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Major Article

Effectiveness of infection prevention and control interventions in health care facilities in Africa: A systematic review

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Background: Health care-associated infections (HAIs) are a major threat to patient safety and quality care. However, they are avoidable by implementing evidence-based infection prevention and control (IPC) measures. This review evaluated the evidence of the effectiveness of IPC interventions in reducing rates of HAIs in health care settings in Africa.
Methods: We searched several databases: CENTRAL, EMBASE, PUBMED, CINAHL, WHO IRIS, and AJOL for primary studies reporting rates of the 4 most frequent HAIs: surgical site infections, central line–associated bloodstream infections, catheter-associated urinary tract infections, ventilator-associated pneumoniae, and increase in hand hygiene compliance. Two reviewers appraised the studies and PRISMA guidelines were followed.
Results: Out of 4,624 studies identified from databases and additional sources, 15 studies were finally included in the review. The majority of studies were of pre- and post-test study design. All the studies implemented a combination of interventions and not as stand-alone components. Across all included studies, an improvement was reported in at least 1 primary outcome.
Conclusions: Our review highlights the potential of IPC interventions in reducing HAIs and improving compliance with hand hygiene in health care facilities in Africa. For future research, we recommend more pragmatic study designs with improved methodological rigor.

BACKGROUND

Health care-associated infections (HAIs) occur across all health care settings worldwide and are regarded as the most frequent adverse event in the care continuum.[1] The impact of HAIs on health care is significant as it affects cost, morbidity, mortality, prolonged hospital stays, and reduced quality of life.[2] In Africa and many developing countries, this is worrisome as perennial challenges within the health care system further aggravate the burden of HAIs.[3] Poor national surveillance of HAIs, underfunded health care systems, and inadequate resources for infection prevention and control (IPC), including poor compliance of health workers to IPC practices, are widely reported in the literature as the root causes.[3,4]

The World Health Organisation (WHO) in 2011 estimated that the hospital-wide prevalence of HAIs ranged between 5.7% to 19.1% in developing countries and 3.5% to 12% in developed countries.[5] Several studies published since the WHO report suggest that at least 50% of HAIs are avoidable if IPC measures are adhered to.[6,7] This was supported by Houghton and colleagues, who suggest the need for evidence-based information to guide uptake of IPC interventions by health care facilities to strengthen the capacity to control HAIs.[8]

Globally, emerging and re-emerging infections threaten public health. Epidemic and pandemic-prone diseases have a huge impact on health security.[9] In Africa, there have been recurrent outbreaks of infectious diseases with devastating consequences.[9,10] Several studies have reported a high number of infectious disease outbreaks with studies showing as high as 96 new outbreaks across 36 of 47 member states within the African region as reported to the WHO in

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2018.[10,11] Today, this region reports the highest infectious disease burden compared with other regions.[10,11]

Contextually, this underscores the need to understand measures that could effectively reduce cross-transmission of pathogens within health care facilities, to ensure that health care systems in Africa remain functional and resilient in delivering safe and quality care. Therefore, the objective of this systematic review is to identify and synthesize available evidence on IPC interventions in health care facilities in Africa and to determine their effectiveness in either reducing any of the most common HAIs or in improving hand hygiene compliance of health workers.

METHODS

We followed the Preferred Reporting Items for Systematic Review and Meta-analysis Statement (PRISMA 2020), in reporting this systematic review.[12] The protocol for this systematic review was registered on the international prospective register for systematic reviews (PROSPERO) with Reg No., CRD 42020186190.

Search strategy

The search strategy was carefully planned and developed by U.I., assisted by librarians at the University of the West of England, Bristol, UK. A comprehensive list of search terms was derived from the population, intervention, comparison, outcome, and settings concepts. Keywords were matched to database-specific indexing terms. Index terms and free-text words were combined with appropriate Boolean operators. The search string was developed for PubMed and adapted for other databases. Two reviewers (U.I. and O.J.O.) conducted searches on the following databases: CENTRAL via Cochrane Library (inception to September 8, 2023), PubMed (1974 to September 8, 2023), EmBase via Ovid (1974 to September 8, 2023), CINAHL via EBSCO (1935 to September 8, 2023), African Journals Online (AJOL, from inception to September 8, 2023), and gray literature through WHO Iris via Google Scholar (searched on September 8, 2023). An updated search was carried out in February 2024. Reference lists of included studies were hand-searched by U.I. and O.J.O. (September 2023) for additional eligible studies. The complete search strategy is included in the Supplementary File.

Selection criteria

We considered including the following study designs: randomized controlled trials, nonrandomized controlled trials, quasi-experimental studies, before-and-after studies, and interrupted time series in our review. Studies were included if they evaluated IPC interventions in reducing the rates of HAIs or increase in hand hygiene compliance (measured by direct observation) as the primary outcome and published in English. They were no restrictions on publication dates. Studies conducted in nonhealth care settings, studies focused on antimicrobial resistance, studies whose full texts were not accessible, posters, conference proceedings, case reports, and studies in nonhuman population were excluded in the review.

Studies were included if they assessed any of the following IPC interventions: IPC programs, IPC guidelines, IPC education and training, surveillance, multimodal strategies, monitoring/audit of IPC practices, workload, staffing and bed occupancy, built environment, materials, and equipment for IPC and hand hygiene. The primary outcomes of the review include surgical site infection (SSI), catheter-related urinary tract infection (CAUTI), ventilator-associated pneumonia (VAP), central line–associated bloodstream infection (CLABSI), and hand hygiene compliance. These infections are the commonest infections caused by cross-transmission of pathogens in health care settings. Hand hygiene compliance was included as a primary outcome because it is a cornerstone of IPC. The secondary outcomes were mortality, quality of life, length of hospital stay, or as reported by included studies.

Data extraction

The search results were exported to the Distiller SR software. Two reviewers performed data extraction independently (U.I. and O.J.O.) using an adapted data extraction tool on Distiller SR (a copy is attached in Supplementary File). The data extracted include study title, type and year of publication, study authors, country of study, study objectives, setting, study design, sample size, population, intervention, and outcomes. Conflicts were resolved by discussion or arbitrated by E.A. and S.U.I.

Quality assessment and data synthesis

The Risk of Bias Tool for Nonrandomized Studies (ROBINS-I) tool (version 19) was used to assess quality of each study.[13] A study was judged low risk, moderate risk, serious risk, or critical risk depending on the answers to the signaling question for each domain. The strength/certainty of evidence was assessed for each outcome using the Grading of Recommendation Assessment Development and Evaluations approach across 4 levels (high, moderate, low, and very low).[14] This takes into consideration elements such as risk of bias, imprecision, inconsistency, indirectness, and publication bias.

In this review, due to heterogeneity across the studies, we could not perform a meta-analysis. There was wide variation in the population, type, and mode of implementation of the interventions for the different outcomes. Thus, we used narrative synthesis to explore, describe, and interpret the data of included studies. First, we tabulated the characteristics of the included papers and outlined the outcomes of the different IPC interventions in reducing either of the 4 HAIs or increase in hand hygiene compliance. Thereafter, we explored the patterns of the data by examining key characteristics of each of the included studies, examined the findings between the various studies for each of the 5 outcome categories, and the effectiveness of the interventions.

RESULTS

Study selection

A total of 4,624 studies were identified from electronic database searches and gray literature (PubMed = 1,753; CINAHL = 548; EMBASE = 1,957; CENTRAL = 237; WHO IRIS = 123; AJOL = 6). Seven hundred and fifty-eight duplicates were removed. The remaining 3,866 studies were screened by reading through their titles and abstracts, 37 studies remained after this process, and the full texts of these articles were retrieved. Thirteen studies met the selection criteria, and the reference lists of these papers were snowballed for other relevant papers. Two additional studies were identified, and 15 studies were finally selected for data extraction (as shown in Fig. 1).[15-29]

Characteristics of included studies

Table 1 summarizes the key characteristics of the studies. Of 15 articles identified, 3 studies focused on VAP,[15-17] a single study each for CLABSI[18] and CAUTI,[19] 3 studies on SSI,[20-22] and 7 studies on hand hygiene compliance.[23-29] Majority of the studies were conducted in tertiary hospitals and predominantly in intensive care units. Studies were conducted across different African countries, Northern Africa (n = 4), Central Africa (n = 3), East Africa (n = 4), South Africa (n = 2), and West Africa (n = 2).

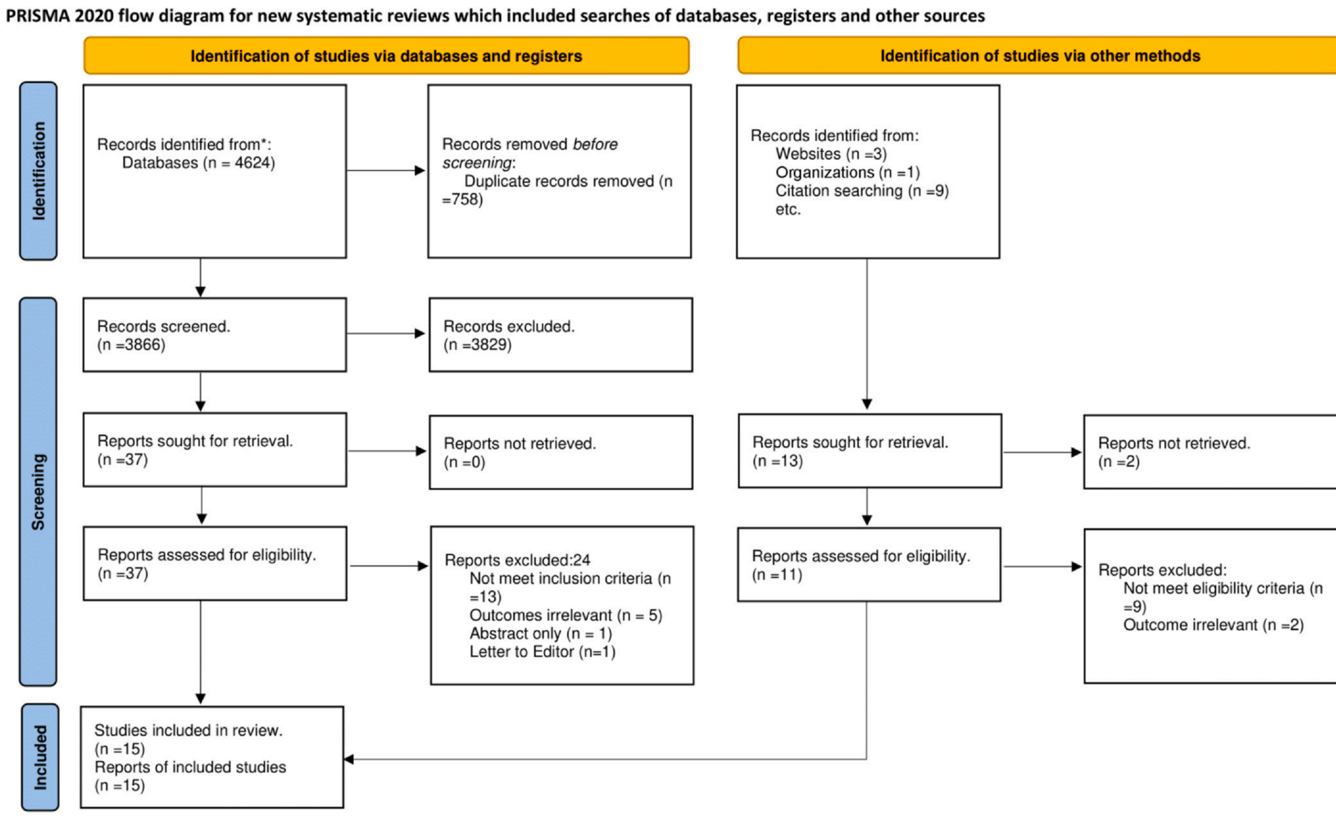

Fig. 1. PRISMA flow showing different phases of the search process. PRISMA, Preferred Reporting Items for Systematic Review and Meta-analysis.
Source: Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.

All the studies implemented a combination of interventions.[15-29] The interventions varied in terms of the number of elements of IPC measures included. In this review, education and training to improve health care workers' knowledge, were identified as the most frequently implemented element (n = 15) of all the IPC interventions, followed by the use of reminders such as hand hygiene posters, campaigns to promote desired actions (n = 9), and "system change" (n = 7), which relates to improving available infrastructure and equipment to promote best practice. Most of the facilities implemented local production of alcohol-based handrub (ABHR) as a means of increasing supplies to needed resources. Most of the device-associated HAIs used IPC care bundles/checklists as part of the implementation tools.[15-22]

Results of individual studies by study outcomes

Three studies focused on the incidence of VAP as a primary outcome.[15-17] All the studies on VAP implemented several preventive measures in a bundle approach alongside routine IPC protocols.[15-17] The VAP bundles were slightly similar, although some bundles were more expanded than the others. The results show that the interventions reduced the incidence of VAP in 3 studies, but they were implemented in diverse ways and the bundle components differed across the studies.[15-17] In addition, the lack of a uniform diagnostic standard made comparisons difficult.

A landmark study in South Africa implemented phased interventions in a stepwise manner to Netcare group of hospitals.[18] The study reported a 95.5% significant reduction in rates of CLABSI over a 6-year period with significant bundle compliance improvement. The interventions in the breakthrough series consisted of multiple regional lectures, bundle training, feedback and peer audits, and other measures to ensure informed and enthusiastic involvement of the entire team working in the Intensive Care Units (ICU).[18]

There was only 1 study on CAUTI.[19] The study reported that there were 13 CAUTIs pre intervention and eventually reduced to nil post intervention ($P = .002$) after implementation of IPC measures. This study demonstrates how a low-cost multifaceted intervention, consisting of lectures, reminders, and IPC rounds, targeted at health care personnel in a resource-limited setting, decreased both CAUTI rates and urinary catheter use in a public hospital.[19] Although there was no change in mean catheterization in the pre- and post-intervention phases.

Two of the 3 studies on SSI implemented multimodal interventions,[20,21] the third study evaluated a bundle-based approach targeted at reducing the incidence of SSI.[22] Of the 3 studies, 1 was a multicenter study in 5 African hospitals and implemented a multimodal intervention consisting of 6 technical areas of SSI prevention measures alongside an adaptive approach targeted at improving team work and safety climate with emphasis on local leadership.[21] The results showed that the cumulative incidence of SSI decreased significantly, with the decrease persisting during the sustainability period.[21] Forrester and colleagues implemented an adaptive multimodal infection prevention program termed "Clean Cut" aimed at using a simple intervention and recorded improvement in compliance across the 6 perioperative IPC standards, resulting in significant reduction in risk of postoperative infections.[20] In Wassef and collaborators study,[22] they evaluated the use of care bundle approach to reduce SSI. The health care workers were properly trained on implementation of the bundle and adequate compliance was ensured before implementing the bundle. Their study also reported significant reduction in rates of SSI post intervention.[22] However, on the effect on mortality rate, only 1 study reported an effect that was not significant.[21]

Table 1
Shows key characteristics of included studies, including the study design, authors, population, intervention, and duration of study

Authors/(year)	Study design	Setting	Intervention guidelines	Intervention content	Sample size	Study period/ duration	Outcomes
Ventilator-associated pneumonia (VAP)							
Mavinga et al[15] (2018)	Noncontrolled before-after (NCBA)	Tertiary Hospital ICU-DRC Congo	CDC guidelines	VAP presentations, hospital hygiene presentations, VAP bundle: handwashing, head-to-bed elevation 30°-45°, daily removal of sedation, and oral decontamination.	102 patients: 44 patients (observational phase) and 58 patients (interventional phase).	February 2014-February 2016	Incidence density of VAP decreased from 33.74 VAP for 1,000 mechanical ventilation-days to 18.05 VAP for 1,000 MV-days. There was no difference in length of stay in the ICU, mortality, and mechanical ventilation duration.
Azab et al[16] (2015)	NCBA	University Hospital Neonatal Intensive Care Unit (NICU)—Egypt	CDC guidelines	Education and training on VAP, retraining on each VAP bundle item: hand hygiene reinforcement, head-of-bed elevation 30°-45°, sterile suction and handling of respiratory equipment, oral hygiene, and sedation vacation.	2,500 MV-days. 143 neonates, 62 cases (phase 1) and 81 cases (phase II).	January 2013-March 2014	Incidence density of VAP decreased from 67.8% (42/62) corresponding to 36.4 VAP episodes/1,000 mechanical ventilation-days in phase 1 to 38.2% (31/81) corresponding to 23 VAP/1,000 MV-days (RR 0.565, 955 confidence interval 0.408-0.782, $P = .0006$) after implementation of bundle. There was a trend toward reduction in NICU length of stay (23.9 ± 10.3 vs 22.8 ± 9.6 d, $P = .56$) and overall mortality (25% vs 17.3%, $P = .215$)
Elmenshawy et al[17] (2014)	NCBA	University Hospital–surgical/medical ICU—Egypt	CDC guidelines	Supplementary supplies, interactive education, VAP campaign, VAP bundle: head-of-bed elevation, oral care, daily sedation vacation, ulcer prophylaxis, cuff pressure measurement, and hand hygiene.	598 patients: 263 patients (pre intervention) and 335 patients (post intervention	September 2007-May 2013	Significant decrease in VAP rate by 35% (from 66.5-43 per 1,000 MV-days) (95% CI: 9.73-37.15, $P = .002$). Increase in ventilator utilization ratio post intervention ($P < .001$). Adherence to VAP bundle increased in the post intervention. Increase in hand hygiene from a mean of 8%-28.5% ($P = .001$).
Central line–associated bloodstream infections (CLABSI)							
Richards et al[18] (2017)	NCBA–stepwise approach	Netcare Private Hospitals—South Africa	IHI "100,00" lives, Canadian "Safer Healthcare Now" campaigns	Training sessions, posters, and bundle checklist: hand hygiene, barrier precautions on insertion, chlorhexidine gluconate (CHG) skin antisepsis, optimal selection of catheter site, daily review of CVC, monitoring, and feedback audits.	1,119,558 Central line days; 1,397 ICUs and 439 high-care beds (pre intervention); 1,700 ICUs and 493 high-care beds (post intervention).	April 2010-May 2016	Significant decline in CLABSI rate from a mean of 3.55 (SD: 0.82; range: 2.54-5.78) per 1,000 central line days to a mean of 0.13 (SD: 0.09; range: 0-0.33) per 1,000 central line days; $P < .0001$. Bundle compliance improved from a mean of 73.1% (SD: 11.2; range: 40.6%-81.7%) to a mean of 90.5% (SD: 4.7; range: 76.5%-97.2%).
Catheter-associated urinary tract infections (CAUTI)							
Tillekeratne et al[19] (2014)	NCBA	Public District Hospital—Nairobi, Kenya	Modified CDC guidelines	Educational videos, posters, and weekly IPC rounds	125 patients: 82 patients (pre intervention), 43 patients (post intervention)	March-July 2012	The rate of CAUTIs decreased from 13 CAUTIs pre intervention (30.4 infections per 1,000 catheter-days) to zero CAUTI post intervention ($P = .002$). There was no change in the mean duration of catheterization between phases (6.9 vs 5.6 d, respectively; $P = .322$). Catheter utilization ratio decreased from 0.14-0.09 ($P < .001$).

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Table 1 (*continued*)

Authors/(year)	Study design	Setting	Intervention guidelines	Intervention content	Sample size	Study period/ duration	Outcomes
Surgical site infections (SSI)							
Forrester et al[20] (2021)	NCBA	5 surgical referral hospitals—Ethiopia	WHO Surgical Site Checklist	Hand and surgical site preparation; sterility of gowns, drapes, gloves, instrument decontamination and sterilization, selection of prophylactic antibiotics, routine gauze, and routine use of the surgical site checklist	2,202 patients. 2,213 surgeries: 374 (baseline), 1,839 (post intervention).	August 2016-October 2018	Relative risk of surgical infections after implementation of the intervention was reduced by 35% (RR = 0.65; 95% CI: 0.43-0.99; $P = .043$). Improved compliance with standards reduced the risk of postoperative infection by 46% (RR = 0.54, 95% CI: 0.30-0.97); for adherence score, 3-6 versus 0-2; $P = .038$. Compliance rose from a baseline of 2.9 to a mean of 4.5 ($P < .001$).
Allegranzi et al[21] (2018)	NCBA	5 hospitals—Kenya, Uganda, Zambia, and Zimbabwe	Comprehensive Safety Unit-based Program USA; US CDC, National Health Safety Network	Staff education, engagement of local leadership, preoperative bathing, avoiding hair removal/doing it with clippers, appropriate surgical hand preparation, optimal antibiotic prophylaxis, and improving operating room discipline.	4,322 operations. 1,604 (at baseline), 1,827 (follow-up), and 891 (sustainability period)	July 2013-December 2015	Cumulative SSI incidence significantly decreased post intervention from 8.0% (95% CI: 6.8-9.5; n = 129) to 3.8% (95% CI: 3.0-4.8, n = 70). The decrease persisted in the sustainability period 3.9% (95% CI: 2.8-5.4, n = 35). Improvement in compliance with preventive measures was observed consistently in the follow-up and sustainability periods. The likelihood of death was not significantly reduced 0.72 (0.42-1.24, $P = .2360$).
Wassef et al[22] (2020)	NCBA	Tertiary Hospital Surgical Intensive Care Unit (SICU)—Egypt	CDC guidelines	Education and training, Bundle: antimicrobial prophylaxis, skin preparation, sterile dressing, safe operating room cleaning and discipline, decolonization using CHG, and screening for colonization	177 patients in phase I, 93 patients in phase III	March 2018-February 2019	Significant reduction of colonixation from 24%-15%. The implementation of the bundle was associated with 70% reduction of SSI (odds ratio = 0.3; 95% CI: 0.14-0.6). There was significant difference in the average length of stay between phase III (8.1 d) and phase I (14.58), $P < .001$.
Hand hygiene compliance							
Anwar et al[23] (2019)	NCBA	Tertiary Hospital (6 ICU units) —Egypt	WHO guidelines	Training/education, workplace reminders, active presentation (video shows), and handouts.	1,281 HH opportunities: 608 (at baseline) and 673 (post intervention).	March-August 2017	Statistically significant improvement in the overall HH compliance rate from 30.9 (95% CI: 27.2%-34.6%, $P = .01$) before the intervention to 69.5 (95% CI: 65.2%-72.6%, $P = .001$) post intervention.
Allegranzi et al[24] (2013)	NCBA (stepwise approach)	University Teaching Hospital—Mali 5 departments, 9 wards	WHO Multimodal Hand Hygiene Improvement Strategy	Locally produced alcohol-based handrub (ABHR), monitoring HH compliance, providing performance feedback, educating staff, placing reminders in the workplace, and promoting institutional safety climate	3,546 HH opportunities	December 2006-June 2008	HH compliance increased from 8.0% (95% CI: 6.8-9.3) at baseline to 21.9% (95% CI: 19.9-24.0).

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Table 1 (*continued*)

Authors/(year)	Study design	Setting	Intervention guidelines	Intervention content	Sample size	Study period/ duration	Outcomes
Pfafflin et al[25] (2017)	NCBA	University Teaching Hospital—Ethiopia	WHO Multimodal Hand Hygiene Strategy	Training workshop, locally made ABHR, reminders, and posters	164 health care workers (HCW) 7,997 HH opportunities 2,888 (at baseline), 2,865 (first follow- up), and 2,244 HH opportunities (second follow-up).	8 mo	HH compliance increased from 1.4% at baseline to 11.7% and 13.1% at first and second follow-up, respectively. The median scores for HH knowledge increased from 13 (interquartile range [IQR]: 11-15) at baseline to 17 (IQR: 15-18). Perception surveys showed appreciation of different strategy components.
Holmen et al[26] (2016)	NCBA	Secondary/ Nonreferral Rural Hospital—Rwanda	WHO Hand Hygiene Guidelines	Education of HCW on HH, introducing locally produced ABHR, provision of pocket-sized ABHR, and placing HH reminders in the workplace.	1,049 HH opportunities	2.5 mo	HH compliance increased from 34.1% at baseline to 68.9% post intervention ($P = .001$). Knowledge of HH was significantly enhanced $P < .001$.
Saito et al[27] (2017)	NCBA	Rural Referral/ Teaching Hospital—Uganda	WHO Hand Hygiene Guidelines	Training, portable handrubs, educational posters.	7,102 HH opportunities. 3,770 (baseline) and 3,332 (post intervention).	October 2014-April 2015	HH compliance improved significantly from 9.2% at baseline to 56.4% during the intervention phase ($P < .001$). There was no change in the incidence of health care-associated infections between baseline and intervention phases (incidence rate ratio [IRR] = 1.07; 95% CI: 0.79-1.44). Subgroup analysis showed significant reduction in HAIs on the surgical (IRR = 0.39; 95% CI: 0.16-0.92) and pediatric departments (IRR = 0.21, 95% CI: 0.10-0.47). However, there was a significant increase in the obstetrics department (IRR = 2.99, 95% CI: 1.92-4.66). There was higher hospital mortality (RR = 11.55; 95% CI: 4.78-27.93, $P < .01$), longer length of hospital stays (mean difference of 3.8 d; 95% CI: 3.4-4.3; $P < .01$).
Muller et al[28] (2020)	NCBA	Regional Hospital—Guinea (16 wards)	WHO Hand Hygiene Improvement Strategy	Training, local production of ABHR, and HH reminder sessions	941 HH opportunities. 384 (baseline) 557 (follow-up)	12 mo	Significant increase in hand hygiene compliance from 23.7% at baseline to 71.5% at follow-up. Baseline knowledge score showed a significant increase from (13.0/25) at baseline to 19.0/25 at follow-up.
Schmitz et al[29] (2014)	NCBA	University Teaching Hospital—Ethiopia	WHO Multimodal Hand Hygiene Strategy Guidelines	Availability of supplies for HH, training, posters, hand hygiene champions, monitoring, and feedback	2,000 HH opportunities	May 2012-August 2012	HH compliance increased from 2.15 at baseline (21 HH actions per 1,000 HH opportunities) to 12.7% (127 HH actions per 1,000 HH opportunities) after the implementation of the campaign (OR = 6.8, 95% CI: 4.2-10.9).

CI, confidence interval; *HAI*, health care-associated infections; *HH*, hand hygiene; *ICU*, intensive care units; *MV*, mechanical ventilation; *OR*, odds ratio; *RR*, risk ratio.

Seven studies implemented interventions to increase hand hygiene compliance as the primary outcome.[23-29] In Egypt, 6 ICUs of a referral hospital evaluated hand hygiene compliance after the implementation of an educational program.[23] Training was re-enforced using posters and reminders on hand hygiene techniques. The study reported significant increase in hand hygiene compliance after the intervention.[23] A multicenter study at a tertiary hospital in Mali, implemented 5 components of the multimodal strategy to assess hand hygiene compliance.[24] The study reported an increase in hand hygiene compliance and significant enhancement of knowledge of health care workers.[24] Pfafflin and colleagues[25] implemented 3 of the 5 components of the multimodal hand hygiene strategy and reported increase in hand hygiene compliance and knowledge. Another study implemented the same strategy in a nonreferral rural hospital in Rwanda, which also reported overall improvement.[26] Saito and collaborators in their study, termed the "Ward Gel study" in Uganda, assessed hand hygiene compliance and incidence of HAIs after the introduction of ABHRs in departments where ABHR was almost nonexistent.[27] The result showed that hand hygiene compliance increased significantly by more than 500%.[27] Significant improvements were also reported in additional studies conducted in Guniea[28] and Ethiopia.[29]

Result of risk-of-bias assessment and summary of certainty of evidence

A summary of the risk of bias of included studies is presented in Table 2. Seven studies were at low risk of bias for large effect size and minimizing possible confounders in the study.[15,16,18,20,21,23,24] Five studies were at moderate risk of bias for confounding issues such as where an assessor is not blinded to the study or where bias due to confounders could potentially influence outcomes[17,22,25,27,28] and 3 studies were at serious risk of bias due to short period of study, temporal proximity of intervention and assessment phases, and modification of standardized guidelines for study purpose.[19,26,29]

A summary of the strength of evidence across outcomes using Grading of Recommendation Assessment Development and Evaluations (Table 3). Evidence on IPC interventions on CLABSI from more than one thousand ICUs and over one million central line days was rated high for large magnitude of effect. Moderate evidence for IPC interventions on SSI on over five thousand surgeries was rated down by 1 level due to inconsistency. The certainty of evidence for CAUTI was rated down by 2 levels for imprecision due to effect estimate from a small sample size. Low-quality evidence on VAP due to risk of bias and inconsistency. Low-quality evidence on HHC was rated down by 2 levels due to risk of bias and imprecision.

DISCUSSION

The Covid-19 pandemic has served as an urgent reminder on the crucial role of IPC in mitigating threats posed by infectious diseases and ensures health systems' preparedness for future health emergencies.[30-32] Regarding this, there was concern for Africa and other developing countries at the onset of the pandemic on potential of being overwhelmed due to lack of surge capacity, a trajectory of poor disease containment strategies, and multiple outbreaks and epidemics common within the region.[33] Today, IPC is one of global health priorities, positioned to improve patients' and workers' safety, reduce HAIs, and maintain resilience of health systems.[34] Therefore, operationalizing IPC is a core element of pandemic planning.[32-34] Despite this, the evidence on the effectiveness of IPC interventions and the best combination of the interventions in health care settings in Africa is lacking. This may create confusion regarding ways of combining the interventions and the expected outcomes. This frustrates measures aimed at mitigating the high burden of infections acquired within health care settings in the region, which reportedly has the highest burden of infectious diseases compared with other WHO regions.[10,11]

The composition of IPC interventions and the implementation approach in our review varied widely across studies included in our review. These interventions were multifaceted and generically reported as "multimodal."[24,25,29] We recognize that multimodal interventions are largely supported by consensus and expert advice as more effective than stand-alone interventions.[35] Studies were not explicit in implementing these interventions in line with best

Table 2
Summary of risk-of-bias assessment using ROBINS-I tool

Authors/study	Selection of Participants (selection bias)	Confounding variable (selection bias)	Measurement of intervention (performance bias)	Blinding for outcome assessment (detection bias)	Incomplete Outcome (attrition bias)	Selective outcome reporting (reporting bias)	Other bias	Judgement
Mavinga et al[15] 2018	+	+	+	+	+	+	+	Low Risk
Azab et al [16] 2015	+	+	+	+	+	+	+	Low Risk
Elmenshawy et al[17] 2014	+	+	+	+	+	+	?	Moderate risk
Richards et al[18] 2017	+	+	+	+	+	+	+	Low Risk
Tillekerante et al[19] 2014	+	+	+	+	+	?	?	Serious risk
Forrester et al[20] 2021	+	+	+	+	+	+	+	Low Risk
Allegranzi et al[21] 2018	+	+	+	+	+	+	+	Low Risk
Wassef et al[22] 2020	+	+	+	+	+	+	?	Moderate risk
Anwar et al[23] 2019	+	+	+	+	+	+	+	Low Risk
Allegranzi et al[24] 2013	+	+	+	+	+	+	+	Low Risk
Pfafflin et al[25] 2017	+	+	+	+	+	?	+	Moderate risk
Holmen et al[26] 2016	+	+	?	?	+	?	+	Serious risk
Saito et al[27] 2017	+	+	+	+	+	?	+	Moderate risk
Muller et al[28] 2020	+	+	?	+	+	+	+	Moderate risk
Schmitz et al[29] 2014	+	+	?	?	+	+	?	Serious risk

Key	+ Low risk	? Moderate risk	- Serious risk

ROBINS-I, Risk of Bias Tool for Nonrandomized Studies.

Table 3
GRADE assessment for rating the certainty/strength of included studies for each outcome

Outcomes	No. of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Certainty	Judgment
Hand hygiene compliance	7	Pre and post study design	Very serious	Serious	Serious	Very serious	None	⊕⊕	Low quality
Ventilator-associated pneumonia (VAP)	3	Pre and post study design	Very serious	Very serious	Serious	Serious	None	⊕⊕	Low quality
Surgical site infections (SSI)	3	Pre and post study design	Not serious	Serious	Not serious	Not serious	None	⊕⊕⊕	Moderate quality
Central line–associated bloodstream infections	1	Pre and post study design	Not serious	Not serious	Not serious	Not serious	None	⊕⊕⊕⊕	High quality
Catheter-associated urinary tract infections (CAUTI)	1	Pre and post study design	Very serious	Not serious	Serious	Very serious	None	⊕⊕	Low quality

GRADE, Grading of Recommendation Assessment Development and Evaluations.

practices of the multimodal approach that involves systematically integrating the interventions. This emphasizes the need to optimize the implementation of IPC measures in a manner that will yield expected or desirable outcomes. Furthermore, compliance with IPC measures can be enhanced using bundles and checklists that serve as implementation tools to reduce unrecognized omissions during patient care. Aligning with the views of Frank and colleagues,[36] they are "used to improve health care safety by empowering the delivery of consistent, high-fidelity care." The use of bundles and checklists to improve patient outcomes is widely documented in the IPC literature, resulting in a decrease in the rate of HAIs.[36,37]

Our review found strong reasons to recommend continuous education and training of the health workforce on IPC in Africa and the need to harmonize the training curriculum and content. Majority of the studies provided training alongside a combination of other interventions as part of the intervention strategies.[15-29] Previous studies and expert consensus strongly recommend that education and training of health care workers are critical to drive IPC improvements.[35,38] As earlier mentioned, IPC training activities were delivered using various formats. The heterogeneity of IPC trainings and content is documented in the literature.[39] The training activities were often complemented with reminders, that is, visual cues such as posters that serve as prompts to remind health care workers to comply with IPC measures, as well as keep patients and visitors aware of standards of care expected from their health care practitioners.

Our findings demonstrate that availability of IPC supplies can be a game changer in the IPC landscape in Africa. In this regard, we observed that increased availability of hand hygiene products or supplies in resource-constrained settings led to increase in health workers' compliance with hand hygiene.[23-29] The centrality of the role of hand hygiene in infection prevention is well-documented in the wider literature.[40] We found that meeting product supply needs led to behavioral change among health workers, which potentially could lead to a decline in burden of infections (none of the studies measured the direct effect of improvement in compliance with burden of HAIs). This underscores the need for countries to make investments in manufacturing and supply chain of materials for IPC, particularly hand hygiene supplies. For instance, studies focused on hand hygiene compliance engaged in local production of ABHRs to meet hand hygiene demands, while reporting marked improvement in adherence.[24-28]

To state clearly, our review suggests that in limited-resource settings, IPC interventions could lead to reduction in HAIs and increase adherence of health workers to hand hygiene, which are the primary outcomes in this study. On secondary outcomes, we found a trend in the reduction of length of hospital stays but not on mortality rate as reported in some studies.[15-22] Few studies also reported significant increase in knowledge, perception, and compliance with IPC measures by health care workers.[23-28] Overall, we acknowledge that it was not possible to combine studies into a meta-analysis nor attribute the effectiveness to a particular intervention for obvious reasons of heterogeneity.

This review demonstrates the paucity of data on IPC interventions in health care facilities in Africa. The data may be insufficient to shape policy but can inform practice, guide actions and need-based interventions on IPC requirements, and areas of priority attention. We provide suggestions for future research in Africa to consider the use of more pragmatic study designs such as step-wedged cluster-randomized trial or interrupted time series design that can account for trends over time, enable pooling of studies, and causal inferences to be made. Future pre-post-test studies could minimize bias by use of a control group, blinding of assessors, ensuring that before- and after-cohorts are well-matched, consistency in measuring and reporting criteria, and minimized time lag between cohorts according to WHO guidelines.

There are some limitations in our review, we included only studies reported in English Language. Limiting study based on language may potentially introduce language bias. Considering that this study is focused in Africa, cultural context could have been enhanced by including studies in other languages since there are non–English speaking countries in Africa. Many of the studies were conducted in tertiary hospitals, as such, the results may not be generalizable to a broader patient or health care worker population or as evidence base to inform health care decisions. As with pre-post-test study designs, studies are inherently susceptible to subtle bias, which could influence the outcomes and invalidate the conclusion. The exclusion of many studies on the basis of not meeting eligibility criteria, could have precluded many studies with potential of increasing evidence base for the review.

CONCLUSIONS

Our review suggests that IPC interventions could potentially reduce HAIs and improve compliance with hand hygiene in health care facilities in Africa, but the certainty of evidence was low for majority of the outcomes. Due to significant heterogeneity within and between studies in population, intervention, comparator, and outcome measures, we could not conclude on the effectiveness of IPC interventions within health care settings in Africa. However, our review highlights the need for more research on IPC interventions in Africa, including contextual factors determining the implementation of recommended control measures.

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at doi:10.1016/j.ajic.2024.06.004.

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