



CROSS-SECTIONAL ASSESSMENT OF HAND HYGIENE PERFORMANCE AND HOSPITAL-ACQUIRED INFECTION RATES: A SINGLE-CENTRE STUDY

M. R Navya^{1*}, Rashmi A²

^{1*} Assistant professor, Department of Microbiology, S. Nijalingappa medical college, Bagalkot. Mail ID: navyasettymr@gmail.com

² Assistant professor, Department of community medicine, Sri Lakshmi Narayana institute of medical sciences, puducherry. Mail ID: rashmiaraj260289@gmail.com

*Corresponding Author: M. R Navya
Mail ID: navyasettymr@gmail.com

ABSTRACT:

Background: Hospital-acquired infections (HAIs) remain a critical public health burden, contributing to increased morbidity, mortality, and healthcare costs. Hand hygiene (HH) is the cornerstone of infection prevention, yet compliance among healthcare workers (HCWs) is often suboptimal. Contemporary, concurrent assessments linking direct HH observation with real-time HAI rates are needed to validate this relationship in modern practice settings.

Objectives: This study aimed to: 1) Assess the overall and profession-specific HH compliance rates among HCWs in a tertiary hospital using direct observation, 2) Measure the point prevalence of key HAIs, and 3) Correlate unit-specific HH performance with corresponding HAI prevalence.

Methods: A hospital-wide cross-sectional assessment was carried out on a single day. Hand hygiene compliance was directly observed by trained staff following the WHO “My Five Moments for Hand Hygiene” approach. At the same time, the point prevalence of healthcare-associated infections was recorded, including ventilator-associated pneumonia, central line-associated bloodstream infections, catheter-associated urinary tract infections, and surgical site infections. Standard CDC/NHSN definitions were used for case identification. The collected data were summarized using descriptive statistics, and the association between variables was examined using Spearman’s rank correlation test.

Results: Overall HH compliance was 78.4% (1256/1602 observed moments). Compliance varied significantly by HCW profession: physicians 71.2%, nurses 82.1%, and ancillary staff 68.5%. The hospital-wide HAI point prevalence was 8.7% (89/1023 inpatients). A significant inverse correlation was found between ward-level HH compliance and HAI prevalence ($r_s = -0.72$, $p=0.008$).

Conclusion: Overall hand hygiene compliance was good; however, noticeable differences were seen between professional groups. Wards with better compliance tended to report fewer healthcare-associated infections, underscoring the importance of hand hygiene in routine patient care. There is a clear need for focused efforts to support and improve compliance among groups where performance remains suboptimal.

Keywords: Hand Hygiene; Cross-Sectional Studies; Hospital-Acquired Infection; Infection Control; Compliance.

INTRODUCTION

Hospital-acquired infections (HAIs) constitute a major threat to patient safety globally, leading to extended hospital stays, long-term disability, antimicrobial resistance, and significant additional financial costs for health systems [1]. Despite advancements in medical technology, HAIs affect millions of patients annually, with prevalence rates varying from 5% to 15% in developed countries and often exceeding this in resource-limited settings [2]. The transmission of pathogens primarily occurs via the contaminated hands of healthcare workers (HCWs), making hand hygiene (HH) the single most effective measure to interrupt this chain of infection [3]. The World Health Organization (WHO) launched the "Clean Care is Safer Care" campaign in 2005, promoting the "My Five Moments for Hand Hygiene" model, which has since become the global standard for HH practice and auditing [4]. While this framework has increased awareness, achieving sustained, high-level compliance among all categories of HCWs remains an elusive goal worldwide. Compliance rates are notoriously variable, influenced by a complex interplay of individual knowledge, institutional safety culture, workload, and access to resources [5]. Furthermore, the majority of evidence linking improved HH to reduced HAI rates comes from longitudinal interventional studies or quasi-experimental designs. There is a recognized gap in contemporary, snapshot assessments that capture a simultaneous, institution-wide picture of both HH performance and the burden of HAIs [6]. Such cross-sectional analyses provide a valuable, real-time benchmark of the relationship between practice and outcome, free from the temporal confounding of longer studies. The need for this study arises from the persistent challenge of HAIs and the critical requirement to validate the foundational assumption of infection prevention: that better hand hygiene leads to fewer infections, using immediate, correlative data. Most recent studies focus on compliance alone or on specific infection types. A concurrent, point-prevalence assessment covering multiple HAI types and correlating them directly with HH compliance at the ward level offers a powerful, holistic snapshot of a hospital's infection prevention ecosystem as it functions on a single day. This methodology can identify specific high-risk units and professional groups with precision, enabling targeted quality improvement.

Therefore, the aim of this single-centre, cross-sectional study was to conduct a comprehensive, concurrent assessment of HH compliance and HAI prevalence. The specific objectives were:

- 1) To determine the overall and profession-specific HH compliance rate among HCWs using direct observation according to the WHO "My Five Moments"
- 2) To measure the point prevalence of major HAIs (VAP, CLABSI, CAUTI, SSI) across all inpatient wards.
- 3) To analyze the correlation between unit-specific HH compliance rates and the corresponding point prevalence of HAIs.

MATERIAL AND METHODS

Study Design

A hospital-wide cross-sectional study was conducted over one day to evaluate hand hygiene compliance and healthcare-associated infection prevalence. The cross-sectional approach enabled both factors to be observed at the same time, providing a clear picture of their association without being affected by changes over time or intervention-related influences.

Study Setting

The study was carried out in a 750-bed public tertiary-care university hospital located in an urban area. The hospital offers a wide range of clinical services, including general medicine, general surgery, pediatrics, obstetrics and gynecology, orthopedics, and intensive care. All 32 inpatient wards and clinical units were included in the study, such as the medical intensive care unit, surgical intensive care unit, neonatal intensive care unit, and high-dependency units. The hospital had an established Infection Prevention and Control team, and alcohol-based hand rub was routinely available at ward entrances and at each patient bedside.

Study Population

The study population comprised two distinct groups:

For HH Observation: All HCWs (including physicians of all grades, registered nurses, nursing assistants, physiotherapists, and phlebotomists) performing direct patient care activities in the inpatient wards during the 12-hour observation period (07:00 to 19:00) were eligible for inclusion. Administrative staff and visitors were excluded.

For HAI Prevalence: All patients admitted to the inpatient wards before 08:00 on the study day and who did not have a discharge order were included. Patients in the emergency department, outpatient clinics, and day-care units were excluded.

Sample Size

For HH observation, a convenience sample of all observable moments during the 12-hour period across all wards was taken. To estimate the required patient sample for HAI prevalence with 95% confidence level, 5% margin of error, and an expected HAI prevalence of 10% based on previous hospital audits, a minimum sample size of 139 patients was calculated using the formula for single proportions: $n = (Z^2 * P(1-P)) / d^2$. Given a total inpatient census of approximately 1023, this was deemed sufficient.

Sampling Technique

A non-probability, total population sampling method was used for the HAI prevalence component, as all eligible inpatients were assessed. For HH observation, a mix of purposeful and convenience sampling was employed. Trained observers were stationed in pre-selected high-activity areas within each ward (e.g., nursing stations, areas around patient beds) to maximize the number of observables "Moments." Observations were conducted openly (non-covertly) as per the hospital's IPC audit policy, but HCWs were not informed of the specific study day to minimize the Hawthorne effect.

Data Collection Tools and Variables

On the same day, two separate data-gathering procedures were carried out.

Hand Hygiene Compliance: The standardized WHO Hand Hygiene Compliance Observation Form was used to gather data. This form keeps track of: Ward, Time, and Observer information.

- HCW Category: Ancillary Staff, Physician, and Nurse.
- Opportunity Type: Moment 1 (before contacting a patient), Moment 2 (before clean/aseptic process), Moment 3 (after bodily fluid exposure danger), Moment 4 (after touching a patient), and Moment 5 (after touching patient surroundings).
- Actions: Missed, used soap and water, and used ABHR.
- The formula for calculating compliance was (number of times HH was done / total number of observed chances) x 100.

HAI Point Prevalence Survey: A modified version of the European Centre for Disease Prevention and Control (ECDC) point prevalence survey was used to develop a standardized case report form for data collection. The survey process included two main steps:

a. Screening: Patient records were reviewed for signs of infection over the previous 48 hours. This included new antibiotic prescriptions, fever, purulent discharge, or positive culture results. Sources examined were medical records, nursing and temperature charts, microbiology reports, and drug administration records.

b. Validation: Patients identified during screening were further assessed by a senior member of the Infection Prevention and Control (IPC) team using CDC/NHSN criteria. Bedside evaluations and detailed chart reviews were conducted to confirm healthcare-associated infections (HAIs), excluding infections present on admission or still in the incubation phase.

Specific HAIs were clearly defined, including:

- Central Line-Associated Bloodstream Infection (CLABSI)
- Ventilator-Associated Pneumonia (VAP)
- Catheter-Associated Urinary Tract Infection (CAUTI)
- Surgical Site Infection (SSI)

Data were collected on patient demographics, ward location, use of medical devices, surgical procedures, antibiotic use, and the type of HAI.

Statistical Analysis

Data were entered into a Microsoft Excel spreadsheet and analyzed using IBM SPSS Statistics for Windows, Version 26.0. Descriptive statistics were used to summarize the data. Categorical variables (HCW profession, Moment type, HAI type) were presented as frequencies and percentages. Continuous variables (compliance percentage) were presented as mean $\pm$ standard deviation. The Chi-square test was used to compare HH compliance rates across professional categories and across the Five Moments. The point prevalence of HAI was calculated as (Number of patients with at least one HAI / Total number of surveyed patients) $\times$ 100. To address the primary objective of correlation, the Spearman's rank correlation coefficient (r_s) was computed to assess the strength and direction of the relationship between the HH compliance rate (independent variable) and the HAI point prevalence rate (dependent variable) at the ward/unit level ($n=32$ units). A p -value of <0.05 was considered statistically significant.

Ethical Consideration

Ethical approval for the study was obtained from the Institutional Review Board. The requirement for individual informed consent was waived for the hand hygiene (HH) observation component, as it was conducted as part of routine quality assurance and assessment of standard clinical practice. For the healthcare-associated infection (HAI) point prevalence survey, patient data were collected retrospectively from medical records, with all identifiers removed to ensure anonymity. Strict confidentiality of all information was maintained, and data were used solely for the objectives of this study. The study was conducted in full compliance with the ethical principles outlined in the Declaration of Helsinki, ensuring respect for patient rights and adherence to internationally recognized research standards.

RESULTS

During the 12-hour observation period across 32 wards, a total of 1602 HH opportunities were observed. The overall HH compliance rate was 78.4% (1256/1602). Compliance varied significantly among different professional groups ($\chi^2 = 45.3$, $p < 0.001$). Nurses demonstrated the highest compliance at 82.1% (745/907), followed by physicians at 71.2% (344/483), and ancillary staff at 68.5% (167/244).

Table 1: Hand Hygiene Compliance by Healthcare Worker Profession.

Healthcare Worker Profession	Observed Opportunities	Compliance Actions	Compliance Rate (%)
Physician	483	344	71.2
Nurse	907	745	82.1
Ancillary Staff	244	167	68.5
Total	1602	1256	78.4

Analysis by the WHO "My Five Moments" revealed significant differences in compliance depending on the indicated moment ($\chi^2 = 61.8$, $p < 0.001$). Compliance was highest for Moment 4 (After touching a patient) at 85.2% and Moment 3 (After body fluid exposure risk) at 83.5%. Lower compliance was

observed for Moment 1 (Before touching a patient) at 74.1%, Moment 5 (After touching patient surroundings) at 73.8%, and notably, Moment 2 (Before clean/aseptic procedure) at 70.3%.

Table 2: Hand Hygiene Compliance by WHO My Five Moments.

WHO Moment	Description	Observed Opportunities	Compliance Rate (%)
Moment 1	Before touching a patient	420	74.1
Moment 2	Before clean/aseptic procedure	185	70.3
Moment 3	After body fluid exposure risk	200	83.5
Moment 4	After touching a patient	452	85.2
Moment 5	After touching the patient's surroundings	345	73.8

Concurrently, the HAI point prevalence survey included 1023 inpatients. The overall point prevalence of HAI was 8.7% (89 patients). Among these 89 patients, a total of 94 HAIs were identified. The distribution of infection types is presented in Table 3. CAUTI was the most common HAI (32.3%), followed by SSI (24.7%) and CLABSI (22.6%). The highest burden of HAIs was found in the intensive care units, with the SICU showing a prevalence of 28.6% and the MICU 22.2%.

Table 3: Point Prevalence of Hospital-Acquired Infections (HAIs) by Type.

HAI Type	Number of Cases	Percentage of Total HAIs (%)
CAUTI	30	32.3
SSI	23	24.7
CLABSI	21	22.6
VAP	13	14.0
Others	6	6.4
Total	93	100

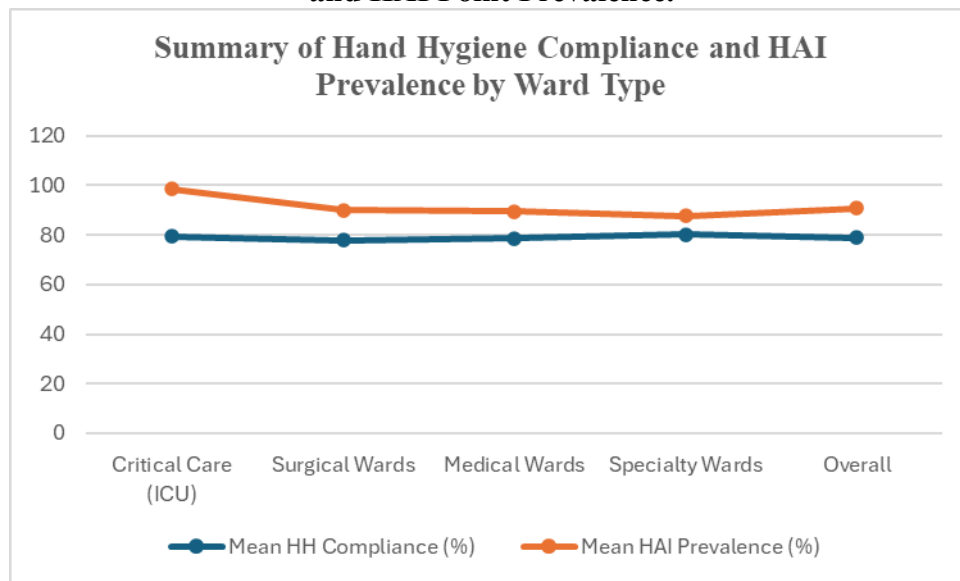
***Other includes hospital-acquired pneumonia (non-ventilated) and gastroenteritis.**

The correlation between ward-level HH compliance and HAI prevalence is displayed in Figure 1. A scatter plot illustrates the distribution of the 32 wards. Statistical analysis using Spearman's rank correlation revealed a strong, statistically significant inverse correlation between the two variables ($r_s = -0.72$, $p = 0.008$). Wards with higher HH compliance rates consistently demonstrated lower point prevalence rates of HAIs. A scatter plot with HH Compliance % on the X-axis (range 60-95%) and HAI Prevalence % on the Y-axis (range 0-30%). The plot shows a downward trend, with a trend line indicating a negative correlation.

Table 4: Summary of Hand Hygiene Compliance and HAI Prevalence by Ward Type.

Ward Type	Number of Wards	Mean HH Compliance (%)	Mean HAI Prevalence (%)
Critical Care (ICU)	4	79.5	19.0
Surgical Wards	10	77.8	12.1
Medical Wards	10	78.6	10.9
Specialty Wards	8	80.1	7.5
Overall	32	78.9	11.8

Figure 1: Scatter Plot Showing Correlation between Ward-Level Hand Hygiene Compliance and HAI Point Prevalence.



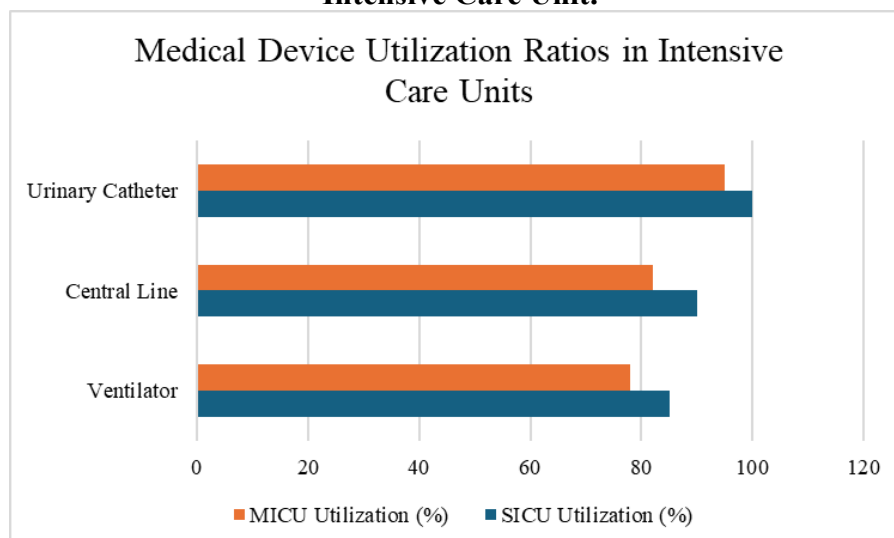
Further analysis by ward category (Figure 1) revealed distinct patterns across different clinical areas. Critical care units (ICUs) demonstrated the highest mean HAI prevalence (19.0%) despite showing relatively high hand hygiene compliance (79.5%). In contrast, specialty wards exhibited the best overall performance with the highest mean compliance (80.1%) and lowest HAI prevalence (7.5%). Surgical and medical wards showed intermediate values, with surgical wards having slightly lower compliance (77.8%) and higher HAI rates (12.1%) compared to medical wards (78.6% compliance, 10.9% HAI prevalence).

Table 5: Medical Device Utilization Ratios in Intensive Care Units.

Device Type	SICU Utilization (%)	MICU Utilization (%)
Ventilator	85	78
Central Line	90	82
Urinary Catheter	100	95

Note: SICU = Surgical Intensive Care Unit; MICU = Medical Intensive Care Unit.

Figure 2: Comparative Analysis of Medical Device Utilization in Surgical and Medical Intensive Care Unit.



Medical device use differed between the surgical and medical intensive care units. In the SICU, device utilization was consistently higher across all categories, with urinary catheters used in every patient. This greater reliance on invasive devices appears to contribute to the higher prevalence of healthcare-associated infections observed in the SICU (28.6%) compared with the MICU (22.2%). Notably, this difference was seen despite similar levels of hand hygiene compliance in both units, suggesting that increased device exposure may play an important role in infection risk.

DISCUSSION

This single-day cross-sectional study provides a contemporary overview of the relationship between hand hygiene (HH) practices and the burden of hospital-acquired infections (HAIs). The overall HH compliance rate of 78.4% observed in this study is comparable to rates reported in similar tertiary care hospitals during the recent pre-pandemic period, although it remains below the optimal benchmark of greater than 90% frequently recommended in the literature [7,8]. A significant variation in compliance was noted among different professional groups, with physicians and ancillary staff demonstrating lower adherence compared to nursing staff. This finding is consistent with reports from multiple international studies and suggests that uniform, hospital-wide HH promotion strategies may not adequately address profession-specific challenges [9,10]. Factors such as time constraints, perceived professional roles, and hierarchical workplace culture may contribute to these differences, highlighting the need for targeted, multimodal interventions. Of particular concern was the lower compliance observed for WHO Moment 2 (before clean/aseptic procedures). This moment is critical for preventing procedure-related infections, including central line-associated bloodstream infections (CLABSI) and surgical site infections (SSI). Reduced adherence at this point suggests a potential gap in risk perception or understanding of aseptic practices, emphasizing the need for focused education and reinforcement in this area [11]. The overall HAI point prevalence of 8.7% falls within the range reported by point prevalence surveys conducted in European and North American hospitals [12]. Catheter-associated urinary tract infections (CAUTI) were the most prevalent, followed by SSI and CLABSI, reflecting patterns commonly documented in acute care settings. These findings underscore the persistent challenge of preventing infections associated with invasive devices and surgical procedures [13]. As expected, the infection burden was highest in intensive care units, attributable to patient vulnerability and higher device utilization ratios. This reinforces that while HH remains a fundamental component of infection prevention, it must be integrated within comprehensive prevention bundles such as those for CLABSI and ventilator-associated pneumonia (VAP) particularly in high-risk settings [14]. The central finding of this study is the strong and statistically significant inverse correlation between ward-level HH compliance and HAI prevalence (Spearman's $r = -0.72$). This result provides robust cross-sectional evidence supporting the foundational role of HH in infection prevention. It complements findings from longitudinal interventional studies by demonstrating that, at a given point in time, wards with higher HH compliance exhibit a lower immediate burden of infection [15]. These findings support the use of HH compliance as a key performance indicator within infection prevention and control (IPC) programs.

However, the results should be interpreted with caution, as correlation does not imply causation. The ward-level ecological analysis may be influenced by confounding factors such as patient case mix, severity of illness, nurse-to-patient ratios, and antimicrobial stewardship practices [16]. The surgical intensive care unit serves as an illustrative outlier, showing relatively high HH compliance alongside the highest HAI prevalence. This highlights that HH, while essential, is not sufficient on its own to offset the elevated risks associated with critically ill patients and extensive device exposure, underscoring the importance of a synergistic, multifaceted prevention approach. The strengths of this study include its concurrent assessment design, use of internationally standardized WHO and CDC/NHSN definitions, and hospital-wide coverage that enabled unit-level comparisons. Although direct observation of HH is subject to the Hawthorne effect, it remains the gold standard for assessing HH behavior and moment-specific compliance [17]. Limitations include the single-center design, which may limit generalizability, and the cross-sectional methodology, which precludes establishing

temporal relationships or causality. Additionally, the single-day snapshot may not fully capture routine variations in HH compliance or patient admission patterns.

In conclusion, this study reinforces that HH compliance is a critical and measurable predictor of HAI burden at the ward level. It highlights the need for a dual strategy: first, implementing targeted, data-driven interventions to address persistently lower compliance among physicians and ancillary staff, particularly before aseptic procedures; and second, ensuring that in high-risk units such as ICUs, high HH compliance is embedded within rigorously applied, evidence-based infection prevention bundles. Future studies employing longitudinal or repeated cross-sectional designs are recommended to evaluate how this relationship evolves over time in response to specific interventions.

CONCLUSION

This cross-sectional study successfully achieved its objectives. It determined an overall hand hygiene compliance of 78.4%, with significant disparities favouring nurses over physicians and ancillary staff and identified Moment 2 (Before aseptic procedure) as the most frequently missed opportunity. It established a hospital-wide HAI point prevalence of 8.7%, dominated by CAUTI, SSI, and CLABSI. Most significantly, it demonstrated a strong inverse correlation between ward-level HH compliance and HAI prevalence, empirically supporting the central role of hand hygiene in infection prevention. The findings highlight the urgent need for profession-specific and moment-specific training interventions, and affirm that hand hygiene is a necessary, though sometimes insufficient, component of a comprehensive strategy to reduce the burden of hospital-acquired infections.

REFERENCE

1. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. *Lancet*. 2011 Jan 15;377(9761):228-41.
2. Haque M, Sartelli M, McKimm J, Abu Bakar M. Health care-associated infections - an overview. *Infect Drug Resist*. 2018 Nov 15;11:2321-33.
3. Pittet D, Hugonnet S, Harbarth S, Mourouga P, Sauvan V, Touveneau S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Infection Control Programme*. *Lancet*. 2000 Oct 14;356(9238):1307-12.
4. Sax H, Allegranzi B, Uçkay I, Larson E, Boyce J, Pittet D. 'My five moments for hand hygiene': a user-centred design approach to understand, train, monitor and report hand hygiene. *J Hosp Infect*. 2007 Sep;67(1):9-21.
5. Erasmus V, Doha TJ, Brug H, Richardus JH, Behrendt MD, Vos MC, et al. Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infect Control Hosp Epidemiol*. 2010 Mar;31(3):283-94.
6. Stiller A, Salm F, Bischoff P, Gastmeier P. Relationship between hospital ward design and healthcare-associated infection rates: a systematic review and meta-analysis. *Antimicrob Resist Infect Control*. 2021 Jan 7;10(1):12.
7. Mathur P. Hand hygiene: back to the basics of infection control. *Indian J Med Res*. 2020 Feb;151(2):118-20.
8. Lee MH, Lee GA, Lee SH, Park YH. Effectiveness and core components of infection prevention and control programmes in long-term care facilities: a systematic review. *J Hosp Infect*. 2019 Sep;103(1):92-95.
9. Price L, MacDonald J, Melone L, Howe T, Flowers P, Cleary K, et al. Effectiveness of national and subnational infection prevention and control interventions in high-income and upper-middle-income countries: a systematic review. *Lancet Infect Dis*. 2018 May;18(5):e159-e171.
10. Azim S, Juergens C, McLaws ML. An average hand hygiene day for nurses and physicians: the burden is not equal. *Am J Infect Control*. 2020 May;48(5):507-511.

11. *Saito H, Inoue K, Ditai J, Wanume B, Abeso J, Balyejussa J, et al.* Alcohol-based hand rub and incidence of healthcare-associated infections in a rural hospital in Uganda. *Antimicrob Resist Infect Control*. 2021 Jan 20;10(1):17.
12. *Suetens C, Latour K, Kärki T, Ricchizzi E, Kinross P, Moro ML, et al.* Prevalence of healthcare-associated infections, estimated incidence and composite antimicrobial resistance index in acute care hospitals and long-term care facilities: results from two European point prevalence surveys, 2016 to 2017. *Euro Surveill*. 2018 Nov;23(46).
13. *Weiner-Lastinger LM, Abner S, Edwards JR, Kallen AJ, Karlsson M, Magill SS, et al.* Antimicrobial-resistant pathogens associated with adult healthcare-associated infections: Summary of data reported to the National Healthcare Safety Network, 2015-2017. *Infect Control Hosp Epidemiol*. 2020 Jan;41(1):1-18.
14. *Ista E, van der Hoven B, Kornelisse RF, van der Starre C, Vos MC, Boersma E, et al.* Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis. *Lancet Infect Dis*. 2016 Jun;16(6):724-34.
15. *Zellmer C, Blakney R, Van Hoof S, Safdar N.* Impact of sink location on hand hygiene compliance for *Clostridium difficile* infection. *Am J Infect Control*. 2019 May;47(5):583-584.
16. *Mitchell BG, Shaban RZ, MacBeth D, Wood CJ, Russo PL.* The burden of healthcare-associated infection in Australian hospitals: A systematic review of the literature. *Infect Dis Health*. 2017 Sep;22(3):117-128.
17. *Ward DJ.* The Hawthorne effect on hand hygiene compliance: A note of caution. *Am J Infect Control*. 2020 Oct;48(10):1130-1132.