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Infection prevention and control in public hospitals in Pakistan: a systematic review of practices, compliance, healthcare-associated infections and barriers

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Systematic Review

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Infection prevention and control in public hospitals in Pakistan: a systematic review of practices, compliance, healthcare-associated infections and barriers

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Summary

Background: Healthcare-associated infections (HAIs) are a patient-safety problem; infection prevention and control (IPC) is the main defence. In Pakistan, hospital care is delivered largely through public-sector facilities, yet the evidence remains unsynthesised.

Methods: Searches (29 October 2026, under a pre-fixed protocol) covered PubMed (806), Google Scholar and PakMediNet. Studies reported IPC practices, compliance, infection outcomes or barriers in Pakistan's public-sector hospitals. Appraisal used Joanna Briggs Institute checklists with a declared banding convention. Synthesis was narrative; random-effects meta-analysis of proportions was performed for two of the three outcomes meeting a pre-set pooling rule (IPCAF total score was not pooled: only study-level medians were available). Observed and self-reported results were never merged.

Results: Of 825 records, 105 studies were included. Pooled healthcare-associated infection prevalence was 11.44% (95% CI 8.18–15.16; I^2 = 90.8%; 95% prediction interval 0–73.6%), and 13.22% (11.78–14.73; I^2 = 0%) in the two paediatric surveys, excluding the one sector-pooled survey. Surgical site infection rates ranged from 1.7% to 33.7% (median 9.29%). One cross-sectional study reported directly observed hand-hygiene compliance (20%); self-reported practice ranged from 38.8% to 78.6%. Public-

sector WHO IPCAF medians fell in the 'Basic' band. Barriers centred on supplies, training and knowledge deficits.

Limitations: Hand hygiene was directly observed in only one study; 26 studies were at high risk of bias; heterogeneity was substantial.

Funding: None.

Conclusions: Pakistan's public hospitals carry a substantial infection burden while IPC capacity sits at a basic level and hand hygiene is almost never observed; priorities are reliable supplies, training, surveillance and observation.

Keywords: infection prevention and control; healthcare-associated infections; hand hygiene; public hospitals; Pakistan; systematic review

1. Introduction

Healthcare-associated infections (HAIs) — infections acquired during the process of care in a hospital or other healthcare facility — prolong admission, increase costs and cause avoidable deaths. Infection prevention and control (IPC), the set of practices and programme structures that interrupt transmission within facilities, is the main defence available to hospitals. Its core elements are simple: hand hygiene, standard precautions, sterilisation and disinfection, waste management, isolation where needed, and the organisational structures — trained staff, surveillance, supplies and accountability — that make those practices routine.[1] Where resources are scarce, every one of those elements is harder to sustain, and public-sector hospitals, which carry large patient loads with constrained budgets, bear a disproportionate share of that exposure.

Much of Pakistan's hospital care is delivered through public-sector facilities, from district hospitals to large tertiary teaching centres. A considerable primary literature on IPC in these hospitals has accumulated over more than two decades: surveys of healthcare workers' knowledge and practice, audits of hand hygiene, point-prevalence surveys of HAI, outbreak reports, facility assessments and intervention studies. Two nationwide assessments using the World Health Organization (WHO) Infection Prevention and Control Assessment Framework (IPCAF) have recently described facility-level IPC capacity across the country, including public-sector hospitals.[2,3] These are valuable primary studies, but they measure facility structures and scores; they do not synthesise the wider outcome literature. Beyond them, what exists is fragmented — mostly single-centre studies published in local and regional journals — and the one previous review touching on IPC in Pakistan specifically was narrative in approach, spanned all sectors (public and private) and all settings rather than public hospitals specifically, and pooled no outcomes.[4] No systematic review has applied pre-set eligibility, verified the sector of each study at full text, appraised study quality, and synthesised the practice, compliance and HAI-outcome evidence for Pakistan's public hospitals.

That gap matters for three reasons. First, decisions about IPC investment in the public sector need an honest summary of what the evidence shows, including how strong it is. Second, the literature mixes two kinds of measurement — direct observation of practice and self-report by healthcare workers — which diverge and must not be averaged together. Third, a public-sector-only scope is not a technicality: private

hospitals operate under different resourcing and governance, and pooling their results with public hospitals would misdescribe the public-sector system.

This systematic review therefore aimed to answer three questions for Pakistan's public-sector hospitals: (a) what is known about IPC practices and compliance among healthcare workers; (b) what is the burden of HAIs; and (c) what barriers and facilitators shape IPC in these settings?

2. Methods

2.1 Protocol and eligibility criteria

A written protocol (Protocol v1, 29 October 2026) was fixed before screening began and defined the review question, eligibility criteria, sources, extraction fields and synthesis rules in advance. Reporting follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement.[5]

The review was not registered in PROSPERO. A retrospective registration was attempted in November 2026, but PROSPERO does not accept registrations for reviews that have progressed beyond the data-extraction stage, and it requires at least two core team members; this is a sole-author review. The protocol is held by the author and is available on request.

Studies were eligible if they were conducted in public-sector hospitals in Pakistan and reported at least one of: IPC practices or compliance among healthcare workers; HAI prevalence or incidence or related patient-safety outcomes; or barriers and facilitators to IPC. Eligible designs were cross-sectional studies, cohort studies, case–control studies, point-prevalence surveys, audits, facility assessments (including IPCAF assessments[1]), intervention studies (randomised and non-randomised), and qualitative studies. Studies from any publication year and in English (or Urdu, had any been found) were eligible. Mixed-sector studies were included only if public-sector results were reported separately or the sample was majority-public, with the decision and its basis recorded for each study. Excluded were: private-sector-only studies; community and other non-hospital settings; single case reports; editorials and opinion pieces without data; and reviews, which were used for reference-mining only. Preprints, had any been eligible, were to be flagged and analysed separately, never pooled with peer-reviewed studies; in the event, no eligible preprint was identified.

2.2 Information sources and search strategy

Three sources were searched on 29 October 2026, and every search was logged with its exact string, date and result count. PubMed was searched with the following string, used unchanged:

> ***("infection control" OR "infection prevention" OR "hand hygiene" OR "healthcare-associated infection" OR nosocomial OR "standard precautions") AND (Pakistan) AND (hospital)***

The search returned 806 records, all of which were captured in full (via the NCBI E-utilities interface, with the count verified on the PubMed web interface). Google Scholar was searched with an adapted string (Scholar does not support truncation or nested Boolean logic), and the first results page (10 records)

was captured exactly as displayed; Scholar did not display a total count in the captured page, and none is reported. PakMediNet, which indexes Pakistani medical journals, has no Boolean interface; its MeSH keyword route for "Infection Control" was attempted, but the live listings were membership-walled and the interface displays no result totals, so PakMediNet could not be captured in full; nine on-topic titles visible in web-search snippets of PakMediNet pages were recorded as a partial, supplementary capture. Together, the Scholar and PakMediNet captures contributed 19 records, of which six were duplicates of PubMed records, leaving 13 additional records for screening. Embase and Scopus are not freely accessible and were not searched; this is recorded as a limitation. The adapted Google Scholar strategy is recorded in full in the review's search log, as is the PakMediNet route as run; the log is available from the author on request.

2.3 Selection process

Selection was two-stage. At title/abstract stage, all 819 records (806 PubMed + 13 additions) were screened against the eligibility criteria; where eligibility was in doubt, the record was passed to the full-text stage rather than excluded. At full-text stage, the 236 records carried forward (123 title/abstract inclusions and 113 unresolved records) were assessed against the full criteria, and — because sector is often unstated in abstracts — the public/private status of each study's setting was verified from the full text, the journal record, or author affiliations. Free full texts were retrieved for 85 of the 123 title/abstract inclusions (44 through PubMed Central, the remainder through journal sites and open-access repositories); 17 were paywalled and 21 could not be found. Every full-text exclusion carries a recorded reason code and a one-line statement of its evidence basis. All stages — searching, screening, extraction and appraisal — were conducted by the author working with AI assistance, following the pre-set protocol (see Declarations); eligibility judgements and their recorded bases are the author's responsibility.

2.4 Data extraction

For each included study, the following were extracted: citation, year and journal; city/province and hospital level; sector composition; design; sample (population and size); IPC domain(s); measurement method, with observed/record-based measurement always distinguished from self-reported measurement; key results (compliance percentages, HAI percentages, knowledge–attitude–practice (KAP) scores, IPCAF scores); barriers and facilitators as reported; and funding or conflicts where stated. Where an abstract was silent on setting or sector and a retrieved full text resolved the point, the full-text value was used and marked as such.

2.5 Critical appraisal

Each study was appraised with the Joanna Briggs Institute (JBI) critical appraisal checklist matching the design its methods actually follow (analytical cross-sectional, 8 items; prevalence, 9 items; quasi-experimental, 9 items; randomised controlled trial, 13 items; cohort, 11 items; case–control, 10 items; qualitative, 10 items), following the JBI Manual for Evidence Synthesis.[6] Items not addressed in a report were scored "Unclear" — silence was never read as compliance. Because JBI prescribes no cut-off scores for its checklists, this review declared its own banding convention in advance and applied it uniformly: at least 70% of applicable items answered "Yes" = low risk of bias; 50–69% = moderate; below 50% = high. Appraisal was based on the full text where one had been retrieved (47 of the 101 appraised studies in the final set) and on the abstract otherwise (54 studies). Low-quality studies were described and retained, not silently dropped.

2.6 Synthesis methods

Synthesis was structured by outcome domain, as pre-specified: primarily narrative, with meta-analysis for the outcomes meeting the pre-set rule below. For each domain, the extracted values are reported with their range and median where three or more comparable values exist. Observed/record-based and self-reported results are reported in separate lines throughout and were never merged. The protocol's rule for meta-analysis was that pooling would be undertaken only if at least three studies reported a comparable outcome with comparable methods. Three outcomes met the count rule — overall HAI point prevalence, overall surgical site infection (SSI) rate in surgical cohorts, and IPCAF total score. Two were taken forward to pooling, with their comparability caveats carried into the interpretation rather than used to suppress the estimates: the prevalence surveys differ in age group and sector composition, and the SSI cohorts differ sharply in procedure mix, so both pooled estimates are reported with full heterogeneity statistics and, respectively, a sensitivity analysis and a secondary-summary framing. IPCAF total scores were not pooled: only study-level medians rather than facility-level data were available, so that outcome remains narrative.

Meta-analysis used a random-effects model with the between-study variance (τ^2) estimated by the DerSimonian–Laird method. Proportions were pooled on the Freeman–Tukey double-arcsine transformed scale and back-transformed for reporting. Heterogeneity is reported as I^2 and τ^2, together with 95% prediction intervals. For the HAI point-prevalence analysis, a sensitivity analysis excluded the one survey whose published figure pooled its public and private hospitals (Saleem Z 2019), so that the estimate for the public-sector surveys could be examined separately. The meta-analyses were implemented in Python 3 (NumPy 1.26.4, SciPy 1.11.4; Python Software Foundation, https://www.python.org; accessed 29 October 2026), with the DerSimonian–Laird estimator applied to the Freeman–Tukey transformed proportions; as a robustness check, both analyses were repeated on the logit scale and gave materially unchanged estimates.

Two assessments were deliberately not undertaken. No formal assessment of reporting bias (small-study effects) was performed, because the syntheses are predominantly single-proportion prevalence and knowledge–attitude–practice summaries from non-comparative studies, for which funnel-plot-based methods are not interpretable. No formal certainty rating (for example GRADE [Grading of Recommendations Assessment, Development and Evaluation]) was applied; certainty considerations are instead conveyed through the design-specific JBI risk-of-bias distribution and the heterogeneity statistics reported for each pooled outcome.

3. Results

3.1 Study selection

The searches identified 825 records (806 from PubMed and 19 from the supplementary sources). After removal of six duplicates, 819 records were screened at title/abstract stage and 583 were excluded, most commonly because the record was not about IPC or HAI (245), was an ineligible publication type (158), or was not a Pakistan setting (120); smaller numbers were excluded for having no primary data (30), a non-hospital setting (25), duplication (3) or a clearly private-only setting (2). The remaining 236 records entered full-text assessment, of which 131 were excluded: 62 because the setting proved to be private-

sector only, eight because mixed-sector data were pooled with public results neither separable nor majority-public, one because sector could not be verified from the full text, and the remainder for non-hospital settings, absence of IPC content on full reading, non-Pakistan or inseparable multinational data, ineligible publication type, or absence of primary data. **105 studies** were included in the synthesis (Figure 1). The full list of the 131 full-text exclusions, with the reason recorded for each, is retained in the review's records and is available from the author on request.

One exclusion illustrates the process: a hand-hygiene knowledge–attitude–practice study that is in PubMed but was not retrieved by the review's search string was recovered through the Google Scholar capture, passed title/abstract screening as unresolved, and was then excluded at full text because the hospitals it surveyed are never named in the report, so public-sector eligibility could not be verified. The episode is reported here because it demonstrates both a real limit of the search string and the working of the safeguards around it.

3.2 Study characteristics

The 105 included studies are summarised in Table I. By design, analytical cross-sectional studies (including knowledge–attitude–practice surveys and facility assessments) were most common (40), followed by prevalence-type studies (point-prevalence surveys, frequency/incidence studies and outbreak reports; 28), quasi-experimental studies (19), randomised controlled trials (9), cohort studies (7), one case–control study and one qualitative study. The primary IPC domain was general IPC in 55 studies, SSI in 20, device-associated infection in nine and hand hygiene in seven, with the remaining 14 covering topics such as stethoscope contamination, nasal carriage, sharps injuries and bloodborne-virus exposure; three further studies carried hand hygiene as a secondary domain.

Geographically, Punjab contributed 33 studies, Sindh 18, Khyber Pakhtunkhwa 15, Islamabad Capital Territory eight and Balochistan two; 13 studies were multi-province or nationwide and 16 did not report a locatable setting. The most frequent cities were Karachi (15 studies), Lahore (13), Islamabad (12), Rawalpindi (11) and Peshawar (10). Publication years spanned the full period searched: 18 studies were published up to 2010, 32 in 2011–2019 and 55 in 2020–2026, the recent majority driven substantially by COVID-19-era IPC studies. By measurement type, 69 studies used observed or record-based measurement only, 23 self-report only, 10 both, and three reported no classifiable measurement. Sixty-three studies reported a numeric participant count; summed across those studies, the evidence base covers 20,163 participants, with a median study size of 211 (range 7–1,553). Four included studies contributed no extractable outcome data (abstracts not captured and full texts not located) and appear in the characteristics but in no outcome synthesis below.[7,8,9] One of the four — a hand-hygiene compliance survey at Mardan Medical Complex, captured in the Google Scholar search — could not be verified against the published record despite repeated searching of bibliographic databases, and is therefore identified by this description rather than by a reference entry.

3.3 Hand hygiene

Observed compliance. Directly observed hand-hygiene compliance is almost entirely absent from the cross-sectional literature in this set. Only one study reports an absolute observed compliance value: a clinical audit of 81 urinary catheterisations in a tertiary hospital found that hand hygiene was not performed before catheterisation in 80% of procedures — an observed compliance of 20%.[10] No range or median can be computed from a single value. The only other observed hand-hygiene figures come

from intervention studies (Section 3.7): a quality-improvement project raised observed adherence from 50% to 84%, and at the Pakistan site (Pakistan Institute of Medical Sciences, Islamabad) of the WHO multimodal hand-hygiene strategy study, observed compliance rose from 38.2% to 58.6% (1,332 observed opportunities); the study's headline compliance figures (51.0% rising to 67.2%) are its pooled multinational results, not Pakistan-site values, and are not entered into any Pakistan-specific summary here.

Self-reported knowledge and practice. Self-reported values, kept strictly separate, paint a different picture. Among 211 intern and trainee physicians in Karachi, self-reported hand-hygiene compliance was 38.8%, only 4.7% decontaminated their hands before patient contact, and only 17% were aware of WHO recommendations.[11] Among 360 residents and nurses in Lahore, self-reported knowledge was 56%, attitude 72% and practice 78.6%.[12] In a third survey, 47.9% of students and healthcare professionals were satisfied with their own hand-hygiene knowledge (a satisfaction measure, not a knowledge score).[13] The two self-reported practice values (38.8% and 78.6%) come from different populations and instruments and are shown side by side, not averaged. The contrast with the single observed value (20%) is consistent with the usual direction of self-report inflation, but with one observed study it can only be noted, not demonstrated.

3.4 General IPC knowledge and practice

Only one study reports general (standard-precautions) knowledge–attitude–practice levels in percentage form: among 533 healthcare personnel across six Punjab cities, 37.5% had good knowledge, 46.7% positive attitudes and 46.3% safe practices regarding standard precautions, with prior IPC training and guideline availability associated with better scores.[14] In a survey of 290 dentists at a public dental teaching hospital, more than half did not follow standard precautions for every patient.[15] Remaining knowledge/practice evidence is score-based or arises within training evaluations (Section 3.7); no summary median is computable.

3.5 Facility IPC assessments

Five studies report total scores on the WHO Infection Prevention and Control Assessment Framework (IPCAF, scored out of 800),[2,3,16–18] each summarised by the median across its facilities (Table II). Study-level medians were 117.5 (five Islamabad public hospitals, all scoring below 200), 349.25 (108 hospitals nationwide), 387.8 (42 hospitals nationwide), 405 (12 facilities in Gilgit-Baltistan, Azad Jammu & Kashmir and Khyber Pakhtunkhwa) and 532.5 (11 Punjab public hospitals) — a range of 117.5–532.5, with a median of study medians of 387.8. In the two nationwide surveys, the public-sector median was 353[2] and 337.5,[3] inside WHO's "Basic" band (201–400 of 800).[1] Across the assessments, the recurring weakest IPCAF components were education and training, HAI surveillance, and monitoring/audit and feedback.

Related facility instruments, on different scales and not combined with IPCAF, point the same way: a WHO Water and Sanitation for Health Facility Improvement Tool (WASH FIT) comparison of two hospitals scored 75.8% versus 65.5% of available points, with sanitation the weakest domain;[19] a children's hospital raised its WHO Hand Hygiene Self-Assessment Framework score from 122 to 352 (inadequate to intermediate) through a quality-improvement collaborative;[20] only three of 18 Lahore public hospitals (17%) had acceptable COVID-19 preparedness on a WHO-based checklist;[21] and an

early assessment of infection-control measures in seven northern-Punjab hospitals reported no extractable score.[22]

3.6 Healthcare-associated infection burden

Overall HAI point prevalence. Three point-prevalence surveys report overall HAI prevalence: 8.4% among 1,553 patients in 13 Punjab hospitals,[23] 13.1% among 888 hospitalised children in four hospitals,[24] and 13.3% among 1,147 neonates and children in 19 public hospitals[25] — a range of 8.4–13.3% with a median of 13.1%. One caveat applies to the lowest value: the 8.4% figure pools that study's public and private hospitals (its private-hospital prevalence was 25.0%), and a public-sector-specific figure is not stated in the report.[23]

Pooling the three surveys (3,588 patients) in a random-effects meta-analysis of proportions gave a pooled prevalence of 11.44% (95% CI 8.18–15.16), with substantial heterogeneity (I^2 = 90.8%; τ^2 = 0.0085 on the Freeman–Tukey scale; 95% prediction interval 0–73.6%). The heterogeneity was compositional rather than unexplained: the two paediatric surveys — both conducted in public-sector hospitals — agreed closely (13.1% and 13.3%), whereas the third survey (8.4%) covered an all-age population in a mixed public and private sample in which prevalence was not reported separately for the public sector. In a sensitivity analysis restricted to the two public-sector paediatric surveys, the pooled prevalence was 13.22% (95% CI 11.78–14.73; I^2 = 0%; τ^2 = 0), indicating that approximately one in eight hospitalised children in these surveys had a healthcare-associated infection on the day of the survey. Because only three surveys were available — two of them paediatric — the pooled estimate should be read as a summary of these surveys rather than as a national prevalence for Pakistan's public hospitals, and no pooled estimate is presented for adult or all-age populations.

Intensive care unit (ICU) infection frequency. Two intensive-care cohort studies, a different design from prevalence surveys and kept separate, found nosocomial infection in 39.7% of 254 medical-ICU patients in Karachi (urinary tract infection, bloodstream infection and pneumonia predominating)[26] and 29.13% of 333 ICU patients in Hyderabad.[27]

Surgical site infection. Five studies report an overall SSI percentage in defined surgical cohorts: 1.7% after carpal tunnel surgery (n = 176 procedures in 164 patients),[28] 8.84% in general surgery records (n = 882),[29] 9.29% in general surgical patients (n = 269; 4.88% for clean wounds versus 20.45% for contaminated/dirty wounds),[30] 11.1% after caesarean section (n = 323),[31] and 33.68% across mixed surgical wards (n = 95)[32] — a range of 1.7–33.68% with a median of 9.29%. The spread is dominated by case-mix, from minor hand surgery to mixed emergency surgical wards, rather than by measurement differences alone. (A sixth study's extracted overall rate was internally inconsistent with its own arm rates and is excluded from this summary; its arm rates appear in Section 3.7 with that flag.)

As a clearly-labelled secondary summary, pooling the five cohorts (1,745 patients/procedures) in a random-effects meta-analysis of proportions gave a pooled SSI rate of 10.82% (95% CI 5.40–17.78), but heterogeneity was extreme (I^2 = 93.2%; τ^2 = 0.0464 on the Freeman–Tukey scale; 95% prediction interval 0–43.1%) and is structural: the cohorts span minor clean elective hand surgery (1.7%), general surgery (8.84% and 9.29%), caesarean section (11.1%) and mixed surgical wards with a high emergency share (33.68%). The pooled figure is therefore an average across unlike surgical case-mixes, not the SSI rate of any real ward, procedure or population; the interpretable findings are the study-level rates above, their

range (1.7–33.7%) and their median (9.29%), and no single pooled SSI rate should be cited as representative of Pakistani public hospitals.

Device-associated and other burden. Ventilator-associated pneumonia (VAP) affected 17% of 93 ventilated children in a Lahore paediatric ICU[33] and 33.3% of 150 ventilated children in a second Lahore paediatric ICU cohort, in which VAP patients had higher mortality (32% versus 0%).[34] Catheter-related bloodstream infection occurred in 17% of 89 catheterised cancer patients in Rawalpindi.[35] In a comparative study, catheter-tip colonisation at day five was 8 of 36 (silicone) versus 17 of 36 (latex) catheters.[36] Shunt infections were reported as counts only (three infections in 151 shunt procedures).[37] In haemodialysis populations, hepatitis B surface antigen positivity was 11.7% and anti-HCV (antibody to hepatitis C virus) positivity was 23% at one year among 172 patients,[38] and HCV seroconversion occurred in 49.7% of 990 dialysis patients in another unit, negatively correlated with the unit's universal infection-control compliance score ($r = −0.665$, $P = 0.018$).[39] In an isolate-based study at a Peshawar teaching hospital, *Staphylococcus aureus* was found in 180 of 390 isolates (46.2%) and methicillin-resistant *S. aureus* (MRSA) in 16 (4.1%), with isolates sampled before and one month after simple control measures were introduced.[40] No included study headlines a public-sector device-day rate (infections per 1,000 device-days). Finally, antimicrobial exposure was near-universal where measured: 94.6% of 916 hospitalised children in a repeated point-prevalence survey received at least one antibiotic.[41]

3.7 Interventions

Hand-hygiene and practice interventions (observed outcomes). In the WHO multimodal hand-hygiene strategy study, observed compliance at the Pakistan pilot site (Pakistan Institute of Medical Sciences, Islamabad) rose from 38.2% to 58.6% (1,332 opportunities); across the multinational study as a whole, overall compliance rose from 51.0% to 67.2% and knowledge scores from 18.7 to 24.7, and those pooled figures are presented as context only.[42] A Plan–Do–Study–Act (PDSA) quality-improvement project in a military neonatal ICU (Combined Military Hospital (CMH), Multan) raised aseptic non-touch technique compliance from 66% to 89% and then 94%, observed hand-hygiene adherence from 50% to 84%, and tray cleaning from 64% to 87%.[43] The children's-hospital collaborative raised the Hand Hygiene Self-Assessment Framework score from 122 to 352, although its compliance change was not numerically extractable.[20]

Training and education interventions (test-score or self-reported outcomes). Hand-hygiene knowledge scores rose after training in one study (doctors 3.22 to 4.51; nurses 3.14 to 4.00).[44] A three-hour training session for auxiliary staff improved knowledge scores (8.22 ± 2.83 to 12.43 ± 2.05) and practice scores (3.64 ± 1.39 to 6.11 ± 1.27; both $P < 0.001$).[45] A web-based education module taken by 500 healthcare workers improved self-reported preventive practices, including more frequent handwashing.[46] IPC training workshops produced significant knowledge and skills gains in another evaluation, without extractable values.[47]

System and quality-improvement interventions (observed outcomes). Joining an international quality-improvement collaborative for congenital heart surgery was followed by a fall in SSI and bacterial sepsis from 30% to 1% ($P = 0.0001$), with mortality falling non-significantly from 9% to 6%.[48] An ISO 9001 quality programme at a public cardiac centre was associated with HAI rates falling from 3.2% to 2.0% (1.3% by 2025), a difference-in-differences net reduction of 30% against comparison hospitals.[49] A

PDSA initiative reduced blood-culture contamination from 12.9% to 6.09%.[50] Control measures with training at a military hospital reduced neonatal sepsis from 63 to 14 per 1,000 live births.[51] A hand-hygiene and asepsis intervention stopped nosocomial transmission of *Burkholderia cepacia* in intensive care and paediatric units (34 of 58 strains were isolated before the intervention; only sporadic recurrence followed).[52] An education-plus-surveillance intervention was followed by a non-significant decline in VAP rates, with values not reported.[53]

Comparative effects on infection outcomes. Trial and two-group comparisons (Table II) include: intrawound vancomycin powder in spinal surgery, SSI 5.2% versus 20.5%;[54] purse-string versus linear closure in stoma reversal, SSI 14.5% versus 38.7% ($P = 0.002$);[55] polydioxanone versus polypropylene closure, wound infection 33.9% versus 67.1%;[56] intradiscal gentamicin in microdiscectomy, discitis 1.5% versus 6.6% ($P = 0.033$);[57] protocol-based versus routine shunt placement, shunt infection 7.6% versus 18.1% ($P < 0.05$);[58] preoperative vaginal cleansing before caesarean section, endometritis 1% versus 7% ($P < 0.03$);[59] single versus additional postoperative antibiotic dose in appendicectomy, SSI 7.8% versus 9.1% ($P = 0.65$, not significant);[60] preoperative cefazolin versus none in low-risk cholecystectomy, SSI 3.98% versus 4.9% ($P = 0.584$, not significant);[61] povidone-iodine versus chlorhexidine-alcohol skin preparation, SSI 10% versus 7.1% ($P = 0.324$, not significant);[62] povidone-iodine versus saline wound irrigation, SSI 28.8% versus 32.2% ($P = 0.624$, not significant);[63] single-dose versus three-dose cefotaxime prophylaxis, wound infection in 3 of 75 versus 4 of 75 patients (not significant);[64] closed irrigation–suction drainage after hysterectomy in diabetic women, significantly fewer SSIs ($P < 0.0001$) with arm rates not reported;[65] and endoglove versus no-endoglove gallbladder extraction, port-site infection 0.2% versus 5.28% — this last study's overall rate was internally inconsistent as extracted and its results should be read with that flag.[66] In summary, where interventions were evaluated with observed outcomes, effects were consistently in the protective direction and several were large; however, six of the nine randomised trials are at high risk of bias (Section 3.9), so these effect sizes are fragile.

3.8 Barriers and facilitators

Barriers were counted only where a study's data or abstract states them explicitly. The most frequent theme was **resource and supply shortages** (nine studies): only 28.5% of frontline workers in one survey had adequate personal protective equipment (PPE) access at all times,[67] 61% in another reported PPE shortages,[68] outbreak control was described as "limited by resources" in an early report,[69] and supply gaps recur in facility and preparedness studies,[2,11,70,71] including insufficient PPE reported by 53% of respondents in a neonatal/child point-prevalence survey's facilities[25] and resource scarcity described in a mixed-methods MRSA study.[72] **Training and education gaps** were reported by eight studies: training gaps in hospitals managing drug-resistant tuberculosis,[70] only 12.5% of hospitals training waste-management staff regularly in an early Karachi survey,[73] poor infection-control perception with capacity-building recommended in Quetta teaching hospitals,[74] 58.2% of COVID-19 treatment-centre staff reporting no IPC training,[71] and education/training among the weakest IPCAF components in three assessments.[3,17,18] The qualitative study adds training disparities and, uniquely in this set, was designed to elicit barriers in depth.[75] **Knowledge and awareness deficits** were reported by seven studies,[11–15,76,77] including only 17% awareness of WHO hand-hygiene recommendations among trainee physicians[11] and no worker in one study identifying tourniquets as a potential infection source.[76] **Staffing shortages and workload pressure** (four studies),[2,18,75,78] **governance, supervision and accountability gaps** (four studies[70,75] — including 99.2% of respondents in one survey reporting

no hospital accountability criteria[79] and lacking administrative support in another[80]), **weak HAI surveillance and monitoring/audit** (three studies — the same IPCAF assessments),[3,17,18] attitudinal barriers (two studies)[72,78] and psychosocial burden (two studies)[68,75] complete the picture; cost was named once, as a barrier to hepatitis B vaccination (20.9%).[78] Facilitators were rarely reported explicitly; where associations imply them, they mirror the barriers — prior IPC training and guideline availability were associated with better standard-precautions scores,[14] and timely PPE availability plus hand-hygiene training with lower COVID-19 seropositivity.[81]

3.9 Risk of bias

Of the 105 included studies, 101 were appraised and four could not be appraised because no readable abstract or full text could be obtained. Under the review's declared banding, 46 studies (43.8%) were at low risk of bias, 29 (27.6%) moderate and 26 (24.8%) high. Appraisal quality varied sharply by design. Prevalence-type studies appraised best, reflecting standardised Global Point Prevalence Survey (Global-PPS) and European Centre for Disease Prevention and Control (ECDC) point-prevalence methods and objective, culture-based outcomes. Randomised trials appraised worst: none of the nine was at low risk of bias and six were at high risk, because randomisation method and allocation concealment were usually unstated, blinding was absent, and one trial allocated by even/odd alternation. Cross-sectional knowledge–attitude–practice surveys — the modal design — split across all three bands, separated mainly by instrument validation, sample-size justification and adjusted analysis. These patterns temper the intervention findings in Section 3.7 in particular: the largest effects come from before–after quality-improvement studies and from trials whose reporting leaves their protection against bias unclear.

4. Discussion

This review systematically assembled, sector-verified and appraised 105 studies of IPC in Pakistan's public hospitals. Three findings stand out. First, the measured burden is substantial: point-prevalence surveys place HAI prevalence at 8.4–13.3% of inpatients, SSI ranges from under 2% in minor elective surgery to a third of patients in mixed surgical wards, and the two nationwide public-sector IPCAF medians sit in WHO's "Basic" band. Second, the most basic protective behaviour in this literature — hand hygiene — is essentially unmeasured by observation: a single cross-sectional observed value exists (20%), while the self-reported values that dominate the literature (38.8–78.6%) sit far above it. Third, the barriers named again and again are not exotic: supplies, training, staffing and the absence of surveillance and accountability — the same components that score weakest in the IPCAF assessments.

The measurement gap is itself a finding. A literature that asks healthcare workers whether they practise hand hygiene, rather than watching whether they do, will systematically flatter performance and cannot detect failure or improvement. The one audit that observed practice found hand hygiene omitted in four of five catheterisations.[10] The intervention literature shows what observation makes possible: the projects that measured practice directly (a PDSA project in a neonatal ICU; a surgical quality collaborative) could demonstrate large improvements.[43,48] Until direct observation — for example with the WHO hand-hygiene observation method — becomes routine in Pakistani public hospitals and in the studies conducted in them, neither managers nor researchers will know the true level of hand-hygiene practice itself.

Facility capacity and barriers tell one consistent story. The IPCAF evidence shows a system at "Basic" level: structures exist, but the components that turn structures into practice — education and training, HAI

surveillance, monitoring with audit and feedback — are the weakest.[3,17,18] The barrier counts from the wider literature converge on the same points: PPE, soap, water and disinfectant shortages; staff who have never received IPC training (58.2% of COVID-19 treatment-centre staff in one survey);[71] too few staff; and no one accountable (99.2% of respondents in one survey reported no hospital accountability criteria).[79] This convergence across independent study types strengthens the inference that these are system properties, not artefacts of any one instrument. It also identifies where money and management attention would bite first: reliable supply chains for IPC consumables, structured IPC training with protected time, dedicated IPC staffing, and functioning HAI surveillance — the last being a precondition for knowing whether anything else works.

Burden estimates need careful reading. The point-prevalence median of 13.1% rests on three surveys, two of them paediatric; the 8.4% survey pooled public and private hospitals and reported a much higher private-sector figure (25.0%),[23] so the pooled value, if anything, overstates the public-sector figure: the public-sector component of that survey necessarily sits below its 8.4% overall value. SSI estimates vary mainly with case-mix, and the trial literature's large effects (for example vancomycin powder, 5.2% versus 20.5%[54]) come from studies at moderate or high risk of bias and should not be adopted into practice on this evidence alone. Multinational studies contributed where Pakistan data were separable — one survey's Pakistan arm alone covered 55 Punjab public hospitals[82] — but pooled multinational figures were excluded from Pakistan-specific summaries wherever they could not be separated, a discipline that cost some data but protects every number in this review.

What the literature cannot yet answer is as important as what it can. There are no public-sector device-day infection rates to benchmark against international surveillance; outcome-level evidence from Balochistan, Gilgit-Baltistan and Azad Jammu & Kashmir is almost absent; patient-important consequences of HAI (mortality, length of stay) are reported by only a handful of studies in non-comparable forms;[34,83,84,85] and barrier evidence is mostly incidental to surveys, with a single qualitative study designed to explore it in depth.[75] The post-2020 literature is inflated by COVID-19 studies whose findings may not generalise to routine IPC. One further caution emerged during synthesis: at least one included report presents an organism-positivity rate among clinical samples in terms easily mistaken for patient prevalence[86] — readers of this literature must check denominators carefully, as this review has done.

Strengths of this review include a protocol fixed before screening; per-study sector verification at full text, which removed 70 studies (62 private-only and eight inseparable mixed-sector) that abstract-level screening alone would have carried into a "public hospital" synthesis; strict separation of observed and self-reported measurement; design-specific JBI appraisal of 101 of 105 studies with a declared banding convention; and a pre-set pooling rule, applied so that meta-analysis was undertaken for two of the three outcomes meeting the pre-set rule (HAI point prevalence and SSI rate; IPCAF total score met the count rule but was not pooled, as only study-level medians were reported), with heterogeneity statistics and caveats reported alongside every pooled figure. **Limitations** are also clear. Embase and Scopus were not searched, and PakMediNet could not be captured in full because its listings are membership-walled, so some Pakistani-journal studies may have been missed — the demonstrated miss of one on-topic study by the PubMed string, recovered only through Google Scholar, shows this risk is real, though the supplementary captures and the string's sensitivity (806 records) limit it. The JPMA and JCPSP archives were not hand-searched as a separate logged search, and the reference lists of the 27 reviews excluded at

screening were mined for references without a separate log. Four included studies (3.8%) could not be appraised for want of any readable text, and four contributed no outcome data.[7,8,9] Sector was verified from published reports and affiliations, which depend on the accuracy of those reports. Appraisal of 54 studies rested on abstracts alone. No formal reporting-bias assessment or GRADE certainty rating was undertaken, as declared in the Methods. Finally, all review stages were conducted by a single author working with AI assistance rather than by two independent reviewers; the safeguards against the errors this invites were the pre-set criteria, the rule that doubt always passed a record forward rather than excluding it, and a written evidence basis for every full-text decision.

Implications. For hospital managers and provincial health departments, the priorities are supplies, training, surveillance and accountability — in that order of dependency, since surveillance is what converts the rest into managed practice. For researchers, the priorities are observational measurement of hand hygiene and other practices, device-day surveillance with standard denominators, studies outside the major cities, and trials reported to a standard that permits appraisal. For journal editors and funders in Pakistan, requiring sector identification, denominators and observation methods in IPC manuscripts would materially raise the value of the next decade's literature.

5. Conclusions

In Pakistan's public hospitals, point-prevalence surveys found healthcare-associated infections in 8.4–13.3% of surveyed patients, reaching roughly one in eight children in the paediatric surveys, IPC facility capacity sits at a basic level, and the barriers are dominated by shortages of supplies, training and staff and by weak surveillance. The evidence base — 105 studies — is broad but uneven: strong in prevalence surveys, fragile in trials, and nearly silent on directly observed hand-hygiene practice. Closing that measurement gap, and acting on the supply, training and surveillance deficits the literature documents consistently, are the clearest routes to safer public hospital care in Pakistan.

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Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author used Muse (Meta) in order to assist with literature searching, screening support, data organisation and drafting. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the published article.

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Tables

Table I. Characteristics of the 105 included studies.

Characteristic	**n**
Design	
Analytical cross-sectional (incl. KAP surveys, facility assessments)	40
Prevalence-type (point-prevalence surveys, frequency/incidence and outbreak reports)	28
Quasi-experimental (pre–post, before–after QI, non-randomised comparisons)	19
Randomised controlled trial	9
Cohort	7
Case–control	1
Qualitative	1
Primary IPC domain	
General IPC	55
Surgical site infection (SSI)	20
Other	14
Device-associated infection	9
Hand hygiene	7
Region	
Punjab	33
Sindh	18
Khyber Pakhtunkhwa	15
Multi-province / nationwide	13
Islamabad Capital Territory	8

Balochistan	2
Not reported	16
Publication period	
≤2010	18
2011–2019	32
2020–2026	55
Measurement type	
Observed / record-based only	69
Self-reported only	23
Both observed and self-reported	10
Not reported	3
Total	**105**

Table II. Domain results.

Domain	Measure	Studies (n)	Values	Range	Median
Hand hygiene	Observed compliance (cross-sectional)	1	20% (Waheed S 2022)	-	—
Hand hygiene	Self-reported practice/compliance	2	38.8%; 78.6%	38.8–78.6%	-
General IPC KAP	Good knowledge / positive attitudes / safe practices (Kiddeer 2025)	1	37.5% / 46.7% / 46.3%	-	—
Facility assessment (WHO IPCAF)	Study-level median total score (/800)	5	117.5; 349.25; 387.8; 405; 532.5	117.5–532.5	387.8
Facility assessment (WHO IPCAF)	Public-sector median in the two nationwide surveys	2	337.5; 353 (WHO "Basic" band)	-	—
HAI burden	Overall HAI point prevalence	3	8.4%; 13.1%; 13.3%	8.4–13.3%	13.1%
HAI burden	Nosocomial infection frequency (ICU cohorts)	2	29.13%; 39.7%	29.13–39.7%	-
HAI burden	Overall SSI rate (surgical cohorts)	5	1.7%; 8.84%; 9.29%; 11.1%; 33.68%	1.7–33.68%	9.29%

HAI burden	Ventilator-associated pneumonia	2	17%; 33.3%	17–33.3%	-
HAI burden	Catheter-related bloodstream infection	1	17%	-	—
Interventions (pre–post, observed)	Aseptic non-touch technique compliance; observed hand-hygiene adherence — PDSA project (Shahbaz A 2025)	1	66% → 94%; 50% → 84%	-	—
Interventions (pre–post, observed)	SSI + bacterial sepsis — International Quality Improvement Collaborative (IQIC) (Khan A 2017)	1	30% → 1%	-	—
Interventions (pre–post, observed)	HAI rate — ISO 9001 programme (Shakoor H 2026)	1	3.2% → 2.0%	-	—
Interventions (pre–post, observed)	Blood-culture contamination — PDSA initiative (Khan M 2026)	1	12.9% → 6.09%	-	—
Interventions (pre–post, observed)	Neonatal sepsis — control measures + training (Mahmood 2008)	1	63 → 14 per 1,000 live births	-	—
Interventions (pre–post, observed)	Hand-hygiene compliance — WHO multimodal strategy, Pakistan site (Allegranzi B	1	38.2% → 58.6%	-	—

	2013; PIMS Islamabad; the study's pooled multinational values, 51.0% → 67.2%, are not used here)				
Interventions (training)	Hand-hygiene knowledge scores after training (Afzal 2019)	1	Doctors 3.22 → 4.51; nurses 3.14 → 4.00	-	—
Interventions (training)	Knowledge and practice scores after 3-hour training (Khan N 2022)	1	8.22 → 12.43; 3.64 → 6.11	-	—
Interventions (comparative)	Intrawound vancomycin powder vs none — SSI (Khalid 2023)	1	5.2% vs 20.5%	-	—
Interventions (comparative)	Purse-string vs linear closure, stoma reversal — SSI (Ameer 2024)	1	14.5% vs 38.7%	-	—
Interventions (comparative)	Polydioxanone vs polypropylene closure — wound infection (Naz S 2017)	1	33.9% vs 67.1%	-	—
Interventions (comparative)	Intradiscal gentamicin vs none — discitis (Khan B 2026)	1	1.5% vs 6.6%	-	—
Interventions (comparative)	Protocol-based vs routine shunt placement — shunt infection (Kumar 2016)	1	7.6% vs 18.1%	-	—
Interventions (comparative)	Pre-operative vaginal cleansing vs standard prep —	1	1% vs 7%	-	—

	endometritis (Memon S 2011)				
Interventions (comparative)	Single vs additional post-operative antibiotic dose — SSI (Rafiq 2015)	1	7.8% vs 9.1% (NS)	-	—
Interventions (comparative)	Pre-operative cefazolin vs none — SSI (Ullah K 2022)	1	3.98% vs 4.9% (NS)	-	—
Interventions (comparative)	Povidone-iodine vs chlorhexidine-alcohol skin prep — SSI (Bibi 2015)	1	10% vs 7.1% (NS)	-	—
Interventions (comparative)	Povidone-iodine vs saline wound irrigation — SSI (Ali A 2023)	1	28.8% vs 32.2% (NS)	-	—
Interventions (comparative)	Single-dose vs three-dose cefotaxime prophylaxis — wound infection (Zahid 2003)	1	3/75 vs 4/75 (NS)	-	—
Interventions (comparative)	Closed irrigation–suction drainage vs standard — SSI (Saaqib 2023)	1	Significantly fewer SSIs ($P < 0.0001$); arm rates not reported	-	—
Interventions (comparative)	Endoglove vs no endoglove — port-site infection (Taj 2012)	1	0.2% vs 5.28% (overall rate internally inconsistent — see text)	-	—
Barriers	Resource & supply shortages	9	-	—	-
Barriers	Training & education gaps	8	-	—	-

Barriers	Knowledge / awareness deficits	7	-	—	-
Barriers	Staffing shortages & workload pressure	4	-	—	-
Barriers	Governance, supervision & accountability gaps	4	-	—	-
Barriers	Weak HAI surveillance / monitoring & audit	3	-	—	-
Barriers	Attitudinal barriers	2	-	—	-
Barriers	Psychosocial burden	2	-	—	-
Barriers	Cost barriers	1	-	—	-

Notes: For barrier rows, n is the number of studies explicitly reporting the theme. Observed/record-based and self-reported values are kept separate throughout and were never merged. Taj 2012 is excluded from the SSI summary in the HAI-burden rows because its extracted overall rate is internally inconsistent with its own arm rates; its arm rates are shown among the comparative effects.

Figure legends

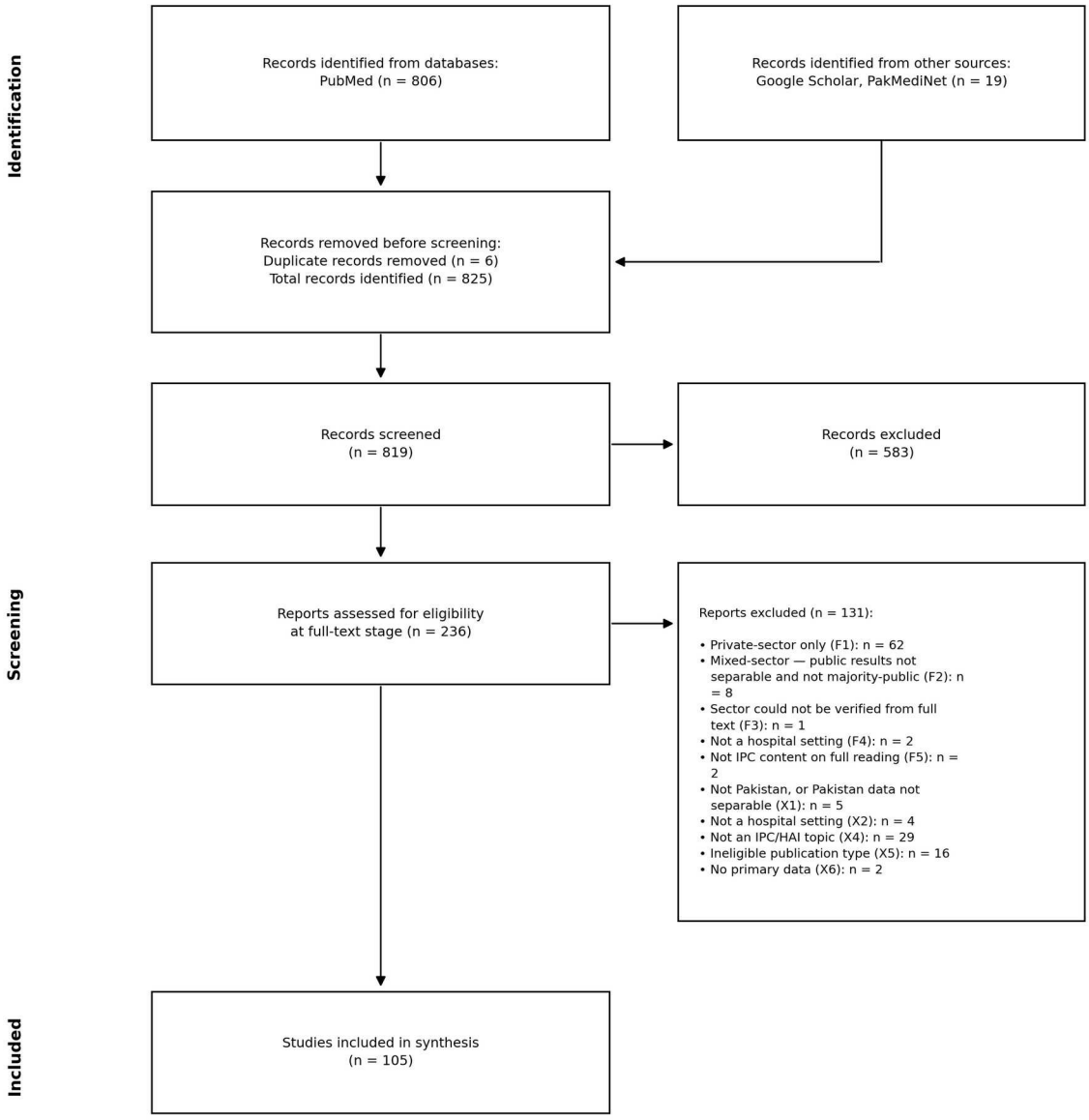

Figure 1. PRISMA 2020 flow diagram of study identification, screening and inclusion (the submitted diagram, FIGURE1_PRISMA.png, gives the full breakdown of the 131 full-text exclusions: private-sector only, 62; mixed-sector with public results inseparable, 8; sector unverifiable, 1; not a hospital setting, 6; no IPC content on full reading, 2; not Pakistan or Pakistan data inseparable, 5; not an IPC/HAI topic, 29; ineligible publication type, 16; no primary data, 2).

— End of JHI-formatted version 2 —

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- PRISMA2020Checklist.pdf