

Prevention of hospital-acquired infections: A construct during Covid-19 pandemic

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ABSTRACT

Introduction: Hospital-acquired infection (HAI) rates were reported to have declined in healthcare settings during the Covid-19 pandemic. Needless to mention that HAI is of paramount interest and relevance to a primary care physician who need to care from womb to tomb inside pandemic. **Objectives:** This study was conducted to find the impact of Covid-19 pandemic on the four parameters of HAIs, namely, catheter-associated urinary tract infections (CAUTI), central-line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP) and surgical site infections (SSIs) with hand hygiene compliance rates among healthcare workers. **Materials and Methods:** This retrospective data mining was undertaken in a 700 bed multispecialty teaching hospital in the Eastern India which was a Government of Bihar approved speciality Covid Care Hospital. Data from the monthly routine infection control monitoring and surveillance activities was collated from January 2019 to December 2020. Control charts with upper and lower control limit set at mean \pm 1 SD were used to monitor monthly trends of HAIs. **Results:** The CAUTI rates reduced by 28.01%; the CLABSI rates declined by 37.61%, the SSI rates reduced by 62.39%, while the highest VAP rates were reported in November 2019 (1.9 per 1000 ventilator days). The hand hygiene compliance rates from January 2019 to December 2020 among different healthcare staffs showed a sharply rising trend. **Conclusion:** Covid-19 pandemic highlighted paramount importance regarding compliance to hand hygiene and implementation of standard infection control practices as recommended by World Health Organisation and Centres for Diseases Control and Prevention (CDC), which can drastically reduce range of HAIs.

Keywords: CAUTI, CLABSI, Covid-19, HAIs, SSI, VAP

Introduction

Hospital-acquired infections (HAIs) are those infections, which are not present at the time of admission and acquired during the course of hospital settings manifested 48–72 h after admission, more prevalent in critical care settings.^[1,2] World Health Organisation (WHO) reported overall 5.1–11.6% prevalence rate of HAIs in high-income countries (HICs).^[3] The impact of HAIs range from increased morbidity and mortality to more hospital stay, laboratory procedures, chances

of antibiotic resistance that culminate in sickening financial burden on patients, families and healthcare systems.^[4] As per WHO, HAIs directly contribute to an estimated 1,40,000 deaths with economic impact of US\$ 6.5 billion (USA 2004 alone); bloodstream infections and ventilator-associated pneumonia have more deleterious effects on health outcomes and costs. National surveillance data on HAIs from low- and middle-income countries are mostly unavailable; hospital-based studies reported much higher rates compared to HICs.^[3] HAIs rates reportedly declined in healthcare settings during this pandemic; however, there is a paucity of published literature from the Indian settings though Covid-19 pandemic has opened our vision on HAIs. Infection control practices and importance of compliance to standard precautions are the responsibility of all healthcare professionals. Primary care

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physicians are the first point of contact with the patients in the community. They play crucial role in the continuum of care of diverse prehospital care to hospital-based care spectrum. Critical conditions in the family medicine practices entail collaborative outpatients and in-patients domains with follow-up and domiciliary care after discharge. Considering the importance of HAIs amid Covid-19 pandemic situation, this study was conducted to find out the impact of hand hygiene compliance among healthcare workers on catheter-associated urinary tract infections (CAUTI), Central-line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), and surgical site infections (SSIs).

Methods

This retrospective hospital-based study was undertaken in a 700 bed multispecialty teaching hospital in Eastern India which was a Government of Bihar approved speciality Covid care hospital for admitting and treating Covid-19 positive cases. Data for the study was collated for the period from January 2019 to December 2020 considering the importance of HAIs.

This tertiary care teaching hospital has standard operating procedure of routine process for monthly data collection on four HAI, namely, CAUTI, CLABSI, VAP, and SSI and computation of HAIs following Centres for Diseases Control and Prevention (CDC) guidelines as follows:

Operational definitions^[5]

CAUTI: A urinary tract infection of the urinary system (urethra, bladder, ureters, and kidney) associated with the indwelling urinary catheter.

CLABSI: A serious infection that occurs when microbes reach bloodstream via central line.

VAP: A serious lung infection developing in patients who are on ventilators for life-saving interventions.

SSIs: An infection following surgery in the part of the body where the surgery was conducted (a) superficial infections involving only the skin; (b) serious deeper SSIs involving tissues under the skin, organs, or implanted material.

Inclusion criteria

All patients with urinary catheter, central line, ventilated and postsurgery patients admitted in the non-Covid critical care units and wards in the hospital were recruited for the purpose of data collection in this study.

Exclusion criteria

The SARS-COV-2 suspected or confirmed positive cases, who were isolated and admitted in dedicated critical care units and wards, were excluded from the study.

Primary outcome variables

Incident cases of CAUTI; central line-associated blood stream infection; VAP, SSIs and computation/collation of HAIs. The rates computed as per standard definitions of National Healthcare Safety network criteria as below:^[6]

CAUTI rate: Number of CAUTIs per 1,000 urinary catheter days.

CLASBI: Number of CLABSIs per 1,000 central line days.

VAP rate: Number of VAPs per 1,000 ventilator days.

SSI: Number of SSIs per 100 surgeries.^[7]

Data collection procedure

Following approval from the Institutional Ethics Committee (MGM/PRI-40/21), this study was conducted. The hospital has a predesigned form for collecting the data on the four above mentioned components of the HAIs, which has the patient identifiers and demographic characteristics, date of the procedure like catheterisation, central line insertion, intubation, and date of surgery, date of development of the signs and symptoms specific to the event, date of sending the microbiological samples like urine routine and culture, blood culture and central line tip culture, radiological findings, ET tube culture, wound culture, date of the relevant microbiological reports coming positive, data on ventilator settings, fever and blood counts, antibiotics that the patient was receiving, any change in antibiotics within the last 48 h. There are separate forms for looking into the bundle compliance for the catheterised patients, patients with central line, intubated patients, and postsurgical patients. These forms are also reviewed routinely for the purpose of monitoring compliance to the specific bundles. Data was collected across the hospital daily on the ward-wise basis by the infection control team in the predesigned forms as mentioned above. The hospital has a process of following up SSI for a period of 1 year postsurgery, through follow-up of postsurgery patients in the surgery OPDs or through telephone. HAI rates calculated as per the standard definitions, ratified by the Infection Control Officer, analysed, reported and presented before the Infection Control Committee as a part of routine infection control monitoring and surveillance activities.

The hospital also has a practice of overseeing the hand hygiene compliance rates including the correct standardised process of hand washing as per standard WHO May 2009 Guidelines and compliance to the five moments of hand hygiene for the different categories of healthcare staffs like doctors, nurses and other healthcare workers like physiotherapists and housekeeping staffs selected at random and data collected through mystery observers.^[8]

For the purpose of the study, these routine processes of data collection as above were utilised except using the data confined to the Covid-19 free units across the hospital only to nullify the possible effects of confounding due to Covid-19 infections.

Data analysis

Data were entered into Microsoft Excel sheet and analysed using SPSS version 21.0. Besides measures of central tendencies like mean and standard deviation to represent the continuous data along with two tailed Student's *t*-test, *P* value of less than 0.05 was considered statistically significant. Control charts with upper control limit and lower control limit set at mean \pm 1 SD were used to monitor monthly trends for the four commonly used rates to signify HAIs as mentioned above from January 2019 to December 2020. The trend line was drawn to indicate an upward or a declining trend signifying improvement. Change in rates like increase or decrease was calculated as the difference between the average rate in January 2019 to December 2019 and January 2020 to December 2020/ average rate in January 2019 to December 2019 expressed as percentage.

Results

There is true need to mention here that, during this 24 months period, the numbers of surgeries were not uniform in the wake of Covid-19 pandemic. From May 2020 onwards, the corresponding figures were drastically reduced to 20% of the usual volumes due to stoppage of planned surgical interventions from April 2020 to July 2020 as per the decision of the OT user committee and the hospital management committee during imposition of the nationwide lockdown; the slow resumption of normalcy in the surgical cases took another 2 months.

The average CAUTI rate in January 2019 to December 2019 was 2.82 and in January 2020 to December 2020 was 2.03, and this difference was statistically significant. The average CLABSI rates in January 2019 to December 2019 was 2.26 and in January 2020 to December 2020 was 1.41, and this difference was also statistically significant. The average VAP rates in January 2019 to December 2019 was 1.34 and in January 2020 to December 2020 was 1.41; but this difference was not statistically significant.

The average SSI rates in January 2019 to December 2019 was 2.34 and in January 2020 to December 2020 was 0.88, and this difference was statistically significant. The CAUTI rates reduced by 28.01%; the CLABSI rates declined by 37.61%, while the SSI rates reduced by 62.39%. Though VAP rates showed a slight increase of 5.22%, this was not statistically significant [Table 1].

The average days from catheter insertion to development of CAUTI was 8.24 ± 2.10 in January 2019 to December 2019 and 9.36 ± 1.56 in January 2020 to December 2020, and this difference was statistically significant with a *P* value of 0.004. The average days from insertion of central line to development of CLABSI were 7.76 ± 1.46 in January 2019 to December 2019 and 9.04 ± 1.15 in January 2020 to December 2020, and this difference was statistically significant with a *P* value of 0.035. The average days from intubation to development of VAP was 5.28 ± 3.86 in January 2019 to December 2019 and 5.23 ± 3.18 in January 2020 to December 2020, but this difference was not significant with a *P* value of 0.442. The average days from operation to SSI was 10.53 ± 4.02 in January 2019 to December 2019 and 10.34 ± 3.47 in January 2020 to December 2020, but this difference was not statistically significant with a *P* value of 0.502 [Table 2].

The compliance rates regarding the hand hygiene among doctors were 81.34% in January 2019 to December 2019 and 94.50% in January 2020 to December 2020. Hand hygiene compliance rates among nurses were 91.63% in January 2019 to December 2019 and 98.52% in January 2020 to December 2020, while the hand hygiene compliance rates among other healthcare workers like physiotherapists and housekeeping staffs were 70.40% in January 2019 to December 2019 and 82.90% in January 2020 to December 2020. The differences were statistically significant with a *P* value of 0.000 [Table 3].

CAUTI rates from January 2019 to December 2020 showed a sharply declining trend with the highest CAUTI rate reported in

Table 1: Average CAUTI, CLABSI, VAP and SSI Rates in January 2019 to December 2019 and in January 2020 to December 2020

	Jan'19-Dec'19	Jan'20-Dec'20	P	Percentage change
Average CAUTI rates	2.82	2.03	0.005*	28.01 (decrease)
Average CLABSI rates	2.26	1.41	0.000*	37.61 (decrease)
Average VAP rates	1.34	1.41	0.562	5.22 (increase)
Average SSI rates	2.34	0.88	0.000*	62.39 (decrease)

Two tailed Student *t*-test; **P*<0.05 was statistically significant. CAUTI=Catheter-associated urinary tract infections, CLABSI=Central-line-associated bloodstream infections, VAP=Ventilator-associated pneumonia, SSIs=Surgical site infections

Table 2: Average days from insertion of catheter, central line and intubation to development of CAUTI, CLABSI and VAP in January 2019 to December 2019 and in January 2020 to December 2020

	Jan'19-Dec'19	Jan'20-Dec'20	P
Average days from catheterisation to CAUTI	8.24 ± 2.10	9.36 ± 1.56	0.004*
Average days from insertion of central line to CLABSI	7.76 ± 1.46	9.04 ± 1.15	0.035*
Average days from intubation to VAP	5.28 ± 3.86	5.23 ± 3.18	0.442
Average days from operation to SSI	10.53 ± 4.02	10.34 ± 3.47	0.502

Two tailed Student *t*-test; **P*<0.05 was statistically significant. CAUTI=Catheter-associated urinary tract infections, CLABSI=Central-line-associated bloodstream infections, VAP=Ventilator-associated pneumonia, SSIs=Surgical site infections

January 2019 as 3.92 per 1000 catheter days and lowest in August 2020 as 1.24 per 1000 catheter days [Figure 1].

CLABSI rates from January 2019 to December 2020 showed sharp declining trend from the highest CLABSI rate in February 2019 as 2.73 per 1000 central line days and the lowest in November 2020 as 0.75 per 1000 central line days [Figure 2].

VAP rates from January 2019 to December 2020 showed a slightly increasing trend with the highest VAP rates reported in November 2020 as 1.9 per 1000 ventilator days and lowest 0.8 per 1000 ventilator days in July 2020 [Figure 3].

SSI rates from January 2019 to December 2020 showed a sharply declining trend with the highest SSI rate of 3.09 per 100 surgeries reported in March 2020 and the lowest of nil SSI rates in May 2020 and August 2020 [Figure 4].

Hand hygiene compliance rates from January 2019 to December 2020 among doctors, nurses and other healthcare workers like physiotherapists and housekeeping staffs shows a sharply rising trend among all categories of healthcare workers [Figure 5].

was through respiratory droplets with close contacts and every individual being susceptible to the disease.^[12]

Thus, all individuals complied with the guidelines issued by the WHO and CDC to safeguard against the Covid-19 infections like keeping a safe distance of 2 metres; covering the nose and mouth with tissue when coughing and sneezing; avoiding crowded places; frequent hand washing and use of personal protective equipment like face mask. In addition, hospital authorities

Discussion

We have noted significant reductions in CAUTI, CLABSI and SSI rates from January 2019 to December 2020. The CAUTI rates reduced by 28.01% during the Covid-19 pandemic from January 2020 to December 2020 when compared with the previous year from January 2019 to December 2019; the CLABSI rates declined by 37.61, while the SSI rates were reduced by 62.39%. Increased incidences of HAIs are associated with urinary catheterization, central venous catheterization, and mechanical ventilation which together with SSIs constitute majority of HAIs.^[9] Despite continuous efforts by international agencies over the last decade to improve infection prevention and control programs and compliance to standard practices, the documentations regarding the efforts to reduce HAIs have gone unheard to a great extent. The efforts largely remained one sided with the hospital infection and quality control teams trying hard to attain the desired objectives.^[10]

The first case of Covid-19 was reported in the state of Kerala in India on 27 January 2020.^[11] The country went into total lockdown from 23 March 2020. Controlling HAIs along with the Covid-19 pandemic was initially considered a major challenge. It was well established that the transmission of Covid-19 infection

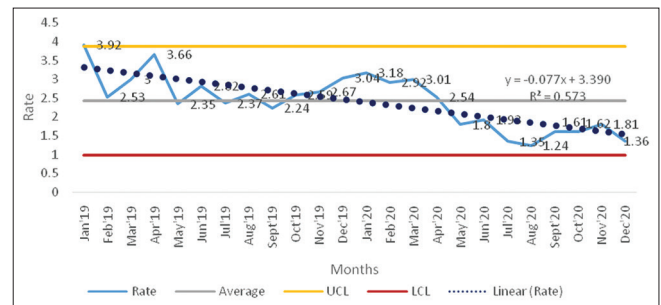


Figure 1: Catheter-associated urinary tract infection rates from January 2019 to December 2020

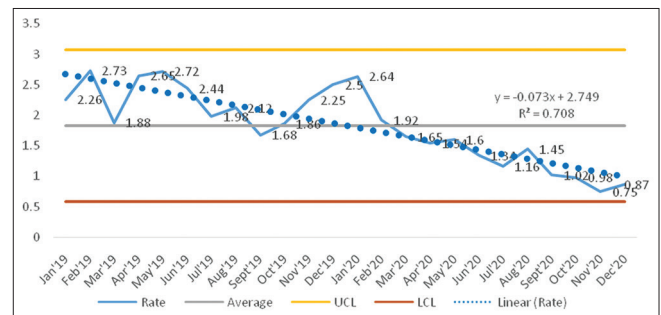


Figure 2: Central-line-associated blood stream infection rates from January 2019 to December 2020

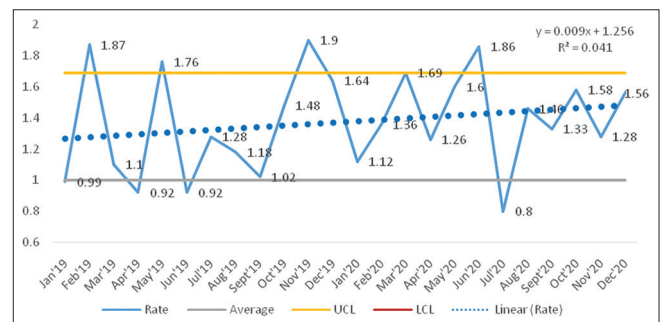


Figure 3: Ventilator-associated pneumonia rates from January 2019 to December 2020

Table 3: Hand hygiene compliance rates among different categories of health care workers

	Average		P
	Jan'19-Dec'19	Jan'20-Dec'20	
Hand hygiene compliance rates Doctors	81.34%	94.50%	0.000*
Hand hygiene compliance rates Nurses	91.63%	98.52%	0.000*
Hand hygiene compliance rates HCWs	70.40%	82.90%	0.000*

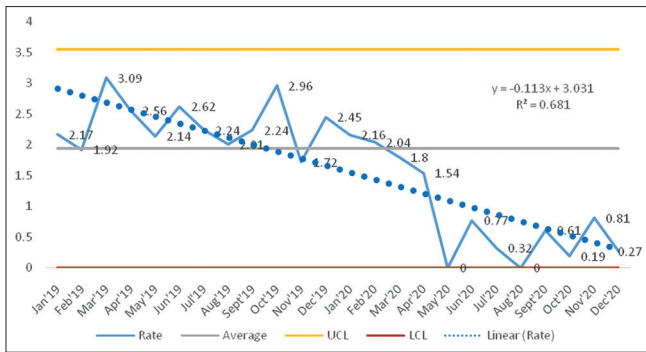


Figure 4: Surgical site infection rates from January 2019 to December 2020

implemented and the healthcare personnel strictly followed triaging and cohorting of patients, reducing hospital footfalls and standard infection control practices as recommended by WHO and CDC for control of HAIs. Staff training on hand hygiene guidelines, use of N95 mask and other PPEs, donning and doffing of PPEs, steps of planned intubation and care of ventilator patients, central line and catheter insertion and care of patients with catheters and central lines and ensuring availability of PPEs were also enforced.^[13]

Studies by Cerulli IE *et al.*, Losardo P *et al.* and Jabarpour M *et al.* too found significant decrease in HAI rates during the Covid-19 pandemic compared to previous years.^[14-17] However, studies by McMullen KM *et al.*^[18] noted that CLABSI and CAUTI rates were on the rise with SSI rates on the decline during the SARS COV-2 pandemic.

We further observed significant increase in the days from catheter or central line insertion or intubation to the event like development of CAUTI or CLABSI or VAP, respectively as well. We also observed an improved hand hygiene compliance rates and compliance to hand hygiene practices as per standard guidelines during the Covid-19 pandemic. It is an established fact that strict compliance to aseptic precautions during catheterisation and central line insertion reduce UTIs and CLABSIs, while adherence to infection control guidelines reduce SSI rates.^[19,20] As per a study in a hospital setting in Taiwan and New York, use of face masks, hand hygiene compliance and strict adherence to contact precautions during Covid-19 pandemic resulted in a decrease in HAIs.^[21,22]

It is also an established fact that increasing awareness through on job training and continuous education are the effective means of reducing nosocomial infections through improved compliance to standard protocols and guidelines.^[23,24] Systematic use of PPE, strict triaging, cohorting and isolating patients; footfall restriction and enforcement of training activities pertaining to standard precautions and its implementation and compliance by healthcare workers including enforcement of strict relevant bundle compliances are standard recommendations to prevent spread of HAIs which overlap with those for limiting the spread of Covid-19 infections.^[25-28] The higher rate of SSI in developing

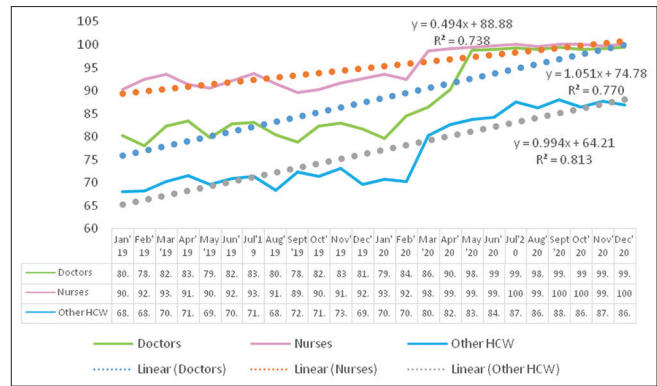


Figure 5: Hand hygiene compliance rates among different healthcare professionals from January 2019 to December 2020

countries is attributed to operating room congestion, poor hand hygiene and unnecessary use of antibiotics.^[29] Research group from India in their recent work noted preponderance of Gram-negative infections among Covid-19 cases with reported resistance to newer generation of antimicrobials leading to higher mortality risks. This warrants improved infection control and antimicrobial stewardship to prevent HAIs.^[30]

In our clinical settings during the Covid-19 pandemic, there was a significant increase in hand hygiene compliance. The number of surgeries reduced drastically as planned surgical cases were stopped from May 2020 for 3 months, which resulted in lesser operating room congestion and better operation theatre cleaning in between and after cases. It was noted that surgeon, anaesthetist and other operation theatre healthcare professionals complied with better hand hygiene and infection control practices due to reduced work load.

Strengths of the study

The article being one of its kind in the backdrop of the Covid-19 pandemic highlights on a very important concept of compliance to standard precautions and reduction of HAIs, which has been clearly depicted and consolidated in the concluding section. This study conducted in non-Covid wards as part of the routine process of hospital infection control monitoring and surveillance activities makes it free from selection bias.

Limitations of the study

We had several limitations. First, this study was a single-centre study done in a tertiary care teaching institute. So the results of the study may not be replicable elsewhere, which necessitates the need for similar multicentric studies in various hospitals across the country. Second, this study was conducted during the first wave of the Covid-19 pandemic when there was better enforcement of health protocols which can have an impact on the rate of nosocomial infections. In the second wave, we are yet to collate data of the importance of sensitization on hygienic practices. Finally, the study was retrospective data mining based on the routine data collected without any scope of intervention being done on the patients.

Future directions of the study

Further studies in the area is needed with in-depth focus on the practices, behavioural perspectives and attitudes of healthcare workers concerning enforcement of health protocols in the second wave of Covid is required.

Conclusion

The findings of the study once again stressed on the absolute importance of hand hygiene compliance and control of HAI; we also highlighted that even in the midst of a pandemic situation we can succeed in bringing down HAIs through strict compliance to standard infection control practices. Covid-19 pandemic thus highlighted that compliance to the simple standard infection control practices can drastically reduce HAIs. With increasing Covid-19 cases in second wave and upcoming third wave, we should strictly continue with the standard infection control practices, hand hygiene compliance, systematic use of PPEs and henceforth thereafter, making the standard infection control practices, a part and parcel of our clinical practice, the way it is recommended by international agencies. If we could do it during the Covid-19 pandemic, we should do it always!

Author contributions

MB and MM contributed in subject concept development, data collection and collation, data analysis and article writing; MM, AG and RP contributed in data management and article editing. MM, AG, RP and MB contributed in the review and approved the final manuscript before submission.

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Key message

- Strict compliance to hand hygiene practices help control hospital-acquired infections
- Covid-19 pandemic once again highlighted importance of infection control practices
- We will continue standard precautions even after the Covid-19 pandemic curve is flat.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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