# Title : "Laboratory-based surveillance of health care associated infections in a tertiary care hospital of Chhattisgarh, India."

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**Background**: Healthcare-associated infections (HCAIs) are one of the worst events that can occur to a hospital admitted patient. HCAIs can cause increase in economic burden to patient and patient load to hospital. **Objectives:** The objective of this study was to generate HCAI rate based on laboratory data and to identify the common pathogens associated with nosocomial infections prevalent in various Intensive Care Units (ICUs) and surgical wards.

**Method:** This is a laboratory-based targeted surveillance conducted from 1st June 2019 to 30th September 2019. The study included all the patients admitted in the ICUs, surgical wards and burn ward within the study period and had positive culture result of their clinical

specimen. **Results:** The incidence of nosocomial infection in ICUs and wards was 21.49%. It was observed that people are more prone to acquiring infection if the duration of stay in ICU is ≥ 7 days. Most common isolated organism was *K. pneumoniae* followed by *P. aeruginosa, A. baumannii* and *E. coli* making more than 70% isolates. **Conclusions:** The mean HAI rate was 21.49%, implicates massive failure in preventing these infections by the health care workers**.** All parties involved must make a conscious effort to implement hospital Infection Prevention & control practices. Use of devices such as urinary catheter and peripheral/central iv lines should be minimized and used judiciously. Duration of device days should be reduced as much as possible.

**Key words**: Healthcare-associated infections, nosocomial infections, surveillance, Infection Prevention and Control

## INTRODUCTION

Healthcare-associated infections (HCAIs) are one of the most common adverse events in patient care and account for substantial morbidity and mortality. It increases the length of hospital stay and also the cost associated with the hospital stay**.**(1) As per World health organisation (WHO) estimation, about 1.4 million people globally are affected by infection acquitted in a health care setting at any given time.(2) According to the World Health Organization, at any time, up to 7% of patients in developed and 10% in developing countries acquire at least one HAI. "Hospitals are intended to cure the sick but they are also source of infection. Ironically, advances in medicine are partially, responsible for the fact that today, hospital infection are being leading cause of death in developing countries says World Health Report. A high proportion of these infections occur in high-risk areas like ICUs and burn ward. Worldwide at least 1 in 4 patients in ICU acquire an infection during their stay in hospitals. In developing countries their estimation may be double.(3) ICU patients are prone to infection due to the reduced host defence mechanisms caused by the severity of illness, underlying diseases, presence of multiple invasive devices resulting in disruption of anatomical and immunological protective barriers, and administration of various drugs. On the other hand, due to heavy workload and low staffing levels, healthcare personnel working in ICUs have low compliance with hand hygiene and other basic infection prevention and control (IPC) measures, resulting in cross-infection of microorganisms from patient to patient.(4) The increased incidence of HAIs is indicator of overall poor functioning of hospitals. Many studies indicate that up to 10% – 70% of HCAIs can be prevented by implementation of appropriate infection control protocols. Most studies support the

observations that at least 1/3rd of HCAIs can be prevented in hospitals by surveillance and implementation of evidence-based guidelines for prevention of infections.(5)(6) Failure to comply with hand hygiene is considered as the leading cause of health care associated infection, contributes to the spread of multi resistance organism, and is recognized as a significant contributor to outbreaks of infections. Improved hand hygiene practice is temporally related to the decrease frequency of health care associated infections and spread of multi resistance organism. In addition, reinforcement of hand hygiene practice helps in control epidemics in health care infection.

**Objectives:** Our study was aimed to find out the HCAI rate, and to identify the common causative organisms associated with HCAIs.

## MATERIALS AND METHODS

1) **Design of study**: It was a laboratory based targeted HCAI surveillance. The microbiologists retrospectively visited the ward with the positive culture report to correlate with the clinical data and history. HCAI rate is generated by laboratory based targeted surveillance of specific site/ device associated infections -e.g. – Catheter Associated Urinary Tract Infections (CAUTI), Ventillator Associated Pneumonia (VAP), Central Line Associated Blood Stream Infections (CLABSI) and Surgical Site Infections (SSI).

2) **Place of study**: The study was conducted in the Department of Microbiology, Late Shri Lakhiram Agrawal Memorial Government Medical & Hospital, Raigarh, Chhattisgarh.

**Duration of Study - 1st June 2019 to 30$^{th}$ September 2019**

**Ethical Clearance :** Ethical clearance was obtained from the Institutional ethics committee before starting the data collection (vide S.No./27/IEC/GMC/2019 dated 27/04/2019)

**Inclusion criterion:**

- All the patients who were admitted in the ICUs & Burn ward of the hospital for a period of 48 hours or more and up to 3 days after being discharged or within 30 days of a surgical procedure are considered as population at risk.
- The ‘at risk’ patients who showed the following clinical symptoms are included in the study:

**Table 1: Diagnosing criteria for nosocomial infections.**(7)

| HCAIs | Clinical features | Laboratory findings |
|---|---|---|
| **CAUTI (Catheter Associated Urinary Tract Infection)** | 1. Fever<br>2.Lower abdominal pain<br>3.Change in urine characteristics | 1. Leucocytosis<br>2. Positive urine culture (105 CFU of a single organism per ml of urine) |
| **VAP (Ventilator Associated Pneumonia)** | 1. Fever<br>2. Pleuritic chest pain<br>3. Decreased intensity of breath sound<br>4. Presence or increase in rales. | 1. Leucocytosis<br>2. Chest X rays Showing infiltration<br>3. Positive culture of respiratory sample |
| **CLABSI (Central Line Associated Bloodstream Infection)** | 1. Unexplained fever with chills and rigor pain<br>2.Tenderness or purulent discharge at the site of insertion of intravenous (IV) access or CVP catheter | 1. Leucocytosis<br>2. Positive blood culture<br>3. Positive IV tip or CVP catheter culture (after removing the device) |
| **SSI (Surgical Site Infection)** | 1. Fever<br>2. Pain or tenderness<br>3. Localised swelling, redness and warmth<br>4. Discharge from the site of incision or at the site of surgical drain | 1. Leucocytosis<br>2. Positive pus swab culture |

**Exclusion Criteria:**

- Those who were admitted in the hospital with fever or any sign and symptoms of infection or developed fever or sign and symptoms of infection within 48 hours of admission are excluded from the study.

**Sample Collection and Laboratory testing:** Blood, pus, Swab, urine, ET aspirate and tip of IV catheter were collected using guideline mentioned in SOP-ICMR-AMP from patients showing clinical signs of nosocomial infections**.**(7)

1. **Culture:** The collected samples was inoculated in appropriate culture media.
   - Blood agar (BA) plate was incubated at $37^{o}$C.
   - MacConkey agar plate was incubated aerobically at $37^{o}$C.

Inoculated primary plates were incubated for 48 to 72 hours and was discarded as negative after examining once daily for 72 hours.

**Identification of causative organism**

- **Culture:** The colony morphology and cultural characteristics were used to identify the organism.
- **Gram-stained smear**: Gram staining was performed to identify whether the causative organism is gram positive or gram negative.
- **Biochemical reactions** – Biochemical tests were used for identification. Some of commonly used tests were Indole test, Citrate utilization test, Urea hydrolysis test, Triple sugar iron test, Coagulase test and Oxidase test.

**Calculation of HCAI Rates:**

- Infection caused by multiple organisms of similar origin at the same site = single infection.
- In patient with a previously established infection a second nosocomial infection was recorded in two situations-

1. The appearance of clinical infection at a new and different site.
2. The appearance of new and different organism (if re-cultured, on persistence on infection) in patient.

- All the HCAI rates were calculated in per 1000 Hospital Days on Device (1000 HD) except SSI, which was calculated in per 100 surgeries.
- ***For Catheter -associated Urinary Tract Infection, CAUTI rate was calculated as-***

$$\textit{CAUTI rate} = \frac{\textit{Total Number of CAUTI cases}}{\textit{Number of Urinary Catheter Days}} \; x \; 1000$$

- **For Surgical Site infection (SSI), SSI rate was calculated as-**

$$\textbf{SSI rate} = \frac{\textbf{Number of SSI cases}}{\textbf{Number of Surgeries done}} \textbf{x } 100$$

- ***For Central Line Associated Blood Stream Infection, CLABSI rate was calculated as***

$$\textbf{CLABSI rate} = \frac{\textbf{Number Of CLABSI cases}}{\textbf{Number of Central Line days}} \textbf{x } 1000$$

- **For Ventilator Associated Pneumonia, VAP rate was calculated as**

$$\textbf{VAP rate} = \frac{\textbf{Number of VAP cases}}{\textbf{Number of Mechanical Ventillation days}} \textbf{x } 1000$$

- Every day, "Days on Device" were counted to get the Rate.

1. Device days are only assigned if they have been in patients for more than 2 days.
2. If patient gets infection just after insertion of device, then it will not be counted as Device Associated Infection (for example UTI after 1 day on insertion of Urinary Catheter).
3. If device is removed and reinserted on day of device removal or the next day Urinary catheter day count will continue.
4. If device is removed and reinserted thereafter, device days count will be started as new.

**Data entry and Statistical analysis:** The data was entered in Excel sheet and was analysed in SPSS v 20 provided by Public Health Foundation of India (PHFI). For citation Zotero version 6.0.5 was used. Frequency,95% CI were calculated and appropriate tests of association were done wherever needed. A p-value of <0.05 was considered as significant.

## OBSERVATION & RESULTS

In the present study, a total of 156 HCAIs occurred in SICU, MICU, NICU, surgery ward, orthopaedics ward and burn Wards (based on the criteria of Hospital Acquired Infections). The overall mean Incidence rate for all HCAI (VAP, CAUTI, CLABSI, SSI) was found to be 21.49%.

**Table 2: Distribution of Healthcare Associated Infections** (N=161)

| Type of HCAI | Total No. of HCAI | Percentage | 95% CI |
|---|---|---|---|
| **VAP** | 24 | 14.90 % | 0.1023-0.2122 |
| **CAUTI** | 57 | 35.40 % | 0.2844-0.4305 |
| **CLABSI** | 6 | 3.72 % | 0.0172-0.0789 |
| **SSI** | 74 | 45.96 % | 0.3845-0.5367 |
| **Total** | 161 | 100 % | |

**Table. 3: Different HCAI rates**

| HCAIs | HCAI Rate per 1000 Hospital days on Device (HD) |
|---|---|
| **CAUTI** | 38.9/1000 HD |
| **SSI** | 29.13/100 surgeries |
| **VAP** | 51.28/1000 HD |
| **CLABSI** | 37.73/1000 HD |

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Total CAUTI cases were 57, and total hospital days (HD) on urinary catheters were 1464, for a CAUTI rate of 38.9 per 1000 HD.

Total number of admitted patients (on whom surgery was performed and who met the inclusion criteria) was 254 and total SSI was 74, resulting in a SSI rate of 29.13 per 100 surgeries. 24 VAP in total and 468 days spent on a mechanical ventilator in hospitals equals a VAP rate of 51.28 per 1000 HD on device.

The overall number of CLABSI was 6, and there were 159 central line days (when a Central Line was used), bringing the CLABSI rate to 37.73 per 1000 HD.

The mean duration of stay for ICU patients was 14.2 days, with an elevated risk of infection beginning on day 7 and lasting up to 24 days. The risk of infection was shown to increase with longer stays. The first HCAI in patients was discovered on day four of their stay, although day seven and day eight were the most frequent.

Nosocomial infections were linked to chronic diseases; of the 24 VAP patients, 9 had COPD (chronic bronchitis and emphysema), and 1 had type II diabetes. 12 of the 57 CAUTI patients had diabetes mellitus. Three of the six patients with CLABSI had diabetes mellitus, while 16 of the 74 patients with SSI had the DM, along with one patient who had hypothyroidism.

**Table 4: Distribution of Isolated organisms**

| Organism | CAUTI | SSI | VAP | CLABSI | Burn | Total | Percentage | P-value |
|---|---|---|---|---|---|---|---|---|
| *Klebsiella pneumoniae* | 24 | 18 | 12 | - | 18 | 72 | 29.03 | 0.02 |
| *Pseudomonas aeruginosa* | 6 | 25 | 6 | - | 15 | 52 | 20.96 | 0.06 |
| *Acinetobacter baumannii* | 6 | 16 | 12 | - | 3 | 37 | 14.91 | 0.000 |
| *Escherichia coli* | 6 | 15 | 3 | - | 3 | 27 | 10.88 | 0.09 |
| *Enterococcus faecalis* | 15 | - | - | - | 3 | 18 | 7.25 | 0.000 |
| CONS | - | 12 | - | 6 | 9 | 27 | 10.88 | 0.000 |
| *Citrobacter koseri* | - | - | - | - | 6 | 6 | 2.41 | 0.005 |
| Non-Fermenter GNB* | - | - | - | - | 6 | 6 | 2.41 | 0.005 |
| MRSA | - | - | - | - | 3 | 3 | 1.20 | 0.12 |

***Non-Fermenter Gram Negative Bacteria other than Pseudomonas and Acinetobacter.**

## DISCUSSION

The majority of HCAI studies carried out in industrialised nations show the value of surveillance and highlight how much it helps to reduce patient morbidity and mortality. On the other hand, there aren't many research that provide HAI using such uniform definitions in developing nations. This study was conducted to determine the HCAI rate and pathogens mostly associated with HCAI.

In our study the mean incidence of HAI was 21.49% which was more than the study conducted by Suman et al 2016 (18.97 %) and Mythri et al 2014 (17.7%) but less than Dasgupta et al 2015 (11.98%)**.**(8) (9) (10)

In our study, we found that patients who stayed in the ICU for 7 days or more were more likely to develop HCAIs than those who stayed for shorter time. According to a study by Tess et al., patients were more susceptible to infection between the 14th and 19th day of their stay in the intensive care units .(11) According to Hassan et al., HCAI typically takes 9.32 days to occur.(12) While the majority of studies claim that stays longer than 8 days are significant, Singh et al study's claims that stays of 5 days or less are relevant for getting HAI , which is less than our observed value.(13)

It was also inferred from the study that if a patient has any pre-existing chronic illness such as chronic bronchitis, emphysema, diabetes mellitus or hypothyroidism, they have more chances of acquiring HAIs.

Catheter associated urinary tract infections (CAUTIs) are the most common and poses serious health affected problems in hospitalized patients**.**(8) In our study, urinary tract infection was the most common acquired infection accounting for 38.9/1000 HD CAUTI rate. Other studies have also found UTIs to be the most common HAI .(14) The most common bacteria causing CAUTIs in hospitalized patients include *E. coli, K. pneumonia, P. aeruginosa, E. faecalis and A. baumannii* **.**(15) *K. pneumonia* was the most common isolated organism from the urine samples in our study. Other studies have shown *E. coli* to be most common isolated organism **[13,20].**(16)(17) High rates of CAUTI are also due to extensive use of indwelling urinary catheter in IPDs. High rate of *K. pneumonia* also suggests long use of same catheter than normal prescribed days.

Surgical site infection was the second most common infection resulting in 29.13/100 surgeries. In other studies, the incidence of SSI ranged from 3-31% .(8)(18) In India, the incidence of SSI varied from 2-26% **.**(17) *A baumannii, K. pneumonia, E. coli, P. Aeruginosa* and CoNS were common isolated organisms. Similar microbial profile was observed by Ramasubramaniam et al in his meta-analysis **.**(17)

VAP rate is 51.28/1000 HD in our study. Previous studies have shown VAP to be the most common HAI . (11)(18)(19) But the high VAP rate in our study is due to high number of referrals of ventilated patients to higher centre. So, the hospital days on ventilator

(Denominator) were less in case of VAP rate. The common organisms isolated from respiratory samples in our study were *K. pneumonia, P. aeruginosa, A. baumanni, E. coli.* Similar microbiological profile was observed in study by Mehndiratta et al.(19)

The CLABSI rate was 37.73/1000 HD in our study. Central line days were also less in our hospital, as most of the critical cases were referred to higher centres. The isolated organisms were CoNS. Similar result was observed by Ghadiri et al where CoNS and E. coli was the most common isolated organism.(20)

The isolated organism from Burn Associated Skin Infection was K. pneumonia, P. aeruginosa, *CoNS, C. koseri, NFGNB, E. coli, A. baumannii, E. faecalis* & MRSA. Most commonly K. pneumonia was isolated. Similar profile was observed in the study by Neelam Taneja et al.(21)

Our study might have missed those cases where the clinical specimens were not sent to the laboratory. Active Surveillance of HCAI by Infection control nurses or passive surveillance by Hospital Infection Control committee are more recommended methods. Prospective Incidence surveys by monitoring patient during their stay in the hospital and prospective data collection by daily visits is the most recommended methods for HCAI surveillance.

## CONCLUSIONS

The mean HAI rate was 21.49% which is at the upper limit of most of the studies previously conducted in other hospitals of developing countries. It implicates massive failure in preventing these infections by the healthcare workers**.** All parties involved must make a conscious effort to keep hospital stays as short as possible. Use of devices such as urinary catheter and peripheral/central iv lines should be minimized. If these must be used, they ought to be stopped as soon as possible.

Our study suggests that Infection prevention & Control Practices in hospitals are need of the hour. If it is implemented and followed, then it is very much possible to decrease the incidence rates of HAI. Proper surveillance system should be developed to control HAIs.

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