



International Journal of Medical and All Body Health Research

Evaluating the Evolving Role of Nurses in Healthcare Infection Control Amid COVID-19

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Article Info

ISSN (online): 2582-8940

Volume: 03

Issue: 04

October-December 2022

Received: 13-11-2022

Accepted: 08-12-2022

Page No: 122-130

Abstract

The COVID-19 pandemic has significantly reshaped the role of nurses in healthcare infection control, highlighting their critical contributions to patient safety, disease prevention, and public health resilience. As frontline healthcare providers, nurses have played an essential role in implementing infection prevention and control (IPC) measures, including the enforcement of hygiene protocols, proper use of personal protective equipment (PPE), and patient education on infection risks. Beyond direct patient care, they have been instrumental in surveillance efforts, conducting screenings, managing isolation procedures, and mitigating the spread of infection within healthcare facilities. However, the pandemic has also exposed various challenges, including workforce shortages, increased psychological stress, PPE shortages, and ethical dilemmas related to patient prioritization and self-protection. Despite these challenges, nurses have adapted by leveraging innovative strategies such as telehealth, AI-driven infection monitoring, and advanced sterilization technologies to enhance infection control. Additionally, the crisis has emphasized the need for ongoing IPC training and professional development, equipping nurses with the skills necessary to manage future public health emergencies. Moving forward, strengthening policy frameworks, improving working conditions, and investing in nurse education will be crucial in sustaining infection control efforts beyond COVID-19. Collaborative partnerships between nurses, healthcare institutions, and public health agencies are essential in reinforcing global preparedness for emerging infectious diseases. This study evaluates the evolving role of nurses in infection control, emphasizing their resilience, adaptability, and the long-term impact of their contributions in shaping future healthcare practices. By acknowledging the lessons learned from the pandemic, policymakers and healthcare leaders can implement sustainable strategies that empower nurses to continue safeguarding public health in an increasingly complex healthcare environment.

DOI: <https://doi.org/10.54660/IJMBHR.2022.3.4.122-130>

Keywords: Evolving, Nurses, Healthcare infection, Control amid, COVID-19

1. Introduction

The COVID-19 pandemic profoundly transformed global healthcare systems, particularly in the realm of infection prevention and control (IPC) (Adegoke *et al.*, 2022). The rapid spread of the SARS-CoV-2 virus exposed vulnerabilities in healthcare infrastructure, emphasizing the need for stringent IPC measures to protect both patients and healthcare workers.

Nurses, as frontline healthcare providers, played a crucial role in mitigating infection risks by implementing new protocols, adapting to evolving guidelines, and ensuring patient safety in high-risk environments (Dowding *et al.*, 2020; Matthew *et al.*, 2021). Their contributions not only shaped the immediate pandemic response but also set new standards for long-term infection control practices.

Despite their critical role, nurses faced unprecedented challenges during the pandemic, including increased workloads, shortages of personal protective equipment (PPE), and the mental and physical toll of prolonged crisis management (Schwerdtle *et al.*, 2020). The heightened demand for infection control measures placed additional responsibilities on nursing staff, requiring them to develop advanced competencies in disease prevention, patient isolation, and emergency response. These challenges underscored the need for ongoing training, policy support, and leadership involvement in infection control to strengthen healthcare resilience.

This review aims to examine how the COVID-19 pandemic redefined nurses' roles in IPC, focusing on the skills and strategies they adopted to combat infections effectively. By analyzing their evolving responsibilities, this discussion will explore the long-term implications of pandemic-driven changes in infection control, including improvements in healthcare preparedness, policy adaptations, and the integration of advanced IPC training in nursing education

(Ibn-Mohammed *et al.*, 2021; Callegari and Feder, 2022). Understanding these transformations is essential to enhancing future healthcare responses to infectious disease outbreaks. The COVID-19 pandemic fundamentally reshaped infection control practices in nursing, highlighting the importance of enhanced skills, leadership, and policy advocacy (Frenk *et al.*, 2022). Nurses emerged as key figures in safeguarding public health, advocating for improved safety protocols, and influencing policy decisions to strengthen healthcare systems. As the world moves beyond the pandemic, the lessons learned must inform future infection control strategies to ensure a more resilient and adaptive healthcare system (Sundaraman *et al.*, 2021).

2. The expanding role of nurses in infection control

Nurses play a crucial role in infection control, serving as the first line of defense against the spread of infectious diseases in healthcare settings and the broader community as shown in figure 1 (Al Hasan *et al.*, 2021; Braun *et al.*, 2020). Their responsibilities encompass implementing prevention measures, conducting surveillance for early detection, and educating patients and communities on infection prevention. With the increasing prevalence of infectious diseases and antimicrobial resistance, the role of nurses in infection control has expanded significantly (Tomczyk *et al.*, 2021). This explores the key areas where nurses contribute to reducing the transmission of infections.

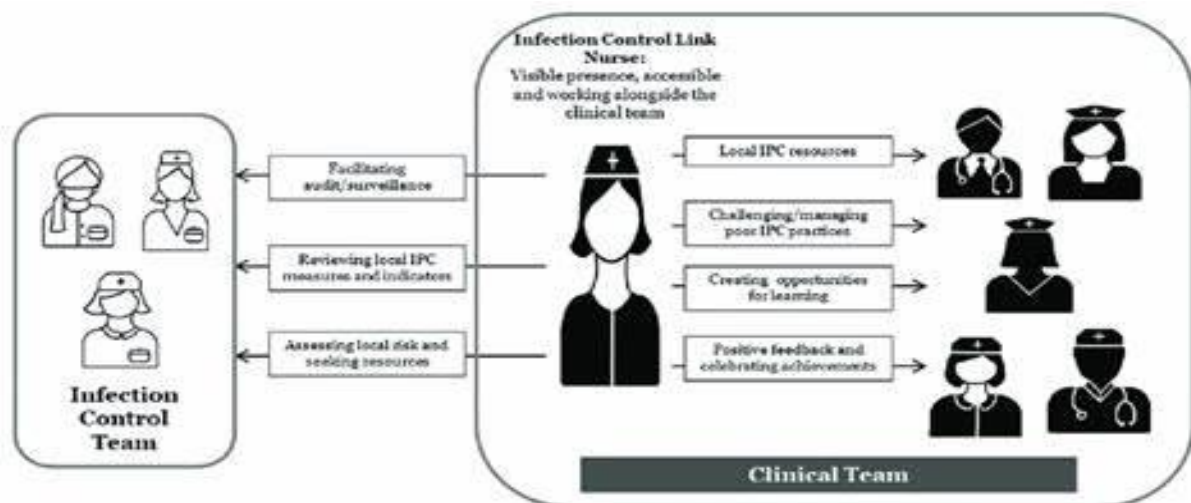


Fig 1: Infection control link nurse acting as a link between infection control and clinical teams (Braun *et al.*, 2020)

One of the most critical responsibilities of nurses in infection control is the implementation of hygiene and sanitation protocols to prevent the spread of pathogens (Alhumaid *et al.*, 2021). Nurses ensure that proper hand hygiene is maintained among healthcare workers, patients, and visitors. Hand hygiene is recognized as one of the most effective measures to reduce hospital-acquired infections (HAIs) (Mouajou *et al.*, 2022). Beyond hand hygiene, nurses oversee the proper disinfection and sterilization of medical equipment and hospital surfaces. This includes ensuring that surgical instruments, patient rooms, and common areas are regularly cleaned and disinfected according to standardized protocols (Bali, 2021). By maintaining high hygiene standards, nurses play a fundamental role in breaking the chain of infection. Personal protective equipment (PPE) serves as a barrier against infectious agents, and nurses are responsible for

ensuring strict compliance with PPE protocols among healthcare workers (Lee *et al.*, 2021). This includes proper use of gloves, masks, gowns, and face shields, especially during high-risk procedures and interactions with infectious patients. During the COVID-19 pandemic, nurses played a critical role in training staff on correct PPE usage, monitoring PPE availability, and enforcing adherence to protocols to minimize the risk of transmission (CDC, 2022). By reinforcing proper PPE use, nurses not only protect themselves and their colleagues but also reduce the spread of infections within healthcare facilities (Brooks *et al.*, 2021). Nurses are key players in disease surveillance, closely monitoring patients for symptoms of infectious diseases (Meckawy *et al.*, 2022). By tracking patterns of illness and identifying unusual clusters of symptoms, nurses contribute to the early detection of outbreaks. Their vigilance enables

rapid intervention, preventing the further spread of infections within hospitals and the community. In long-term care facilities, nurses observe residents for symptoms of influenza or norovirus, which can quickly spread among vulnerable populations. Early identification allows for timely isolation measures and targeted treatments. Infection control nurses are also responsible for screening patients and staff for contagious diseases, particularly during public health emergencies (Song *et al.*, 2021). Routine screenings for conditions such as tuberculosis, COVID-19, and multidrug-resistant infections help identify carriers and prevent outbreaks. Additionally, nurses play a vital role in contact tracing, identifying individuals who may have been exposed to infectious diseases and advising them on quarantine or testing protocols. This proactive approach is essential in curbing the spread of infectious diseases in hospitals and the general population. Nurses act as educators and advocates for infection prevention, equipping patients and their families with essential knowledge on reducing the risk of infections (Michael and Nguyen, 2022). This includes guidance on handwashing techniques, respiratory hygiene (e.g., covering coughs and sneezes), wound care, and antibiotic stewardship. For hospitalized patients, nurses educate them on proper post-discharge infection control measures, such as wound care, medication adherence, and follow-up appointments. By ensuring that patients and caregivers understand and apply these preventive measures, nurses help reduce readmissions due to preventable infections.

Vaccination is one of the most effective tools in infection control, and nurses play a critical role in promoting vaccine uptake and addressing vaccine hesitancy (Peters, 2022). They provide accurate, evidence-based information to patients and communities, countering myths and misconceptions surrounding vaccines. During vaccination campaigns, such as those for influenza, COVID-19, and human papillomavirus (HPV) vaccines, nurses are often on the frontlines administering vaccines and educating the public on the benefits and safety of immunization. Studies indicate that nurses are among the most trusted healthcare professionals, making their role in vaccine advocacy particularly impactful. Nurses play an increasingly vital role in infection control, ensuring the safety of patients, healthcare workers, and communities. Their responsibilities span frontline prevention measures, disease surveillance, and public education, each of which is essential in reducing the spread of infections. By implementing strict hygiene protocols and PPE adherence, nurses prevent healthcare-associated infections. Through symptom monitoring, early outbreak detection, and contact tracing, they contribute to public health surveillance (Burkom *et al.*, 2021). Additionally, their efforts in educating patients and promoting vaccinations strengthen community resilience against infectious diseases. As healthcare continues to evolve, expanding the role of nurses in infection control through enhanced training, resource allocation, and policy support will be essential in preventing future outbreaks and safeguarding public health (Filip *et al.*, 2022). Nurses remain indispensable in the global fight against infectious diseases, demonstrating both their expertise and commitment to patient safety.

2.1 Challenges faced by nurses in infection control during COVID-19

The COVID-19 pandemic presented unprecedented challenges for healthcare workers, particularly nurses, who

played a critical role in infection prevention and control (IPC) (Rubano *et al.*, 2022). As frontline responders, nurses were responsible for implementing safety protocols, managing patient care, and mitigating the spread of the virus. However, these responsibilities came with significant obstacles, including workforce shortages, supply chain disruptions, and ethical dilemmas. These challenges not only affected the well-being of nurses but also impacted the overall effectiveness of IPC efforts during the pandemic as shown in figure 2.

One of the most significant challenges faced by nurses during the COVID-19 pandemic was workforce shortages, which led to increased workloads and psychological stress. The rapid surge in COVID-19 cases overwhelmed healthcare systems, forcing nurses to work extended shifts under extreme pressure. Hospitals and healthcare facilities struggled to maintain adequate staffing levels, as many nurses either contracted the virus or experienced burnout due to prolonged exposure to high-stress environments.

Burnout became a widespread issue as nurses faced emotional exhaustion, fatigue, and post-traumatic stress (Fateminia *et al.*, 2022). The psychological burden of caring for critically ill patients, witnessing high mortality rates, and dealing with the uncertainty of the pandemic further exacerbated stress levels. Studies have shown that prolonged stress and burnout among nurses can lead to reduced job performance, higher rates of absenteeism, and even long-term psychological disorders such as anxiety and depression (Jun *et al.*, 2021; Li *et al.*, 2022). Additionally, high infection rates among healthcare workers further strained the nursing workforce. Many nurses became infected due to direct exposure to COVID-19 patients, often as a result of inadequate personal protective equipment (PPE) or long working hours, which increased the likelihood of errors in infection control practices (Chen *et al.*, 2021; Haegdorens *et al.*, 2022). These factors created a vicious cycle, where workforce shortages led to increased workloads, which in turn heightened the risk of infection and burnout.

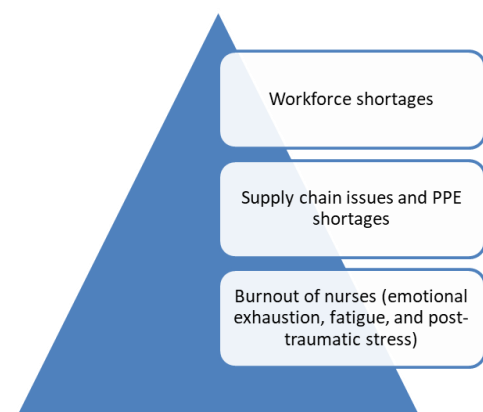


Fig 2: Challenges faced by nurses in infection control during covid-19

The global supply chain disruptions caused by COVID-19 led to severe shortages of essential medical supplies, particularly PPE (Sigala *et al.*, 2022). Masks, gloves, face shields, and gowns were in high demand, yet many healthcare facilities struggled to secure adequate supplies. Nurses had to manage limited resources while ensuring their own safety and that of their patients. In many cases, they were forced to reuse PPE beyond recommended usage or improvise protective

measures, increasing their risk of exposure to the virus. The shortage of PPE placed nurses in an extremely vulnerable position, as adequate protection is a fundamental requirement for effective infection control (Ilesanmi *et al.*, 2021; Al Baalharith *et al.*, 2021). In some regions, healthcare workers were given substandard or expired protective gear, further compromising their safety. These supply chain challenges underscored the importance of healthcare systems being better prepared for future pandemics by maintaining sufficient stockpiles of critical medical supplies and improving logistical frameworks for rapid distribution during health crises.

Nurses faced difficult ethical dilemmas throughout the pandemic, particularly when balancing patient care with self-protection (Zhu *et al.*, 2021). The shortage of PPE forced many healthcare workers to make tough decisions about whether to continue treating highly infectious patients without proper protection, putting their own health at risk (Razu *et al.*, 2021; Best and Williams, 2021). This ethical conflict created immense moral distress, as nurses felt a duty to provide care but also had concerns about their own well-being and that of their families.

Another major ethical challenge involved resource allocation and prioritization (Adeoba, 2018). During peak infection periods, hospitals faced shortages of ventilators, ICU beds, and life-saving medications (Tyrrell *et al.*, 2021; Pugh *et al.*, 2021). Nurses were often at the forefront of making critical decisions regarding which patients would receive limited medical interventions. This responsibility placed an enormous emotional burden on nurses, as they had to navigate life-and-death decisions under conditions of extreme uncertainty and scarcity.

Additionally, nurses had to advocate for vulnerable populations who were disproportionately affected by the pandemic. Marginalized communities, including low-income groups and racial minorities, often had less access to quality healthcare. Nurses played a crucial role in highlighting these disparities and pushing for equitable distribution of resources (Wakefield *et al.*, 2021). However, systemic challenges made it difficult to address these inequalities effectively, further complicating ethical decision-making in infection control efforts. The COVID-19 pandemic exposed critical challenges in infection control that placed significant burdens on nurses. Workforce shortages and burnout led to increased stress and exhaustion, affecting both nurses' well-being and patient care. Supply chain disruptions and PPE shortages forced nurses to work under unsafe conditions, increasing the risk of infection. Ethical dilemmas, including balancing self-protection with patient care and navigating resource allocation, created additional moral and emotional challenges. Moving forward, healthcare systems must implement policies to strengthen nurse staffing, improve mental health support, and ensure the availability of essential medical supplies during health emergencies. Additionally, ethical frameworks must be established to support healthcare workers in decision-making during crises (Guidolin *et al.*, 2022). Addressing these challenges is crucial in preparing for future pandemics and ensuring that nurses can effectively perform their roles in infection prevention and control.

2.2 Innovations and strategies for strengthening nurses' role in infection control

Nurses play a pivotal role in infection control, serving as the frontline defenders against healthcare-associated infections (HAIs) and emerging infectious diseases. As healthcare systems evolve, innovations and strategic improvements are necessary to strengthen the capacity of nurses in infection prevention and control (IPC) as shown in figure 3 (Birgand *et al.*, 2022). This explores three key strategies: the adoption of advanced infection control technologies, the integration of telehealth and remote monitoring, and the enhancement of education and training programs.

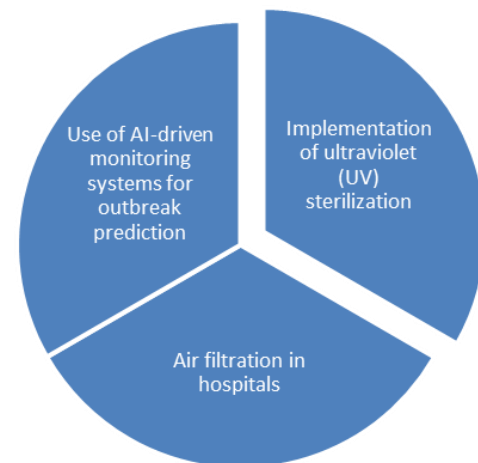


Fig 3: Innovations and strategies for strengthening nurses' role in infection control

Artificial intelligence (AI) is revolutionizing infection control by enabling real-time monitoring and early outbreak prediction. AI-driven systems analyze vast amounts of data, including electronic health records (EHRs), patient symptoms, and environmental factors, to detect infection patterns and predict potential outbreaks. For nurses, AI-powered infection control systems provide alerts for early interventions, helping them identify high-risk patients and implement targeted preventive measures. These systems also aid in tracking antibiotic resistance patterns, ensuring that nurses and clinicians use the most effective treatments. Hospitals are increasingly adopting UV sterilization and advanced air filtration systems to reduce pathogen transmission. UV light, particularly UV-C radiation, has been proven to inactivate bacteria, viruses, and fungi on surfaces and in the air. Automated UV disinfection systems are being deployed in operating rooms, intensive care units (ICUs), and isolation wards to enhance sterilization efforts beyond manual cleaning (Holland *et al.*, 2021; Beswick *et al.*, 2022). Nurses play a critical role in overseeing the implementation of these technologies, ensuring that they are used correctly and integrated into routine IPC protocols. Additionally, high-efficiency particulate air (HEPA) filtration systems are being installed in hospitals to remove airborne contaminants, reducing the risk of airborne disease transmission, particularly for patients with tuberculosis (TB), COVID-19, and influenza (Zia *et al.*, 2021; Nair, *et al.*, 2022).

The COVID-19 pandemic accelerated the adoption of telehealth and remote monitoring solutions, which have become essential tools in infection control as illustrated in figure 5 (Jung, 2021).

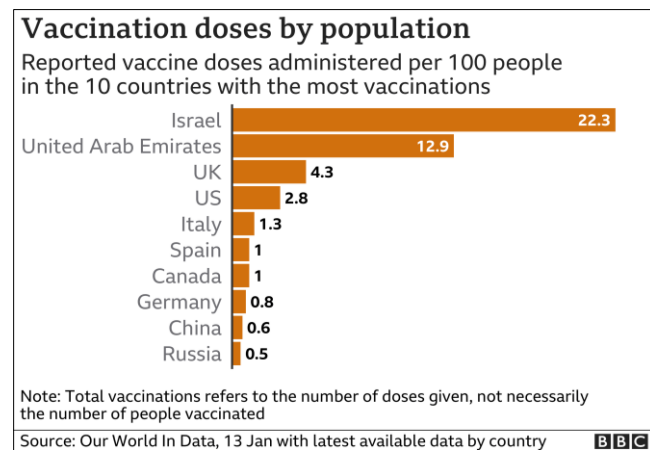


Fig 4: COVID-19 vaccination doses by population (Jung, 2021)

Telehealth allows nurses to provide virtual consultations, monitor patients remotely, and reduce the need for in-person hospital visits, thereby minimizing the risk of disease transmission (Almuslim and AlDossary, 2022). Remote monitoring devices, including wearable biosensors, enable nurses to track patients' vital signs, temperature, oxygen levels, and other health indicators in real time. This is particularly useful for immunocompromised patients who require continuous monitoring but need to avoid hospital-acquired infections. Nurses can use this data to detect early signs of deterioration and intervene before conditions worsen. To fully leverage the benefits of telehealth and remote monitoring, nurses must be trained in digital health technologies (Troncoso and Breads, 2021; Abernethy *et al.*, 2022). This includes learning how to conduct virtual patient assessments, interpret data from wearable devices, and use telemedicine platforms effectively. Nursing curricula and professional development programs should incorporate courses on digital health, telehealth ethics, and cybersecurity to ensure that nurses are well-equipped to navigate the evolving healthcare landscape. As healthcare shifts toward hybrid models that blend in-person and virtual care, nurses must develop proficiency in both traditional and digital care delivery.

A robust foundation in infection prevention and control (IPC) is essential for all nursing professionals. However, studies indicate that IPC training is often inconsistent across nursing programs. To address this, nursing curricula should include comprehensive modules on infection control, epidemiology, and outbreak management. Key areas of focus should include; proper hand hygiene and PPE usage. Infection transmission dynamics. Antimicrobial stewardship and resistance prevention. Emergency response protocols for infectious disease outbreaks. By integrating evidence-based IPC training into nursing education, future nurses will be better prepared to handle emerging infectious threats and contribute to public health efforts (Gulliver *et al.*, 2020).

Given the rapid advancements in infection control practices, nurses must engage in continuous professional development (CPD) to stay updated on the latest guidelines and innovations (Wieland *et al.*, 2021). Hospitals and healthcare organizations should provide regular workshops, simulation

training, and certification programs focused on IPC. One effective strategy is the use of simulation-based training, where nurses practice infection control procedures in virtual or controlled environments. This approach has been shown to improve adherence to IPC protocols and enhance decision-making in high-risk situations. Additionally, CPD programs should emphasize interdisciplinary collaboration, allowing nurses to work closely with epidemiologists, infection control specialists, and public health officials. Strengthening nurses' role in infection control requires a multifaceted approach that incorporates technological advancements, telehealth integration, and enhanced education and training (AL Anizi *et al.*, 2021; Pappas and Frisch, 2022). The adoption of AI-driven surveillance, UV sterilization, and advanced air filtration enhances nurses' ability to prevent and manage infections. Telehealth and remote monitoring reduce disease transmission risks while maintaining high-quality patient care. Meanwhile, reinforcing IPC education in nursing curricula and implementing continuous professional development ensures that nurses remain at the forefront of infection control efforts. As infectious disease threats continue to evolve, investing in these innovations and strategies will empower nurses to protect patients, healthcare workers, and communities, ultimately leading to safer and more resilient healthcare systems (Alotaibi *et al.*, 2022; Emanuel *et al.*, 2022).

2.3 Policy implications and future directions

The COVID-19 pandemic underscored the critical role of nurses in infection prevention and control (IPC) while highlighting systemic weaknesses in global health preparedness (Tomczyk *et al.*, 2021). Moving forward, policymakers must address these challenges by strengthening IPC policies, improving working conditions for nurses, and fostering collaboration between nursing professionals and public health institutions. By implementing evidence-based policies and reinforcing healthcare infrastructure, future pandemics can be better managed, ensuring both patient safety and healthcare worker well-being (Narwal and Jain, 2020; Grant and Pabico, 2022).

One of the most significant policy implications of the COVID-19 pandemic is the need for stronger global health preparedness and IPC frameworks (Kandel *et al.*, 2020). The rapid spread of the virus exposed gaps in pandemic response strategies, particularly in healthcare facilities that lacked standardized infection control measures. Strengthening IPC policies requires a multifaceted approach, including; Governments and international organizations must establish well-defined pandemic response protocols that prioritize infection control measures (Fofanah *et al.*, 2022; Abdalla *et al.*, 2022). This includes clear guidelines on PPE usage, patient isolation strategies, and emergency resource allocation to prevent supply shortages during crises. Policymakers must allocate funding to expand healthcare infrastructure, ensuring that hospitals and clinics are adequately equipped to handle surges in patient cases. Additionally, investment in training programs for nurses and other healthcare professionals will enhance their ability to respond effectively to future public health emergencies. Global health organizations, such as the World Health Organization (WHO), should work with national governments to enhance disease surveillance systems (Mathers, 2020). Improved data sharing and early detection of infectious disease outbreaks will allow for a faster and

more coordinated response, minimizing the impact of future pandemics.

The pandemic revealed severe deficiencies in nurse staffing, mental health support, and workplace safety (Havaei *et al.*, 2021). To ensure a sustainable healthcare workforce, policies must be implemented to improve working conditions and protect nurses from excessive physical and emotional stress. Key policy recommendations include; Governments and healthcare institutions must implement policies that enforce safe nurse-to-patient ratios. Overburdened nurses are more likely to experience burnout and reduced job performance, ultimately affecting patient care quality (Kelly *et al.*, 2021). Increasing nursing school enrollment and offering incentives such as student loan forgiveness and competitive salaries can help address staffing shortages. The psychological toll of the pandemic on nurses cannot be ignored. Many healthcare workers experienced post-traumatic stress, anxiety, and depression due to the high mortality rates and intense work environments (d'Ettorre *et al.*, 2020). Policies should mandate the integration of mental health services into healthcare facilities, providing access to counseling, peer support groups, and stress management programs for nurses. Governments and hospital administrators must ensure a consistent and reliable supply of PPE for nurses and other frontline workers. Policies should also address workplace safety, requiring facilities to implement measures such as improved ventilation, infection control training, and standardized protocols for handling contagious patients (Islam *et al.*, 2020; Abalkhail and Alslamah, 2022).

Effective infection control and disease prevention require strong collaboration between nursing professionals and public health institutions. Strengthening these partnerships will facilitate better surveillance, response planning, and resource allocation during public health crises (Morgan and Pebody, 2022). Key strategies for enhancing collaboration include; Nurses should be actively involved in public health policymaking, contributing their frontline experience to the development of infection control strategies. Establishing advisory committees that include nursing representatives will ensure that IPC policies are practical, evidence-based, and tailored to the realities of patient care. Hospitals, government health agencies, and research institutions should collaborate to develop real-time infection surveillance systems. By leveraging digital health tools and big data analytics, nurses can contribute to early outbreak detection, improving response times and containment efforts (Mahmood *et al.*, 2020). Nurses play a vital role in educating the public on infection prevention strategies, vaccine awareness, and hygiene practices. Policies should support the expansion of nurse-led community health programs, focusing on underserved populations that may lack access to healthcare resources.

The COVID-19 pandemic highlighted the need for comprehensive policy reforms to strengthen global health preparedness, improve working conditions for nurses, and foster collaboration between healthcare professionals and public health institutions. Reinforcing IPC policies, investing in healthcare infrastructure, and developing early warning systems will enhance pandemic response capabilities (Patel *et al.*, 2021). Simultaneously, ensuring adequate nurse staffing, mental health support, and workplace safety measures will protect the well-being of frontline workers. Lastly, integrating nurses into public health decision-making and infection surveillance efforts will improve disease

prevention and response strategies. Moving forward, policymakers must prioritize these reforms to build a more resilient and effective healthcare system, ensuring that nurses are adequately supported in their critical role in infection control (Tumusiime *et al.*, 2020; Haldane *et al.*, 2021).

3. Conclusion

The COVID-19 pandemic highlighted the indispensable role of nurses in infection prevention and control (IPC), while also exposing critical gaps in healthcare preparedness, workforce conditions, and resource allocation. Key findings indicate that nurses faced unprecedented challenges, including staff shortages, burnout, supply chain issues, and ethical dilemmas in patient care. Despite these difficulties, nurses played a pivotal role in implementing IPC measures, adapting to evolving guidelines, and ensuring patient and public safety. Moving forward, these experiences must inform long-term healthcare policies and infection control strategies.

The future of nursing in IPC will be shaped by lessons learned during the pandemic. Strengthening global health preparedness requires investments in healthcare infrastructure, workforce expansion, and interdisciplinary collaboration between nurses, policymakers, and public health institutions. Additionally, improving working conditions—such as enforcing safe nurse-to-patient ratios, providing mental health support, and ensuring the availability of personal protective equipment (PPE)—will enhance the resilience of nursing professionals in future health crises. Advances in digital health tools, surveillance systems, and infection control training programs will further equip nurses with the skills and resources necessary to respond effectively to emerging infectious diseases.

A comprehensive call to action is needed to drive policy reforms, enhance nurse education, and increase investments in infection prevention strategies. Governments and healthcare institutions must implement evidence-based policies that prioritize the well-being of nurses, promote continuous education in IPC best practices, and allocate sufficient funding for research and technological advancements in infection control. By addressing these critical areas, the global healthcare system can build a stronger, more resilient foundation to safeguard public health and support nurses in their essential role as frontline defenders against infectious diseases.

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