Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 13065 – 13074
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i8.6179

The Efficiency of Infection Control Teams in Lowering Infections Linked to Healthcare: Systematic Review

Moamen Abdelfadil Ismail[1], Maha sayil alotaibi[2], Asma Mohammed Ali moafa[3], Mohammed rashed tiny aldossari[4], Albandari ali mutab almutairi[5], Nadia Dafer Majdua Alshehri[6], Norah Muqbil Almutairi[7], Maha Majeb Alotaibi[8], Mead alharbi[9], Fahad Hamoud Aldosari[10], Saud Hussain Alshahrani[11], Naief Saleh AbdulAziz Almatroudi[12], Fawaz Lafi Hajij Al Sharari[13], Fahad Khalaf Mohammed Alrabie[14], Jamal Mansour Musslih Alotaibi[15], Rami Safir Meshal Aljuaid[16], Badr Saud Jarbua Al-Shahrani[17]

Abstract

Healthcare-associated infections (HCAIs) are a major concern in medical facilities worldwide, with an estimated 7–10% of patients affected. Infection control teams (ICTs) play a crucial role in preventing these infections by implementing guidelines, conducting surveillance, and educating healthcare professionals. However, the effectiveness of ICTs, with or without infection control link nurses (ICLNs), in reducing HCAIs remains unclear. This systematic review evaluates the impact of ICTs on infection rates, mortality, and compliance with infection control practices in various healthcare settings.A systematic review of randomized controlled trials (RCTs) was conducted following PRISMA guidelines. Databases searched included PubMed, EMBASE, CINAHL, and Cochrane CENTRAL. Studies assessing ICTs with or without ICLN systems in inpatient hospitals, outpatient clinics, and long-term care facilities were included. The primary outcomes measured were HCAI incidence, mortality, and hospital stay length, while secondary outcomes included staff compliance and cost-related factors. Risk of bias was assessed using the Cochrane risk-of-bias tool, and meta-analyses were performed where possible. Nine RCTs met the inclusion criteria, covering hospital wards, dialysis units, and nursing homes. Meta-analysis of three studies showed no significant reduction in HCAI incidence (RR = 0.65, 95% CI: 0.45–1.07, very low certainty). Mortality due to HCAIs remained unaffected (RR = 0.32, 95% CI: 0.04–2.69, very low certainty). However, ICTs with ICLNs significantly improved compliance with infection control practices (RR = 1.17, 95% CI: 1.00–1.38, moderate certainty). Limited evidence was available for hospital stay duration and cost-related outcomes.While ICTs, particularly with ICLN systems, enhance compliance with infection control measures, their direct impact on reducing HCAIs and mortality remains uncertain. The high risk of bias and heterogeneity in study designs highlight the need for high-quality research with standardized outcome measures to assess the effectiveness of ICT interventions in healthcare settings.

Keywords: *Healthcare, Healthcare-Associated Infections, ICT.*

Introduction

Healthcare-associated infections (HCAIs) are infections acquired by patients while receiving medical care for other conditions in settings such as hospitals, clinics, community health centers, or care homes (1). These infections are prevalent in acute care hospitals, with an estimated 7–10% of patients affected worldwide (2). Additionally, they can occur in various care environments, including outpatient clinics,

[1] Internal Medicine consultant, King Abdulaziz specialist hospital - Sakaka –Aljouf, Email: moamen.fadil83@gmail.com
[2] Nursing specialist, Gharnada Primary Healthcare Center.
[3] Technician-Nursing, Ghurnata Primary Healthcare Center.
[4] Nursing technician, Primary Care Ghurnata.
[5] Nursing specialist, Ghrnatah Primary Healthcare Center
[6] Technician-Nursing, Gharnada Primary Healthcare Center
[7] Nursing technician, Gharnada- health center
[8] Nursing technician, Salah aldein - health center
[9] Nursing Specialist, Ministry of Health branch in Medina
[10] Epidemiology specialist, Ghrnatah PHC
[11] Epidemiological observer, Granada Health Center
[12] General Physician, Aljanadriyyah west PHC
[13] Health Services Management Technician, Al-Qurayyat General Hospital
[14, 15, 16] Operating Room Technician, QIYA General Hospital
[17] Operating Room Technician, Maternity and Children's Hospital in Khamis Mushait

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ambulatory surgical centers, dialysis facilities, and long-term care settings like nursing homes and rehabilitation facilities (3).

It is estimated that up to 70% of HCAIs can be prevented (4, 5, 6). Infection control departments with dedicated staff play a crucial role in preventing these infections within hospitals (7). Preventing HCAIs requires the implementation of infection control guidelines, which are typically managed by the infection control team (ICT) (8). The ICT is responsible for various tasks, such as (1) creating and distributing guidelines and policies, (2) organizing ongoing education and training programs, (3) setting up systems for HCAI surveillance, (4) overseeing and auditing care practices and standards, and (5) fostering collaboration with other departments and staff (2, 9).

Core members of the ICT include doctors, epidemiologists, microbiologists, and nurses, often referred to as infection control nurses (ICNs). Over time, the ICT framework has expanded to include additional roles, such as infection control link nurses (ICLNs) and infection control champions. ICLNs and infection control champions work directly on the wards under the guidance of ICNs, serving as intermediaries between their clinical wards and the ICT (9). The ICT and ICLN system are also applied in nursing homes (11, 12, 13, 14, 15).

The ICT model was first established in the 1950s, and the ICLN system was introduced in the 1990s. Previous reviews have explored ICT operational practices (9), the ICLN system concept (16), and the factors that facilitate or hinder the implementation of the ICLN system (17). However, an initial review of the literature on infection control highlighted a lack of systematic reviews focusing on the effectiveness of ICT, with or without the ICLN system, in both inpatient hospitals and outpatient or long-term care settings. This systematic review, therefore, aims to assess the effectiveness of these systems in reducing the incidence of HCAIs in hospitals, outpatient clinics, and long-term care facilities.

Materials and Methods

Protocol and Registration

The protocol for this review was registered with the International Prospective Register of Systematic Reviews (PROSPERO) (18). This review follows the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) statement (19).

Eligibility Criteria

We included randomised controlled trials (RCTs) that compared an infection control team (ICT), with or without the inclusion of the infection control link nurse (ICLN) system, to other interventions or no intervention at all. The studies considered were those involving patients of any age in inpatient hospitals, outpatient facilities, and residents in long-term care settings. These studies assessed patient-based outcomes and also examined the behavioral outcomes of healthcare professionals, including doctors, nurses, and nursing home staff. The ICT in this review is defined as a team consisting of both medical and nursing professionals trained in infection prevention and control or equivalent (2). The primary and secondary outcomes are outlined as follows:

Primary Outcome

Patient-Based Outcomes

- *Incidence of HCAIs:* We did not place restrictions on the types or timing of healthcare-associated infections (HCAIs). The incidence was measured as either the number of infections per 1000 patient-days or the number of infected patients relative to the total number of patients during the study period.

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- *Mortality Due to HCAIs:* The rate of deaths resulting from HCAIs was calculated as the number of patients who died with an HCAI compared to the total number of patients with HCAIs.

- *Length of Stay*: This was measured in terms of days in the hospital.

Staff-Based/Behavioral Outcomes

- *Compliance with Infection Control Practices*: Compliance was assessed based on the measurements reported by the authors of the studies.

Secondary Outcome

- *Costs Related to HCAIs*: We examined the financial impact of HCAIs.

Search Strategies

We searched four electronic databases—PubMed, EMBASE, CINAHL, and Cochrane Central Register of Controlled Trials (CENTRAL)—from their inception up to May 2020. The search strategy is detailed in the protocol (18). The results from these databases were imported into the EndNote reference management software (20), where duplicate entries were removed. The remaining studies were then imported into Covidence (Covidence systematic review [software], Veritas Health Innovation, Melbourne, Australia) for the selection process.

Study Selection

Five pairs of authors (MMT, MOR, RH, SM, SO, JM, YY, CM, MN, and TB) independently screened titles and abstracts to determine eligibility. Disagreements were resolved through discussion. Pairs of authors (MMT, MOR, RH, SO, JM, YY, and CM) also independently reviewed the full texts to apply the eligibility criteria. Any disagreements were settled through discussion or by consulting a third author (TB). Although the protocol initially excluded studies focusing solely on hand hygiene compliance or antimicrobial prescription, we revised this and included studies that reported on hand hygiene, among other factors, to ensure that primary or secondary outcomes were not excluded.

Data Extraction

The first author (MMT) created a standardized data extraction form, which was piloted using at least one relevant study. Two authors (MOR and RH) reviewed the form. Data extracted for each study included the first author's name, publication year, study design, setting, country, participant characteristics, sample size, intervention and control group details, outcome measures, and study results. Two authors (MMT, MOR, or RH) independently extracted the data, and discrepancies were resolved by discussion.

Risk-of-Bias Assessment

Two of the authors (MMT, MOR, or RH) independently assessed the risk of bias in each included study using the Cochrane risk-of-bias tool (21). This tool examines several areas, including random sequence generation, allocation concealment, participant and personnel blinding, outcome assessment blinding, incomplete outcome data, selective reporting, and other biases. Each domain was rated as low, high, or unclear risk of bias. Any disagreements were resolved through discussion.

Data Analysis

Meta-analyses were conducted when two or more studies examined a comparable intervention and outcome. Data were entered into RevMan 5.4 for statistical analysis, and a random-effects model was employed, as ICTs are complex interventions (22). Risk ratios (RR) were used for dichotomous data, and mean differences were used for continuous data, with 95% confidence intervals (CI). The I2 statistic was

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used to assess the heterogeneity among the studies, and the results were interpreted according to the Cochrane Handbook for Systematic Reviews of Interventions (23). If there were insufficient studies to combine the data, we reported the findings narratively.

Subgroup analysis by ICT intervention categories (surveillance, education, and monitoring of practices) was planned, but was not possible due to a lack of sufficient studies. Sensitivity analysis on primary outcomes, excluding studies with a high risk of bias, was also planned. However, all studies had a high risk of bias, so no sensitivity analysis was performed.

The Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used to assess the certainty of the evidence for three outcomes: HCAI incidence rate, death due to HCAIs, and compliance with infection control practices (24). The GRADE method evaluates evidence based on domains like risk of bias, imprecision, inconsistency, indirectness, and publication bias, assigning certainty ratings as very low, low, moderate, or high. Due to an insufficient number of studies, publication bias was not assessed through funnel plots. We used the GRADEpro web-based platform to create a 'Summary of Findings' table, accounting for the certainty of evidence (GRADEpro GDT: GRADEpro Guideline Development Tool [Software].

Results

A total of 12,666 studies were initially identified through the four databases. After removing duplicates, 11,719 titles and abstracts were screened. This process led to the exclusion of a large number of studies (n = 11,676). The remaining 43 studies were reviewed in full text, resulting in the exclusion of 35 studies due to issues with study design, intervention or outcome mismatch, or the absence of complete text (e.g., conference abstracts or protocols). In total, 9 studies were deemed eligible for inclusion in the review ([25], [26], [27], [28], [29], [30], [31], [32], [33]).

The studies included in this review were published between 1990 and 2020 and were predominantly cluster-randomized controlled trials. The number of clusters varied from 6 to 45, with these clusters being hospital wards, outpatient long-term haemodialysis units, or nursing homes. Five studies were conducted in inpatient hospitals, one in outpatient haemodialysis units, and three in nursing homes. The study durations ranged from 5 weeks to 20 months.

Participants in these studies included patients, residents, and healthcare professionals (nurses and staff). In four studies, data was reported for a total of 2085 patients in hospitals and outpatient haemodialysis units, and 1743 residents in nursing homes. Five studies reported on healthcare professionals, with 1508 nurses and 333 nursing home staff involved in the interventions. In the hospital settings, participants were primarily nurses in three studies, patients in one study, and a combination of both in another study. In outpatient haemodialysis units, participants were patients, while in nursing homes, the participants were residents in one study and a combination of residents and staff in two others.

Four studies evaluated the effectiveness of ICT without the ICLN system ([28], [29], [31], [32]), while the remaining five explored ICT with the ICLN system ([25], [26], [27], [30], [33]) (Appendix A Table A1). The ICT teams in these studies consisted of infection control doctors, infection control nurses (ICNs), nephrologists, dialysis staff, ICU co-directors, ICU physicians, nurses, and infection control practitioners. In the studies using the ICLN system, staff or nurses were chosen as link nurses, opinion leaders, or champions. The infection control measures employed by ICTs in the studies included developing and disseminating guidelines and policies ([26], [33]), providing continuous education and training ([25], [26], [27], [29], [30], [32], [33]), performing HCAI surveillance ([28], [31]), monitoring and auditing infection control practices ([26], [27], [29], [30], [32], [33]), ensuring care standards, and fostering effective collaboration with other departments and staff ([25], [26], [27], [30], [33]).

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Control Groups

Of the included studies, five used usual care as a control, two used lectures as a control, and two did not implement any intervention as a control.

Outcome Measures

Two studies assessed patient-based outcomes, four focused on staff-based outcomes, and three measured both ([25], [28], [29], [30], [31], [32], [33]). For patient-based outcomes, the incidence rate of HCAIs was reported in five studies ([25], [28], [29], [30], [31]), death due to HCAIs was reported in two studies ([28], [31]), and one study measured the length of hospital stay ([28]). For staff-based outcomes, nurses' compliance with infection control practices was evaluated in three studies ([26], [29], [33]), changes in infection control scores were measured in three studies ([25], [27], [33]), and the level of compliance with infection control guidelines at the facility level was reported in two studies ([30], [32]). Only one study addressed the cost associated with HCAIs ([28]).

Funding Sources

Six studies disclosed their funding sources, though three did not provide specific details regarding their financial support.

Incidence of Healthcare-Associated Infections (HCAIs)

Five studies assessed the incidence of HCAIs ([25, 28, 29, 30, 31]). Three studies, which reported the number of affected patients/residents, were included in the meta-analysis. The combined analysis indicated that the ICT interventions, with or without the ICLNs system, did not result in a significant reduction in HCAI rates (RR = 0.65, 95% CI: 0.45–1.07, very low certainty of evidence). A subgroup analysis, which categorized the studies based on the type of intervention, also did not show significant differences between the groups (Group 1.1.1: RR = 0.52, 95% CI: 0.30–0.88, Group 1.1.2: RR = 0.98, 95% CI: 0.67–1.41, p = 0.06).

Two additional studies provided data on the mean HCAI rates ([29, 30]). However, due to incomplete participant data in one study ([29]), a meta-analysis could not be conducted. The study reported a significant reduction in HCAI rates in the intervention group compared to controls (adjusted incidence rate ratio = 0.19, 95% CI: 0.06–0.57). Conversely, another study found no significant change in the mean HCAI rate between the intervention and control groups (relative difference = −6.7, 95% CI: −36.2–36.4) ([30]).

Mortality Due to HCAIs

Two studies evaluated mortality due to HCAIs ([28, 31]). The meta-analysis showed no significant effect of ICT interventions on mortality related to HCAIs (RR = 0.32, 95% CI: 0.04–2.69, very low certainty of evidence).

Length of Hospital Stay

One study reported the length of hospital stay ([28]). The findings indicated no significant difference between the intervention and control groups in terms of hospital stay duration (42 days vs. 45 days, p = 0.52).

Staff-Based/Behavioral Outcomes

The included studies assessed three different aspects of compliance among staff:

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Compliance with Infection Control Practices

Three studies measured the proportion of compliance with infection control practices among staff. One study ([29]) could not be included in the meta-analysis due to insufficient reporting. In this study, infection control practices increased in both the intervention and control groups over time. The meta-analysis of the other two studies revealed a significant improvement in compliance with infection control practices (RR = 1.17, 95% CI: 1.00–1.38, moderate certainty of evidence) ([26, 33]).

Changes in Infection Control Compliance Scores

Three studies assessed changes in infection control compliance scores. One study in a nursing home found that the mean infection control audit score was significantly higher in the intervention group compared to the control group after 12 months (82% vs. 64%, $p < 0.001$) ([25]). Another study in a hospital reported a significant improvement in self-reported compliance with standard precaution scores (15.43 vs. 14.32, $p = 0.024$) ([27]). A third study found that ICT with ICLNs was more effective than the control group, reporting higher mean infection control practice scores (5.63 in the intervention group with lectures and demonstration, 4.96 with demonstration alone, and 3.29 in the control group, $p < 0.05$ in both comparisons) ([33]).

Facility-Level Compliance with Infection Control Guidelines

Two studies from nursing homes evaluated facility-level compliance with infection control guidelines. One pilot study measured weekly surface swab bacterial counts and hand-washing occasions per resident/week, finding significant improvements in these outcomes in the intervention group compared to the control group ([30]). Another cluster-RCT reported on hand hygiene, environmental cleanliness, and safe disposal of clinical waste, though no statistically significant differences were observed between the intervention and control groups ([32]).

Cost Related to HCAIs

One study evaluated the cost associated with HCAIs ([28]). The findings revealed a significant difference in the cost of treating HCAIs between the intervention and control groups (USD 337.3 vs. USD 516.6, $p = 0.01$).

Table 1. Characteristics of Included Studies (*N* = 9).

Characteristics		No	%
Publication year	1990–2000	2	22.22
	2001–2010	3	33.33
	2011–2020	4	44.44
Location	USA	3	33.33
	Europe	3	33.33
	Asia	3	33.33
Setting	Inpatient hospitals	5	55.56
	Outpatient haemodialysis units	1	11.11
	Nursing homes	3	33.33
Type of intervention	ICT	4	44.44
	ICT + ICLN system	5	55.56
Outcome assessed	Patient-based		
	HCAIs	5	55.56
	Deaths	2	22.22
	Length of hospital stay	2	22.22
	Staff-based		
	Compliance	7	77.78

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	Cost	1	11.11

HCAIs, healthcare-associated infections; ICLN, infection control link nurse; ICT, infection control team; USA, The Unite States of America.

Table 2. Summary of Findings and GRADE Evidence Profile

Outcomes	**Anticipated Absolute Effects (95% CI)**		**Relative Effect (95% CI)**	**No of Participants (Studies)**	**Certainty of the Evidence (GRADE)**
	Risk with Usual Care	**Risk with Infection Control Team**			
Incidence rate of HCAIs (follow-up: range 4 months to 20 months)	116 per 1000	75 per 1000 (46 to 124)	RR 0.65 (0.40 to 1.07)	2511 (3 RCTs)	⨁◯◯◯ Very low [a,b,c]
Death due to HCAIs (follow-up: range 4 months to 20 months)	296 per 1000	95 per 1000 (12 to 797)	RR 0.32 (0.04 to 2.69)	299 (2 RCTs)	⨁◯◯◯ Very low [a,b,c]
Compliance with infection control practices (follow-up: mean 5 weeks)	419 per 1000	491 per 1000 (419 to 579)	RR 1.17 (1.00 to 1.38)	914 (2 RCTs)	⨁⨁⨁◯ Moderate [a]

Explanations: [a] Downgraded one level due to performance bias, attrition bias and other bias; [b] Downgraded one level for inconsistency due to heterogeneity across the studies (I2 > 50%); [c] downgraded one level for imprecision due to wide 95% CI.

Discussion

This review consolidates the effectiveness of ICT, either with or without an ICLN system, across various settings, including inpatient hospitals, outpatient dialysis units, and nursing homes. A total of nine cluster-RCTs were analyzed, assessing five distinct types of infection control strategies implemented by ICT with or without ICLNs: guideline formulation and revisions, HCAI surveillance, healthcare worker education and training, monitoring practices, and collaboration across teams and departments. The control groups typically received usual care, lectures alone, or no intervention. Most studies were found to have a high risk of bias. The analysis found no significant evidence to suggest that ICT, with or without ICLNs, was effective in reducing the rate of HCAIs (very low certainty of evidence) or in preventing deaths due to HCAIs (very low certainty of evidence). However, significant evidence indicated that ICT with ICLN systems improved nurses' compliance with infection control practices (moderate certainty of evidence). Due to the heterogeneity of outcomes, we could not conduct a meta-analysis on the length of hospital stay or the costs associated with HCAIs, as only one study addressed the latter.

To our knowledge, this is the first systematic review that evaluates the impact of interventions by ICT, with or without ICLNs, on preventing HCAIs. Previous Cochrane reviews on infection control adherence, including professional adherence to infection guidelines and strategies for preventing methicillin-resistant Staphylococcus aureus, indicated that education, whether alone or coupled with other support measures, could enhance adherence to infection control protocols (36,37,38). Our review includes six studies not included in these Cochrane reviews (27,28,29,30,31,33), some of which were excluded from earlier reviews due to not being RCTs.

Another systematic review, which included one of the trials from our analysis, concluded that multidisciplinary approaches, including ICT-led education, effectively improved adherence to infection

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control practices (39). Additionally, a review by Aboelela et al. found that educational programs and the establishment of multidisciplinary teams could reduce HCAIs, though the impact on healthcare worker compliance with infection control practices was mixed (40).

The role of ICT in inpatient settings is endorsed in many countries, though the use of ICLN systems may not be as universally implemented (41). Our findings support the idea that ICT combined with ICLN systems enhances compliance with infection control measures, but the effectiveness of ICT alone remains unclear.

Several barriers to successful implementation of ICT exist, including workload challenges, insufficient staffing, and limited resources, as identified by Alhumaid et al. (42). Addressing these challenges requires strong governmental and healthcare leadership support to ensure the effective implementation of ICT and ICLN systems in healthcare facilities.

This review highlights the need for higher-quality research on ICT interventions. The WHO has recommended that infection control programs, supported by dedicated and trained teams, be established in acute care settings to prevent HCAIs, but evidence supporting this is still limited, with only two studies currently available (43). The effectiveness of ICT in reducing HCAIs remains inadequately evaluated, especially in the context of the COVID-19 pandemic. Future research should include head-to-head RCTs comparing ICT with and without ICLN systems to determine whether an ICLN system is essential for effective ICT interventions.

Further studies should focus on both clinical outcomes, such as the incidence of HCAIs, death rates due to HCAIs, and length of hospital stays, as well as staff-based outcomes. There is a need for more consistent reporting on compliance with infection control practices. Due to the variability in outcomes and insufficient data from the studies analyzed, more uniformity in outcome measures is necessary for future research to enable better comparison and stronger evidence.

While our analysis has shown a clear link between ICT and improved compliance with infection control practices, further research is needed to explore the potential causal relationship between improved compliance and reduced HCAI rates (44,45,46).

Conclusions

The evidence regarding the impact of ICT, with or without ICLN systems, on reducing HCAIs in inpatient and outpatient care settings remains limited. Our analysis found no significant evidence of ICT reducing the incidence of HCAIs, deaths due to HCAIs, or length of hospital stay. However, ICT with ICLN systems likely improves nurses' adherence to infection control practices. Due to high bias, inconsistency, and imprecision, these findings should be interpreted with caution. High-quality studies with consistent outcome measures are needed to better assess the effectiveness and cost-effectiveness of ICT in healthcare settings.

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Journal of Ecohumanism
2024
Volume: 3, No: 8, pp. 13065 – 13074
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
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