectives-—Medical device-associated candida infections at a tertiary care teaching hospital of U.P. India‖ with an aim to evaluate rate of medical device-associated candida infections.

Materials and methods: This study was conducted in Department of Microbiology, Rama Medical College Hospital & Research Centre Kanpur from January 2018 to December 2018. In this study, the following three commonly encountered medical devices associated infections (MDAI), ventilator-associated pneumonia (VAP), central line associated blood stream infections (CLABSI) and catheter associated urinary tract infection (CA-UTI), as per the definition of CDCs National Nosocomial Infection Surveillance (NNIS) system criteria, were included.

Results: During the study period, a total of 928 patients were exposed to different types of medical devices for a total duration of 3334 days. Out of these, 41 (4.4%) patients developed different types of Medical device associated infection (MDAI). Bacterial infection was noted in 31 (3.3%) patients, where candida spp. were isolated from 10 (1.0%) cases. The overall rate of MDAI in our hospital was 12.2 per 1000 devices days. The overall rates of bacterial and candida MDAI (1000 devices days) were 9.2 and 2.9 respectively.

Conclusion: Systematic surveillance of device-associated infections has facilitated a reduction in the rates of DAIs and an increased compliance to preventive bundles and hand hygiene. Identification of priority areas, focused interventions and prompt information dissemination have aided in this reduction.

Key Words: VAP, CLABSI and CAUTI.

INTRODUCTION

Health care associated infections are infections that occur after 48 hours of hospitalization but are neither present nor incubating upon hospital admission. Various factors like increasing incidence of hospitalization, rapid advancement in medical technology andinjudicious use of antibiotics along with better adaptation of microbes to the hospital environment contribute to exponential increase in HCAIs[1]. Ventilator-associated pneumonia (VAP) is a common problem in intensive care unit (ICU) patients, with various studies reportingrates of 10% to 65% [2,3]. In the recent Canadian VAP study,[4] no bacterial pathogen was identified in 33.3% of enrollment cultures in patients with a clinical suspicion of VAP (CSVAP). Blood stream infections related to central venous catheterization constitute one of the major nosocomial devices associated infections[5,6]. Blood stream infections (BSI) due to *Candida spp*. are becoming an increasingly important cause of morbidity and mortality in hospitalized patients. *Candida spp.* have been shown to be the fourth most common cause of nosocomial BSI in the United States [7]. The three most common causes of nosocomial BSIs are coagulase-negative *staphylococci*, *S. aureus*, and *enterococci* [8]. Previous studies have suggested that possible risk factor for candidemia are antibiotic therapy, chemotherapy and presence of intravascular catheters. Gram-positive cocci are responsible for at least two thirds of the infections followed by Gram-negative bacilli, which are responsible for a higher proportion of catheter related infections (CRIs) in intensive care unit (ICU) than in non-ICU patients[9].

Indwelling catheter use in acute care usually short term, while chronic catheters are most common for residents of long-term care facilities. Clinical and microbiologic considerations may vary for short and long term catheters. Urinary catheter acquired infection is usually manifested as asymptomatic bacteriuria (CA-ASB). The term catheter associated urinary tract infection (CA-UTI) is used to refer to individuals with symptomatic infection [10]. These infections can occur during healthcare delivery for other diseases and even after the discharge of the patients. Additionally, they comprise occupational infections among the medical staff [11]. Invasive devices such as catheters and ventilators employed in modern health care are associated to these infections [12]. Of every hundred hospitalized patients, seven in developed and ten in developing countries can acquire one of the healthcare associated infections[13]. Populations at stake are patients in Intensive Care Units (ICUs), burn units, undergoing organ transplant and neonates. According to Extended Prevalence of Infection in Intensive Care (EPIC II) study, the proportion of infected patient with in the ICU are often as high as 51% [14]. Based on extensive studies in USA and Europe shows that HCAI incidence density ranged from 13.0 to 20.3 episodes per thousand patient-days [15]. The most frequent types of infections include ventilator-associated pneumonia, central line associated bloodstream infections, catheter-associated urinary tract infections and surgical site infections.

MATERIAL & METHODS:

This study was conducted in Department of Microbiology, Rama Medical College Hospital & Research Centre Kanpur from January 2018 to December 2018. 928 Sample were collected, the following three commonly encountered medical devices associated infections (MDAI), ventilator- associated pneumonia (VAP), central line associated blood stream infections (CLABSI) and catheter associated urinary tract infection (CA-UTI), as per the definition of CDCs National Nosocomial Infection Surveillance (NNIS) system criteria, were included.

In case of CA-UTI- urine sample.

Collection Of Sample: Clinical history of the patients comprising of signs and symptoms such as pain in flanks/perineal regions, fever, catheter obstruction if any are obtained from the patients.

- The catheter was clamped for at least half an hour.
- After wearing sterile gloves, the catheter valve port was cleaned with an alcohol impregnated swab and allowed to dry.
- The valve was opened and a small amount of urine was released to flush the valve.
- The valve was opened again and the remaining urine was emptied into a sterile container ensuring the valve did not comeinto direct contact with the container.
- The valve was closed and the port was wiped with an impregnated swab.
- The specimen was labelled and transported immediately to the lab.

If there was any delay sample was refrigerated at 4 C

In case of CLABSI BLOOD SAMPLE:

The CLABSI was suspected when a patient with central venous catheter developed fever or other symptoms of sepsis of unknownorigin.

Collection of peripheral blood sample and processing Blood sample collected under aseptic precautions from the peripheral vein in Brain Heart Infusion broth for qualitative culture were incubated at 37 C.

- For blood from young children was added 1-2 ml of blood into 20 ml of blood culture.
- For blood from adults was added 5-10 ml of blood into 50 ml of blood culture broth.

Subcultures were made on MA, blood agar and SDAS plates after 24, 48 and 7 days and incubated for 24 hrs at 37 C.

Method of Collection of the Catheter Specimen.

Catheter tip collection (Maki *et al.*, 1977; Isenberg, 2007) [189]-

The skin was cleaned with 70% alcohol prior to catheter removal. The catheter was held at the proximal end and carefully removed from the patient with a sterile instrument, taking care to avoid contact with the skin. The distal 5 cm was cut with sterile blade and collected in a sterile tube and transported to the lab as soon as possible.

Catheter tip processing- Extraluminal Maki‘s roll over plate method and endoluminal catheter flush culture was used for processing. It was performed on MacConkey agar and Blood agar.

Extraluminal Maki’s roll over method-

Forceps was dipped in 95% alcohol, flame sterilized and allowed to cool. The catheter tip was transferred from transport container to agar plate using sterile forceps. The catheter tip was rolled back and forth across agar surface using slight pressure at least four times. It was made sure that the catheter tip was having good contact with the surface of the plate. The plates were incubated for at least 72 hrs at 35 C in a CO2 incubator

In Case Of VAP- Sputum, Bronchoalveolar (BAL), Mucus Suction:

VAP was suspected in a patient on mechanical ventilator when there was a development of new fever, cough, and purulentexpectoration, supported by radiological evidence of a new or progressive pulmonary infiltrate and leukocytosis.

Collection of endotracheal aspirates

Endotracheal aspirate (≥1 ml) was collected under aseptic precaution after 48 hours of intubation Whenever patient was suspected to have developed VAP in ICU. The ETA was collected using a 22- inch Ramson‘s 12 F suction catheter with a mucus extractor, which was gently introduced through the endotracheal tube for a distance of approximately 25- 26 cm. Chest vibration or percussion for 10 min was used to increase the retrieved volume (1 mL) in case the patient produced very little secretions. Only 1 ETA sample was collected from each patient and was immediately taken to the laboratory for possessing.

All the samples were subjected to Gram staining and KOH mount as wellKOH MOUNT-
Prepare specimens for microscopy by reducing to thin fragments on a slide and adding a drop of 20% potassium hydroxide dissolved
in 40% aqueous dimethyl Sulphoxide dissolved (KOH/DMSO). This allowed rapid penetration and maceration of the tissue without resort to heating before viewing. Apply a coverslip; after a few minutes. For the further identification we performed germ tube test.

Candida species were identified using HiChrom agar

RESULTs-

During the study period, a total of 928 patients were exposed to different types of medical devices for a total duration of 3334 days. Out of these, 41 (4.4%) patients developed different types of Medical device associated infection (MDAI). Bacterial infection was noted in 31 (3.3%) patients, where candida spp. were isolated from 10 (1.0%) cases. The overall rate of MDAI in our hospital was 12.2 per 1000 devices days. The overall rates of bacterial and candida MDAI (1000 devices days) were 9.2 and
2.9 respectively.

TABLE-1: Number of Patients on Medical Devices and Total Device Days.

number of patients		Total number of device days
On ventilator	=(220)	508
with central line	=(108)	482
with foley,s catheter	=(600)	2344
Total= 928		Total= 3334

TABLE-2: Rate of Medical Devices associated infections.

	No. of positive cases	Rate of MDAI
MDAI	41	12.2
Bacterial infection	31	9.2
Candida infection	10	2.9

Graph -2: Rate of Medical Devices associated infections

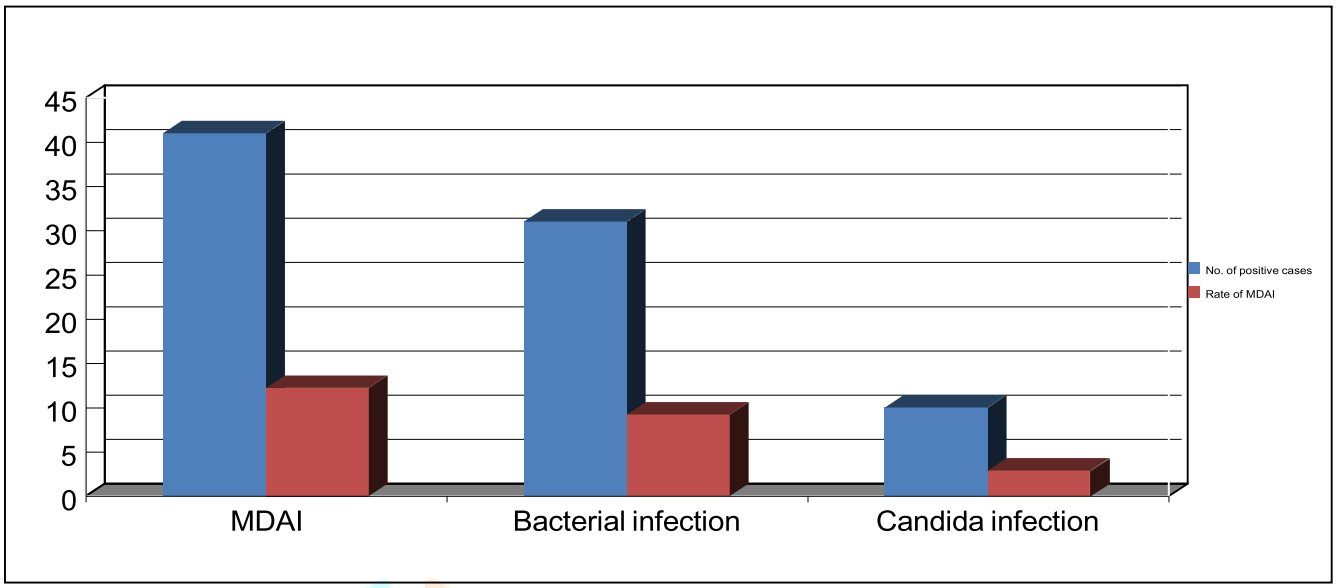

TABLE-3: No. of MDAI Detected

Types of MDAI	Bacterial	Candida	Total
VAP	14	3	17
CLABSI	9	1	10
CAUTI	8	6	14
Total-	31	10	41

Out of 41 cases 31 samples showed bacterial culture growth and 10 samples showed candida culture growth

TABLE-4: Spectrum Of Microorganism Percentage (%) Of Bacterial Spp. Infection (MDAI) % Bacterial spp. isolated (n=31)

Organism	VAP %	CLABSI %	CAUTI %	Total %
E. coli	14.28	44.44	50	32.25
Enterococcus feacalis	0	0	12.5	3.22
Pseudomonas aeruginosa	21.42	11.11	12.5	16.12
Klebsiella pneumoniae	35.71	22.22	25	29.03
MSSA	7.14	11.11	0	6.45
Acinetobacter baumanni	21.42	11.11	0	12.90

Graph-4: Spectrum Of Microorganism Percentage (%) Of Bacterial Spp. Infection (MDAI) % Bacterial spp. isolated (n=31)

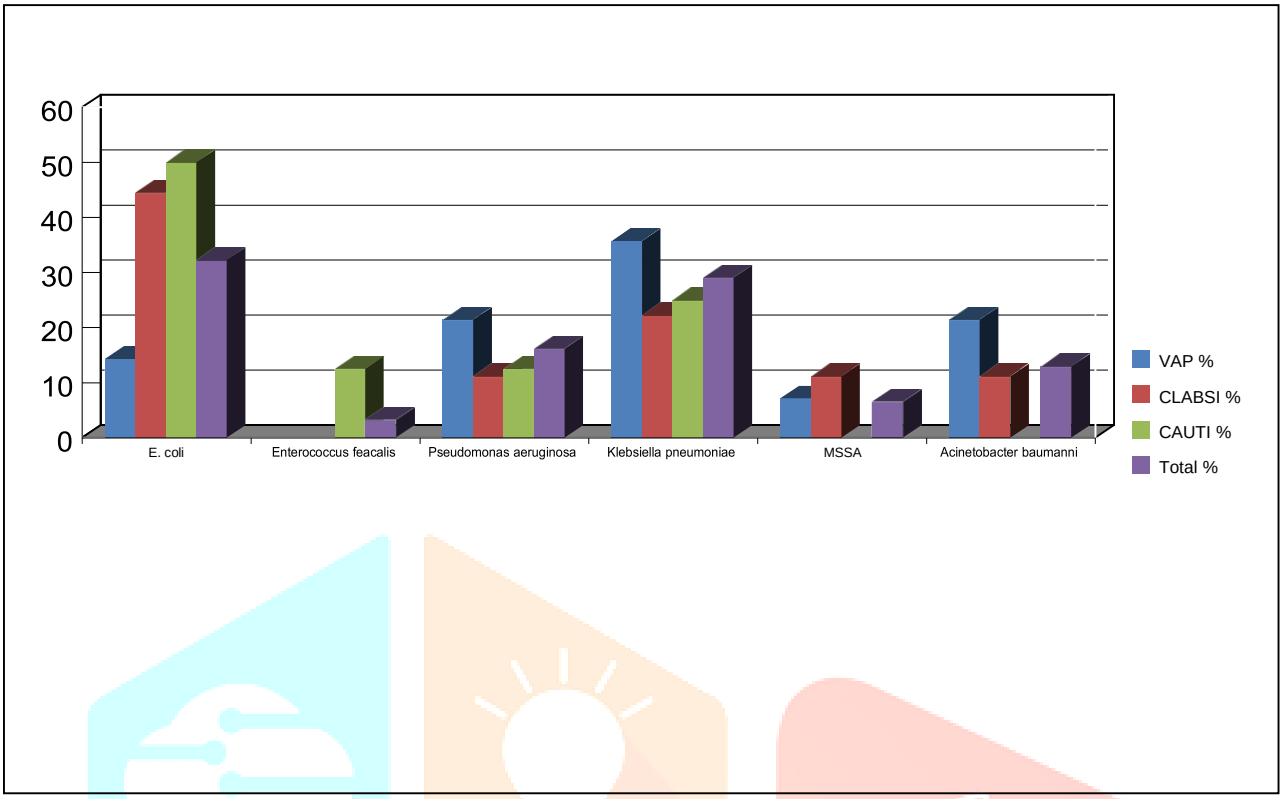

TABLE-5: Spectrum of Candida Spp. Percentage (%) Infection in MDAI Out of total 10 candida spp., maximum isolates were from cases of CAUTI (06 in number) followed by 03 isolates in cases of VAP and 01 isolates in CLABSI. % Candida spp. isolated n=10

Organism	VAP %	CLABSI %	CAUTI %	Total %
C.albicans	0	0	33.33	20
C.tropicalis	33.33	0	33.33	30
C.glabratas	33.33	100	0	20
C.krusei	33.33	0	33.33	30

TABLE-6: Prevalence Rate of Candida Spp. In MDAI.

Devices Name	Candida Spp.	Prevalence Rate %
VAP	3	30
CLABSI	1	10
CAUTI	6	60

TABLE-7: Infection Rate (Per 1000 Device Days).

	Bacterial	(%)	Candida	(%)	Total	(%)
VAP	14	(27.5)	3	(5.9)	17	(33.4)
CLABSI	9	(18.6)	1	(2.0)	10	(20.7)
CAUTI	8	(3.0)	6	(2.5)	14	(5.9)

DISCUSSION-

HCAI are one of the most common adverse, iatrogenic events experienced by hospitalized patients. These infections have occurred since care of patients in hospitals began and health care providers have often been haunted by the maxim: ―the patient initially responded to the treatment but later he died of an infection.‖ In recent years, increasing usage ofindwelling medical devices has led to an increase in HCAIs. In the present study, the overall MDAI rate was found to be

per 1000 device days, which is comparable to the rate reported by P.Mathur et al (13.8 per 1000 device days). The rates of MDAI vary with the category of the hospital and health care unit studied. In the present surveillance, the rate of catheter-associated urinary tract candidiasis per 1000 device days was 2.5 Candiduria is an increasingly prevalent HCAI and is rarely noted as a community acquired infection in a healthy person with structurally normal urinary tract. Approximately about 10–15% of health care associated UTIs are due to *Candida* spp. Presence of indwelling catheter is one of the important risk factors associated with candiduria. Platt et al. reported *Candida* as the causative agent in 27% of all UTI related to indwelling catheters. Candiduria in the presence of other risk factors can predispose to disseminatedinfections.

■ Rate Of MDAI Isolates Infection Rate (Per 1000 Device Days).

			Infection rate isolates per 1000 device days							
S .no	Study	year	VAP	%	CLABSI	%	CAUTI	%	Total	%
1.	P. Mathur et al[19]	2012	264	17.07	88	7.2	275	15.5	13.8	
2.	Deorukhkar et al[18]	2014	04	3.3	09	0.8	80	2.4	2.1	
3.	Present study	2018	17	33.4	10	20.7	14	5.9	12.29	

The rate of MDAI isolates infection rate (per 1000 device days), was in accordance to P.Mathur et al study, and in contrast to Sachin C. Deorukhkar et al.

- Rate Of MDAI Candida Infection Rate (Per 1000 Device Days).

S.no	Study	year	VAP	%	CLABSI	%	CAUTI	%	Total	%
1.	P Mathur et al [19]	2012	2	0.7	19	19.7	156	52.8	177	27.2
2.	Deorukhkar et al[18]	2014	0	0	03	0.1	33	0.3	36	0.2
3.	Present study	2018	3	5.9	1	2.0	6	2.5	10	2.9

The infection rate of candida in the present study, was 2.9 which is in contrast to P.Mathur et al study.

- Common Organism Isolated In VAP

S.NO	STUDY	YEAR	COMMON ISOLATES
1	Ramesh Babu Myneni et al[26]	2016	*Klebsiella, Acinetobacter followed byPseudomonas*
2	Abhishek Singh et al [27]	2018	*Klebsiella, Acinetobacter followed by Pseudomonas*
3	Present Study	2018	*Klebsiella, Acinetobacter followed by Pseudomonas*

In the present study the common isolates were *Klebsiella, Acinetobacter* followed by *Pseudomonas.* The results are in accordance with Ramesh Babu et al and Abhishek et al

- Rate of Central-line associated Bloodstream Infections (CLABSI)

In the present study, the CLABSI rate was 20.7/1000 catheter days and the rate was comparable to Kaur et al (14.59/1000 catheter days), Datta et al (13.86/1000) and in contrast to Chopdekar et al (9.26/1000 catheter days).

Our study showed that patients in the age group of 51-60 years and it is in accordance with C. Bhavana et al andcomparable with Deepti et al

- Common Organism Isolated In CLABSI.

S.no	Study	year	Common isolates
1.	K. chodekar et al [33]	2011	*Pseudomonas aeruginosa, Enterococcus faecalis, Klebsiella pneumoniae, E.coli, MSSA, Acinetobacter baumanni*
2.	M. kaur [34]	2015	*Acinetobacter baumanni, Enterococcus faecalis, Pseudomonas aeruginosa, E.coli, Klebsiella pneumoniae,*
3.	Present study	2018	*E.coli, Klebsiella pneumoniae, Pseudomonas aeruginosa, MSSA, Acinetobacter baumanni*

In the present study, common organism isolated was comparable to K. Chodekar et.al and contrasting to M. kaur et.al

- Rate Of CAUTI Cases Studied.

Sr.No	Study	Year	No. of CAUTI cases	Total no. of catheter days	CAUTI rate
1	Priya Datta et al[35]	2014	73(679)	8083	9.08
2	Mukhitkazi et al[36]	2015	34(1380)	11655	4.59
3	Hanumantha et al l [37]	2016	19(640)	5199	3.65
4	Present Study	2018	14(600)	2344	5.97

In the present study, the CAUTI rate was 5.97 per 1000 catheter days and the rate was comparable to Muhammad Mukhitkazi et al(4.59 per 1000 catheter days) and Sreedevi Hanumantha et al(3.65 per 1000 catheter days) in contrastto Priya Datta et al (9.08 per 1000 catheter days.

- Isolates Of CAUTI Cases Studied.

Sr. No	Study	Year	No. of isolates
1	Priya Datta et al [35]	2014	73(10.75%)
2	Muhammad Mukhit kazi et al [36]	2015	34(2.46%)
3	Karkee Prahamsa et al [38]	2017	17(12.5%)
4	Sreedevi Hanumantha et al [37]	2016	19(42.2%)
5	Present Study	2018	14(33.3%)

The no. of isolates obtained in the present study was 14(33.3%) and is comparable to Sreedevi Hanumantha et al and contrasting to Muhammad Mukhit kazi et al, Priya Datta et al and Karkee Prahamsa et al.

- Correlation of CAUTI Bacterial Spp. in Other Studies.

Common bacteria isolates are depicted in this table, the common isolates obtained in the present study are comparable to Muhammad Mukhit kazi et al, Karkee Prahamsa et al, Priya Datta et al and contrasting to Sreedevi Hanumantha et al, who isolated *Citrobacter* species as the commonest isolate.

■ Common Candida Spp. Isolated In Different MDAI Cases.

S.no	Study	Year	Common candida spp.		
			VAP	CLABSI	CAUTI
1.	Sachin C. Deorukhkar et$_{al}$ 18	2014	*C.albicans* *C.tropicalis* *C.glabrata* *C.krusei*	*C.albican* *C.tropicalis* *C. parapsilosis*	*C.tropicalis C.albican* *C.glabrata C.krusei* *C. parapsilosis*
2.	Present study	2018	*C.tropicalis* *C.glabrata* *C.krusei*	*C.glabrata*	*C.albican C.tropicalis* *C.krusei*

Common Candida species isolated in cases of VAP and CAUTI almost similar as reported by Sachin et al. In contrast, in cases of CLABSI, *Candida glabrata* was isolated.

CONCLUSION-

Device associated HAIs are a threat to patient safety particularly those patients who are admitted into an intensive care unit. Additional attention should be given to each ICU relating to the types of organisms identified, and each type of device associated infection. The majority of gram-positive bacteria identified in this study as the cause of CLABSI should be examined for proper skin preparation along with care bundles. Ventilator Associated Pneumonia is one of the most encountered hospital-acquired infections in ICU and is associated with significant morbidity, longer hospital stays and high cost of care. Prolonged mechanical ventilation is an important risk factor.

The link between CAUTIs and gram-negative bacteria should be examined further. There should be standardized evidence-based practices followed for all the ICUs. Surveillance monitoring with educational sessions should be considered to help provide better opportunity to make the necessary changes in healthcare practices for device insertion and maintenance. The goal should be to achieve a reduction in device-associated HAIs.

Systematic surveillance of device-associated infections has facilitated a reduction in the rates of DAIs and an increased compliance to preventive bundles and hand hygiene. Identification of priority areas, focused interventions and prompt information dissemination have aided in this reduction.

References:-

1. S. C. Deorukhkar, S. Mathew, et.al. Non-albicans Candida infection: an emerging threat, Interdisciplinary Perspectives on Infectious Diseases, 2014; 615958:7

2. P. Eggimann and D. Pittet, Infection control in the ICU‖ Chest, 2001; 6:2059–2093.

3. WHO Guidelines on Hand Hygiene in Health Care. First Global Patient Safety Challenge. ―Clean Care is Safer Care. WHO Hand Hygiene‖. Indian Journal of Medical Microbiology, 2015; 33(1): 51-62.

4. McFee RB. Nosocomial or Hospital acquired infections: An overview‖ Dis Mon 2009; 55:422-38.

5. Rosenthal VD, et al. Device-associated nosocomial infections in 55 intensive care units of 8 developing countries‖. Ann Intern Med 2006; 145:582-91.

6. Kanji SS, Kanafani ZA, et al. International Nosocomial Infection Control Consortium findings of device- associated infection rates in an intensive care unit of a Lebanese University hospital‖. J Glob Infect Dis 2012; 4:15-21.

7. Behera B, et al. High prevalence of carbapenem resistant Pseudomonas aeruginosa at a tertiary care centre of north India. Are we under- reporting?‖ Indian J Med Res 2008; 128:324-5.

8. Cook DJ, Kollef MH. Risk factors for ICU-acquired pneumonia‖ JAMA 1998; 279:1605-6.

9. Kerver AJ, et al. Colonization and infection in surgical intensive care patients – a prospective study‖. Intensive Care Med 1987; 13:347-51.

10. Heyland DK, et al. A randomized trial of diagnostic techniques for ventilator-associated pneumonia‖ N Engl J Med 2006; 355:2619-30

11. Schnabel RM, et al. Candida pneumonia in intensive care unit?‖ Open Forum Infect Dis. 2014; 1(1):26

12. el-Ebiary M, Torres A, et al. Significance of the isolation of Candida species from respiratory samples in critically ill, non-neutropenic patients. An immediate postmortem histologic study‖ Am J Respir Crit Care Med. 1997; 156:583

13. Azoulay E, et al. Candida colonization ofthe respiratory tract and subsequent pseudomonas ventilator-associated pneumonia‖ Chest. 2006; 129(1)

14. Hamet M, et al. Candida spp. airway colonization could promote antibiotic-resistant bacteria selection in patients with suspected ventilator-associated pneumonia‖ Intensive Care Med. 2012; 38(8): 1272.

15. McAlester G, et al. Signal-mediated interactions between Pseudomonas aeruginosa and Candida albicans‖ J Med Microbiol. 2008; 57(5): 563

16. Bianchi SM, et al. Impairment of apoptotic cell engulfment by pyocyanin, a toxic metabolite of Pseudomonas aeruginosa‖ Am J Respir Crit Care Med. 2008; 177(1): 35

17. Leon C, Ruiz-Santana S, Saavedra P, et al. Usefulness of the ―Candida score‖ for discriminating between Candida colonization and invasive candidiasis in non-neutropenic critically ill patients: A prospective multicenter study‖ Crit Care Med 2009; 37:1624-33.

18. Pittet D, Monod M, et al. Candida colonization and subsequent infections in critically ill surgical patients‖. Ann Surg1994; 220:751-8.

19. Rao S, Alladi A, Das K, Cruz AJ. Medium and long term central venous access in children‖ Indian Pediatr 2003; 40:41-4

20. Salzman MB, Rubin LG Intravenous catheter related infections‖ Adv Pediatr Infect Dis 1995; 10:337-68.

21. S Shivaprakasha, et al.CANDIDA SPP. OTHER THAN CANDIDA ALBICANS: A MAJOR CAUSE OF FUNGAEMIA IN A TERTIARY CARE CENTRE. Indian Journal of Medical Microbiology, (2007) 25(4): 405-7

22. Adolf W. Karchmer: Nosocomial Bloodstream Infections: Organisms, Risk Factors, and Implications. Division of Infectious Diseases, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts, CID 2000; 31(4)

23. Blumberg HM, et al. Risk factors for candidal bloodstream infections in surgical intensive care unit patients: TheNEMIS prospective multicenter study. Clinical Infect Dis 2001; 33:177-86.

24. Eggimann P, Overview of catheter related infections with special emphasis on prevention based on educationalprograms.. Clinical Microbiology Infect 2002; 8:295.309.

25. Pittet O, et al. Candida colonization and subsequent infection in critically ill day surgical patients. Ann Surg 1994; 220:751-8

26. Seeling MS,et.al. The role of antibiotics in the pathogenesis of candida infection. Am J Med 1996; 40:887-97

27. Merle V, et.al. Nosocomial urinary tract infections in urologic patients: assessment of a prospective surveillanceprogram including 10,000 patients. Eur Urol 2002; 41: 483-489

28. Turck M,et.al. Nosocomial infection of the urinary tract. Am J Med 1981; 70: 651-654

29. Graves N, et al. Factors associated with health care-acquired urinary tract infection. Am J Infect Control 2007; 35: 387-392.

30. Derya Keten1, et al. Catheter-associated urinary tract infections in intensive care units at a university hospital in TurkeyBosn. J Basic Med Sci. 2014; 14(4):227-233.

31. Hooton TM, Bradley SF, et al. Diagnosis, prevention and treatment of catheter-associated urinary tract infection in adults; 2009 international clinical practice guidelines from the Infectious Diseases Society of America. Clinical Infect Dis2010, 50:625.663.

32. Gubbins PO, et al. Candida urinary tract infections: a comprehensive review of their diagnosis and management. Pharmacotherapy.1993; 13:110-27

33. Tumbarello M, et al. Biofilm] production by Candida species and inadequate antifungal therapy as predictors of mortality for patients with candidemia. J.Clin.Microbiol.2007; 45(6):1843- 50.

34. Rex JH, et al. Resistance of Candida species to fluconazole. Antimicrob Agents Chemother. 1995; 39:1-8

35. Piscitelli SC, Danziger LH. Candida urinary tract infections: A comprehensive review of their diagnosis and management.. Pharmacotherapy1993; 3:110-27.

36. Pfaller M, Wenzel R. Impact of the changing epidemiology of fungal infections.. Eur J Clin Microbiol Infect Dis 1990; 187:19-26.

37. Achermann, Y., Vogt, M., Leunig, M., WuN st, J. & Trampuz, A. \Improved diagnosis of periprosthetic joint infection by multiplex PCR of sonication fluid from removed implants.. Journal of Clinical Microbiology.2010; 48:1208.1214.

38. Centers for Disease Control. National Healthcare Safety Network Surveillance (NHSN) Patient Safety Component Manual.. Available from: [Last accessed on 2018 Jan 19].