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Device-Associated Infection Trend Analysis in a Tertiary Care Centre in India: A Comparative Study Before and After the COVID-19 Pandemic

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Abstract

Background: Device-Associated Infections (DAIs) pose significant challenges in healthcare settings, leading to increased morbidity, mortality, and healthcare costs. Understanding the impact of the COVID-19 pandemic on DAIs and device utilization rates is crucial for optimizing infection control practices and enhancing patient safety.

Objectives: This study aims to elucidate the shifts in infection rates, specifically CAUTI, VAP, and CLABSI in a tertiary care centre before and after the onset of the global pandemic.

Methods: In this retrospective study, we analysed trends in DAIs and device utilization rates before (October 2019 - March 2020) and after (August 2021 - January 2022) the COVID-19 pandemic. Data on urinary catheter days, central line days, ventilator days, and rates of Catheter-Associated Urinary Tract Infection (CAUTI), Central Line-Associated Bloodstream Infection (CLABSI), and Ventilator-Associated Pneumonia (VAP) were collected from medical records.

Results: According to the findings of the present study, fluctuations in CAUTI, CLABSI, and VAP rates pre- and post-pandemic, with no significant difference in infection rates between the two periods ($P>0.05$) were observed. There was a notable increase in urinary catheter days post-pandemic, accompanied by reductions in ventilator days and central line days. The urinary catheter utilization ratio substantially increased post-pandemic, while ventilator and central line utilization ratios showed slight declines.

Conclusion: This study highlights the dynamic nature of DAIs and device utilization rates in the wake of the COVID-19 pandemic. Implementing evidence-based protocols and continuing research in infection control practices are essential for optimizing healthcare delivery and enhancing patient safety in the post-pandemic era.

Keywords: Device-Associated Infections, COVID-19 Pandemic, Infection Control, Surveillance, Patient Safety

1. Background

In the dynamic landscape of healthcare, understanding the impact of significant events on patient outcomes and infection rates is paramount for effective clinical management and quality improvement. The COVID-19 pandemic has prompted a re-evaluation of healthcare practices and infection control protocols, necessitating a comprehensive examination of device-associated infection trends in tertiary care settings.[1] Healthcare-Associated Infections (HAIs) continue to be a critical concern for patient safety, with Device-Associated Infections (DAIs) playing a significant role in this landscape.[2] DAIs encompass a spectrum of infections directly linked to the use of medical devices, such as urinary catheters, ventilators, and central lines.[3] Understanding the epidemiology of these infections is vital for shaping effective infection control strategies and improving patient outcomes. As the healthcare grappled with unprecedented challenges during the pandemic, ranging from resource constraints to dynamic patient populations, it becomes imperative to assess the implications on device-associated infections.[4] The comparative analysis presented in this study seeks to identify temporal trends, disparities, and potential contributing factors that may have influenced infection rates.[5]

Centres for Disease Control and Prevention (CDC) has defined Catheter-Associated Urinary Tract Infection (CAUTI) as urinary tract infection diagnosed when an Indwelling Urinary Catheter (IUC) has been in situ for over two consecutive days in an inpatient setting on the date of the event or the preceding day, designating the day of device placement as Day 1.[6]

Central Line-Associated Bloodstream Infections (CLABSIs) are a significant concern in healthcare settings, particularly in Intensive Care Units (ICUs), due to their association with increased morbidity, mortality, and healthcare costs. According to CDC, a CLABSI is

defined as a laboratory-confirmed bloodstream infection in which an eligible Bloodstream Infection (BSI) organism is identified, and an eligible central line is present on the day of the BSI Occurrence Event (DOE) or the day before.[7]

Ventilator-Associated Pneumonia (VAP) represents a significant concern in critical care settings, particularly among patients undergoing mechanical ventilation, due to its associated morbidity and mortality rates. As defined by CDC, VAP is characterized by pneumonia occurring in patients who have been mechanically ventilated for more than two consecutive calendar days on the date of the event, with the day of ventilator placement designated as Day 1, and the presence of the ventilator on the date of the event or the preceding day.[8] This CDC definition serves as a cornerstone for the surveillance, prevention, and management of VAP within healthcare facilities, guiding clinicians in the identification and appropriate management of this potentially life-threatening infection.

2. Objectives

This study aims to elucidate the shifts in infection rates, specifically CAUTI, VAP, and CLABSI in a tertiary care centre before and after the onset of the global pandemic. By scrutinizing pre-pandemic and post-pandemic data, our objective is to provide insights into the evolving landscape of device-associated infections and inform evidence-based strategies for optimizing patient care.

3. Methods

This retrospective study was conducted at UCMS & GTB Hospital, Delhi in two phases: pre pandemic period (October 2019 - March 2020) and post-pandemic (August 2021 - January 2022).

3.1. Inclusion Criteria

- Patients with documented urinary catheter, central line, or ventilator days during their hospital stay.
- Patients admitted for at least 24 hours.

3.2. Exclusion Criteria

- Patients with incomplete medical records.
- Patients with missing data on device utilization or DAI rates.

The number of samples for each device during the pre-pandemic and post-pandemic periods were:

- Pre-pandemic period:
- Urinary catheter days: 898
- Ventilator days: 1203
- Central line days: 1113
- Post-pandemic period:
- Urinary catheter days: 1730
- Ventilator days: 950
- Central line days: 799

Data Collection: Data on patient demographics, device utilization (urinary catheter days, central line days, and ventilator days), and device-associated infection rates (CAUTI, CLABSI, and VAP) were collected from medical records.

3.3. Data Management and Statistical Analysis

Descriptive statistics were used to summarize patient characteristics and device-associated infection rates. A comparison of device-associated infection rates between the pre-pandemic and post-pandemic periods was conducted using the chi-square test or Fisher's exact test, as appropriate. A *P*-value <0.05 was considered statistically significant.

4. Results

During the comparative analysis between the pre-pandemic and post-pandemic phases, shifts were observed in DAIs and device utilization rates within the tertiary care Centre as depicted in Table 1. Figure 1 depicts the comparison of various DAI rates. In the pre-pandemic group, the rates of CAUTI, CLABSI, and VAP were recorded at 17.1, 18.8, and 31 cases per 1000 device days respectively. In contrast, the post-pandemic group exhibited varying trends, with CAUTI and VAP rates at 19.5 and 20.8, respectively, while the CLABSI rate increased to 22.1 cases per 1000 device days. Interestingly, although not statistically significant (*P* >0.05), the *P*-values for CAUTI (*P* = 0.2) and CLABSI (*P* = 0.4) rates suggest a trend towards higher infection rates post-pandemic. Moreover, while there were no significant

Table 1. Pre- and Post-COVID Comparison of DAI

Parameters	Pre-pandemic group	Post-pandemic group	*P*-value
CAUTI (cases per 1000 device days)	17.1	19.5	0.2
VAP (cases per 1000 device days)	31	20.8	0.3
CLABSI (cases per 1000 device days)	18.8	22.1	0.4
Urinary catheter days	149.67	288.33	0.7
Ventilator days	200.5	158.33	
Central line days	185.5	133.17	
Urinary catheter utilization ratio	0.55	0.88	0.4
Ventilator utilization ratio	0.807	0.745	
Central line utilization ratio	0.731	0.715	

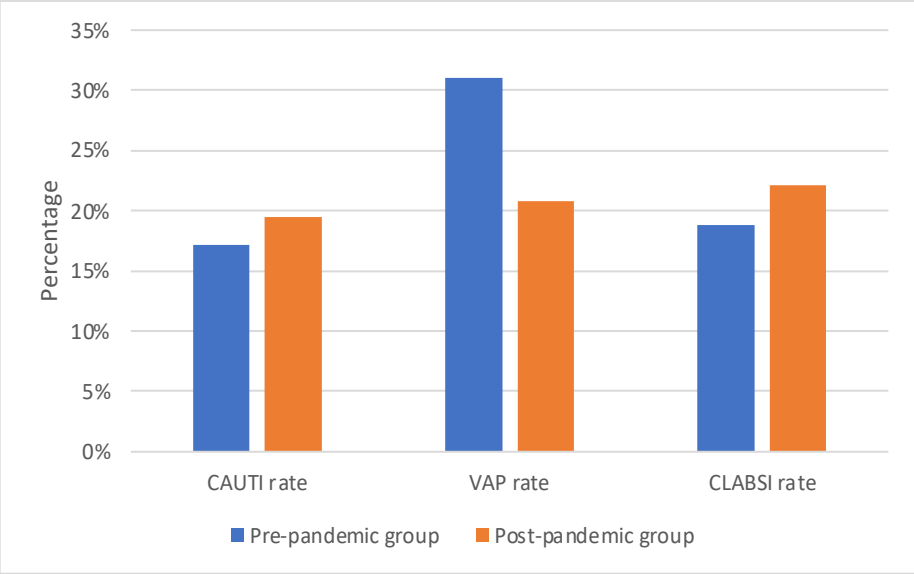

Figure 1. Comparison of DAI Rates.

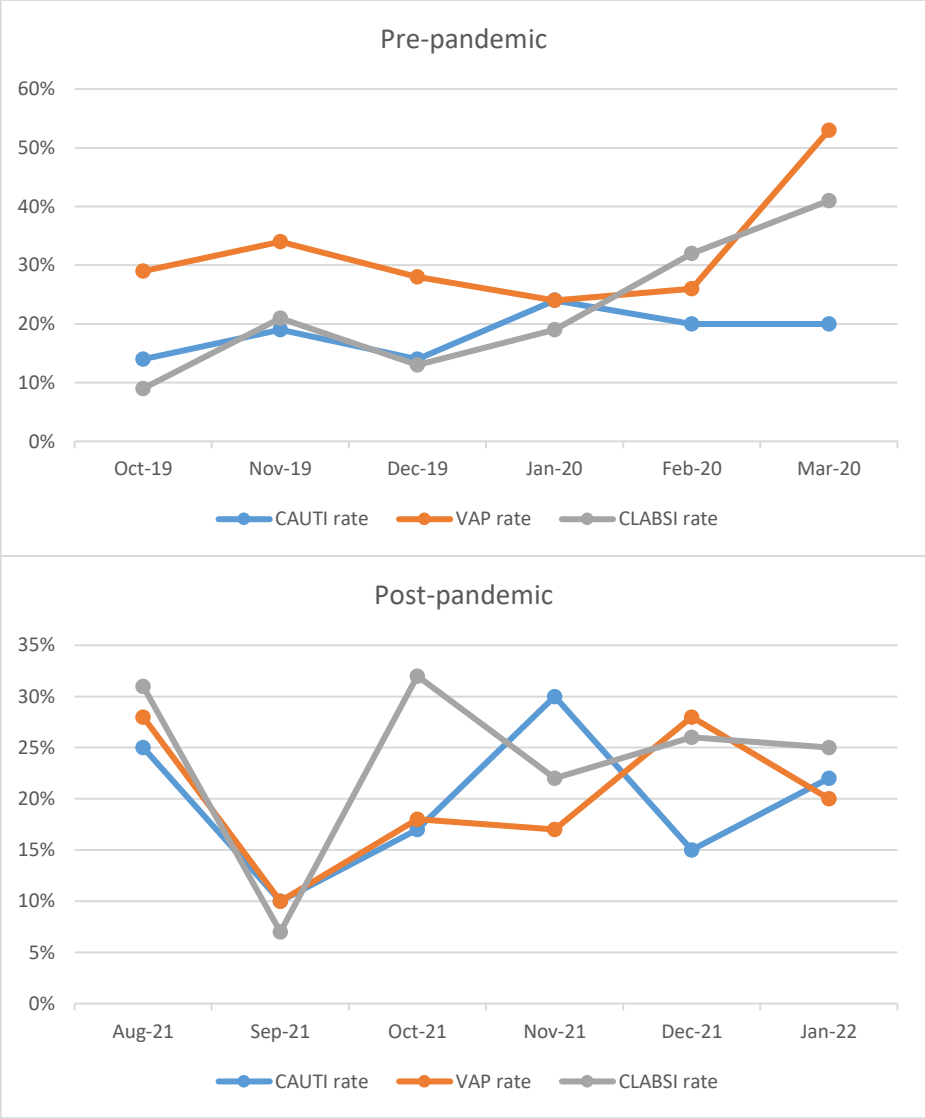

Figure 2. Trend of Pre-pandemic and Post-pandemic DAI Rates.

differences in ventilator days between the two groups, there was a notable increase in urinary catheter days (from 149.67 to 288.33) post-pandemic, coupled with reductions in both ventilator days and central line days. Correspondingly, the urinary catheter utilization ratio demonstrated a substantial increase post-pandemic (from 0.55 to 0.88), while the ventilator and central line utilization ratios showed slight declines.

The month-wise trends in device-associated infections pre- and post-pandemic reveals significant fluctuations in infection rates, as illustrated in Figure 2.

4.1. Pre-pandemic Period (Oct 2019 - Mar 2020)

CAUTI Rate: The CAUTI rate varied throughout the pre-pandemic period, ranging from 14 to 24 cases per 1000 device days. Notable fluctuations were observed, with peaks in January 2020 (24 cases per 1000 device days) and February 2020 (20 cases per 1000 device days).

VAP Rate: Similarly, the VAP rate exhibited fluctuations, ranging from 28 to 53 cases per 1000 device days. The highest rate was recorded in March 2020 (53 cases per 1000 device days), while the lowest was observed in December 2019 (28 cases per 1000 device days).

CLABSI Rate: The CLABSI rate also demonstrated variability, ranging from 9 to 41 cases per 1000 device days. Peaks were noted in March 2020 (41 cases per 1000 device days) and November 2019 (21 cases per 1000 device days).

4.2. Post-pandemic Period (Aug 2021 - Jan 2022)

CAUTI Rate: In the post-pandemic period, the CAUTI rate fluctuated between 10 and 30 cases per 1000 device days. The highest rate was observed in November 2021 (30 cases per 1000 device days), while the lowest was recorded in September 2021 (10 case per 1000 device days).

VAP Rate: The VAP rate varied between 10 and 28 cases per 1000 device days post-pandemic. The highest rate occurred in August 2021 (28 cases per 1000 device days), while the lowest was observed in September 2021 (10 case per 1000 device days).

CLABSI Rate: Similar to the other DAIs, the CLABSI rate showed fluctuations, ranging from 7 to 32 cases per 1000 device days. The highest rate was recorded in October 2021 (32 cases per 1000 device days), while the lowest was observed in September 2021 (7 cases per 1000 device days).

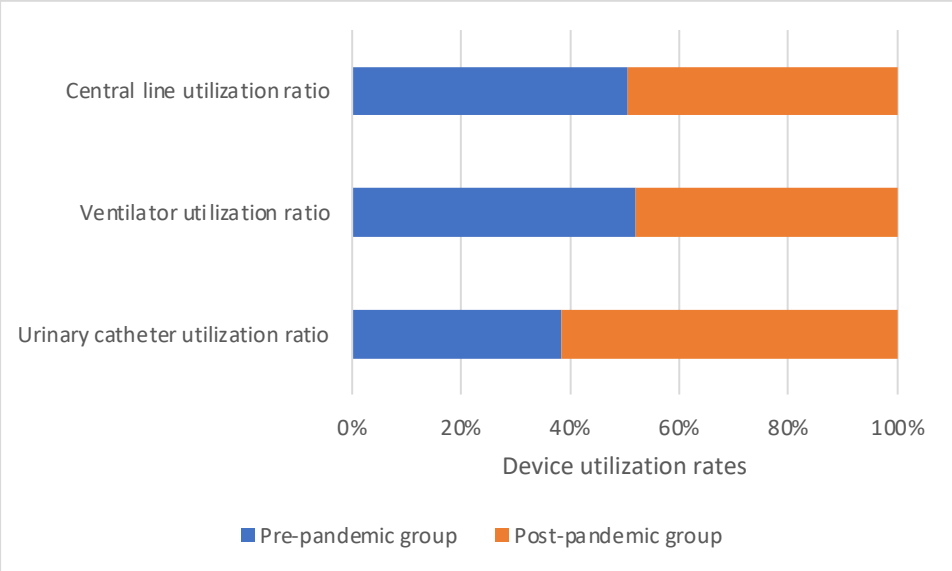

Figure 3. Distribution of Device Utilization Rates Pre- and Post-pandemic.

The stacked bar diagram in Figure 3 illustrates significant shifts in device utilization ratios between the pre-pandemic and post-pandemic groups. A notable increase in the urinary catheter utilization ratio from 0.55 to 0.88 post-pandemic is observed, indicating a substantial rise in urinary catheter usage for patient care. Conversely, the ventilator utilization ratio decreased from 0.807 to 0.745 post-pandemic, suggesting a reduced reliance on ventilators for respiratory support. While the central line utilization ratio also exhibited a slight decrease from 0.731 to 0.715 post-pandemic, the difference was not statistically significant.

5. Discussion

The comparative analysis between the pre- and post-pandemic phases of DAIs and device utilization rates within the tertiary care centre reveals intriguing shifts in infection dynamics and healthcare resource utilization. The recorded rates of CAUTI, CLABSI, and VAP in the pre-pandemic period in our study were 17.1, 18.8, and 31 cases per 1000 device days respectively, reflecting the baseline prevalence of DAIs. A study done in Iran

reported that the incidence rate of CAUTI, CLABSI, and VAP was 7.42, 10.20, and 21.08 per 1000 device-days, respectively, comparable to our study.[9] As per data from the World Health Organization, developed countries typically report lower incidence for CLABSI, VAP, and CAUTI, with rates of 3.5, 7.9, and 4.1 per 1000 device-days, respectively. Conversely, developing countries tend to have higher incidence densities, with rates of 12.2, 23.9, and 8.8 per 1000 device-days for CLABSI, VAP, and CAUTI, respectively.[10] The prevalence of various healthcare-associated infections varies considerably across nations and is influenced by economic disparities. Research indicates that individuals in low- and middle-income countries face a significantly elevated risk of contracting HAIs, with some studies suggesting this risk may be as much as 20 times higher compared to individuals in higher-income settings.[9]

The comparison between post-pandemic device-associated infection rates from our study and those reported by Zand et al. in Iran reveals notable disparities. While our findings show marginal increase in CAUTI and VAP rates, along with a notable rise in CLABSI rate post-pandemic, Zand et al.'s study reported a significant decrease in VAP rates during the pandemic period, while CLABSI and CAUTI rates remained relatively stable.[11] Comparing the post-pandemic DAI rates from our study with those reported by Alsaffar et al., revealed marginal increase in CAUTI and VAP rates, alongside a notable rise in CLABSI rate post-pandemic. Conversely, Alsaffar et al. observed contrasting trends, with CLABSI rates significantly increasing in 2020-2021 compared with 2019, while CAUTI rates significantly decreased during the same period.[12] These disparities underscore the varied impacts of the pandemic on DAIs across different healthcare settings and highlight the need for context-specific interventions to address evolving infection trends. Further research is warranted to elucidate the underlying factors driving these outcomes.

In comparing the results between our study and that of AlAhdal et al., similarities and disparities are evident. Both studies found no significant impact on DAI rates when comparing monthly trends before and after the pandemic, with *P*-values >0.05. Our study, spanning from October 2019 to March 2020 for the pre-pandemic period and from August 2021 to January 2022 for the post-pandemic period, revealed notable fluctuations in CAUTI, VAP, and CLABSI rates. Similarly, AlAhdal et al. found no statistically significant differences in DAIs between 2019 and 2020.[13] These parallel findings suggest a consistent pattern of DAI dynamics and infection control practices across different healthcare settings, highlighting the resilience of infection prevention measures in the face of pandemic-related disruptions. In contrast to our study, Mitra et al. in their study on observed significant reductions in CAUTI and CLABSI rates from 2019 to 2020, however, found non-significant variations in VAP rates over the same period, similar to our study.[14]

The observation of a notable increase in urinary catheter days post-pandemic, accompanied by reductions in ventilator days and central line days, emphasizes a dynamic reconfiguration in healthcare resource utilization patterns. This shift is further elucidated by the substantial rise in the urinary catheter utilization ratio (from 0.55 to 0.88) post-pandemic, indicative of increased reliance on urinary catheters for patient care. Conversely, while the ventilator and central line utilization ratios exhibited slight declines, the overall impact on infection dynamics and healthcare resource allocation warrants careful consideration. These findings highlight the multifaceted interplay between infectious disease epidemiology, healthcare delivery systems, and the broader societal response to public health crises, emphasizing the imperative for continuous surveillance and adaptive healthcare strategies to mitigate the evolving landscape of healthcare-associated infections.

6. Conclusion

In conclusion, this study highlights the need for ongoing surveillance and intervention strategies to mitigate the risk of infections associated with medical devices in the post-pandemic landscape. By identifying trends and potential areas for improvement, this study provides valuable insights that can inform targeted infection control measures and contribute to enhanced patient safety.[15] Implementing evidence-based protocols, such as proper device insertion and maintenance, adherence to hand hygiene practices, and regular staff education, may help reduce the incidence of DAIs and improve overall healthcare outcomes.[16] The organizational measures implemented during the COVID-19 pandemic that may have contributed to the observed trends include enhanced infection control protocols, increased staffing and rigorous training on device handling.[17] These efforts likely played a crucial role in maintaining or reducing DAIs despite the increased device usage. Our hospital was a dedicated COVID care Government centre, which was among the most crowded facilities with a higher patient load and limited infrastructure. The infection control measures were especially critical in this setting, where the patient-to-staff ratio was strained, and the risk of infection transmission was elevated. The implementation of these protocols helped manage the increased demand for medical care and mitigated the risks associated with device-associated infections. The Infection Control Committee of our hospital played a significant role in overseeing and implementing these measures, ensuring that the best practices were followed even under challenging circumstances. Furthermore, continued research is needed in responding effectively to emerging challenges and mitigating the burden of DAIs and enhancing patient

safety across diverse demographic groups during and beyond the pandemic era.

6.1. Limitations and Future Directions

One significant limitation of our study is the lack of detailed demographic data and information on underlying diseases for the patients included in the study. This limits our ability to fully understand the impact of these variables on DAI rates and to perform multivariable analyses. Future studies should aim to collect comprehensive patient demographic and clinical data to provide a more in-depth analysis.

Research Highlights

What Is Already Known?

- The DAIs are a significant concern in healthcare settings, leading to increased morbidity, mortality, and costs.
- The COVID-19 pandemic had a profound impact on healthcare delivery and infection control practices worldwide.
- Prior research has demonstrated fluctuations in infection rates and device utilization during public health crises, including pandemics.

What Does This Study Add?

- This study provides a comprehensive analysis of trends in DAIs and device utilization rates before and after the COVID-19 pandemic, offering insights into the pandemic's influence on infection dynamics.
- Despite fluctuations, no significant difference in infection rates between the pre- and post-pandemic periods was observed, highlighting the resilience of infection control measures.
- The study identifies a notable increase in urinary catheter days post-pandemic, alongside reductions in ventilator and central line days, underscoring the shifting patterns of device usage in the pandemic's aftermath.

Author Contributions

BK contributed in the concept, design, definition of intellectual content, clinical studies, experimental studies, data acquisition, manuscript preparation, manuscript editing and manuscript review. KS contributed in design, definition of intellectual content, clinical studies, data acquisition, manuscript editing and manuscript review. RJ contributed in design, definition of intellectual content, experimental studies, data acquisition, and manuscript review. SS contributed in design, definition of intellectual content, experimental studies, data acquisition, and manuscript review.

Conflict of Interest Disclosures

All authors declared that they have no conflict of interest.

References

1. Ismaeil R, Nahas AR, Kamarudin NB, Abubakar U, Mat-Nor MB, Mohamed MH. Evaluation of the impact of COVID-19 pandemic on hospital-acquired infections in a tertiary hospital in Malaysia. BMC Infect Dis. 2023;23(1):779. doi:10.1186/s12879-02308770-3
2. Safdar N, Anderson DJ, Braun BI, Carling P, Cohen S, Donskey C, et al. The evolving landscape of healthcare-associated infections: recent advances in prevention and a road map for research. Infect Control Hosp Epidemiol. 2014;35(5):480-93. doi:10.1086/675821
3. Guggenbichler JP, Assadian O, Boeswald M, Kramer A. Incidence and clinical implication of nosocomial infections associated with implantable biomaterials–catheters, ventilator-associated pneumonia, urinary tract infections. GMS Krankenhhyg Interdiszip. 2011;6(1):Doc18. doi:10.3205/dgkh000175
4. Gupta N, Dhamija S, Patil J, Chaudhari B. Impact of COVID-19 pandemic on healthcare workers. Ind Psychiatry J. 2021;30(Suppl 1):S282-4. doi:10.4103/0972-6748.328830
5. Lohiya R, Deotale V. Surveillance of health-care associated infections in an intensive care unit at a tertiary care hospital in Central India. GMS Hyg Infect Control. 2023;18:Doc28. doi:10.3205/dgkh000454
6. Centers for Disease Control and Prevention (CDC): National Healthcare Safety Network (NHSN), Urinary Tract Infection (Catheter-Associated Urinary Tract Infection [CAUTI] and Non-Catheter-Associated Urinary Tract Infection [UTI]) Events, Atlanta: CDC; 2024. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/7psccauticurrent.pdf
7. Centers for Disease Control and Prevention (CDC): National Healthcare Safety Network (NHSN), Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-central Line Associated Bloodstream Infection), Atlanta: CDC; 2024. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf
8. Centers for Disease Control and Prevention (CDC): National Healthcare Safety Network (NHSN), Pneumonia (Ventilator-associated [VAP] and non-ventilator-associated Pneumonia [PNEU]) Event, Atlanta: CDC; 2024. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/6pscvapcurrent.pdf
9. Afhami S, Seifi A, Hajiabdolbaghi M, Bazaz NE, Hadadi A, Hasibi M, et al. Assessment of device-associated infection rates in teaching hospitals in Islamic Republic of Iran. East Mediterr Health J. 2019;25(2):90-7. doi:10.26719/emhj.18.015
10. World Health Organization. Report on the burden of endemic health care-associated infection worldwide; 2011. Available from: https://iris.who.int/bitstream/handle/10665/80135/?sequence=1
11. Zand F, Vakili H, Asmarian N, Masjedi M, Sabetian G, Nikandish R, et al. Unintended Impact of Covid-19 Pandemic on The Rate of Catheter Related Nosocomial Infections and Prevalence of Multiple Drug Resistance Pathogens in Three Intensive Care Units Not Allocated to Covid-19 Patients in A Large Teaching Hospital. BMC Infect Dis. 2023;23(1):11. doi:10.21203/rs.3.rs-1396691/v1
12. Alsaffar MJ, Alsheddi FM, Humayun T, Aldalbehi FZ, Alshammari WH, Aldecoa YS, et al. Impact of COVID-19 pandemic on the rates of central line... associated bloodstream infection and catheter-associated urinary tract infection in an. Яintensive care setting:. ЯNational experience. Am J Infect Control. 2023;51(10):1108-13. doi:10.1016/j.ajic.2023.03.016
13. AlAhdal AM, Alsada SA, Alrashed HA, Al Bazroun LI, Alshoaibi A. Impact of the COVID-19 pandemic on levels of device-associated infections and hand hygiene compliance. Cureus. 2022;14(4):e24254. doi:10.7759/cureus.24254
14. Mitra M, Ghosh A, Pal R, Basu M. Prevention of hospital-acquired infections: A construct during Covid-19 pandemic. J Family Med Prim Care. 2021;10(9):3348-54. doi:10.4103/jfmpc.jfmpc_742_21

15. Braun BI, Chitavi SO, Suzuki H, Soyemi CA, Puig-Asensio M. Culture of safety: impact on improvement in infection prevention process and outcomes. Curr Infect Dis Rep. 2020;22:34. doi:10.1007/s11908-020-00741-y
16. Gould DJ, Moralejo D, Drey N, Chudleigh JH, Taljaard M. Interventions to improve hand hygiene compliance in patient care. Cochrane Database Syst Rev. 2017;9(9):CD005186. doi:10.1002/14651858.CD005186.pub4
17. Alsuhaibani M, Kobayashi T, McPherson C, Holley S, Marra AR, Trannel A, et al. Impact of COVID-19 on an infection prevention and control program, Iowa 2020-2021. Am J Infect Control. 2022;50(3):277-82. doi:10.1016/j.ajic.2021.11.015