



Infection Control Education And Training: Bridging the Gap between Knowledge and Practice

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Abstract:

Hospital-acquired infections (HAIs) are a significant global issue associated with increased morbidity, mortality and healthcare costs.

Transmission of pathogens occurs mainly through healthcare workers' (HCWs) hands during patient care activitie. Effective infection control practices and compliance with standard precautions are crucial to curb the spread of HAIs.

This review aims to systematically review the literature on infection control training for HCWs and identify factors influencing compliance. The findings can help optimize training strategies and bridge the knowledge-practice gap.

A literature search was conducted in PubMed, Embase, CINAHL, and Cochrane Library from inception to January 2022 using search terms such as "infection control", "hand hygiene", "competency-based training", "compliance", and "knowledge-practice gap".

The literature demonstrates competency-based training improves compliance when incorporating skills assessment and addressing multi-level barriers. However, sustaining behaviors over time remains challenging. This review aims to evaluate the evidence further.

A systematic search was conducted in PubMed, CINAHL, and Cochrane Library from inception to January 2022, following the PRISMA guidelines. The search strategy involved combinations of terms such as "infection control", "hand hygiene", "training", "education", "compliance", and "knowledge-practice gap". Studies evaluating the impact of infection control training programs for HCWs and reporting pre-post measures of compliance were included.

A total of 22 studies met the eligibility criteria. Sample sizes ranged from 42 to over 3000 participants. Studies were conducted in various countries and settings including tertiary hospitals, long-term care facilities, and outpatient clinics.

Training modalities included lectures, videos, online/bedside modules, return-demonstration, and competency evaluation with feedback. Multimodal programs combining different methods showed significantly improved hand hygiene, isolation precautions and personal protective equipment compliance compared to pre-training levels or single modality training ($p < 0.05$).

This review provides evidence that multimodal infection control training incorporating various teaching strategies is most effective in improving HCWs' compliance in both the short and long-term.

The findings are consistent with existing literature emphasizing the need for culture change through leadership commitment and a systems approach to compliance. Future training programs should be competency-based, involve multilevel stakeholders and provide continuous support to sustain best practices.

While the evidence reviewed indicates that multimodal, competency-based infection control training can effectively improve healthcare worker compliance with best practices, there remain open questions about how to optimize and ensure the sustained success of such programs.

More research is still needed to identify the most effective training modalities and schedules for long-term behavior change. In particular, well-designed controlled trials are needed to evaluate the impact of multilevel, system-oriented interventions that address individual, supervisory and organizational influences together through a coherent strategy.

In closing, while competency-based education has demonstrated success in narrowing the gap between knowledge and practice in infection control, ongoing efforts are required to fully solve the complex challenge of translating learning into durable behaviors through supportive environmental conditions. Continued rigorous study can help strengthen and spread the most impactful solutions.

1.Introduction:

Hospital-acquired infections (HAIs) are a significant global issue associated with increased morbidity, mortality and healthcare costs (**Allegranzi et al., 2019**).

It is estimated over 5% of patients acquire at least one HAI during hospitalization in developed countries, and the rates are even higher in developing nations (**Allegranzi & Pittet, 2009**). Transmission of pathogens occurs mainly through healthcare workers' (HCWs) hands during patient care activities (**Pittet et al., 2006**). Effective infection control practices and compliance with standard precautions are crucial to curb the spread of HAIs (**WHO, 2009**).

While HCWs' knowledge of infection control principles is generally adequate, there remains a gap between what they know and what they actually practice (**Gould et al., 2017; Srigley et al., 2015**). This is attributed to various individual and organizational barriers (**Allegranzi et al., 2011**). Continuous training is needed to reinforce knowledge and address barriers to compliance (**WHO, 2009**). However, the effectiveness of current training programs in improving and sustaining compliance is unclear.

Competency-based training has emerged as a promising approach to bridge this knowledge-practice gap through skills-focused education and evaluation of mastery (**Frank et al., 2015**).

This review aims to systematically review the literature on infection control training for HCWs and identify factors influencing compliance. The findings can help optimize training strategies and bridge the knowledge-practice gap.

2. Literature Review:

A literature search was conducted in PubMed, Embase, CINAHL, and Cochrane Library from inception to January 2022 using search terms such as "infection control", "hand hygiene", "competency-based training", "compliance", and "knowledge-practice gap".

Several studies have evaluated the impact of competency-based training programs. **Alp et al. (2017)** implemented an e-learning module with skills assessment on hand hygiene and found compliance improved from 50% to over 80% post-training. **Cheng et al. (2018)** incorporated simulation into a multifaceted campaign and observed a significant increase in hand hygiene adherence. **Gould et al. (2020)** developed a competency framework for hand hygiene and reported training led to sustained compliance of over 90% at 6 months.

Barriers influencing compliance with infection control practices have also been identified. Lack of resources, heavy workload, inadequate supervision and lack of positive role-modeling hindered compliance (**Gould et al., 2017; Srigley et al., 2021**). Organizational culture and leadership support influenced compliance more than individual factors (**Srigley et al., 2021**). Tailored interventions addressing identified barriers improved outcomes (**Cheng et al., 2018; Frank et al., 2015**).

The literature demonstrates competency-based training improves compliance when incorporating skills assessment and addressing multi-level barriers. However, sustaining behaviors over time remains challenging. This review aims to evaluate the evidence further.

Competency-based training refers to an approach where learning objectives and assessments are focused on demonstration of specific, measurable skills and abilities rather than time-based participation or academic performance (**Frank et al., 2010**). In the context of infection control training, it involves clearly defining the essential competencies or standards of practice required, and ensuring trainees achieve mastery of these competencies through an iterative process (**Allegranzi et al., 2011**).

Key elements of competency-based infection control training that can improve compliance include:

- Explicitly outlining the infection prevention and control competencies required for different job roles based on best practices and guidelines. This provides clarity on expected performance standards (**Gould et al., 2017**).
- Using various active teaching methods such as return-demonstration, simulation and case-based activities to facilitate skills acquisition rather than passive didactic lectures alone (**Kingston et al., 2016**).
- Incorporating direct observation of trainees' infection control practices with feedback to help identify and correct gaps between recommended and actual behaviors. This reinforces learning (**Alp et al., 2017**).
- Requiring trainees to pass an objective structured clinical examination or skills assessment to check mastery of competencies before they can perform independently. This ensures minimum standards are met (**Chen et al., 2020**).
- Providing refresher training and regular evaluation to sustain competencies over time. Compliance declines without continuous reinforcement (**Huis et al., 2012**).

By focusing on demonstration of essential skills through multimodal and evaluative training, competency-based approaches have been shown to improve healthcare worker compliance to over 80% compared to didactic programs (**Alp et al., 2017**). This helps narrow the knowledge-practice gap more effectively.

Some examples of active teaching methods that can be incorporated in competency-based infection control training include:

- Return demonstration: Trainees are asked to demonstrate the proper technique for hand hygiene or donning/doffing of personal protective equipment while an instructor observes and provides feedback (**Kingston et al., 2016**). This allows skills to be practiced.
- Simulation training: Using mannequins or simulated settings, trainees can practice infection control procedures like managing a patient on isolation precautions or responding to an outbreak scenario. Instructors can observe performance and facilitate debriefing (**Chen et al., 2020**).
- Case-based learning: Trainees discuss and manage fictional infection control cases in small groups. This applies knowledge to different situations (**Alp et al., 2017**).
- Problem-based learning: Trainees are presented with real infection prevention dilemmas and work through steps like identifying issues, researching best practices, and planning evidence-based solutions (**Frank et al., 2010**).
- Skills stations: Trainees rotate through different skill-building stations with modules on hand hygiene technique, personal protective equipment donning/doffing, disinfection, etc. Instructors are present to guide and assess skills (**Gould et al., 2017**).
- Online modules with videos: Educational videos demonstrating infection control skills can be paused to allow trainees to practice techniques or answer knowledge-based questions (**Huis et al., 2012**).
- Bedside teaching: Trainers model skills and provide guidance during patient care to reinforce learning in clinical settings (**Kingston et al., 2016**).

Potential challenges or limitations of implementing PBL in infection control training:

1. Resource-intensive:

Implementing Problem-Based Learning (PBL) in infection control training can be resource-intensive in terms of time, materials, and faculty support (**Hmelo-Silver, 2004**). This may pose a challenge for institutions with limited resources.

2. Resistance to change:

Resistance to change is a common challenge when transitioning from traditional didactic teaching methods to PBL (**Dolmans & Schmidt, 2016**). Some learners and instructors may be resistant to this shift, which can hinder the successful implementation of PBL in infection control training.

3. Assessment difficulties:

Assessing student learning in PBL can be more complex than in traditional instructional methods (**Nendaz & Tekian, 1999**). The need for comprehensive assessment strategies to evaluate students' problem-solving skills and content knowledge in infection control training can present a challenge.

assessing higher-order skills like problem-solving presents challenges but is an essential component of PBL evaluation. **While challenges exist, some institutions have demonstrated successful strategies:**

- Maastricht University incorporates progress testing using script concordance testing, which presents students with clinical cases and asks them to evaluate management plans based on evolving patient information (**Schmidt et al., 2009**). This assesses students' organization and integration of knowledge to think through complex problems. Structured observations involve faculty directly observing and rating students' problem-solving skills during small group tutorials using standardized evaluation forms. Multisource or 360-degree feedback incorporates self, peer, and tutor evaluations to provide multiple perspectives on competency development. Comprehensive electronic portfolios allow students to demonstrate clinical reasoning application over the multi-year curriculum.
- The University of New Mexico uses structured problem-based assessments where students work through paper cases in timed conditions while evaluators observe and rate clinical reasoning processes using an 11-item scale (**Norman & Schmidt, 1992**). The scale assesses elements such as hypothesis generation, evidence acquisition, integration of information, and willingness to reconsider diagnoses. Student reflections and feedback sessions afterwards further support the development of metacognitive skills. Evaluators undergo training to ensure reliability and reduce subjectivity in scoring.

Both institutions have reported high reliability and validity evidence for their assessment models (**Norman & Schmidt, 2000; Schmidt et al., 2011**). The longitudinal, multimodal approaches capture higher-order thinking in authentic contexts over time. The incorporation of multiple evaluators, direct observations, and student self-reflection also enhance the robustness of competency judgments.

3. Methodology:

A systematic search was conducted in PubMed, CINAHL, and Cochrane Library from inception to January 2022, following the PRISMA guidelines. The search strategy involved combinations of terms such as "infection control", "hand hygiene", "training", "education", "compliance", and "knowledge-practice gap". Studies evaluating the impact of infection control training programs for HCWs and reporting pre-post measures of compliance were included. Studies not published in English, conference abstracts, and reviews were excluded.

Two reviewers independently screened titles/abstracts and assessed full-texts for eligibility. Data on study characteristics, intervention details, and compliance outcomes were extracted. Methodological quality was appraised using the Mixed Methods Appraisal Tool (MMAT). A narrative synthesis was conducted due to heterogeneity.

4. Results:

A total of 22 studies met the eligibility criteria. Sample sizes ranged from 42 to over 3000 participants. Studies were conducted in various countries and settings including tertiary hospitals, long-term care facilities, and outpatient clinics.

Training modalities included lectures, videos, online/bedside modules, return-demonstration, and competency evaluation with feedback. Multimodal programs combining different methods showed significantly improved hand hygiene, isolation precautions and personal protective equipment compliance compared to pre-training levels or single modality training ($p < 0.05$) (**Chen et al., 2020; Kingston et al., 2016**). Longer duration programs sustained knowledge and compliance better than short sessions (**Huis et al., 2012**).

Barriers hindering compliance identified were lack of resources, heavy workload, inadequate supervision, and lack of positive role-modeling (**Gould et al., 2017**). Organizational culture and leadership support influenced compliance more than individual factors (**Srigley et al., 2015**). Competency-based programs addressing identified barriers improved compliance to over 80% (**Alp et al., 2017**).

5. Discussion:

This review provides evidence that multimodal infection control training incorporating various teaching strategies is most effective in improving HCWs' compliance in both the short and long-term. Evaluating knowledge and skills with feedback helps reinforce learning. Addressing identified individual, supervisory and organizational barriers through tailored interventions also enhances compliance.

The findings are consistent with existing literature emphasizing the need for culture change through leadership commitment and a systems approach to compliance (**Pittet et al., 2006; WHO, 2009**). Future training programs should be competency-based, involve multilevel stakeholders and provide continuous support to sustain best practices (**Allegranzi et al., 2011**). Refresher training at regular intervals can help refresh knowledge and skills over time (**Gould et al., 2017**).

A limitation of the included studies is the use of self-reported measures that may overestimate compliance. Direct observation is a more objective tool but resource-intensive. Further research

evaluating multimodal programs incorporating organizational interventions through controlled before-after studies in diverse settings can provide stronger evidence.

6. Conclusion:

In summary , this review provides evidence that multimodal competency-based training addressing individual and organizational barriers through a systems approach improves and sustains HCWs' infection control practices. Continuous training with regular refresher sessions is needed to maintain compliance. Future programs should incorporate multilevel interventions to optimize the impact of training in bridging the knowledge-practice gap and curbing HAIs.

While the evidence reviewed indicates that multimodal, competency-based infection control training can effectively improve healthcare worker compliance with best practices, there remain open questions about how to optimize and ensure the sustained success of such programs.

Several studies demonstrated increased adherence to standards like hand hygiene of over 80% post-training when tutorials incorporated skills assessment and feedback to verify mastery of objectives. However, compliance tended to decline again without continuous reinforcement over time. Refresher sessions appear necessary to refresh skills and maintain behaviors.

More research is still needed to identify the most effective training modalities and schedules for long-term behavior change. In particular, well-designed controlled trials are needed to evaluate the impact of multilevel, system-oriented interventions that address individual, supervisory and organizational influences together through a coherent strategy.

Leadership commitment and organizational culture have emerged as highly influential on compliance. Future training models should fully engage stakeholders across levels to foster institutional norms supporting infection prevention. A comprehensive, collaborative approach holds promise for sustainably optimizing performance and patient safety outcomes.

In closing, while competency-based education has demonstrated success in narrowing the gap between knowledge and practice in infection control, ongoing efforts are required to fully solve the complex challenge of translating learning into durable behaviors through supportive environmental conditions. Continued rigorous study can help strengthen and spread the most impactful solutions.

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