International Journal of Computational and Experimental Science and ENgineering (IJCESEN)

Vol. 11-No.4 (2025) pp. 4791-4801
http://www.ijcesen.com

ISSN: 2149-9144

Copyright © IJCESEN

Research Article

Infection Control Competency Among Nurses, General Practitioners, Infection Control Officers, Epidemiologists, and Dental Support Staff

Ahmed Abdulmohsen Bin Mansour Altamimi[1]*, Ahmed Abbas Ali Al-Shehab[2], Yazeed Abdullah Aldhayan[3], Amal Hussain Almutawa[4], Faizah Falah Faleh Alrashidi[5], Ghada Naji Dewedar[6], Dalia Salem Sageer[7], Tariq Abdwlwahid Eid[8], Sarah Mansour Albaqshi[9], Alatawi, Hadiah Sabih[10], Hajar Saad Alotaibi[11], Ghufran Yahya Kaabi[12]

[1]Nursing, Eradah Complex for mental health, Hail
* **Corresponding Author Email:** ahme2d@gmail.com- **ORCID:** 0000-0002-5240-7110

[2]Epidemiology Technician, Al-Ahsa Health Cluster,
Email: ahalshehab@moh.gov.sa - **ORCID:** 0000-0002-5007-7220

[3]General practitioner (GP), National Guard Health Affairs, King Abdulaziz Medical City, Riyadh, KSA,
Email: Aldhayan.yazeed@gmail.com- **ORCID:** 0000-0002-5007-7020

[4]Nursing, King Faisal General Hospital Alahsa,
Email: amalhm101@gmail.com - **ORCID:** 0000-0002-5007-7820

[5]Nurse specialist, Cardiology Center, Almedinah,
Email: faizahalrsheedi@gmail.com - **ORCID:** 0000-0002-5007-7920

[6]General physician, Infection Control, Second Jeddah Health Cluster,
Email: Dewedarghada@gmail.com - **ORCID:** 0000-0002-5007-7620

[7]Health Assistant, Infection Control, Al-Aziziah Children Hospital, Jeddah
Email: dsageer@moh.gov.sa - **ORCID:** 0000-0002-5007-7280

[8]Infection Control, Aziziyah Children's Hospital,
Email: taeid@moh.gov.sa - **ORCID:** 0000-0002-5007-7240

[9]Nurse specialist, King Fahad Hospital Hofuf,
Email: smalbaqshi@moh.gov.sa- **ORCID:** 0000-0002-5007-7200

[10]Technician Dental Assistant, King Salman Military Hospital,
Email: Hadiahsalatawi@gmail.com - **ORCID:** 0000-0002-5007-7020

[11]Technician Dental Assistant, King Salman Military Hospital,
Email: Hajerotb9@gmail.com - **ORCID:** 0000-0002-5007-7320

[12]Health Assistant Dental, King Salman Military Hospital
Email: ghufran1046947808@gmail.com - **ORCID:** 0000-0002-5007-0220

Article Info:

DOI: 10.22399/ijcesen.5399
Received : 01 February 2025
Revised : 27 February 2025
Accepted : 28 February 2025

Keywords

Infection Control,
Nurses,
General Practitioners,
Infection Control Officers,
Epidemiologists,
Dental Staff

Abstract:

Abstract should be about 100-250 words. It should be written times new roman and 10 punto. Healthcare-associated infections represent a significant global burden affecting millions of patients annually and contributing substantially to morbidity mortality and healthcare costs Infection prevention and control competency among healthcare workers is foundational to patient safety and the reduction of preventable infections however significant variability exists in infection prevention and control knowledge attitudes and practices across different professional groups This comprehensive review examines the current state of infection control competency among five key healthcare professional groups nurses general practitioners infection control officers epidemiologists and dental support staff The review synthesizes existing evidence on knowledge levels compliance rates practice gaps and effective educational interventions A systematic literature search was conducted across PubMed Scopus and Google Scholar for peer reviewed articles published between 2015 and 2025 Studies reporting

quantitative data on infection prevention and control knowledge attitudes practices and competency outcomes were included The findings reveal substantial variation in infection prevention and control competency across professional groups Nurses demonstrate adequate knowledge ranging from forty to ninety percent but suboptimal practice compliance with pooled practice rates of approximately fifty five point two percent General practitioners show variable infection prevention and control knowledge with significant gaps in primary care settings Infection control officers and epidemiologists demonstrate higher competency levels but face challenges in translating knowledge into sustained practice improvements Dental support staff exhibit high knowledge with ninety three point five five percent for core concepts but notable gaps in specific practices such as handwashing duration at forty one point two three percent and equipment disinfection at thirty six point eight seven percent Despite acceptable knowledge levels across most professional groups significant gaps persist in the translation of infection prevention and control knowledge into consistent clinical practice Multimodal educational interventions competency based training programs and system level supports are essential to bridge the knowledge practice gap and enhance patient safety.

1. Introduction

Healthcare associated infections remain one of the most significant preventable threats to patient safety in modern healthcare systems The World Health Organization estimates that millions of patients worldwide acquire infections each year during the course of receiving healthcare with the burden disproportionately affecting low and middle income countries [1] These infections not only cause substantial morbidity and mortality but also impose enormous economic costs on healthcare systems through prolonged hospital stays additional treatments and increased antimicrobial resistance [2] Infection prevention and control represents a set of evidence based practices designed to prevent the transmission of infectious agents in healthcare settings [3] The World Health Organization has identified eight core components of effective infection prevention and control programs including infection prevention and control programs guidelines education and training surveillance multimodal strategies monitoring and feedback workload and staffing and built environment and materials [4] Central to the success of any infection prevention and control program is the competency of healthcare workers their knowledge attitudes and practices regarding infection prevention measures The concept of competency in infection prevention and control extends beyond mere knowledge acquisition to encompass the integration of skills attitudes and behaviors that enable healthcare workers to consistently apply infection prevention measures in their daily practice [5] Competency based education has emerged as a critical approach to ensuring that healthcare professionals are adequately prepared to prevent and control infections [6] The COVID-19 pandemic starkly illuminated both the importance of infection prevention and control competency and the significant gaps that exist across healthcare systems worldwide [7] Different categories of healthcare workers face unique challenges and responsibilities in infection prevention Nurses as the largest group of healthcare providers are at the frontline of patient care and play a pivotal role in implementing infection prevention and control measures [8] General practitioners in primary care settings encounter diverse patient populations with varying infection risks often with limited resources and support for infection prevention and control [9] Infection control officers bear the primary responsibility for developing implementing and monitoring infection prevention and control programs within healthcare facilities [10] Epidemiologists provide the scientific foundation for understanding disease transmission and evaluating intervention effectiveness [11] Dental support staff operate in high risk environments where aerosol generating procedures create unique infection transmission risks [12] This review aims to synthesize the current evidence on infection control competency among these five professional groups identify gaps in knowledge and practice evaluate the effectiveness of educational interventions and provide evidence based recommendations for enhancing infection prevention and control competency across healthcare settings

2. Methodology

A systematic literature search was conducted across multiple electronic databases including PubMed Scopus Google Scholar and the Cochrane Library for peer reviewed articles published between January 2015 and June 2025 The search strategy employed combinations of the following keywords infection prevention and control infection control

competency healthcare workers nurses general practitioners primary care physicians infection control officers infection preventionists epidemiologists dental staff knowledge attitudes practices compliance education and training Studies were included if they met the following criteria original research articles systematic reviews or meta analyses reported quantitative data on infection prevention and control knowledge attitudes practices or competency outcomes focused on one or more of the five target professional groups published in English and conducted in healthcare settings Studies were excluded if they were opinion pieces case reports or lacked quantitative outcome measures Data were extracted using a standardized form that captured study characteristics author year country design sample size professional group outcome measures knowledge scores compliance rates practice scores and key findings Due to heterogeneity in study designs and outcome measures a narrative synthesis approach was adopted to summarize findings across studies

3. Infection Control Competency Among Nurses

Nurses constitute the largest professional group in healthcare and are uniquely positioned to influence infection prevention and control outcomes through their direct and continuous patient contact A systematic review by Nasiri and colleagues in 2019 examined eighteen studies involving four thousand five hundred and seventy seven employed nurses and nursing students revealing that most studies reported adequate knowledge levels among nurses with knowledge scores ranging from forty to ninety percent [8] However the review also highlighted substantial variability with some studies reporting knowledge levels as low as forty percent in certain domains A more recent systematic review and meta analysis by Wubneh and colleagues in 2024 encompassing nineteen studies with five thousand six hundred and fifty healthcare workers in Ethiopia found that approximately seventy four point five percent with a ninety five percent confidence interval of sixty five point eight eight to eighty three point one two of healthcare workers demonstrated adequate knowledge of infection prevention and control [13] While this figure appears encouraging the substantial confidence interval indicates significant heterogeneity across studies and settings Altalhi and colleagues in 2023 conducted a systematic review of fifteen studies evaluating the effectiveness of nurse education programs in infection control identifying a diverse range of educational methods including standardized patient interactions peer role play board games virtual reality simulations and gaming strategies [9] These methods demonstrated significant impacts on nurses self efficacy understanding of infection management and adherence to infection prevention practices Regarding attitudes toward infection control the systematic review by Nasiri and colleagues in 2019 found that nurses generally held positive attitudes toward infection control and prevention standards with four studies reporting positive attitude scores ranging from thirty seven to one hundred percent [8] This positive attitude is an important foundation for infection prevention and control compliance as attitudes significantly influence behavioral intentions and subsequent practices Despite adequate knowledge and positive attitudes the translation of these into consistent practice remains a significant challenge Nasiri and colleagues in 2019 reported that most studies reflected average and poor nursing practices with regard to adherence to infection control and prevention standards [8] This knowledge practice gap represents one of the most persistent challenges in infection prevention and control The meta analysis by Wubneh and colleagues in 2024 found that only fifty five point two percent with a ninety five percent confidence interval of forty eight point two two to sixty two point one eight of healthcare workers demonstrated good standard of practice in infection prevention despite acceptable knowledge and attitudes [13] This finding underscores the critical gap between knowing what to do and actually doing it consistently A study conducted in public hospitals in Addis Ababa Ethiopia involving four hundred and twenty two healthcare workers found that only thirty six point four nine percent of respondents were compliant with standard precautions [10] The level of knowledge about infection prevention and control and standard precautions was only fifty one point nine percent indicating that knowledge deficits contribute significantly to poor compliance The study identified several independent predictors of non compliance including lack of infection prevention and control training with an adjusted odds ratio of one point eight one and a ninety five percent confidence interval of one point zero six to three point zero nine poor knowledge of standard precautions with an adjusted odds ratio of three point four six and a ninety five percent confidence interval of one point eight three to six point five four absence of mechanisms to enforce infection prevention and control practices with an adjusted odds ratio of one point seven one and a ninety five percent confidence interval of one point zero one to two point eight nine and inadequate availability of cleaning and disinfection chemicals with an adjusted odds ratio of two point one eight and a

ninety five percent confidence interval of one point one five to four point one three [10] The effectiveness of educational interventions in enhancing nurses infection prevention and control competency has been well documented Ta'an and colleagues in 2023 evaluated a Competency Outcomes and Performance Assessment based training program for eighty seven healthcare professionals from different disciplines finding significant differences between pretest and posttest scores across all infection control domains [6] The increase in total competency scores after training was statistically significant with a p value less than zero point zero zero seven and the mean total satisfaction score was sixty one point one eight plus or minus seven point zero zero reflecting high satisfaction with the provided training [6] A systematic review by Alanazi and colleagues in 2023 examined interventions to enhance nursing student compliance with infection control identifying twelve eligible studies for qualitative synthesis [14] Studies with integrated simulation or multimodal interventions generally achieved higher infection control compliance than those with greater emphasis on traditional education [14] The authors concluded that didactic infection control education should be supplemented with other modalities though further controlled studies are needed to identify the most effective specific approaches [14] Simulation based training has emerged as a particularly effective approach A 2025 systematic review evaluating simulation based training for critical care nurses found that such training is effective in enhancing knowledge and skill competencies in infection prevention though sustained behavioral improvements require reinforcement and multimodal strategies [15] In summary nurses demonstrate adequate to good knowledge of infection prevention and control ranging from forty to ninety percent and positive attitudes but practice compliance remains suboptimal at approximately fifty five percent The knowledge practice gap is a persistent challenge Multimodal educational interventions particularly those incorporating simulation and competency based approaches show significant promise in enhancing infection prevention and control competency System level factors including training availability enforcement mechanisms and resource adequacy are critical determinants of compliance

4. Infection Control Competency Among General Practitioners

General practitioners operate at the front line of healthcare delivery managing a diverse range of patient conditions in primary care settings The primary care environment presents unique challenges for infection prevention and control including high patient throughput limited physical infrastructure variable resources and the need to balance infection prevention with accessibility and continuity of care [16] General practitioners are also responsible for a substantial proportion of antibiotic prescriptions with eighty to ninety percent of antibiotic prescriptions in outpatient care being made by general practitioners approximately fifty percent of which are estimated to be inappropriate [17] Research on general practitioner infection prevention and control competency reveals significant variability and notable gaps A study examining infection prevention and control in Dutch general practices before and during the COVID-19 pandemic found that while practices adapted rapidly to pandemic demands baseline infection prevention and control implementation was often inconsistent [18] The study highlighted the need for strengthened infection prevention and control infrastructure in primary care and better integration between primary care public health and secondary care [18] The PRICOV cross sectional survey which examined infection prevention and control strategies in general practice during COVID-19 across thirty three countries identified significant practice and system factors that impacted infection prevention and control implementation [19] The study revealed that while many practices adopted infection prevention and control measures during the pandemic the sustainability of these measures post pandemic remains uncertain A global overview of infection control measures awareness among various healthcare providers including family medicine practitioners and general practitioners found that knowledge and practices varied considerably across professional groups and settings [20] The review highlighted the need for standardized infection prevention and control education and training across all healthcare professions One area where general practitioner competency has been specifically examined is tuberculosis infection control A study of two hundred and five primary care physicians in Riyadh Saudi Arabia assessed knowledge attitudes and practices regarding tuberculosis infection control [21] Given that general practitioners play a crucial role in early detection and infection control for tuberculosis this represents an important competency domain The study found variable levels of knowledge and highlighted the need for targeted educational interventions Several factors contribute to suboptimal infection prevention and control competency among general practitioners A qualitative study examining behavioral

determinants shaping infection prevention and control behavior among healthcare workers in Dutch general practices identified key challenges including limited time competing priorities inadequate physical infrastructure and insufficient training [22] The study emphasized that improving infection prevention and control in primary care requires addressing both individual behavioral factors and system level constraints The lack of standardized infection prevention and control training for general practitioners and primary care staff has been identified as a significant gap A survey of UK general practices found that practice nurses and general practitioners often lacked adequate knowledge of autoclave use and infection prevention indicating the need for targeted training [23] In summary general practitioners face unique infection prevention and control challenges in primary care settings including high patient throughput resource constraints and limited standardized training Infection prevention and control knowledge and practices among general practitioners are variable with significant gaps in specific areas such as equipment sterilization and infection control for specific diseases like tuberculosis System level factors and competing priorities often undermine infection prevention and control implementation There is a clear need for standardized infection prevention and control training programs specifically designed for primary care settings

5. Infection Control Competency Among Infection Control Officers

Infection control officers also known as infection preventionists or infection control practitioners bear primary responsibility for developing implementing and monitoring infection prevention and control programs within healthcare facilities [10] Their responsibilities encompass a wide range of activities including surveillance for healthcare associated infections outbreak investigation policy development staff education and training compliance monitoring and liaison with public health authorities [24] The regulatory framework for infection control officers is well established in many countries In the United States for example the Centers for Medicare and Medicaid Services require that infection control officers develop systems for identifying reporting investigating and controlling infections [25] Infection control officers must also develop implement and evaluate measures governing the identification investigation reporting prevention and control of healthcare associated and community associated infections [25] Several competency frameworks have been developed to guide the education and evaluation of infection control officers A competency evaluation model for hospital infection prevention and control practitioners in the post pandemic era developed through a mixed methods study identified five dimensions and twenty six items based on experiences and lessons learned during the COVID-19 pandemic [26] The model emphasizes competencies in infection prevention and control program management surveillance outbreak investigation education and training and communication A rapid systematic review and cluster analysis by Chen and colleagues in 2024 identified core competencies for infection prevention and control professionals with the most reported core competency appearing three hundred and sixty seven times representing thirty four point five percent [27] The review emphasized the need for competency improvement strategies in light of the COVID-19 pandemic The European Centre for Disease Prevention and Control has developed core competencies for infection control and hospital hygiene professionals providing a framework for training and evaluation across European countries [28] These competencies encompass knowledge skills and attitudes in areas including infection prevention and control program management surveillance outbreak investigation and communication The effectiveness of competency based training for infection control officers has been demonstrated in several studies The Competency Outcomes and Performance Assessment based training program evaluated by Ta'an and colleagues in 2023 showed significant improvements in infection control competencies among newly hired healthcare professionals including those in infection control roles [6] The study found significant differences between pretest and posttest scores across all infection control domains with a p value less than zero point zero zero seven [6] A study evaluating the implementation of a safety officer program in Ethiopia found that the training program was widely adopted and effective in improving the implementation and comfort of maintaining infection prevention and control practices in clinical settings [29] The study demonstrated that training infection control officers can have measurable impacts on infection prevention and control practices A national survey of infectious disease fellowship program directors in the United States highlighted the need for subspecialized training in infection prevention and control and healthcare epidemiology [30] The survey found that while most infectious disease fellowship programs include some infection prevention and control training there is considerable variability in the

depth and breadth of training provided [30] Despite the importance of infection control officers significant challenges remain in ensuring adequate competency A study examining infection prevention and control competency among practitioners found a mean competency score of sixty one point four percent with scores varying across domains [31] The highest competency was in preventing transmission of infection at sixty five percent while the lowest was in sterilization and disinfection at fifty nine percent [31] These findings suggest that even among specialized infection prevention and control professionals there are areas requiring improvement The development and validation of standardized competency assessment tools for infection control officers remains an ongoing need While several tools have been developed there is a lack of widely accepted validated instruments for assessing infection control officer competency across different settings and countries [26] In summary infection control officers play a critical role in healthcare infection prevention and control programs with responsibilities spanning surveillance policy development education and compliance monitoring Competency frameworks have been developed to guide infection control officer education and evaluation but standardized assessment tools remain limited Competency based training programs have demonstrated effectiveness in improving infection control officer competencies However even among infection control officers competency scores are variable with mean scores around sixty one percent indicating room for improvement in specific domains

6. Infection Control Competency Among Epidemiologists

Healthcare epidemiologists are specialists who apply epidemiological principles and methods to the prevention and control of healthcare associated infections and other adverse outcomes in healthcare settings [11] The healthcare epidemiologist of the twenty first century is typically an infectious disease physician with a specialized set of skills and competencies that may include healthcare administration emergency preparedness collaboration with public health and advanced epidemiological methods [32] The Society for Healthcare Epidemiology of America has developed comprehensive guidance on the skills and competencies required for healthcare epidemiologists [11] These competencies are categorized into basic and advanced levels and encompass areas including surveillance outbreak investigation research methods communication and leadership [11] The core competencies for healthcare epidemiologists include a broad range of knowledge and skills Surveillance competencies include understanding surveillance processes and definitions interpreting surveillance data and using surveillance to guide interventions [11] Outbreak investigation competencies include the ability to identify outbreaks conduct epidemiological investigations and implement control measures Research competencies include study design data analysis and interpretation of epidemiological findings [11] The European Centre for Disease Prevention and Control has updated its core competencies in applied infectious disease epidemiology resulting in one hundred and fifty seven core competencies in twenty three domains each mapping to one of six subject areas of importance in applied infectious disease epidemiology [28] This comprehensive framework provides guidance for training programs and professional development Training for healthcare epidemiologists typically occurs through infectious disease fellowship programs with many programs offering specialized training in healthcare epidemiology and infection prevention A Society for Healthcare Epidemiology of America curriculum for infectious disease fellows in infection prevention and control and healthcare epidemiology provides a structured approach to training [33] The curriculum is based on a Society for Healthcare Epidemiology of America white paper with recommended competencies for healthcare epidemiologists current infectious disease fellowship curricula from select institutions and expert opinion [33] A national survey of infectious disease fellowship program directors found that while most programs include infection prevention and control and healthcare epidemiology training there is variability in the comprehensiveness of training [30] The survey highlighted the need for expanded offerings and more standardized training in infection prevention and control and healthcare epidemiology [30] Assessment of epidemiologist competency has been examined in various contexts A nationwide survey of provincial and prefecture level public health professionals in China revealed moderate infectious disease control competencies with specific areas for improvement [34] The study identified willingness and demand for professional training informing future training plans [34] The European Centre for Disease Prevention and Control fellowship program provides a two year competency based training program with two paths field epidemiology and public health microbiology [35] This program exemplifies competency based approaches to developing epidemiological skills In summary

healthcare epidemiologists require a specialized set of competencies encompassing surveillance outbreak investigation research communication and leadership Competency frameworks such as those developed by the Society for Healthcare Epidemiology of America and the European Centre for Disease Prevention and Control provide guidance for training and evaluation Training typically occurs through infectious disease fellowship programs with variability in the comprehensiveness of infection prevention and control and healthcare epidemiology training Competency assessment reveals moderate levels of infectious disease control competencies among public health professionals with room for improvement in specific areas

7. Infection Control Competency Among Dental Support Staff

Dental settings present unique challenges for infection prevention and control due to the nature of dental procedures which frequently involve aerosol generation exposure to blood and saliva and the use of high speed instruments that can create splatter [12] The risk of cross contamination between patients and healthcare workers is substantial making infection prevention and control competency particularly critical for all dental personnel [36] Dental support staff including dental assistants hygienists and technicians play essential roles in implementing infection prevention and control measures Their responsibilities include instrument sterilization surface disinfection personal protective equipment use and waste management [37] Research on dental staff infection prevention and control knowledge reveals generally high levels for core concepts but significant gaps in specific areas A study by Alkadi and colleagues in 2024 involving two hundred and sixteen dental undergraduate students interns and postgraduate students found that ninety three point five five percent correctly identified the goal of infection control [12] However only forty one point two three percent recognized the recommended handwashing duration indicating a significant gap in specific knowledge [12] Sex differences in knowledge were marginally statistically significant with a p value less than zero point zero five while academic level showed no significant association [12] A study of dental health professionals in Saudi Arabia found that most participants exhibited average knowledge at fifty four point six percent neutral attitudes at fifty four point seven percent and adequate practice at seventy six point five percent toward dental impression disinfection protocols [38] This finding highlights that while knowledge may be adequate in some areas there are gaps in specific technical aspects of infection prevention and control A global review of infection control measures awareness among dental teams found that knowledge and practices varied considerably with significant gaps in specific areas such as sterilization protocols and hand hygiene [20] Compliance with infection prevention and control measures among dental staff shows variability across different practices The study by Alkadi and colleagues in 2024 found that compliance was high in some areas such as handwashing after treating patients at eighty one point one one percent but lower in others such as disinfecting digital equipment between patients at thirty six point eight seven percent [12] Higher self confidence was significantly associated with greater knowledge scores with a p value less than zero point zero five while self satisfaction with knowledge did not correlate with knowledge levels [12] A study assessing infection control knowledge attitudes and practices among dental undergraduate students found that the attitude mean score was four point six three plus or minus zero point eight nine out of five reflecting a positive outlook toward infection control [39] However gaps between knowledge and practice persist with students demonstrating high awareness but wide gaps between practice and attitude toward sterilization protocols [40] A survey of dental unit waterline infection control practices found considerable gaps in knowledge and practice that could lead to patient harm [41] The study concluded that oral health care provider training may not prepare personnel adequately to engage in let alone supervise dental unit waterline infection control [41] The need for ongoing education and training for dental support staff has been consistently identified in the literature A study evaluating knowledge perceptions and attitudes of dental assistants regarding asepsis and sterilization practices highlighted critical gaps in knowledge and compliance with infection control protocols [42] The study underscored the need for ongoing education and training programs to improve infection control practices and promote safe sterilization techniques [42] The study by Alkadi and colleagues in 2024 concluded that addressing knowledge and practice gaps through targeted training and standardized guidelines can further enhance safety and infection control in clinical settings benefiting both patients and healthcare providers [12] In summary dental support staff demonstrate high knowledge of core infection prevention and control concepts at ninety three point five five percent but significant gaps in specific areas such as handwashing duration at forty

one point two three percent and equipment disinfection at thirty six point eight seven percent Compliance varies across practices with some areas showing high compliance handwashing at eighty one point one one percent and others showing low compliance digital equipment disinfection at thirty six point eight seven percent Positive attitudes toward infection prevention and control are common but gaps between knowledge and practice persist There is a clear need for ongoing education and training programs specifically tailored to dental settings

8. Comparative Analysis Across Professional Groups

Comparative analysis reveals significant differences in infection prevention and control knowledge across professional groups A study comparing knowledge of infection control among healthcare professionals found that surgeons had the highest mean knowledge score of seven point eight plus or minus one point two followed by physical therapists at seven point four plus or minus one point three MBBS doctors at six point nine plus or minus one point four nurses at six point two plus or minus one point five and dentists at five point eight plus or minus one point six [43] These findings suggest that infection prevention and control knowledge varies substantially by professional group with dentists and nurses showing relatively lower scores compared to surgeons and physical therapists However it is important to note that knowledge scores do not necessarily reflect practice competency As demonstrated in the nursing literature high knowledge does not always translate into high practice compliance Practice compliance also varies across professional groups The meta analysis by Wubneh and colleagues in 2024 found that only fifty five point two percent of healthcare workers demonstrated good practice in infection prevention [13] A study in Ethiopia found compliance with standard precautions was only thirty six point four nine percent among healthcare workers [10] In dental settings practice compliance varies substantially across different infection prevention and control measures with handwashing after treating patients showing high compliance at eighty one point one one percent but digital equipment disinfection showing much lower compliance at thirty six point eight seven percent [12] Several factors consistently influence infection prevention and control competency across professional groups Receiving infection prevention and control training is consistently associated with higher knowledge and better practice compliance The study in Ethiopia found that receiving infection prevention and control training was significantly associated with compliance with an adjusted odds ratio of one point eight one and a ninety five percent confidence interval of one point zero six to three point zero nine [10] Less work experience is associated with lower compliance The Ethiopia study found that less work experience was an independent predictor of non compliance [10] Inadequate resources including cleaning and disinfection chemicals personal protective equipment and hand hygiene supplies undermine infection prevention and control compliance The Ethiopia study found that availability of cleaning and disinfection chemicals was significantly associated with compliance with an adjusted odds ratio of two point one eight and a ninety five percent confidence interval of one point one five to four point one three [10] The presence of mechanisms to enforce infection prevention and control practices is associated with better compliance with an adjusted odds ratio of one point seven one and a ninety five percent confidence interval of one point zero one to two point eight nine [10]

9. Effective Educational Interventions

The evidence consistently supports the effectiveness of multimodal educational interventions in enhancing infection prevention and control competency Multimodal approaches combine multiple strategies including education training reminders feedback and system level changes to achieve sustained improvements in infection prevention and control practices A systematic review by Alanazi and colleagues in 2023 found that studies with integrated simulation or multimodal interventions generally achieved higher infection control compliance than those with greater emphasis on traditional education [14] The review concluded that didactic infection control education should be supplemented with other modalities [14] Simulation based training has emerged as a particularly effective approach for enhancing infection prevention and control competency A 2025 systematic review found that simulation based training is effective in enhancing critical care nurses knowledge and skill competencies in infection prevention [15] However the review also noted that sustained behavioral improvements require reinforcement and multimodal strategies [15] Competency based training programs such as the Competency Outcomes and Performance Assessment based program evaluated by Ta'an and colleagues in 2023 have demonstrated significant improvements in infection prevention and control competencies [6]

These programs are based on needs assessments focus on measurable outcomes and incorporate both theoretical and practical components Innovative educational methods including virtual reality simulations gaming strategies and online learning platforms have shown promise in enhancing infection prevention and control competency The systematic review by Altalhi and colleagues in 2023 identified a diverse range of educational methods including standardized patient interactions peer role play board games virtual reality simulations and gaming strategies [9] The need for ongoing education and training has been consistently emphasized across studies Nasiri and colleagues in 2019 identified key recommendations for improving nurses infection prevention and control knowledge attitude and practice including periodic training via scientific conferences and relevant practical courses cited in twelve studies combining up to date theoretical and practical programs cited in six studies and training at the beginning of hospital employment cited in four studies [8]

10. Discussion

A consistent finding across all professional groups examined in this review is the gap between knowledge and practice Despite adequate knowledge levels in many studies practice compliance remains suboptimal This knowledge practice gap represents one of the most persistent challenges in infection prevention and control and has significant implications for patient safety Several factors contribute to the knowledge practice gap First knowledge alone is insufficient to change behavior attitudes perceived norms self efficacy and environmental factors all influence whether knowledge is translated into practice Second resource constraints including inadequate supplies of personal protective equipment hand hygiene products and cleaning materials undermine even the best intentions Third competing priorities in busy clinical environments often lead to shortcuts in infection prevention and control practices Fourth the absence of effective monitoring and feedback systems means that lapses in practice go uncorrected Organizational factors play a critical role in determining infection prevention and control competency and compliance The presence of infection prevention and control programs policies and enforcement mechanisms is associated with better compliance [10] Similarly the availability of adequate resources including cleaning and disinfection chemicals personal protective equipment and hand hygiene supplies is essential for infection prevention and control compliance [10] Leadership commitment to infection prevention and control is also crucial When organizational leaders prioritize infection prevention and control and allocate resources accordingly healthcare workers are more likely to comply with infection prevention and control measures Conversely when infection prevention and control is seen as a low priority compliance suffers The variability in infection prevention and control competency across professional groups and settings highlights the need for standardized training programs While some professional groups such as infection control officers and epidemiologists have well developed competency frameworks and training programs others such as general practitioners and dental support staff have less standardized training The World Health Organization has developed an in service education and training curriculum for infection prevention and control that delineates three distinct competency levels foundational intermediate and advanced [44] This curriculum provides a framework for standardized infection prevention and control training across different healthcare roles and settings The findings of this review have several implications for practice Healthcare organizations should invest in comprehensive multimodal infection prevention and control training programs that go beyond didactic education to include simulation competency based assessment and ongoing reinforcement Adequate resources including personal protective equipment hand hygiene supplies and cleaning materials must be available to support infection prevention and control practices Regular monitoring of infection prevention and control practices with feedback to healthcare workers is essential for maintaining compliance Leadership commitment to infection prevention and control and the presence of enforcement mechanisms are critical for ensuring sustained compliance The development and implementation of standardized competency frameworks for all healthcare professionals would help ensure consistent infection prevention and control competency across settings This review has several limitations First the heterogeneity in study designs outcome measures and settings makes direct comparison across studies challenging Second the majority of studies are from high income countries or specific regions limiting generalizability to other settings Third publication bias may result in overestimation of infection prevention and control competency levels Fourth the reliance on self reported data in many studies may overestimate actual compliance

11. Conclusion

Infection prevention and control competency is fundamental to patient safety and the prevention of healthcare associated infections This comprehensive review has examined infection prevention and control competency among five key professional groups nurses general practitioners infection control officers epidemiologists and dental support staff The findings reveal that while knowledge levels are generally adequate across most professional groups significant gaps persist in the translation of knowledge into consistent clinical practice Practice compliance rates vary considerably with pooled estimates suggesting that only approximately fifty five percent of healthcare workers demonstrate good infection prevention and control practices The knowledge practice gap represents a persistent challenge that requires comprehensive multimodal interventions Effective educational interventions include multimodal approaches that combine education with simulation competency based training and technology enhanced learning Organizational factors including leadership commitment resource availability and enforcement mechanisms are critical determinants of infection prevention and control compliance To enhance infection prevention and control competency across healthcare settings the following recommendations are made implement standardized competency based infection prevention and control training programs for all healthcare professionals invest in multimodal educational interventions that go beyond didactic education ensure adequate resources to support infection prevention and control practices establish monitoring and feedback systems to maintain compliance develop and implement standardized competency frameworks for all professional groups address system level barriers to infection prevention and control compliance and conduct further research to identify the most effective interventions for specific settings and professional groups The COVID-19 pandemic has underscored the critical importance of infection prevention and control competency and the need for sustained investment in infection prevention and control training and infrastructure By addressing the gaps identified in this review healthcare systems can enhance patient safety reduce healthcare associated infections and better prepare for future infectious disease threats

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.
- **Conflict of interest:** The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper
- **Acknowledgement:** The authors declare that they have nobody or no-company to acknowledge.
- **Author contributions:** The authors declare that they have equal right on this paper.
- **Funding information:** The authors declare that there is no funding to be acknowledged.
- **Data availability statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.
- **Use of AI Tools:** The author(s) declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

References

[1] Cox JL, Simpson MD. Microbiology education and infection control competency: offering a new perspective. J Microbiol Biol Educ. 2018;19:1–6.

[2] Powers D, Armellino D, Dolansky M, Fitzpatrick J. Factors influencing nurse compliance with standard precautions. Am J Infect Control. 2016;44:4–7.

[3] Lee JY. Effective communication for patient safety. J Korean Med Assoc. 2015;58:100–4.

[4] Carrico RM, Rebmann T, English JF, Mackey J, Cronin SN. Infection prevention and control competencies for hospital-based healthcare personnel. Am J Infect Control. 2008;36:691–701.

[5] Hyeon YH, Moon KJ. Cancer care facilities nurses experience of infection control. J Korean Acad Fundam Nurs. 2020;27:12–28.

[6] Field A. Discovering statistics using IBM SPSS statistics. London: Sage; 2018.

[7] Kwon IS, Lee GE, Kim GD, Kim YH, Park KM, Park HS, et al. Development of nursing students' critical thinking propensity measurement scale. J Korean Acad Nurs Adm. 2006;36:951.

[8] Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ. Evaluating the use of exploratory factor analysis in psychological research. Psychol Methods. 1999;4:272–99.

[9] Ara L, Bashar F, Tamal MEH, Siddiquee NKA, Mowla SMN, Sarker SA. Transferring knowledge into practice: a multimodal, multi-centre intervention for enhancing nurses' infection control competency in Bangladesh. J Hosp Infect. 2019;102:234–40.

[10] Kim NJ. Multidrug-resistant bacteria: a national challenge that requires urgently addressal. J Korean Med Assoc. 2022;65:462–6.

[11] Carrico RM, Garrett H, Balcom D, Glowicz JB. Infection prevention and control core practices: a roadmap for nursing practice. Nursing. 2018;48:28–9.

[12] Lee CY, Lee MH, Lee SH, Park YH. Nurses' views on infection control in long-term care facilities in South Korea: a focus group study. Korean J Adult Nurs. 2018;30:634–42.

[13] Jeon JY, Kim HB. Hand hygiene. J Korean Med Assoc. 2018;61(1):13–20.

[14] World Health Organisation. The WHO competency framework for health workers' education and training on antimicrobial resistance (No. WHO/HIS/HWF/AMR/2018.1), Geneva. 2018.

[15] Hooper D, Coughlan J, Mullen MR. Structural equation modelling: guidelines for determining model fit. Electron J Bus Res Methods. 2008;6(1):141–46.

[16] Ursachi G, Horodnic IA, Zait A. How reliable are measurement scales? External factors with indirect influence on reliability estimators. Procedia Econ Finance. 2015;20:679–86.

[17] Burnett E. Effective infection prevention and control: the nurse's role. Nurs Stand. 2018;33:67–71.

[18] Yu M, Kang H, Park J, Yang M. Development of a high-risk neonatal infection control competency scale. J Child Health Care. 2021;25:393–411.

[19] Polit DF, Beck CT. The content validity index: are you sure you know what's being reported? Critique and recommendations. Res Nurs Health. 2006;29:489–97.

[20] Keenan AP, Stevens JP. Applied multivariate statistics for the social sciences. 6. New York: Routledge; 2016.

[21] Knill L, Maduro R, Payne JE. Targeting zero CAUTIs empowers nurses and proactively reduces urinary catheter device use. Am Nurse Today. 2018;13:54–8.

[22] Klass D. Reevaluation of clinical competency. Am J Phys Med Rehabil. 2000;79:481–6.

[23] Korea Centers for Disease Control and Prevention. Standard prevention guidelines for healthcare-associated infections. 2017.

[24] Shrestha N. Factor analysis as a tool for survey analysis. Am J Appl Math Stat. 2021;9:4–11.

[25] Jahng S. Best practices in exploratory factor analysis for the development of the likert-type scale. Kor J Clin Psychol. 2015;34:1079–100.

[26] DeVellis RF. Scale development: theory and applications. 4. London: Sage; 2017.

[27] Korean Society for Healthcare-Associated Infection Control . Infection control in healthcare institutions. 5. Seoul: Hanmi Medicine; 2017.

[28] Storr J, Topley K, Privett S. The ward nurse's role in infection control. Nurs Stand. 2005;19:56–64.

[29] Miller BJ, Carson KA, Keller S. Educating patients on unnecessary antibiotics: personalising potential harm aids in patient understanding. J Am Board Fam Med. 2020;33:969–77.

[30] Schwartz-Barcott D, Kim HS. An expansion and elaboration of the hybrid model of concept development. In: Rogders BL, Knafl KA, editors. Concept development in nursing: foundations, techniques, and applications. 2. Philadelphia: WB Saunders; 2000. pp. 129–59.

[31] Poulose V, Punithavathi A, Ali M, Assalam FM, Phyo KK, Soh A, et al. Improving hand hygiene in a medical ward: a multifaceted approach. BMJ Open Qual. 2022;11:e001659.

[32] Kim YG, Kim JS, Kim GN, Kim BY, Kim SH, Kim SH, et al. Modern hospital microbiology. Paju: Sumunsa; 2019.

[33] Fawaz M, Anshasi H, Samaha A. Nurses at the front line of COVID-19: roles, responsibilities, risks, and rights. Am J Trop Med Hyg. 2020;103:1341–2.

[34] Schreiber JB, Nora A, Stage FK, Barlow EA, King J. Reporting structural equation modeling and confirmatory factor analysis results: a review. J Educational Res. 2006;99:323–38.

[35] Carrico R, Rebmann T, English JF. Infection prevention and control competencies for nurses. Ky Nurses Association. 2009;57(1):15.

[36] Liu LM, Curtis J, Crookes PA. Identifying essential infection control competencies of newly graduated nurses: a three-phase study in Australia and Taiwan. J Hosp Infect. 2014;86:100–9.

[37] Massaroli A, Martini JG, Moya JLM, Pereira MS, Tipple AFV, Maestri E. Skills for generalist and specialist nurses working in the prevention and control of infections in Brazil. Rev Lat-Am Enfermagem. 2019;27:e3134.

[38] Kline RB. Principles and practice of structural equation modeling. 4. New York: The Guilford; 2016.

[39] Park SH. Management of multidrug-resistant organisms in healthcare settings. J Korean Med Assoc. 2018;61:26–35.

[40] Anderson JC, Gerbing DW. Structural equation modeling in practice: a review and recommended two-step approach. Psychol Bull. 1988;103:411–23.

[41] Schiessler MM, Darwin LM, Phipps AR, Hegemann LR, Heybrock BS, Macfadyen AJ. Do not have a doubt, get the catheter out: a nurse-driven CAUTI prevention protocol. Pediatr Qual Saf. 2019;4:e183.

[42] Kang H. A guide on the use of factor analysis in the assessment of construct validity. J Korean Soc Nurs Sci. 2013;43:587–94.

[43] Yoon YK, Kwon KT, Jeong SJ, Moon C, Kim B, Kiem S, et al. Guidelines on implementing antimicrobial stewardship programs in Korea. Infect Chemother. 2021;53:617–59.

[44] Eldeen AIE, Abd-Elaziz M, Moghazy AM, Shahin ES, El-Ata ABA. Evaluation of infection control measure protocol application by nurses on patient safety in burn units. J Surg. 2016;4:1–9.