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Original Paper

Patient Safety Culture and Nurses' Compliance with Healthcare-Associated Infection Control Standards in Iraqi Teaching Hospitals: A Multicenter Cross-Sectional Correlational Study

Anaam Katran Zughair
College of Nursing, Al-Turath University, Baghdad, Iraq
Correspondence email | anaam.katran@uoturath.edu.iq
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ABSTRACT

Background: Healthcare-associated infections (HAIs) remain a leading cause of preventable harm in low- and middle-income hospitals. Patient safety culture is a recognized organizational determinant of nurses' adherence to infection-control standards, but multicenter Iraqi data linking the two are limited. **Aim:** To characterize patient safety culture among nurses in four Iraqi teaching hospitals using the AHRQ Hospital Survey on Patient Safety Culture (HSOPSC), measure observed compliance with HAI-control standards, and quantify the association between safety culture and compliance. **Methods:** A multicenter cross-sectional correlational study was conducted between September 2025 and February 2026 across the medical–surgical, intensive care, emergency, and neonatal wards of four teaching hospitals in central and northern Iraq, in line with the STROBE statement. The protocol was prospectively registered (ATU-RIR-2025-14, registered 5 September 2025). The HSOPSC (42 items, 12 dimensions) was administered to 380 eligible nurses; 358 returned complete responses (response rate 94.2%). Direct unobtrusive observation captured 1,200 hand-hygiene opportunities using the WHO Five Moments framework, alongside structured audits of personal protective equipment (PPE), sharps and waste management, isolation precautions, and environmental hygiene. Pearson correlations and multivariable linear regression with cluster-robust standard errors at the hospital level were used to identify predictors of total HAI compliance. **Results:** Overall HSOPSC positive response rate was 56.4% across 12 dimensions, with the highest rates for teamwork within units (78.4%) and organizational learning (71.2%), and the lowest for non-punitive response to error (38.1%) and staffing adequacy (42.7%). Mean overall HAI compliance was 68.5% (95% CI 66.4–70.6); hand hygiene compliance was 64.2%, PPE 71.4%, sharps and waste 78.6%, isolation precautions 65.1%, and environmental hygiene 63.2%. Total HSOPSC score correlated moderately with overall HAI compliance ($r = 0.42$, $p < 0.001$); the strongest dimension-level correlations were management support for safety ($r = 0.46$) and feedback and communication ($r = 0.41$). In the adjusted model, total HSOPSC score ($\beta = 0.34$, $p < 0.001$), prior infection-control training ($\beta = 0.21$, $p < 0.001$), and ICU posting ($\beta = 0.17$, $p = 0.004$) independently predicted higher HAI compliance. **Conclusion:** Patient safety culture is a meaningful, modifiable predictor of HAI compliance among Iraqi teaching-hospital nurses. Hospital management should prioritize improvements in non-punitive error reporting, staffing adequacy, and management visibility around safety, alongside repeated infection-control training. The two-instrument framework used here is feasible for routine quality monitoring.

KEYWORDS: *Cross-Infection; Hand Hygiene; Hospitals, Teaching; Iraq; Nurses; Patient Safety; Safety Culture*

1-INTRODUCTION

Healthcare-associated infections (HAIs) remain among the most preventable yet persistent causes of patient harm worldwide, with the World Health Organization estimating that, on average, between seven and ten percent of inpatients in low- and middle-income countries acquire at least one HAI during their hospital stay [1,2]. The clinical and economic burden is substantial: HAIs prolong length of stay, increase antimicrobial use, raise mortality, and inflate hospital costs in ways that fall disproportionately on resource-constrained health systems [3]. Although clinical, environmental, and antimicrobial determinants are well characterized, the organizational determinants of frontline staff behavior—particularly the culture of patient safety in which nurses make moment-to-moment infection-control choices—are less well quantified.

Patient safety culture, conceptualized as the shared values, beliefs, and norms that shape how staff approach safety in their daily work, has been operationalized most widely through the Agency for Healthcare Research and Quality's Hospital Survey on Patient Safety Culture (HSOPSC) [4]. The HSOPSC measures twelve dimensions, ranging from teamwork within and across units to non-punitive response to error, organizational learning, and management support for safety. International evidence suggests that hospitals with stronger safety culture exhibit lower HAI rates, fewer medication errors, better hand-hygiene performance, and lower nurse

turnover [5,6]. Within nursing specifically, dimensions related to communication, error reporting, and management visibility have shown the most consistent associations with adherence behaviors [7,8].

Iraqi teaching hospitals operate under cumulative pressures—periodic infrastructure stress, intermittent resource availability, and varying degrees of digital record adoption—that plausibly weaken safety-culture maturity. Earlier single-site Iraqi reports have indicated moderate HSOPSC performance with persistent weaknesses in error reporting and staffing [9,10], but multicenter data linking safety culture to objectively measured HAI compliance behavior in Iraqi nursing wards remain limited. We therefore designed a multicenter cross-sectional correlational study to (i) characterize the safety-culture profile of nurses in four Iraqi teaching hospitals using the HSOPSC, (ii) measure observed nurse compliance with five HAI-control domains using direct observation and structured audit, and (iii) quantify the association between safety culture and compliance, with a view to identifying the most actionable institutional levers.

2. MATERIALS AND METHODS

2.1 Study Design, Setting, and Reporting

We conducted a multicenter cross-sectional correlational study between September 14, 2025 and February 7, 2026 across four government teaching hospitals in central and northern Iraq: Salah Al-Din General Teaching Hospital, Tikrit Teaching Hospital, Baghdad Teaching Hospital, and Kirkuk General Teaching Hospital. The four sites were selected for broadly comparable bed capacity (450–620 inpatient beds), comparable nursing-staffing frameworks, and the presence of an active infection-control committee at each hospital. Reporting follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [11] for cross-sectional studies. The protocol, statistical analysis plan, and outcome definitions were prospectively registered (the Al-Turath University Research Implementation Registry, ATU-RIR-2025-14, registered 5 September 2025) before data collection began.

2.2 Participants and Sampling

Eligible participants were registered nurses with at least six months of continuous experience in medical–surgical, intensive care, emergency, or neonatal wards at one of the four participating hospitals. Nurses on long-term medical or maternity leave, nurses who had been on the unit for fewer than six months, and nurses who declined consent were excluded. Sample-size calculation assumed a moderate population correlation between safety culture and HAI compliance of $r = 0.30$ (informed by international literature [5,7]), $\alpha = 0.05$, and 90% power, yielding a minimum required sample of 110; this was inflated to allow for hospital-level clustering and ward-stratified analysis, with a target of 350 nurses across the four sites. Stratified proportional sampling was applied: the proportion of nurses recruited at each hospital matched its share of the total eligible nursing workforce, and within each hospital the sample was stratified by ward type.

2.3 Instruments

Three measurement tools were used. (i) The Hospital Survey on Patient Safety Culture (HSOPSC) [4] is a 42-item validated instrument measuring 12 dimensions of patient safety culture on a 5-point Likert scale (strongly disagree to strongly agree, or never to always). Following the AHRQ scoring convention, items were dichotomized into positive responses (4–5 on positively worded items, 1–2 on negatively worded items) and the dimension-level positive response rate was reported as the percentage of positive responses among all responses to that dimension's items. The publisher-licensed Arabic version was used [12]. (ii) Hand-hygiene compliance was measured by direct, unobtrusive observation following the WHO Five Moments for Hand Hygiene framework [13], with each opportunity recorded as performed, missed, or partially performed. Two trained observers (kappa for inter-rater agreement = 0.83 in the pre-study calibration) collected observations across morning, afternoon, and night shifts at each site to minimize observation-time bias. (iii) Compliance with the four other HAI-control domains—personal protective equipment (PPE) use, sharps and waste management, isolation precautions, and environmental hygiene—was measured using a structured 28-item audit checklist developed from WHO and CDC guidance [14,15], with each item scored as compliant or non-compliant.

In the present sample, internal consistency (Cronbach's α) for the HSOPSC dimensions ranged from 0.71 (staffing) to 0.88 (teamwork within units), with an overall scale α of 0.91. Inter-rater agreement on the audit checklist (independent rescoring of 80 randomly selected audit forms) yielded a kappa of 0.79. The full audit instrument and observation protocol are available from the corresponding author.

2.4 Data Collection

Data collection used a hybrid approach. The HSOPSC questionnaire was administered as a paper instrument distributed by trained on-site research assistants during one of three pre-arranged ward visits per shift, with

sealed-envelope return to protect anonymity. Reminders were issued at one and two weeks. Hand-hygiene observations totaled 1,200 opportunities (300 per hospital, balanced across shifts and the WHO Five Moments). The audit checklist was completed quarterly per ward by the trained observer pair, with random ward selection within each hospital. All forms were entered twice and reconciled.

2.5 Ethical Considerations and Registration

The study was approved by the Research Ethics Committee of Al-Turath University (approval ATU-RE-2025-167) and by the local research committees and infection-control committees of each participating hospital. Written informed consent was obtained from every nurse for the questionnaire component; for hand-hygiene observation, blanket consent at the unit level was obtained in line with WHO observational ethics guidance [13]. The protocol was prospectively registered (ATU-RIR-2025-14, 5 September 2025). No identifying information about individual nurses was retained on the observation forms; observations were aggregated to the unit level for analysis. The study followed the Declaration of Helsinki principles.

2.6 Statistical Analysis

Continuous variables are presented as mean ± SD and categorical variables as frequencies and percentages. HSOPSC dimension-level positive response rates are reported as percentages with 95% confidence intervals computed using the Wilson score method. HAI compliance rates were calculated as the number of compliant observations or audit items divided by the total, expressed as a percentage with Wilson 95% CIs. Pearson correlation coefficients were computed between the HSOPSC total positive response rate and overall HAI compliance, and between each HSOPSC dimension and HAI compliance. Multivariable linear regression with cluster-robust standard errors at the hospital level was used to identify independent predictors of overall HAI compliance; predictors entered the model based on bivariate associations at $p < 0.20$ and theoretical relevance, with backward elimination at $p < 0.10$. Variance inflation factors and residual diagnostics were inspected. The model was internally validated using 10-fold cross-validation. Two-sided p-values < 0.05 were considered statistically significant. Analyses used SPSS version 27 (IBM Corp., Armonk, NY) and R version 4.3.2 (R Foundation, Vienna, Austria).

3. RESULTS

3.1 Response Rate and Sample Characteristics

Of 380 eligible nurses approached, 358 returned complete HSOPSC questionnaires (response rate 94.2%). The 22 non-respondents did not differ significantly from respondents in age, sex distribution, or hospital affiliation. Sample characteristics are summarized in Table 1. Most respondents were women (76.5%), held a Bachelor's degree in nursing (62.8%), and had worked for at least three years on their current unit (66.5%). Mean age was 32.7 ± 7.4 years and mean nursing experience was 8.6 ± 5.7 years. Prior structured infection-control training in the past 24 months was reported by 53.1%.

3.2 Patient Safety Culture (HSOPSC)

HSOPSC dimension-level positive response rates are summarized in Table 2. The overall positive response rate across the 12 dimensions was 56.4% (95% CI 54.7–58.1), placing the participating hospitals at the lower end of the moderate band by AHRQ benchmarks. Two dimensions reached the strong-area threshold (≥75% positive): teamwork within units (78.4%) and organizational learning–continuous improvement (71.2%). Five dimensions fell below the weak-area threshold (≤50% positive), most prominently non-punitive response to error (38.1%), staffing adequacy (42.7%), and handoffs and transitions (45.3%). Hospital-level variation was modest (range of overall positive response 53.1–59.8%, ANOVA $p = 0.221$), indicating broadly comparable safety-culture profiles across the four sites.

Table 1. Demographic and occupational characteristics of the 358 nurses surveyed.

Characteristic	n (%) or mean ± SD	Range / categories
Age (years)	32.7 ± 7.4	21–58
Sex: Female	274 (76.5)	—
Sex: Male	84 (23.5)	—
Education: Diploma	104 (29.1)	—
Education: Bachelor's degree	225 (62.8)	—
Education: Master's degree	29 (8.1)	—
Total nursing experience (years)	8.6 ± 5.7	1–32
Years on current ward	4.4 ± 3.2	0.5–18
Time on current ward ≥3 years	238 (66.5)	—
Ward: Medical–surgical	138 (38.5)	—
Ward: Intensive care unit	94 (26.3)	—
Ward: Emergency department	78 (21.8)	—
Ward: Neonatal	48 (13.4)	—
Prior infection-control training (past 24 mo)	190 (53.1)	—
Hours worked per week (mean)	44.6 ± 6.8	32–62
Hospital: Salah Al-Din	98 (27.4)	—
Hospital: Tikrit	82 (22.9)	—
Hospital: Baghdad	97 (27.1)	—
Hospital: Kirkuk	81 (22.6)	—

Note: *SD = standard deviation. Education category percentages do not sum to 100 due to rounding. Prior infection-control training refers to any structured course ≥4 hours in the past 24 months.*

3.3 HAI Control Compliance

Overall observed HAI compliance was 68.5% (95% CI 66.4–70.6) across the five domains (Table 3). The strongest domain was sharps and waste management (78.6%), where simple, observable handling rules and direct supervision tend to drive higher adherence; the weakest was environmental hygiene (63.2%). Hand-hygiene compliance, calculated across 1,200 directly observed opportunities using the WHO Five Moments framework, was 64.2% overall, with the lowest performance on Moment 1 (before patient contact, 56.4%) and the highest on Moment 3 (after body-fluid exposure, 81.7%). Compliance was significantly higher among nurses with prior structured infection-control training (mean 73.9% vs 63.6% in untrained, $p < 0.001$) and in ICU and neonatal wards compared with medical–surgical and emergency wards (74.8% vs 64.5%, $p < 0.001$).

Table 2. HSOPSC dimension-level positive response rates (n = 358 nurses, 12 dimensions).

HSOPSC dimension	Positive response rate (%)	95% CI	Cronbach α
Teamwork within units	78.4	75.7–80.9	0.88
Organizational learning—continuous improvement	71.2	68.3–73.9	0.83
Supervisor expectations and actions promoting safety	63.5	60.4–66.5	0.81
Feedback and communication about errors	61.8	58.7–64.8	0.79
Frequency of events reported	59.0	55.9–62.0	0.86
Communication openness	57.6	54.5–60.6	0.74
Overall perceptions of patient safety	55.4	52.3–58.4	0.78
Management support for patient safety	54.2	51.1–57.2	0.81
Teamwork across units	51.7	48.6–54.8	0.78
Handoffs and transitions	45.3	42.2–48.4	0.74
Staffing	42.7	39.7–45.8	0.71
Non-punitive response to error	38.1	35.1–41.2	0.76
Total HSOPSC (12 dimensions, weighted)	56.4	54.7–58.1	0.91 (overall)

Note: *HSOPSC = Hospital Survey on Patient Safety Culture (AHRQ). Positive response rate is the percentage of items rated 4–5 on positively worded items or 1–2 on negatively worded items, calculated across all respondents and items within each dimension. Wilson score method was used for the 95% CIs. AHRQ benchmark bands: ≥75% strong, 50–74% moderate, <50% weak.*

Table 3. HAI compliance by domain and correlation with HSOPSC dimensions.

Domain	Compliance % (95% CI)	Pearson r vs HSOPSC total	Strongest dimension correlate
Hand hygiene (1,200 observations)	64.2 (61.5–66.9)	0.39*	Management support (r = 0.43*)
Personal protective equipment	71.4 (68.7–73.9)	0.36*	Feedback and communication (r = 0.40*)
Sharps and waste management	78.6 (76.1–80.9)	0.28*	Supervisor expectations (r = 0.31*)
Isolation precautions	65.1 (62.3–67.8)	0.41*	Management support (r = 0.45*)
Environmental hygiene	63.2 (60.4–65.9)	0.34*	Organizational learning (r = 0.38*)
Overall HAI compliance (5 domains)	68.5 (66.4–70.6)	0.42*	Management support (r = 0.46*)

Note: *Compliance percentages are calculated across all observed opportunities (hand hygiene) or audit items (other domains).* ******* *$p < 0.001$ for Pearson correlation. HSOPSC = Hospital Survey on Patient Safety Culture. Wilson score method was used for the 95% CIs.*

3.4 Association between Safety Culture and HAI Compliance

The total HSOPSC positive response rate correlated moderately with overall HAI compliance (Pearson r = 0.42, 95% CI 0.33–0.50, p < 0.001). Among the 12 HSOPSC dimensions, the strongest correlations with HAI compliance were management support for patient safety (r = 0.46, p < 0.001), feedback and communication about errors (r = 0.41, p < 0.001), supervisor expectations (r = 0.39, p < 0.001), and organizational learning (r = 0.36, p < 0.001). The weakest correlations were with non-punitive response to error (r = 0.18, p = 0.001) and staffing (r = 0.21, p < 0.001)—both of which were also the weakest culture areas in absolute terms (Table 2), suggesting that improvement in these dimensions would offer headroom on both fronts.

In the multivariable linear regression with cluster-robust standard errors at the hospital level (Table 4), three factors independently predicted higher overall HAI compliance: total HSOPSC score (β = 0.34, 95% CI 0.23–0.45, p < 0.001), prior infection-control training in the past 24 months (β = 0.21, 0.10–0.32, p < 0.001), and ICU posting (β = 0.17, 0.05–0.29, p = 0.004). Years of nursing experience and ward seniority showed positive but non-significant trends. The model's apparent adjusted R^2 was 0.36; cross-validated R^2 (10-fold) was 0.33. Variance inflation factors were all below 1.7.

Table 4. Multivariable linear regression of factors associated with overall HAI compliance (n = 358).

Predictor	β (std.)	SE	95% CI	p-value
Total HSOPSC positive response rate	0.34	0.06	0.23 to 0.45	<0.001*
Prior infection-control training (past 24 mo)	0.21	0.06	0.10 to 0.32	<0.001*
Ward: ICU (vs medical–surgical)	0.17	0.06	0.05 to 0.29	0.004*
Ward: Neonatal (vs medical–surgical)	0.13	0.06	0.01 to 0.25	0.038*
Master's degree	0.10	0.06	−0.02 to 0.22	0.094
Years on current ward (per year)	0.08	0.05	−0.02 to 0.18	0.122
Total nursing experience (per year)	0.06	0.05	−0.04 to 0.16	0.241
Hours worked per week (per hour)	−0.05	0.05	−0.15 to 0.05	0.314
Female sex	0.04	0.06	−0.08 to 0.16	0.512

Note: *β = standardized regression coefficient; SE = standard error; CI = confidence interval. Estimates derive from a single multivariable linear regression model with cluster-robust standard errors at the hospital level. * p < 0.05. Apparent adjusted R^2 = 0.36; 10-fold cross-validated R^2 = 0.33; F(9, 348) = 23.4, p < 0.001. Variance inflation factors all <1.7. Dependent variable is overall HAI compliance (5-domain composite, 0–100%).*

4. DISCUSSION

This multicenter study of 358 nurses across four Iraqi teaching hospitals provides three principal findings. First, the overall patient safety culture is at the lower end of the moderate band by AHRQ benchmarks (HSOPSC overall positive response 56.4%), with consistent strengths in unit-level teamwork and organizational learning, and consistent weaknesses in non-punitive response to error and staffing. Second, observed HAI compliance averages 68.5% across five domains, with hand hygiene at 64.2%—broadly aligned with low- and middle-income hospital benchmarks summarized in WHO syntheses [1,3] but well below the targets typically pursued in high-resource settings [16]. Third, total safety-culture score is a meaningful, modifiable independent predictor of HAI compliance after adjustment for training, ward type, and experience (β = 0.34, p < 0.001), supporting the international observation that safety culture and adherence behavior co-evolve and should be addressed jointly rather than separately [5–7].

The dimensions most strongly associated with HAI compliance—management support for safety, feedback and communication, supervisor expectations, and organizational learning—are precisely the dimensions over which hospital leadership has direct, low-cost control. Visible management presence on infection-control rounds, structured weekly safety briefings, transparent feedback on observed compliance trends, and a documented commitment to learning from near-misses have each been shown to shift culture metrics within months, and the present data suggest that compliance benefits would follow [17–19]. By contrast, the two

weakest culture dimensions—non-punitive response to error and staffing—correlated less strongly with compliance in absolute terms, in part because their floor effects compress variance; nevertheless, both are widely reported as foundational to sustained safety improvement [20,21], and both are amenable to intervention through clear written reporting policies and systematic ratio review. The combination of weak baseline performance and modest correlation in our data should be read as an opportunity rather than a reason for deprioritization.

Two implementation considerations follow. From a measurement perspective, the two-instrument framework used here—a structured staff survey paired with direct observational compliance—is feasible in Iraqi teaching hospitals at a quarterly cadence and could be adopted as a routine quality-monitoring package. The infrastructure required (trained observers, simple paper or tablet forms, an annual HSOPSC sweep) is already present in most teaching hospital infection-control committees and would not require capital investment. From an intervention-design perspective, the data argue for a paired strategy: continued investment in structured infection-control training, which independently predicts compliance ($\beta = 0.21$), alongside leadership-focused culture interventions targeting management support, feedback, and non-punitive reporting. Either component in isolation is unlikely to yield the maximum benefit visible in our data.

Limitations should be acknowledged. First, the cross-sectional design cannot establish causation; the safety-culture-to-compliance arrow is consistent with theory and prior longitudinal work [5,17] but is not proven by these data alone. Second, hand-hygiene observation is subject to a known Hawthorne effect: the presence of an observer typically inflates compliance [22]. Although we used unobtrusive observation and rotated observation times, some inflation is likely, and the true compliance level in routine practice may be modestly lower than 64.2%. Third, the audit checklist was investigator-developed from WHO and CDC source guidance and, while it showed acceptable inter-rater agreement, has not been externally validated; convergence with other established audit tools (e.g., the IPC Assessment Framework) is a useful next step. Fourth, the participating hospitals are large urban teaching institutions; rural and small-district Iraqi facilities may show different patterns. Fifth, no patient-level outcome data (HAI rates) were collected; whether the variation in compliance translates into measurable differences in HAI incidence is the question of greatest patient interest and requires a longitudinal design with clinical surveillance.

5. CONCLUSIONS

Patient safety culture in four Iraqi teaching hospitals is moderate by AHRQ benchmarks, with consistent strengths in unit-level teamwork and persistent weaknesses in non-punitive error response and staffing. Observed nurse HAI compliance averages 68.5% across five domains and is independently predicted by safety culture ($\beta = 0.34$), prior infection-control training ($\beta = 0.21$), and ICU posting ($\beta = 0.17$). The combination of measured culture and observed behavior used here is feasible, low-cost, and adoptable for routine quarterly monitoring. Hospital leadership should pair sustained infection-control training with deliberate culture-improvement work—particularly visible management commitment, structured feedback on observed compliance, and clear non-punitive error-reporting frameworks—to move both indicators upward together. Longitudinal designs that link these two indicators to HAI rates and to patient-level outcomes are the natural next step.

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