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SHEA

Commentary

Research agenda for transmission prevention within the Veterans Health Administration, 2024–2028

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Introduction

Patient-to-patient transmission and widespread use (and misuse) of antimicrobials has led to an increased incidence of antimicrobial-resistant bacteria, including multidrug-resistant organisms (MDROs). At present, MDROs worsen morbidity and mortality for patients,[1] though there is concern that MDROs could represent a threat to the very core of our healthcare system, as pathogens resistant to all antibiotics continue to spread across the globe. In 2019 the CDC updated their antibiotic resistance threats report, which includes sobering data about the breadth of the problem in the United States, with 2.8 million yearly infections from antibiotic-resistant infections, and 35,000 yearly deaths from antibiotic-resistant infections.[2]

National initiatives to slow the spread of MDROs have increased in their scope in the past decade. The White House released a National Action Plan for Combatting Antibiotic-resistant Bacteria (CARB) for 2020–2025, representing a broad collaboration across multiple government agencies. Broadly speaking, the goals of CARB are to slow the emergence and prevent the spread of MDROs through improved diagnostics, antimicrobial research/development, antimicrobial stewardship, and fostering international collaboration.[3]

The Veterans Health Administration (VHA) is the largest integrated health system in the US, with over 1,300 care facilities serving over 9 million patients. Notably, the VHA has a long history of combatting MDROs through efforts to reduce patient-to-patient transmission. In 2007, the VHA implemented a methicillin-resistant *Staphylococcus aureus* (MRSA) prevention bundle which was associated with sustained declines in infection rates for not just MRSA, but other MDROs such as *Clostridioides difficile* and carbapenem-resistant Enterobacteriaceae (CRE).[4,5]

Given its national footprint, its prior history of combatting MDROs, and its involvement as a CARB collaborator, the VHA is a national leader in MDRO research efforts. In 2017, a collaboration among VHA researchers outlined an agenda for MDRO research within the VHA. That research agenda was set by 37 national experts and outlined the five-year research needs for combating MDROs, including transmission dynamics, antimicrobial stewardship, the microbiome, and special populations.[6–10]

This document is a follow-up of the 2017 research agenda collaborative and is designed as a companion piece for an accompanying 2024 antimicrobial stewardship research agenda.[11] The primary goal of this collaboration is to assess research progress in the domain of MDRO transmission prevention since 2017 and

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utilize this information to identify current MDRO research needs for the VHA system over the next 5 years. When possible, there is a focus on research conducted within the VHA. Our hope is that this document will serve as a roadmap for VHA transmission prevention research during the next five years.

This transmission prevention research agenda is a collaboration between 20 VHA research leaders across the country. Committee members were divided into subgroups tailored to their areas of expertise, with subgroups formed around the core topics of active surveillance/isolation, hand hygiene, environmental cleaning/disinfection, special populations, and biosurveillance. Subgroups all met multiple times and performed independent literature reviews of their topic areas during a six month period, then identified high-need research areas in their respective domains. Once finalized, all topics were reviewed by all member-authors.

Active surveillance

Programs which screen patients to determine whether they are colonized with a specific organism, known as active surveillance (AS), are designed to monitor and control the spread of MDROs. When an organism of interest is detected via AS, it should prompt a response with patient isolation, decolonization, or another intervention with the goal of decreasing the risk of infection in the colonized patient and/or transmission of the organism to other patients. Active surveillance is a common vertical strategy to reduce transmission;[4] for example, the recent joint practice recommendations from the Society for Healthcare Epidemiology of America (SHEA), Infectious Disease Society of America (IDSA), and Association for Professionals in Infection Control and Epidemiology (APIC) lists AS as an "additional recommendation" for prevention of MRSA infections, meaning that AS should be considered in select locations and populations.[12] However, evidence about the efficacy of AS and its associated interventions is conflicting, with some clinical trials showing no difference in acquisition of vancomycin-resistant enterococci (VRE) or MRSA when AS plus expanded use of barrier precautions was compared to no intervention.[13]

In the prior research agenda, several research gaps were identified that still have not been sufficiently addressed (Table 1). For example, it is still unclear when AS is most cost-effective. Studies have occurred in various settings (such as intensive care units, acute care units), with various MDROs of interest (MRSA, VRE, etc), and with various bundles (AS + contact precautions [CP], AS + decolonization, AS + CP + decolonization), so there is great complexity in understanding when AS is most effective.[14–17] Future research should strive to improve the quality of this data, ideally with cluster-randomized trials, though realistically with less expensive cohort and quasi-experimental studies.[18] Modeling could serve as a useful adjunct,[19] and recent literature has tended to focus on risk score models as a prediction tool for determining cost-effectiveness of AS, though the utility of these modeling methods has varied greatly.[20] An important example of how AS varies by setting can be seen in the peri-operative domain. The use of AS coupled with decolonization in the cardiac and orthopedic surgery settings is well established as a tool to reduce MRSA surgical site infections,[21,22] however apart from intra-abdominal surgeries,[23] the efficacy of AS plus decolonization protocols is lacking in other procedures. Additionally, given the potential benefit of AS plus decolonization protocols in non-operative settings,[24,25] this is an area in need of further study.

Isolation measures

The principal tools of isolation are the use of contact precautions (CP) and patient cohort isolation. Contact precautions involve the use of personal protective equipment (PPE) such as gowns and gloves when healthcare workers enter a patient room, while cohort isolation involves moving patients colonized or infected with an MDRO to be separated from non-colonized and non-infected patients. These interventions can be implemented universally[26] or in a targeted approach (eg, guided by AS, or in a syndrome-based manner such as for patients with uncontained wounds).[27] From a research standpoint, a principle challenge is linking policy (eg, CP) to outcomes (eg, reduction in infection rates) given their distant temporal relationship.

MRSA is the best-studied organism in the domain of CP, and national guidelines favor the implementation of CP for MRSA. The aforementioned joint guidelines from SHEA/IDSA/APIC updated in 2022 recommend universal contact precautions for MRSA as an "essential practice" that should be adopted by all hospitals.[12] It is worth mentioning that there remains active discussion about the necessity of universal CP for MRSA.[28,29] This controversy primarily arises from inadequate data as well as the difficulty in separating the effect of CP alone from other interventions often bundled with CP (eg, hand hygiene).[30] Due to the relatively rare detected transmission of MDRO organisms, large sample sizes are needed over long periods to optimally measure effectiveness,[31,32] and modeling is often used as an adjunct to study transmission.[31] It is unlikely that large-scale clinical trials will ever obtain the requisite funding to fully study this issue, so most of the literature in this domain is limited to non-randomized, quasi-experimental studies. Recent data from the VHA, one of the larger data sources available to answer this question, continues to indicate that MRSA isolation practices are associated with lower rates of MRSA infection.[33]

Due to the obstacles associated with studying CP, important questions remain unanswered (Table 2). A topic of great importance is establishing when to utilize targeted CP vs universal CP, as the ability to perform targeted interventions could result in significant cost-savings for healthcare organizations. Some recent work has been done to explore transmission of MDROs,[34,35] and future studies could examine what level of CP is needed for certain types of patient interaction (eg, low-risk vs high-risk). Another aspect of the CP discussion relates to non-infectious adverse events. Data continues to emerge about the psychological aspects of patient isolation,[36] though trial data suggests that CP has minimal impact on non-infectious adverse events.[37] Another non-infectious adverse event of increasing relevance is the environmental impact of contact precautions[29,38] – this is an under-explored topic and research is needed to quantify the environmental impact of different CP scenarios (eg, universal vs targeted CP), and future modeling work should ideally incorporate environmental sustainability metrics (eg, carbon footprint, plastic waste burden) into cost-effectiveness models.

Hand hygiene

Hand hygiene remains the cornerstone of transmission prevention in healthcare settings and is the foundational horizontal intervention included in almost all prevention bundles.[39] The COVID-19 pandemic raised the profile of infection prevention and control, including hand hygiene, and was associated with higher healthcare worker hand hygiene compliance.[40] However, in the majority of published studies hand hygiene rates remain low. For example, in the

Table 1. Veterans Healthcare Administration research agenda for transmission prevention research: active surveillance

Research Question	Interim Published Data	Notes: Research Needs
Establish when active surveillance is most useful in terms of cost-effectiveness, setting (ICU, acute care, long-term care), bundles (with CP, decolonization, both)	Lapointe-Shaw (2017)[15] Kitano (2019)[14] Mac (2019)[17] Lin (2022)[16]	Thresholds for determining where active surveillance is most cost-effective vary widely by setting, organism, and bundle, and data are limited to single-center studies. Randomized controlled trials comparing settings and bundles would help identify when AS is most beneficial.
Validate the effectiveness and cost-effectiveness of "Targeted" active surveillance (monitoring groups suspected of high risk of colonization)	No studies identified	A randomized trial comparing common MRSA bundles to targeted approaches would be ideal. Alternatively, prospective cohort studies of targeted interventions given the challenge of funding RCTs.
Develop and validate prediction rules and risk stratification methods to improve the effectiveness and cost-effectiveness of active surveillance methods	Halloran (2017)[19] Jeon (2023)[20]	Risk score models are the most commonly used prediction tool, though the utility of models varies widely (sensitivity 15%–100%, specificity 46%–98%). Also, additional modeling can improve our understanding of transmission dynamics and facilitate future design of clinical trials.
The effectiveness of active surveillance and decolonization for reducing post-discharge infections is well established in cardiac and orthopedic surgery settings, but data in other surgical settings are lacking	Huang (2019)[24]	Effectiveness of active surveillance and decolonization in non-cardiac/orthopedic surgical settings has theoretical benefits and should be further examined. In addition, data are lacking about how many facilities have adopted surgical surveillance and decolonization protocols, and such data would allow for more robust comparative-effectiveness research to occur.

Table 2. Veterans Healthcare Administration research agenda for transmission prevention research: isolation measures

Research Question	Interim Published Data	Notes: Research Needs
Information about the effectiveness and cost-effectiveness of isolation measures is limited by the need for large sample sizes, collection of surveillance cultures, and tracking of post-discharge infections	Blanco (2019)[32] Khader (2021)[31] Evans (2023)[33]	While some additional research has emerged, large-scale clinical trials remain absent due to the large sample sizes needed to detect transmission events.
Similar to active surveillance, data establishing thresholds for facility-wide, unit-wide, or individual-level targeted use of isolation measures are limited	No studies identified	This remains an under-explored topic with a large potential impact. Ideally would be studied in large healthcare systems given data needs.
To better understand how healthcare workers become contaminated when caring for MDRO-positive patients, we need methods to estimate these transmission events	Thakur (2021)[35]	The transfer of viral DNA surrogate markers from environmental surfaces to hands and clothing suggests that fomites do play an important role in transmission.
	O'Hara (2019)[34]	Future research could consider evaluating the cost-effectiveness of different levels of CP based on the type of patient care (eg, low-risk interactions vs high-risk interactions).
Contact precautions and patient isolation have been associated with non-infectious adverse event, though additional high-quality studies are needed to further understand this relationship	Harris (2021)[37] Sharma (2020)[36]	Trial data did not find a relationship between CP and non-infectious adverse events, though studies should continue to explore the psychological components of CP which are difficult to measure.
Contact precautions generate healthcare waste, yet little has been done to evaluate the environmental impact of CP and how it affects decision-making about when to utilize CP	Diekema (2023)[29] Smith (2023)[38]	Develop estimates of waste and carbon emissions for various CP-use scenarios (eg, by setting, type of organism, and bundle). Future cost-effectiveness modeling for CP should incorporate environmental impact such as carbon footprint and plastic waste generation.

recent multinational trial involving intensive care unit central venous catheter bloodstream infections that included a bundled hand hygiene intervention, compliance only increased to 59%.[41] Thus, significant research focus on hand hygiene includes efforts to determine if 100% hand hygiene compliance is achievable with current policies and technologies. Table 3 lists several research questions for consideration.

Although transmission-based precautions include other interventions such as contact precautions, discussed above, hand hygiene interacts with glove use in several ways. For example, current guidance requires practicing hand hygiene prior to donning non-sterile gloves and recommends against practicing hand hygiene with alcohol hand rub while wearing gloves.[42] However, recent studies suggest that hand hygiene prior to donning non-sterile examination gloves might be an unnecessary barrier in most settings and that allowing hand hygiene while wearing gloves greatly improves compliance compared to standard practice.[43,44] However, there are concerns with both practices that warrant further investigation in specific settings

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Table 3. Veterans healthcare administration research agenda for transmission prevention research: hand hygiene

Research Question	Interim Published Data	Notes: Research Needs
What level of hand hygiene compliance is achievable with current staffing levels, technologies, and policies? The current safe compliance threshold is unknown.	Woodard (2019)[54] Kovacs-Litman (2021)[55] Chang (2022)[56]	Guidance has typically focused on achieving 100% hand hygiene compliance, yet 100% compliance may not be achievable given time constraints and lack of access to alcohol-based hand rub dispensers at the patient bedside in US healthcare systems.
	Siebers (2023)[57] Thom (2023)[43]	Given available data, compliance thresholds should be established for specific care settings including long-term care, intensive care, outpatient clinics, and urgent care.
Should electronic monitoring systems be utilized, and if so which systems are best? Limited data are available to support implementation of current automated surveillance systems	Boyce (2019)[52] Wang (2021)[50]	Electronic hand hygiene monitoring systems face issues of accuracy, data integration, privacy and confidentiality, usability, cost-effectiveness, and infrastructure improvements.
	Kelly (2021)[58] Knudsen (2021)[51]	Future research is needed to establish standardized metrics to measure system performance differences among available electronic hand hygiene monitoring systems. In addition, a consensus on the gold standard for evaluating these systems is needed.
Cluster-randomized trials are needed to establish the optimal methods for sustaining hand hygiene compliance near achievable thresholds. Current hand hygiene bundles include education, reminders, feedback, administrative support, and access to alcohol-based hand rubs	Sreeramoju (2021)[59] Chong (2021)[60] Mazi (2021)[61] Ganesan (2022)[62]	Consistent education, continuous audit and feedback, hand hygiene champions, and patient empowerment along with other methods should be validated as bundle components for sustaining hand hygiene across healthcare settings.
Existing hand hygiene preparations are short-acting and must be reapplied before and after each opportunity. Further testing of new long-acting hand hygiene preparations is needed.	Shevachman (2022)[53]	If validated, long-acting hand hygiene preparations could significantly reduce the required number and frequency of hand hygiene moments, which could reduce the time burden placed on healthcare workers while maintaining a safe car environment.
Is hand hygiene required before donning non-sterile examination gloves?	Thom (2023)[44]	New evidence supports eliminating the requirement of hand hygiene before donning gloves in most clinical settings, but the practice needs validation.
Is practicing hand hygiene with alcohol hand rub while wearing non-sterile examination gloves safe for the healthcare worker?	Kampf (2017)[63] Fehling (2019)[64] Thom (2023)[43]	HH on gloved hands reduced bacterial contamination from 98.5% to 76.6% ($P < .01$). However, micro perforations increased from .3% to 3.0%, $P = .14$. There is a need to further validate safety of this practice.
Identify the effectiveness of existing methods for preventing plasmid transmission, including hand hygiene, and contact precautions.	Marimuthu (2022)[45]	For certain healthcare-associated pathogens, such as carbapenem-resistant Enterobacteriaceae (CRE) a large proportion of cases have been linked to plasmid (vs clonal) transmission. It is unknown if current hand hygiene preparations are effective in reducing plasmid transmission.
Would the adoption of more than one hand hygiene observation method provide a more accurate representation of hand hygiene compliance?	Glowicz (2022)[49]	The utilization of two methods of hand hygiene surveillance is recommended by guidelines, though it is not specified which two methods are most appropriate.

(ie, emergency rooms) and validating the safety for healthcare workers. Some MDROs such as CRE spread via plasmid transmission, with studies suggesting nearly half of CRE spreading via this mechanism.[45] It is unclear if current hand hygiene methods or preparations are effective in reducing plasmid transmission in healthcare settings.

Direct observations remain the gold standard method for observing hand hygiene compliance in the healthcare setting. Historical and recent studies demonstrate that there is a clear Hawthorne effect, with an increase in hand hygiene compliance observed utilizing direct observations, which skews compliance rates.[46–48] Due to this, recent guidance has suggested that utilizing two methods of observation may be appropriate and more effective. However, specific methods were not recommended,[49] thus creating another research question and opportunity for research.

The utilization of automated hand hygiene surveillance systems continues to increase nationwide, but the effectiveness of these methods remains in question after multiple studies. Although increased compliance has been found when using automated methods, one of the glaring issues with automated systems is the lack of standardization of technology and the inability to accurately assess and compare technologies.[50,51] This is in part due to lack of a gold standard to measure the quality and effectiveness, which makes it difficult to determine if the large cost and identified risks of using automated systems would be cost-effective for individual facilities or healthcare systems, such as the VHA. A large gap also needs to be bridged between accuracy of the data and intelligence of the system, with issues identified regarding an automated system's lack of intelligence during clinical emergencies when high hand hygiene compliance may not be achievable.[52]

Hand hygiene bundles remain effective tools for increasing hand hygiene compliance in the hospital setting. These bundles are multifaceted interventions that include increased access to hand hygiene products, education, audit and feedback, and administrative support.[49] Although these bundled interventions have been proven to be very effective in the short term, there is mixed evidence on what is needed to make them more sustainable. Some studies have found that champions and consistent re-enforcement have proven highly effective in sustaining hand hygiene compliance for several years. However, other studies have found that auditing and consistent meetings with healthcare workers did not sustain high hand hygiene compliance numbers. More work is needed to determine what factors influence long term sustainment of hand hygiene compliance.

One of the drawbacks to current hand hygiene solutions is that they are short-acting. There have been some recent trials on a new longer-acting hand prep solution which has been shown in clinical trials to inactivate COVID-19 and bacteria up to 4 hours after application with no reports of skin irritation.[53] This product and others should be evaluated using mixed-method hybrid study designs in various clinical settings to establish effectiveness and optimal implementation strategies.

Environmental cleaning/disinfection and management

The healthcare environment plays a key role in the transmission and persistence of healthcare-associated pathogens.[65] For instance, several recent publications have highlighted that patients are at higher risk of *C. difficile* infection (CDI) if the prior occupant of the room they are in in had CDI.[66] Environmental management is a critical aspect of effective infection prevention, and it is essential for infection prevention and control teams to collaborate and partner closely with environmental management services (EMS) staff. The recent SHEA compendiums on MRSA and CDI prevention and the 2022 update on CDI prevention[12,67] provide a set of recommendations for cleaning of patient rooms and acknowledge that the quality of evidence for many of the recommendations is low. Cleaning and disinfection of patient rooms is a complex activity that is an interplay of several possible discrete tasks (daily vs at discharge, high-touch surfaces vs all surfaces), tools (such as microfiber cloths and a variety of available products), technologies (such as ultraviolet light), healthcare personnel (nursing vs EMS), and physical layout (single vs multiple-occupancy rooms, isolation vs non-isolation patients). Moreover, environmental cleaning and disinfection of a patient's room must often be completed under intense time pressure to have the room ready for the next patient. EMS staff, the personnel at the center of this complex set of behaviors, are often underappreciated and undertrained.

In the prior research agenda, several research gaps were identified, some of which have been addressed, but new, important questions have arisen (Table 4). For example, although it is increasingly evident that cleaning and disinfection are important for reducing the risk of infection to hospitalized patients, the intensity, frequency, technique, choice of product, and the role of novel existing and emerging technologies are all unanswered questions.[68,69] For example, Ultraviolet technology has been studied with positive results for reducing some, but not all, pathogens. In the VHA System, use of Ultraviolet C (UV-C) was associated with a 19% lower incidence of hospital-onset gram-negative bloodstream infection,[70] but no decrease in hospital-onset CDI. Similarly, daily and at post-discharge UV-C added to standard cleaning and disinfection did not reduce VRE or CDI rates in non-VA cancer and solid organ transplant units.[71]

Future studies should systematically examine the set of complex interventions that constitute environmental management with input by stakeholders to address barriers to effective cleaning/disinfection and incorporate innovations in this area. These questions may be well suited to mixed-methods approaches. Moreover, a fundamental gap exists in our understanding of what constitutes effective environmental cleaning and disinfection as it relates to the risk of pathogen transmission and what are the optimal monitoring methods to adopt. It is also important to identify whether or not sporicidal agents are needed for routine daily cleaning and disinfection or whether they should be targeted for high risk areas or for certain pathogens such as *C. difficile*. Given the permutations possible in the various environmental cleaning bundles, simulation modeling could be very useful to identify and narrow down promising approaches for further testing in trials (ideally cluster-randomized trials).

Special populations and settings

Transmission prevention strategies vary by healthcare settings. Most research has focused on acute care settings, but patients receive care across multiple settings such as in nursing homes,[83,84] ambulatory care,[85,86] home care,[87–92] and specialty units such as dialysis[93–98] and rehabilitation or spinal cord injury.[99–101] Policies and general acute care guidelines focusing on prevention of healthcare-associated infections (HAIs) and MDROs may not be appropriate for these patient populations and settings. For example, patients with limited mobility such as those with spinal cord injury may depend on healthcare workers to enter rooms more frequently and have many more opportunities for patient contact than patients with more mobility. As a result, standard protocols may need to be modified for these types of interactions when MDROs are involved.[102] The evidence base on infection prevention in special populations or alternative care settings has evolved over the past five years, but significant research gaps remain.

Special populations have cross-cutting themes across healthcare settings and populations in relation to MDROs. For example, there is a need for additional surveillance activities and definitions of infections in home care. The growing burden and morbidity due to multidrug-resistant gram-negative infections are of particular significance in patients with spinal cord injury and those in long-term care where there is a need to assess prevalence and risk factors and identifying interventions to reduce or interrupt transmission for infections caused by these organisms. Other areas of continued research needs include understanding outbreaks and using lessons learned from the COVID-19 pandemic (long-term care/rehabilitation, dialysis), developing evidence-based practice for maintenance, stopping use of long-term devices (home care) including dialysis catheters, and designing interventions that incorporate patient engagement (dialysis). Additionally, emerging evidence suggests inequities exist in who is affected by HAIs and MDROs (eg, by race, ethnicity, and rurality), but further study is needed to understand the drivers of these inequities.[103] Table 5 highlights the aforementioned research themes needed for special population settings.

Biosurveillance

Biosurveillance, a systematic framework for the comprehensive monitoring, collection, analysis, interpretation, and dissemination of health-related data, plays a foundational role in MDRO epidemiology research.[104] Integrating large healthcare systems with comprehensive electronic health records (EHRs) opened the door for near-real-time data collection from diverse care settings, with VHA leading the nation by establishing the Corporate Data

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Table 4. Veterans Healthcare Administration (VHA) research agenda for transmission prevention research: environmental cleaning/disinfection and management

Research Question	Interim published data	Notes: Research Needs
What is the relationship between levels of environmental contamination and patient acquisition of infection (ie, MRSA or CDI)?	Cohen (2018)[72]	Estimate safe environmental cleanliness/disinfection thresholds by conducting cohort studies to determine the frequency of acquisition of pathogens in rooms with differing levels of cleanliness/disinfection.
What are safe environmental cleanliness thresholds and benchmarks for daily and terminal cleaning?		Establish benchmarks for cleanliness after daily and terminal cleaning and link to effect on transmission rates.
What is the role of daily cleaning using sporicidal versus other agents on CDI?	Allen (2018)[73]	Cleaning and disinfection bundles focused on high-touch surfaces shown to be effective, but bundle components vary. There is a need to conduct studies to identify the most effective interventions to include in cleaning and disinfection bundles.
Which in-room surfaces are the highest value targets for decontamination?	Barker (2018)[74]	Study barriers and facilitators to cleaning and disinfection bundle implementation.
	Mitchell (2019)[75]	Evaluate whether routine use of sporicidal disinfectant (vs non-sporicidal) products in all patient rooms is effective in reducing CDI.
What is the effectiveness and cost-effectiveness of enhanced daily cleaning strategies in ICUs and other care settings?	Barker (2020)[76] Scaria (2021)[77] Ziegler (2022)[78]	Conduct comparative-effectiveness studies to identify optimal methods for audit and feedback to improve cleaning and disinfection.
What is the role of enhanced terminal cleaning using novel technology on HAI and MDRO infection rates?	Rock (2022)[71]	Determine the frequency and sites of UV-C room device use in VA facilities and develop effective strategies to monitor use.
Considering widespread adoption of enhanced terminal cleaning devices in VHA, conduct a quasi-experimental study comparing healthcare-associated infection (HAI) and MDRO infection rates before/after adoption of the technology with concurrent nonequivalent controls.	Goto (2023)[70]	Identify barriers that affect UV-C device utilization, including gaps in training, staffing, and oversight.
What is the role of emerging continuous air and surface decontamination technologies such as far-UV and dry hydrogen peroxide?	Donskey (2023)[69]	Evaluate the impact of monitoring on the overall utilization of UV-C disinfection technology.
		Examine safety and efficacy of emerging continuous air and surface decontamination technologies such as far-UV and dry hydrogen peroxide.
What are the barriers to enhanced daily and terminal cleaning across the care continuum?	Bernstein (2016)[79] Goedken (2022)[80]	Conduct studies that incorporate stakeholder engagement, particularly EMS.
What is the effect of implementing interventions involving EMS training, audits, and feedback on daily and terminal cleaning?	McKinley (2023)[81]	Evaluate the impact on daily and terminal cleaning and disinfection after implementing interventions involving EMS training, audits, and feedback.
What is the impact of interventions focused on addressing staffing and turnover and training gaps for EMS on cleaning and HAI rates?	McKinley (2023)[82]	Examine interventions that address staffing and turnover and training gaps for EMS.

Warehouse (CDW), which includes health data from across the country.[105,106]

CDW also includes microbiology data and has become a fundamental resource in MDRO epidemiology research and operations, including early detection of resistant strains, identifying hotspots and risk factors, tracking antimicrobial use, and evaluating the effectiveness of programs and policies.[5,107–109] VHA's informatics infrastructure can serve as a model for many large, multi-facility healthcare systems.

There are also several areas where VHA may be able to improve upon its groundbreaking efforts. First, most current biosurveillance activities within the VHA continue to rely on structured data elements from the EHR. However, there is a vast quantity of unstructured information also present in the EHR. Expanding utilization of unstructured data elements, such as free-text documentation by healthcare providers, is a potential avenue to conducting more comprehensive surveillance. Second, the expansion of the VHA community care program in recent years allowed Veterans to seek care outside of VHA and improved access to care,[110] but the lack of integration across information systems potentially creates fragmentation of care and gaps in health information, making longitudinal surveillance more challenging.[111] Lastly, the data sets currently accessible to researchers are largely limited to patient-level health data and structural information (eg, facility characteristics). Although VHA collects operational data for healthcare environments (eg, facility water quality monitoring) or daily operations activities (eg, availability and consumption of PPE),[112,113] research access to those data sources and integration with patient care data are relatively limited at this point.

To support advancement in healthcare epidemiology, there are several biosurveillance areas where improvements may be beneficial. First, the aforementioned unstructured data can be harnessed using natural language processing and large language models. VHA established the National Artificial Intelligence Institute (NAII) to facilitate the adaptation of advanced analytic technologies, which should be expanded to include healthcare

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Table 5. Veterans healthcare administration research agenda for transmission prevention research: special populations and settings

Research Needs	Importance
Assess prevalence of resistant gram-negatives and duration of carriage in special populations/settings.	ESBLs, MDROs, impact on clinical outcomes (eg, healthcare utilization and transitions between care settings). Treatment needs are important.
Determine effective strategies for decolonization of MDROs (MRSA, gram-negatives) in special populations/settings	Identification of strategies for MRSA decolonization are needed. Uncharted territory for gram-negatives.
Assess interventions most effective at reducing or interrupting MDRO transmission in special populations/settings, particularly for gram-negatives and emerging pathogens.	Uncertainty remains in transmission-based precaution strategies to reduce the spread of MDROs. Hybrid effectiveness studies are a way to test effectiveness of enhanced barrier precautions and strategies to implement.
Identify strategies to implement best practices for prevention of MDRO transmission in special populations/settings	Hybrid effectiveness studies are a way to test effectiveness of enhanced barrier precautions and strategies to implement.
Assess adherence to evidence-based practices, barriers, and facilitators, and how and when to implement them. Use lessons learned from COVID pandemic to improve implementation of guidelines.	Practices during the COVID-19 pandemic were effective at reducing other healthcare-associated infections. We still need to continue to assess adherence to best practices and barriers/facilitators to adherence.
An improved understanding of how to effectively prevent, recognize and manage MDRO outbreaks in special settings is needed.	Prevention, recognition, and management of outbreaks: What is the role in testing platforms to recognize outbreaks (patient, environmental)? What are effective interventions once an outbreak is identified (what is role of reducing staff to patient/resident, resident to resident interactions, empiric masking, enhanced environmental cleaning, air cleaning)? What are the most effective and efficient strategies for making healthcare settings more resilient or resistant to outbreaks? Important issue for respiratory pathogens.
Identify and define MDRO device-associated infections and HAIs in home care settings	Surveillance definitions for home care are unique.
Develop evidence-based practice for maintenance and reduction in use of long-term devices (urinary, intravascular, etc) to reduce/prevent MDRO infections in special settings	Device research is currently focused on short term device usage. Research on device maintenance during daily use and long-term use is limited. Indications for continued use or removal of long-term devices (eg, dialysis catheters, urinary catheter, intravascular) is unclear.
Design interventions to improve patient education and engagement to prevent MDRO infections in special populations	Many patients do not know that they are at high risk of infection and are often disengaged in infection prevention (eg, don't know the reasons why they are being asked to do infection prevention activities so do not do them).
	Use Veteran engagement methods to ensure Veterans perspectives are incorporated and that education materials are culturally appropriate.

epidemiology research.[114] Second, the timely integration of healthcare data from VHA and non-VHA community partners through improved interoperability and information exchange can help researchers understand the global picture of the VHA patient population. Third, expanded research access to existing environmental and operational data, as well as new modalities of disease surveillance if adopted by VA (eg, facility wastewater monitoring),[115] may help facilitate a better understanding of transmission dynamics. Fourth, expanded access to computational resources within the VHA firewall to support the efforts mentioned above is needed to advance science while protecting privacy and data security.[116] VHA recently launched the VA Enterprise Cloud, partnering with Amazon Web Services and Microsoft Azure platforms,[117] and expanding access to these cloud-based elastic computational resources can accommodate the needs of cutting-edge research. Lastly, VHA is in the midst of a monumental and unprecedented transition of its EHR system with a sequenced roll-out nationwide. These processes could potentially cause disruptions in data access and raise the need for new models of data collection, especially during the roll-out period, projected to last several years. This may hinder the ability of VHA researchers to conduct comprehensive and longitudinal analyses for some time into the future.

Conclusion

This document represents collaboration between national research and operations experts to identify key research goals in MDRO transmission prevention for 2024–2028. Subtopics include AS, contact precautions, hand hygiene, environmental cleaning/disinfection, special populations, and biosurveillance. There is great need for additional research in these areas, and the VHA is well suited to be a national leader in these MDRO transmission prevention domains.

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