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Original Research Article

Speciality specific healthcare-associated infection surveillance over a decade in a tertiary care teaching hospital, South India

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Abstract

Background: Active and robust surveillance of health care associated infections improves the quality of healthcare. Large scale study over a decade provides a more reliable data which serves as a benchmark for intra and inter hospital comparisons.
Materials and Methods: This prospective observational study was conducted over a period of ten years covering 530539 patient days, in a large tertiary care teaching hospital incorporating the NHSN/CDC surveillance guidelines. Device associated infection rates were compared with the device utilization ratio.
Results: The overall CLABSI rate, CAUTI rate and VAE rate were found to be 10.19, 2.51 and 11.39 per 1000 device days respectively. All the device associated infections were high in medicine ICU whereas surgical site infection was higher in surgical ICU. Positive correlation was observed between device associated infections and device utilization ratio.
Conclusion: Active surveillance system is required in every hospital to track the hospital acquired infections on a daily basis which further helps in implementing control measures at the earliest. Speciality specific surveillance system gives a more accurate measure of the hospital acquired infections in that particular location, aiding in bringing about appropriate behavioural changes towards infection control in the targeted location.

Keywords: Hospital acquired infection, Surveillance, Device utilization ratio, Care bundle, Infection control.

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1. Introduction

Health care associated infections are the infections acquired in the hospital premises, often due to multidrug resistant pathogens which add on to prolonged hospital stay, mortality, morbidity and healthcare costs.[1] To prevent this, the actual burden of HAI must be known which is possible only with the implementation of robust surveillance system.[2] In low- and middle-income countries like India, the burden of HAI is higher, and the surveillance system is not strengthened enough because of insufficient human and financial resources.[3]

Traditionally, there are two ways to carry out the HAI surveillance. The self-reporting of suspected HAI by treating physicians, known as passive monitoring, is a very subpar method and ineffective way to monitor HAIs because there's a chance of underreporting and prejudice. Conversely, active surveillance nevertheless, is the methodical gathering of data by a specified impartial surveillance group made up of infection control nurses (ICNs) and infection control officers (ICO). Active surveillance is an unbiased systematic collection of data and is recommended by the Centres for Disease Control and Prevention (CDC) and other surveillance networks.[4]

HAI surveillance is included as a core component of infection prevention and control programmes by the WHO at both the health-care facility and national levels.[5] Therefore, active surveillance of the health care associated infections is a mandate to assess the quality of patient care and implement infection control measures. The four most common HAIs, for

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which surveillance is recommended are—catheter associated urinary tract infection (CAUTI), central line associated bloodstream infection (CLABSI), ventilator associated infection (VAE) and surgical site infection (SSI). The first three in the list are collectively called as device-associated infections.

Although HAI surveillance has been conducted in several facilities in India, there is no single study available in the literature which presents with speciality specific 10 years data. With this background, the study was planned in a large tertiary care teaching hospital to assess the actual burden of the four types of HAIs over a decade. The outcome of this study would serve as a benchmark data for our hospital.

2. Materials and Methods

2.1. Study design

This prospective observational study, was conducted in a 2200 bedded tertiary care government teaching Hospital in South India, over a decade, from 2015–2024. Our study was targeted in 17 Intensive Care Units (ICUs) catering to all surgical and medicine specialties with an overall bed strength of 300. The surveillance was carried out by the eleven infection control nurses (ICNs) posted in hospital infection prevention and control (HICP) unit of the facility, under the supervision of infection control officer.

2.2. Study procedure

Systematic surveillance of HAIs was done by infection control nurses in the targeted intensive care units including burns and transplant units. The methodology followed was as per CDC/NHSN HAI surveillance protocol. Standardised HAI surveillance forms were prepared in accordance with CDC/NHSN guidelines which were used to collect data on surgical site infection and device associated infections. The daily appraisal forms adopted from CDC were used to collect the denominator data which comprises of number of device days such as central line (CL) days, urinary catheter (UC) days and mechanical ventilator (MV) days. The HAI cases identified by the ICNs were reported to the infection control officer and was confirmed with the treating physician.

2.3. Data analysis

The data collected using the standardised HAI surveillance forms were entered in an excel sheet and analysed monthly for HAI rates and device utilization ratio. The monthly data were summed up to get yearly statistics of the HAIs. Cumulative HAI and DU rates for all the ICUs of the hospital were determined over the period from 2015-2024. The DAI rates of the individual ICUs were compared with the corresponding NHSN US HAI rates.

3. Results

The total number of patient days for the entire study period was 530539; maximum patient days were reported from neonatal ICU (218200), followed by adult medical ICU (48660), paediatric ICU medical (38838) and critical care unit (26311).

As depicted in **Table 2**, for all the 17 intensive care locations together, the hospital wide CLABSI rate, CAUTI rate and VAE rate were found to be 10.19 (1684/165206) per 1000 CL days, 2.51 (489/195063) per 1000 UC days, 11.39 (1338/117470) per 1000 MV days respectively. All the device associated infections were found to be high in medical ICU locations with a CLABSI, CAUTI and VAE rate of (13.49 per 1000 CL days), (4.14 per 1000 UC days) and (16.56 per 1000 MV days) respectively. CLABSI rate was low in surgical locations (7.92 per 1000 CL days) whereas, CAUTI (1.42 per 1000 UC days) and VAE rate (3.19 per 1000 MV days) were found to be low in paediatric locations.

Figure 1 illustrates correlation of the location specific surveillance of CLABSI with their central line utilization ratio. The ICUs with highest CLABSI rates per 1000 CL days were found to be— adult medical ICU (15.08), medical oncology ICU (14.89), neonatal ICU (14.77), pediatric surgery ICU (14.31), critical care ICU (13.25), and adult surgery ICU (10.91) where the central line utilization ratio was also correspondingly higher. Kidney transplant unit (1.33) and Pediatric ICU medical (4.34) reported the lowest CLABSI rate per 1000 CL days. The central line utilization ratio showed an overall positive agreement with the CLABSI rates of the corresponding ICUs ($P = 0.18$), except for kidney transplant unit, neonatal ICU and paediatric surgery ICU.

The location specific surveillance of CAUTI is depicted in **Figure 2**. In decreasing order of frequency, adult medical ICU (4.96), neuro medicine ICU (4.42), bone marrow transplant unit (4.41) and kidney transplant unit (4.16) reported the maximum CAUTI rates per 1000 UC days. Surgical oncology ICU (0.47), plastic surgery ICU (0.5), and cardiothoracic ICU (0.73) reported the lowest CAUTI rate per 1000 UC days. The Urinary catheter utilization ratio showed an overall positive agreement with the CAUTI rates of the corresponding ICUs ($P = 0.71$), except for kidney transplant unit, bone marrow transplant unit and neonatal ICU.

Figure 3 represents the location specific surveillance of VAE. The surgical ICU (21.01) reported the maximum VAE rate per 1000 MV days, followed by adult medical ICU (17.66), trauma care ICU (14.5) and critical care units (13.97). Urology ICU did not report any VAE cases. Other ICUs found with low VAE rates were burns, medical and surgical oncology ICUs, plastic surgery ICU, and pediatric ICU (medical). The mechanical ventilator utilization ratio showed an overall positive agreement with the VAE rates of the corresponding ICUs ($P = 0.31$).

Table 1: Formulae of HAI rates and device utilization (DU) ratio

Rates /ratio	Formulae
VAE rate	Number of VAE cases/total number of ventilator days×1000
CLABSI rate	Number of CLABSI cases/total number of central line days×1000
CAUTI rate	Number of CAUTI cases/total number of catheter days×1000
DAI rate (device-associated infection rate)	Number of DAI cases (sum of VAE, CLABSI and CAUTI cases)/total number of device days (sum of ventilator, central line and catheter days) ×1000
SSI rate	Number of SSI/number of surgeries done×100
DU ratio	Number of device days/number of patient days
Ventilator utilization ratio	Number of ventilator days /total number of patient days
Central line utilization ratio	Number of central line days /total number of patient days
Urinary catheter utilization ratio	Number of catheter days /total number patient days

VAE: Ventilator-associated event; CLABSI: Central line-associated blood stream infection; CAUTI: Catheter-associated urinary tract infection; SSI, Surgical site infection; DU: Device utilization, DAI: Device-associated infection

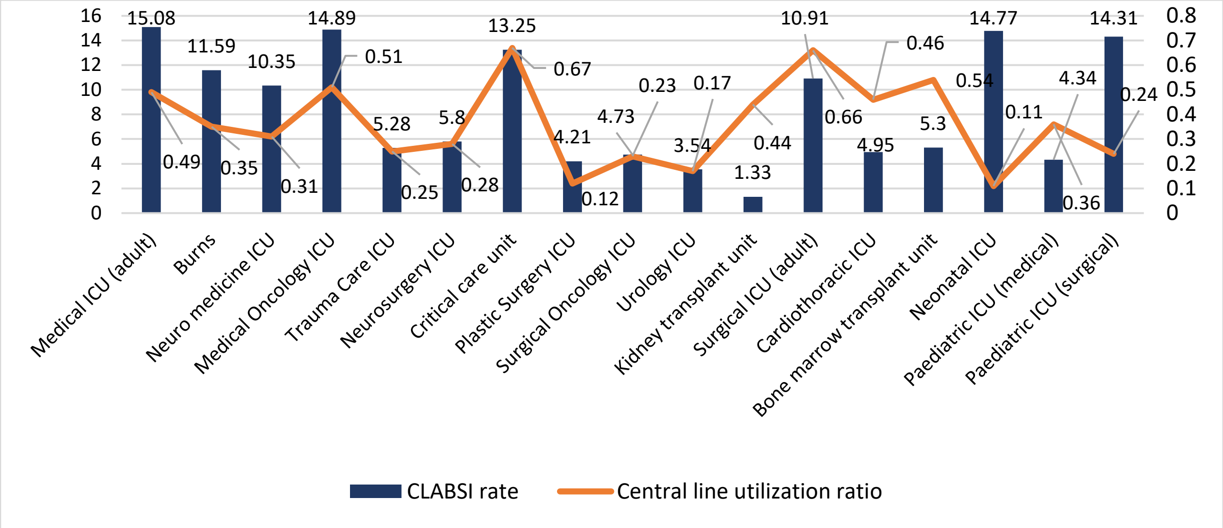

Figure 1: Location specific surveillance of central line associated blood stream infections (CLABSI), 2015-2024

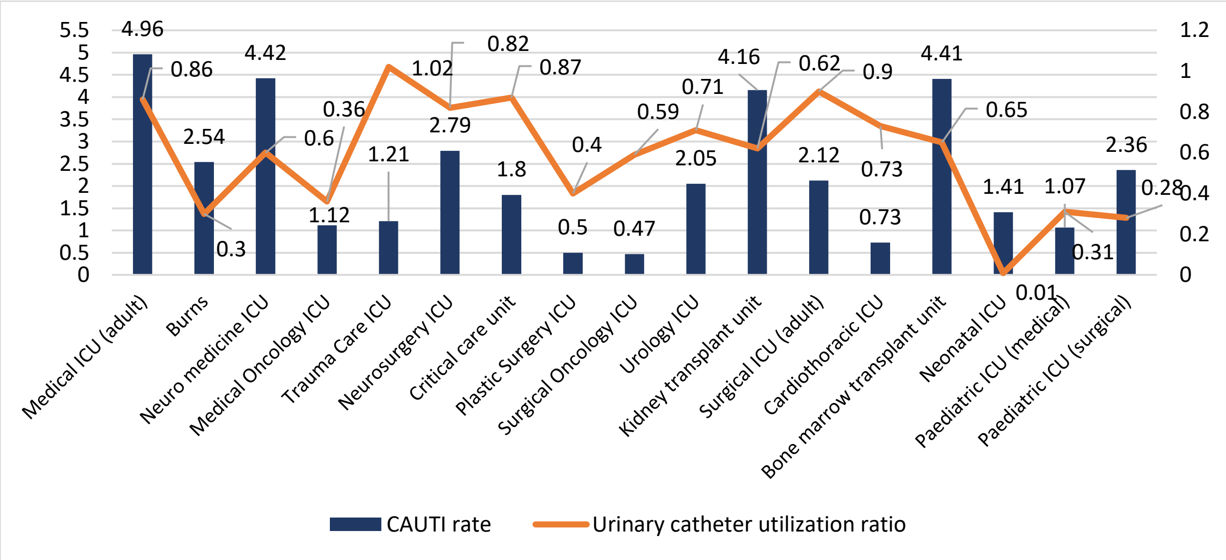

Figure 2: Location specific surveillance of catheter associated urinary tract infections, 2015-2024

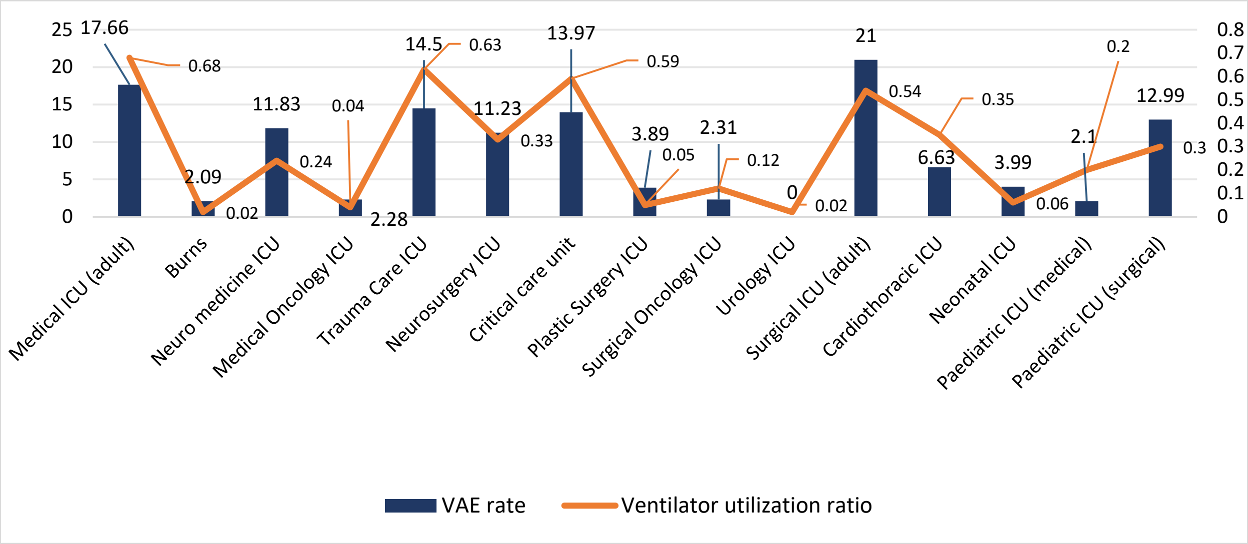

Figure 3: Location specific surveillance of ventilator-associated events, 2015-2024

Table 2: Surveillance of device-associated infections (2015-2024)

Location	**CLABSI rate/ 1000 CL days**	**Central line utilization ratio**	**CAUTI rate/ 1000 UC days**	**Urinary catheter utilization ratio**	**VAE rate/ 1000 MV days**	**Ventilator utilization ratio**
Medical locations	13.49 (574/42555)	0.38 (42555/112480)	4.14 (277/66966)	0.60 (66966/112480)	16.56 (632/38169)	0.34 (38169/112480)
Surgical locations	7.92 (643/81209)	0.56 (81209/144350)	1.69 (186/109820)	0.76 (109820/144350)	13.01 (600/46107)	0.32 (46107/144350)
Paediatric locations	11.27 (467/41442)	0.15 (41442/273709)	1.42 (26/18277)	0.07 (18277/273709)	3.19 (106/33194)	0.12 (33194/273709)
Total	10.19 (1684/165206)	0.31 (165206/530539)	2.51 (489/195063)	0.37 (195063/530539)	11.39 (1338/117470)	0.22 (117470/530539)

CL: Central line; UC: Urinary catheter; MV: Mechanical ventilator

Table 3: Location specific active surveillance for surgical site infections (2015-2024)

ICU	**Number of SSI**	**Number of surgeries done**	**SSI rate (%)**
Trauma Care ICU	26	2821	0.92%
Neurosurgery ICU	53	2133	2.48%
Critical care unit	108	1292	8.36%
Plastic surgery ICU	66	3663	1.80%
Surgical oncology ICU	102	2640	3.86%
Urology ICU	72	4389	1.64%
Kidney transplant unit	16	297	5.39%
Surgical ICU	354	3182	11.13%
Cardiothoracic ICU	75	3418	2.19%
Neonatal ICU	23	310	7.42%
Paediatric ICU (medical)	8	329	2.43%
Paediatric ICU (surgical)	208	2250	9.24%
Total	1111	26724	4.15%

Location specific active surveillance for surgical site infections has been depicted in **Table 3**. Overall, the mean SSI rate of our facility reported for the ten-year period was 4.15% (1,111 SSI cases out of 26,724 surgeries). The ICUs with highest SSI rates were surgical ICU (adult, 11.13%), pediatric ICU (surgical, 9.24%), and critical care unit (8.36%), neonatal ICU (7.42%). Trauma Care ICU reported the lowest SSI rate (0.92%).

4. Discussion

In this study, we report a hospital-wide, unit-specific HAI surveillance system over a decade in a large tertiary care government hospital, South India. The goal was to compile robust baseline data on cumulative HAI rate by ICU to undertake root cause analyses on high-risk ICUs and develop control strategies.

4.1. CLABSI rate

The medical ICUs had reported the highest rate of CLABSI cases, compared to pediatric and surgical locations (**Table 2**). Among all the locations, maximum CLABSI rate was reported from adult medical ICU, medical oncology ICU, neonatal ICU, pediatric surgery ICU, critical care ICU, and adult surgery ICU. The high CLABSI rate in these ICUs (except for NICU) was mainly attributed to poor infection control measures such as poor compliance to hand hygiene and high central line utilization in these locations. Neonatal ICU in our facility reported high CLABSI rate in spite having a good hand hygiene compliance of >80% and low CL utilization ratio, which could be due failure to adhere to other components of care bundle (which may also be an attributing factor for other ICUs with high CLABSI rate) and possible infection source from the labor room. Several studies from India reported similar CLABSI rates ranging from 5.1 to 18.52%.[1,3,6,7]

Adherence to central line care bundle has shown to significantly prevent occurrence of CLABSI.[8,9] Care bundle comprises of three to five evidence-based elements with strong clinician agreement; each of the components must be followed by the caregiver during the insertion or maintenance of the device. The components of care bundle approach for prevention of DAIs have been described in the literature.[10] The components of insertion bundle for centre line include—(i) performing hand hygiene prior to insertion of central line, (ii) use maximum sterile barrier precaution: gloves, gown, drapes, cap, and mask; (iii) selection of subclavian vein over femoral vein for CL insertion, (iv) use of chlorhexidine for skin preparation, (v) use of semipermeable dressing. The components of maintenance bundle for centre line include hand hygiene and alcohol hub decontamination before handling the central line, daily documentation of local sign of infection and change of dressing with 0.5% chlorhexidine. The repeated reinforcement of the HICP team on these aspects may result in a decrease in the CLABSI rates in the high-risk locations.

4.2. CAUTI rate

The CAUTI rate was found to be highest for medical ICUs, followed by surgical locations, whereas pediatric locations had a low CAUTI rate (**Table 2**). Among all the locations, maximum CAUTI rate was reported from adult medical ICU, neuro medicine ICU, bone marrow transplant unit and kidney transplant unit. The high CAUTI rate in MICU and neuro medicine ICU was mainly attributed to poor hand hygiene, high urinary catheterization and failure to adhere to the components of urinary care bundle. The transplant units (bone marrow and kidney) reported high CAUTI rate in spite having low UC utilization ratio, which could be explained by their poor compliance to the components of urinary care bundle. The mean CAUTI rate (2.51 per 1000 UC days) in our study was found to be significantly lower (p value < 0.05) than the baseline CAUTI rate of India (16.72 per 1000 UC days) reported in a large scale multicentric study conducted by International Nosocomial Infection Control Consortium (INNIC), USA.[11]

Adherence to urinary catheter care bundle has shown to significantly prevent occurrence of CAUTI.[1,12-14] The components of insertion bundle for urinary catheter include—(i) use only when appropriate indication is present, (ii) use of only sterile items for insertion, (iii) insertion by non-touch technique with strict asepsis, (iv) continuous-closed drainage system, (v) use of catheter of appropriate size, and (v) secured after placement (plaster-tube-plaster technique). Maintenance care bundle for urinary catheter include— daily catheter care regularly and by strict aseptic measures (hand hygiene and single use gloves), (ii) catheter must be properly secured all the time, (iii) drainage bag must always be above the floor and below the bladder level, (iv) closed drainage system is present all the time and (v) while collection of urine from bag - hand hygiene and change of gloves between patients; separate jug for each bag, alcohol swabs for outlet to be used. The infection control nurse's constant reassurance on these points could lead to a drop in the rates of CAUTI in these high-risk areas.

4.3. VAE rate

The VAE rate was found to be highest for medical ICUs, followed by surgical locations. In contrast, all the paediatric locations reported a very low VAE rate (**Table 2**). Among all the locations, maximum VAE rate was reported from surgical ICU, adult medical ICU, and trauma care ICU and critical care units. The high VAE rate in these locations was mainly attributed to a high mechanical ventilator utilization ratio and failure to adhere to the components of maintenance care bundle of mechanical ventilator. Several studies from India reported similar VAE rates ranging from 6.4 to 38.1%.[15-17] Adherence to ventilator care bundle has shown to significantly prevent occurrence of VAE.[18-21] The HICP team should repeated reinforce and conduct audit to check the adherence level of the ICU staff to the various components of maintenance care bundle of mechanical ventilator, which include—(i) strict adherence to hand hygiene while handling ventilator and its accessory parts, (ii) elevation of the head of the bed to 30–45°, (iii) daily oral care with chlorhexidine 2% solution, (iv) need of PUD (peptic ulcer disease) prophylaxis to be assessed daily; if needed only sucralfate should be used and (v) DVT (deep vein thrombosis) prophylaxis should be provided if needed.

4.4. SSI rate

The mean SSI rate in our study was 4.15%. The surgical ICU, pediatric ICU, neonatal ICU and critical care unit reported high SSI rate of >7%. Several studies from India reported similar SSI rates ranging from 3 to 12.5%.[22-25] The high SSI rate could be attributed to poor compliance to various components of the surgical care bundle which include —(i) pre-operative measures like preoperative bathing, screening for *Staphylococcus aureus*, hair removal not done or removed by clipper, timely administration of appropriate surgical antimicrobial prophylaxis, and (ii) peri-operative measures like surgical site skin preparation (antiseptics + alcohol), hand scrub before and in-between cases, perioperative maintenance of proper oxygenation of FiO2 (80%), normothermia (36°C), blood glucose (140–200 mg/dL), normovolemia, and (iii) post-operative measures like wound care by use of aseptic non-touch technique for surgical dressing etc. The HICP team's constant reinforcement of these points could bring down the SSI rates in these high-risk areas.

Our study's primary drawback is that it only includes data from one large scale government hospital, so it could not be indicative of the entire healthcare systems in the Indian context, such as hospitals in the private sector or smaller medical facilities. Consequently, the mean HAI rates obtained in our study cannot be compared to HAI rates of other healthcare facilities.

5. Conclusion

To find and track the hospital's HAI rates, we set up an active monitoring system based on unit over last one decade. To find areas that need improvement, such a method would be essential. Regular active surveillance of HAIs helps to detect issue areas much earlier, before they become a serious health risk to patients and the hospital environment. Regretfully, only few sizable teaching hospitals in India—particularly those in the public sector, have a decade-longer established HAI surveillance network. We think that our research will contribute to raising awareness about the need for regular HAI surveillance in all hospitals. Such an endeavour might soon open the door to the creation of a national database for HAI. In order to apply infection control measures in a proactive rather than reactive way, there is an increasing need to set up unit-wise, active surveillance systems to detect and monitor the HAI rates. Adherence of HCWs to the components of care bundle would reduce the occurrence of HAI.

6. Ethical Approval

This study was approved by Institute ethical committee with ref. no. JIP/IEC/2022/127.

7. Source of Funding

None.

8. Conflict of Interest

None.

9. Acknowledgements

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