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Laboratory-Nursing Partnerships in Managing Multi-Drug-Resistant Organisms (MDROs): A Comprehensive Review

Abdulkarim Hamad Al Atiyyah[1], Dalela Magna Al Mutairi[1], Khaleel Ibraheem Al Johani[2], Mohammed Burayk Al Mutairi[1], Hadyl Shalan Al Abdaly[1], Imtenan Abdullah Albreak[1], Meshal Abdullah Altoriqi[3], Wasmiya Ayad Alrasheedi[2]

[1] Laboratory Department, King Khaled General Hospital, Majmaah, Saudi Arabia
[2] Nursing Department, King Khaled General Hospital, Majmaah, Saudi Arabia
[3] Laboratory Department, Zulfi General Hospital, Saudi Arabia

Abstract

Background: Multi-drug resistant organisms (MDROs) pose a significant threat to global healthcare, causing prolonged hospitalizations, increased mortality, and substantial economic burdens. Effective management requires robust laboratory-nursing partnerships to enhance detection and infection control.

Aim: This review evaluates the efficacy of laboratory-nursing collaborations in managing MDROs, identifies best practices, and highlights opportunities for improvement in diverse healthcare settings.

Methods: A comprehensive literature review was conducted, synthesizing studies from 2010–2025 on MDRO epidemiology, diagnostic techniques, infection control practices, and interdisciplinary strategies. Data from the CDC, WHO, and peer-reviewed journals were analyzed to assess the impact of laboratory-nursing synergies.

Results: Laboratory professionals utilize advanced diagnostics like PCR and MALDI-TOF MS for rapid MDRO identification, while nurses implement contact precautions and decolonization protocols, reducing transmission by up to 40%. Interdisciplinary communication, standardized protocols, and regional collaboratives, such as SHIELD-OC, have decreased MDRO prevalence by 30.4% in long-term care facilities. Challenges include resource constraints and variable protocol adherence.

Conclusions: Laboratory-nursing partnerships are critical for effective MDRO management. Standardizing protocols, leveraging technology, and fostering regional collaboration can enhance outcomes. Future research should explore cost-effective technologies like whole-genome sequencing and AI-based predictive models.

Keywords: MDROs, laboratory-nursing partnerships, infection control, antimicrobial resistance, surveillance

*Corresponding author e-mail: Almishkhas@gmail.com (**Abdulkarim Hamad Al Atiyyah**).
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Introduction

Multi-drug-resistant organisms (MDROs) represent a formidable challenge to global healthcare systems, characterized by their resistance to multiple classes of antimicrobial agents, rendering standard treatments ineffective (CDC, 2024). These pathogens encompass a range of microbes, including bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococci* (VRE), carbapenem-resistant *Enterobacterales* (CRE), and emerging fungal threats like *Candida auris* (Geng et al., 2025). The clinical implications of MDROs are profound, contributing to extended hospital stays, elevated mortality rates, and substantial economic burdens due to increased healthcare costs (Gussin et al., 2024). For instance, MDRO infections are estimated to add billions of dollars annually to healthcare expenditures in the United States alone, driven by prolonged hospitalizations and the need for specialized treatments (Wong et al., 2022).

The rise of MDROs is fueled by several interconnected factors. Overuse and misuse of antibiotics in both clinical and agricultural settings have accelerated the development of resistance, creating selective pressure that favors resistant strains (Tacconelli et al., 2018). Inadequate infection control practices, such as inconsistent hand hygiene and improper use of personal protective equipment, further exacerbate the spread of these organisms within healthcare facilities (Siegel et al., 2006). Cross-contamination, particularly in high-traffic areas like intensive care units (ICUs) and long-term care facilities (LTCFs), amplifies transmission risks, as patients and healthcare workers inadvertently serve as vectors for MDRO dissemination (Gussin et al., 2024).

Effective management of MDROs demands a multidisciplinary approach, with laboratory-nursing partnerships serving as a cornerstone of infection prevention and control (IPC). Laboratory professionals provide critical diagnostic and surveillance data, utilizing advanced techniques such as polymerase chain reaction (PCR) and antimicrobial susceptibility testing to identify MDROs and their resistance profiles (Bonomo et al., 2018). Meanwhile, nurses, who are at the forefront of patient care, implement infection control measures, such as contact precautions and decolonization protocols, while also educating patients and families to enhance compliance and reduce transmission (Climo et al., 2013). This review synthesizes recent literature to evaluate the efficacy of laboratory-nursing partnerships in managing MDROs, identify evidence-based best practices, and highlight opportunities for improvement to strengthen these collaborations in diverse healthcare settings.

1. Epidemiology of MDROs

MDROs constitute a significant global public health threat, with their prevalence and impact varying widely across geographic regions and healthcare settings. In the United States, the Centers for Disease Control and Prevention (CDC) estimates that approximately 2.8 million antibiotic-resistant infections occur annually, resulting in over 35,000 deaths and placing a substantial burden on healthcare systems (CDC, 2024). Globally, the World Health Organization (WHO) has identified antibiotic resistance as one of the top ten threats to public health, with MDROs contributing to an estimated 1.27 million deaths worldwide in 2019 (O'Neill, 2016). The prevalence of specific MDROs varies by setting, with long-term care facilities (LTCFs) reporting alarmingly high rates of 40–65% for MRSA and up to 80% for CRE in high-risk populations, such as those with indwelling devices or frequent antibiotic exposure (Wong et al., 2022). Intensive care units (ICUs), where patients often undergo invasive procedures and have

compromised immune systems, face particularly elevated MDRO burdens, with VRE prevalence ranging from 20–30% and CRE rates reaching up to 50% in certain regions (Geng et al., 2025).

The transmission dynamics of MDROs are complex and multifaceted. Patient transfers between acute care hospitals, LTCFs, and community settings create regional transmission networks that facilitate the spread of resistant organisms across healthcare systems (Gussin et al., 2024). For example, asymptomatic carriers of MDROs, such as MRSA or *Candida auris*, can introduce these pathogens into new facilities during transfers, leading to outbreaks if not promptly identified (Huang et al., 2020). Key drivers of MDRO transmission include antibiotic misuse, which promotes the selection of resistant strains, and lapses in infection control practices, such as inadequate hand hygiene, improper sterilization of medical equipment, and insufficient environmental cleaning (Tacconelli et al., 2018). Environmental reservoirs, such as contaminated bedrails, doorknobs, and medical devices, further exacerbate transmission, particularly in high-touch areas of healthcare facilities (Dancer, 2014).

Laboratory-nursing partnerships are pivotal in disrupting these transmission chains. Laboratories contribute by conducting active surveillance, using techniques like nasal and rectal swabs to detect asymptomatic carriers, and providing rapid diagnostic results to guide targeted interventions (Septimus et al., 2014). Nurses complement these efforts by implementing stringent infection control measures, such as contact precautions, chlorhexidine bathing, and patient isolation, to prevent further spread (Climo et al., 2013). By combining timely identification with proactive interventions, these partnerships are essential for mitigating the spread of MDROs and reducing their clinical and economic impact.

Table 1: Prevalence of Common MDROs in Healthcare Settings

MDRO	Healthcare Setting	Prevalence (%)	Reference
Methicillin-resistant *Staphylococcus aureus* (MRSA)	LTCFs	40–65	Wong et al., 2022
Vancomycin-resistant *Enterococci* (VRE)	ICUs	20–30	Geng et al., 2025
Carbapenem-resistant *Enterobacterales* (CRE)	LTCFs	50–80	Wong et al., 2022
Candida auris	Acute Care	5–15	CDC, 2024

2. Role of Laboratory Professionals in MDRO Management

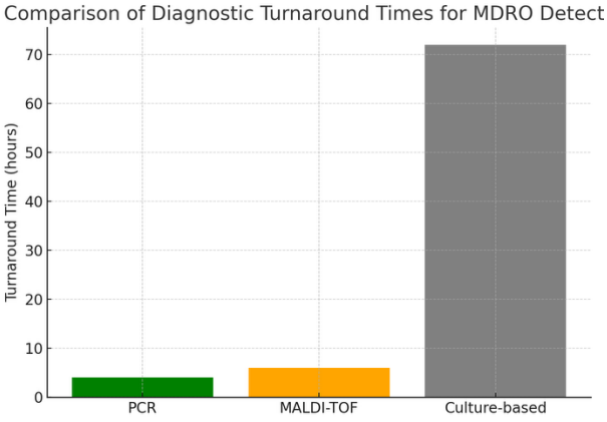
Laboratory professionals play a critical role in the detection, surveillance, and management of multidrug-resistant organisms (MDROs). Their expertise in diagnostic testing, surveillance, and antimicrobial susceptibility testing is essential for controlling the spread of MDROs in healthcare settings, particularly in long-term care facilities (LTCFs).

2.1. Diagnostic Testing

Accurate and timely identification of MDROs is a cornerstone of effective infection control. Laboratory professionals employ advanced diagnostic techniques to detect resistance genes and identify pathogens rapidly. Molecular methods, such as

polymerase chain reaction (PCR), allow for the detection of specific resistance genes like *mecA* (associated with methicillin-resistant *Staphylococcus aureus* [MRSA]) and *blaKPC* (linked to carbapenem-resistant *Enterobacteriaceae* [CRE]). Additionally, matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) provides rapid identification of bacterial species and resistance profiles within hours, compared to days for traditional culture-based methods (Bonomo et al., 2018). These rapid diagnostics reduce turnaround times, enabling clinicians to initiate targeted therapies and infection control measures promptly, which is critical in preventing outbreaks (Timbrook et al., 2017). For instance, PCR-based assays can detect vancomycin-resistant *Enterococcus* (VRE) in under 4 hours, compared to 48–72 hours for culture-based techniques.

Figure 1. Comparison of Diagnostic Turnaround Times



This reduction in diagnostic time enhances patient outcomes and supports infection control efforts by enabling faster isolation of MDRO-positive patients.

2.2. Surveillance and Screening

Active surveillance is a proactive strategy for identifying asymptomatic MDRO carriers, particularly in high-risk populations such as patients in LTCFs or intensive care units. Laboratory professionals process specimens from nasal swabs (for MRSA), rectal swabs (for CRE or VRE), or wound cultures to detect colonization. Surveillance data are critical for informing hospital policies, guiding decolonization protocols, and preventing outbreaks (Huang et al., 2020). For example, routine screening for *Candida auris*, an emerging multidrug-resistant yeast, has been instrumental in reducing its spread in LTCFs, where it is prone to causing outbreaks due to prolonged patient stays and frequent healthcare interactions (CDC, 2024). Laboratories also contribute to regional surveillance networks by sharing data on MDRO prevalence, which helps public health officials track resistance trends and implement targeted interventions (Septimus et al., 2014).

2.3. Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing (AST) is a critical function of laboratory professionals, providing clinicians with detailed resistance profiles to guide treatment decisions. Automated systems like VITEK 2 and broth microdilution methods offer standardized, reproducible results for a wide range of antibiotics (CLSI, 2023). These tests are particularly important for managing complex resistance mechanisms, such as colistin resistance in gram-negative bacteria, which can be challenging to detect due to heteroresistance and emerging resistance genes (e.g., *mcr-1*).

Laboratories also support antimicrobial stewardship programs by analyzing and reporting resistance trends, enabling clinicians to optimize antibiotic use and reduce selective pressure that drives resistance (Barlam et al., 2016). For example, laboratories may identify increasing rates of extended-spectrum beta-lactamase (ESBL)-producing organisms, prompting stewardship teams to restrict the use of broad-spectrum antibiotics like ceftriaxone.

3. Role of Nursing Staff in MDRO Management

Nursing staff are essential in implementing infection control measures, educating patients, and maintaining a safe healthcare environment. Their hands-on role in patient care makes them pivotal in preventing MDRO transmission and managing colonized or infected patients.

3.1. Infection Control Practices

Nurses are responsible for enforcing standard precautions, such as hand hygiene and the use of personal protective equipment (PPE), as well as contact precautions for patients known to be colonized or infected with MDROs (Siegel et al., 2006). Nursing-led interventions, such as daily chlorhexidine bathing and nasal decolonization with mupirocin or iodophor, have been shown to significantly reduce MDRO colonization rates. For instance, a multicenter study demonstrated that chlorhexidine bathing reduced MRSA colonization by 25% in LTCFs (Gussin et al., 2024). Nurses ensure compliance with these protocols, monitor adherence, and train other healthcare staff to maintain consistency. These interventions are particularly effective in high-risk settings, where strict adherence to protocols can reduce transmission rates by up to 40% (Climo et al., 2013).

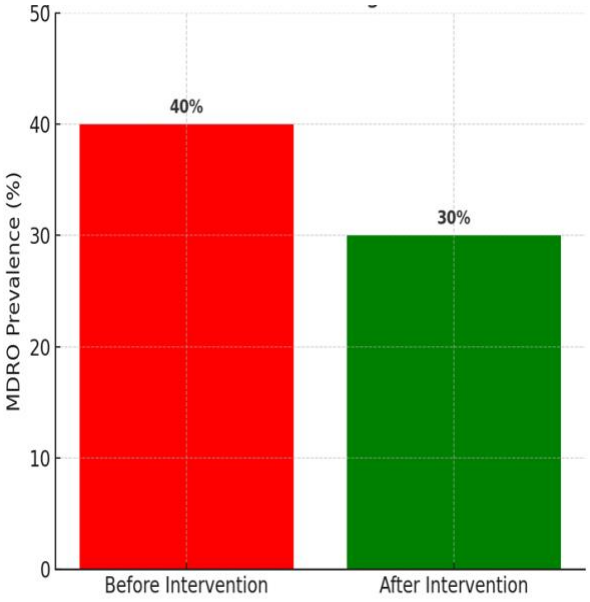


Figure 2: Impact of Chlorhexidine Bathing on MDRO Prevalence

3.2. Patient Education

Nurses play a key role in educating patients and their families about MDROs, including the importance of adhering to infection control measures and completing prescribed antibiotic courses. Effective education reduces patient anxiety, improves compliance with isolation protocols, and addresses stigma associated with MDRO colonization (Shenoy et al., 2017). For example, nurses may explain the rationale for contact precautions to patients, ensuring they understand that these measures protect both themselves and others. Educational efforts also extend to antibiotic stewardship, where nurses reinforce the importance of avoiding unnecessary antibiotic use to prevent further resistance (Anderson et al., 2019).

3.3. Environmental Cleaning

Nurses collaborate with environmental services teams to ensure thorough cleaning and disinfection of high-touch surfaces, such as bedrails, doorknobs, and medical equipment, which are common reservoirs for MDROs. Enhanced environmental cleaning protocols,

including the use of disinfectants effective against *Clostridioides difficile* and *Candida auris*, have been shown to reduce MDRO prevalence by up to 30% in LTCFs (Wong et al., 2022). Nurses also monitor cleaning practices and provide feedback to ensure compliance with hospital standards, contributing to a safer healthcare environment (Dancer, 2014).

4. Laboratory-Nursing Partnerships: Synergies and Strategies

The synergy between laboratory professionals and nursing staff is critical for effective MDRO management. Collaborative strategies enhance communication, standardize processes, and promote education, ultimately improving patient outcomes and reducing MDRO transmission.

4.1. Interdisciplinary Communication

Timely and accurate communication between laboratory and nursing teams is essential for coordinating MDRO management. Electronic health record (EHR) systems with integrated flagging mechanisms alert nurses to MDRO-positive patients, enabling rapid implementation of contact precautions (Trick et al., 2018). Regular interdisciplinary meetings, such as infection control huddles, foster collaboration by allowing laboratory staff to share resistance trends and nursing staff to provide feedback on clinical challenges. These meetings align infection control goals and ensure that both teams are informed about emerging MDRO threats (Hebden et al., 2015).

4.2. Standardized Protocols

Standardized protocols for specimen collection, transport, and reporting are critical for accurate MDRO detection. Nurses trained in proper swabbing techniques (e.g., nasal or rectal swabs) ensure high-quality specimens, which improve the sensitivity of surveillance cultures (Landelle et al., 2014). Laboratories, in turn, provide feedback on specimen quality, such as rejecting contaminated samples or recommending repeat collections, to optimize diagnostic yield (Bauer et al., 2016). These protocols streamline workflows and reduce delays in MDRO identification.

4.3. Joint Training and Education

Joint training programs enhance the skills and knowledge of both laboratory and nursing staff. Simulation-based training on MDRO identification, proper PPE use, and infection control protocols has been shown to improve compliance by 20–30% (Zimlichman et al., 2013). These programs also address resistance to change, a common barrier in healthcare settings, by fostering a culture of collaboration and accountability (Saint et al., 2016). For example, workshops on *Candida auris* management can train nurses to recognize clinical signs and laboratory staff to prioritize rapid testing, ensuring a coordinated response.

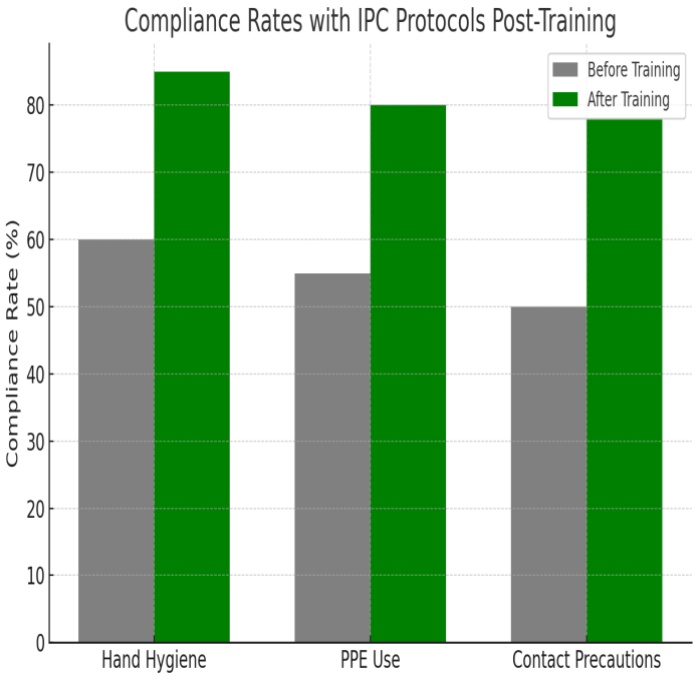


Figure 3: Compliance Rates with IPC Protocols Post-Training

4.4. Regional Collaboratives

Regional collaboratives, such as the SHIELD-OC initiative, exemplify the power of laboratory-nursing partnerships. In a study involving 35 healthcare facilities, a combination of chlorhexidine bathing, nasal decolonization, and laboratory-based surveillance reduced MDRO prevalence by 30.4% in nursing homes (Gussin et al., 2024). Laboratories provided real-time surveillance data to identify high-risk patients, while nurses implemented decolonization protocols and monitored compliance. These collaboratives demonstrate how integrated efforts can achieve significant reductions in MDRO burden, particularly in resource-limited settings like LTCFs (Huang et al., 2020).

5. Challenges in Laboratory-Nursing Partnerships

Despite their potential, laboratory-nursing partnerships face significant challenges that can hinder effective MDRO management. Addressing these barriers is essential for optimizing collaboration and achieving sustainable infection control outcomes.

5.1. Resource Constraints

Resource limitations, particularly in LTCFs and community hospitals, pose a significant challenge to MDRO surveillance and IPC programs. Limited funding and staffing restrict the ability to implement robust surveillance systems, conduct routine screening, or train staff adequately (Wong et al., 2022). Advanced diagnostic technologies, such as PCR and MALDI-TOF MS, are costly and often unavailable in resource-limited settings, forcing reliance on slower, less sensitive culture-based methods (Timbrook et al., 2017). For example, a small community hospital may lack the budget to acquire PCR equipment, delaying MDRO detection and increasing the risk of outbreaks. Addressing these gaps requires advocacy for increased funding and innovative solutions, such as regional diagnostic hubs to share resources.

5.2. Resistance to Change

Resistance to adopting new protocols is a common barrier, particularly among nursing staff who face high workloads and competing priorities. Implementing new IPC measures, such as chlorhexidine bathing or enhanced environmental cleaning, may be met with skepticism or fatigue, especially if staff perceive them as additional tasks (Saint et al., 2016). Similarly, laboratory staff may struggle to communicate complex diagnostic results, such as resistance gene profiles, to non-specialist nurses, leading to misunderstandings or delays in action (Hebden et al., 2015). Overcoming resistance requires targeted education, leadership support, and strategies to integrate new protocols seamlessly into existing workflows.

5.3. Variability in Practice

Inconsistent adherence to IPC protocols across facilities undermines MDRO control efforts. Studies indicate that only 60% of nursing staff consistently follow contact precautions for MDRO-positive patients, often due to time constraints or lack of awareness (Morgan et al., 2015). Similarly, variability in laboratory testing methods, such as differences in AST protocols or inconsistent use of molecular diagnostics, can lead to discrepancies in MDRO identification and reporting (CLSI, 2023). For instance, variations in breakpoint criteria for colistin susceptibility can result in misclassification of

resistant strains, complicating treatment decisions. Standardizing practices across facilities and ensuring regular audits are critical for addressing this challenge.

6. Best Practices and Recommendations

The best practices for optimizing laboratory-nursing partnerships and managing multidrug-resistant organisms (MDROs) in healthcare facilities are outlined. These include adopting rapid diagnostic tools like PCR and MALDI-TOF MS, which can identify MDROs and their resistance genes within hours, and implementing interdisciplinary training programs that cover topics such as specimen collection, MDRO identification, and personal protective equipment use.

Standardizing training is crucial for enhancing knowledge of MDROs and improving adherence to infection prevention and control practices. Simulation-based training has been shown to increase compliance with protocols by 20-30%. Electronic health record (EHR) systems with integrated flagging mechanisms and real-time alerts facilitate communication between lab and nursing teams, enabling the rapid implementation of contact precautions or isolation protocols.

Regional collaboration, such as the SHIELD-OC initiative, is a powerful strategy for coordinating MDRO surveillance and intervention across multiple healthcare facilities. These collaboratives leverage laboratory surveillance data to monitor resistance trends and guide nursing-led interventions, reducing MDRO prevalence by 30.4% in nursing homes.

Addressing resource gaps is essential for supporting MDRO surveillance, rapid diagnostics, and IPC programs, especially in resource-constrained settings. Policymakers and healthcare leaders should prioritize investments in infrastructure, such as diagnostic equipment and training programs, and innovative funding models, such as public-private partnerships or grants for regional collaboratives. By implementing these best practices, laboratory-nursing partnerships can overcome challenges and maximize their impact on MDRO management, ultimately reducing transmission rates and improving patient outcomes across diverse healthcare settings.

7. Future Directions

Emerging technologies, such as whole-genome sequencing (WGS) and artificial intelligence (AI)-based predictive models, hold promise for enhancing MDRO management. WGS can identify transmission networks and guide targeted interventions (Peacock et al., 2018). AI models can predict MDRO outbreaks based on surveillance data, enabling proactive measures (Parino et al., 2021). Future research should focus on evaluating the cost-effectiveness of these technologies in laboratory-nursing partnerships. Additionally, expanding the role of nurses in antimicrobial stewardship programs could strengthen MDRO control. Nurse-driven stewardship initiatives have shown promise in reducing inappropriate antibiotic use (Monsees et al., 2017). Integrating nurses into laboratory-led surveillance programs could further enhance collaboration (Hebden et al., 2015).

8. Conclusion

Laboratory-nursing partnerships are critical for managing the growing threat of MDROs in healthcare settings. By combining laboratory expertise in diagnostics and surveillance with nursing skills in infection control and patient care, these partnerships can significantly reduce MDRO transmission. However, challenges such as resource constraints and variability in practice must be addressed to maximize their impact. Implementing standardized protocols, leveraging technology, and fostering regional collaboration are key to optimizing these partnerships. As MDROs continue to evolve, ongoing research and

innovation will be essential to sustain effective laboratory-nursing synergies.

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