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Control of Drug-Resistant Pathogens in Endemic Settings: Contact Precautions, Controversies, and a Proposal for a Less Restrictive Alternative

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Abstract Contact precautions are routinely employed for the control of multidrug-resistant organisms. Robust measures, however, for the incremental benefit of contact precautions, gowns, gloves, and active detection and isolation strategies for the prevention of cross-transmission in endemic settings are lacking. Unintended consequences and adverse effects from contact precautions, including patient dissatisfaction with care, depression, medication errors, and fewer provider visits, have been reported. Universal gloving strategies in lieu of contact precautions have produced mixed results and raise concerns about a decrease in hand hygiene by glove wearers. We suggest that the use of a sound, horizontal infection prevention strategy that widely and consistently implements infection prevention best practices may be a sufficient and least restrictive alternative strategy for the control of endemic multidrug-resistant pathogens.

Keywords Drug-resistant pathogens · Endemic settings · Contact precautions · Multidrug-resistant pathogens

Introduction: History of Contact Precautions

Isolation has long been employed to prevent the transmission of infectious diseases; examples include leper colonies and tuberculosis sanitariums in the era prior to the development of antimycobacterial therapy [1••]. In the 1960s, isolation became more widely employed in hospitals to protect immunocompromised patients and, later, to prevent cross-transmission of multidrug-resistant organisms (MDROs) [1••, 2••]. The Centers for Disease Control and Prevention recommend utilizing contact precautions for MDROs, including methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococcus (VRE), as well as relevant gram-negative organisms [3].

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Contact Precautions for the Control of Multidrug-Resistant Pathogens

The recent Society for Healthcare Epidemiology of America compendium of strategies for preventing health-care-associated infections calls for the use of contact precautions for MRSA-colonized or infected patients and backs this measure with an A-II recommendation (A, good evidence to support a recommendation for use; II, evidence from well-designed clinical trials, without randomization, from multiple time series, or from dramatic results from uncontrolled experiments) [4]. These measures are also supported by a comprehensive position paper by the Healthcare Infection Control Practices Advisory Committee [5•]. Recently, the Centers for Disease Control and Prevention published a toolkit for guidance on the control of carbabenemase-resistant enterobacteriaciae (CRE) [6]. In this guideline, contact precautions are recommended for all patients either colonized by or infected with CRE. No definitive guidance is provided for the discontinuation of contact precautions on CRE-infected patients. If surveillance cultures are used to determine the ongoing need for contact precautions, more than one culture should be collected in an attempt to improve sensitivity. The optimal, evidence-based strategy for the discontinuation of isolation precautions for the CRE infected remains unknown.

Infection Prevention Knowledge Gaps for the Control of Multidrug-Resistant Pathogens

Much of the literature on the use of barrier methods for the control of MDROs stems from outbreak situations. High-quality evidence for the control of MDROs, in the form of randomized, prospective, controlled trials or robust comparative effectiveness trials, is lacking. An inherent shortcoming of infection prevention science is that multiple interventions for MDRO control are attempted concurrently, thereby making the assessment of the proportionate impact of each intervention challenging. Under this framework, robust measures for the incremental benefit of contact precautions, gowns, and gloves, along with active detection and isolation strategies for the prevention of cross-transmission, are lacking.

For MRSA control, arguably the most researched MDRO, the optimal infection prevention approach is debatable [7, 8, 9•]. The results of higher quality studies are mixed, with some researchers reporting benefits of active MRSA detection and isolation strategies and others reporting no benefit [10, 11, 12, 13]. The Veterans Affairs initiative to prevent MRSA utilized a methodology of active MRSA detection, contact isolation, and patient decolonization and reported up to a 62 % reduction in the incidence of hospital-acquired MRSA infections [14]. A recent paper further scrutinized the results of the Veterans Affairs initiative for MRSA control [15]. By means of mathematical modeling and using parameters from the Veterans Affairs MRSA initiative, the authors estimated the component efficacies of the MRSA reduction strategies: hand hygiene (16 %–20 %) and contact precautions (24 %–29 %). The authors concluded that the universal screening and isolation strategy contributed marginally to the reduction in MRSA infections—specifically, 1 %–5 % in the ICUs and 2 %–6 % in the non-ICUs [15]. On the basis of this analysis, one related editorial underscored the ongoing need for understanding the impact of population-based interventions targeting drug-resistant pathogens through high-quality data utilizing comparative effectiveness methodologies [16]. These findings suggest that the optimal component intervention or bundled strategy for the control of MDROs is not definitively known.

Varying Compliance with Contact Precautions, Universal Gloving, and Controversies with Glove Use

As with hand hygiene, health-care worker (HCW) compliance with gown and glove use varies and is frequently suboptimal. One potential barrier is the availability of gowns and gloves for patients on contact precautions. In one study of personal protective equipment availability performed in four acute care medical wards in France, glove and gown availability for patients requiring transmission-based precautions were 78 % and 89 %, respectively [17]. In a pediatric hospital setting, a similar trend was observed with only 75 % of patients isolated appropriately with proper communication of isolation status and availability of personal protective equipment [18].

A recent publication assessed specific compliance with gown use in a large, tertiary care, teaching community hospital [19]. Overall, compliance with routine gown use was low in 1,542 persons (73 %), including 1,150 HCWs (76 %) and 392 visitors (65 %). In a study from three New York City hospitals, trained observers recorded the availability of personal protective equipment supplies and staff/visitor adherence to contact precautions [20]. Contact precaution signs were available in 85 % of indicated situations, and availability of gloves and gowns varied between 49 % and 71 % and between 91 % and 95 %, respectively. Overall adherence was 63 %–67 % for glove use and 67 %–77 % for gowns [20].

Compliance with contact precautions is complicated by the same issues that challenge hand hygiene surveillance—namely, a Hawthorne effect bias and the effort and expense associated with a surveillance program [20]. At present, there are no formal guidelines for evaluating compliance with contact precautions. Direct observation likely represents the best method for assessing hand hygiene, and this methodology may also apply to compliance measures for contact precautions [21]. A recent publication explored the use of an electronic data collection system for measuring compliance with transmission-based precautions [22]. Using a direct observation methodology for adherence with transmission-based precautions, when compared with a paper-based data collection with subsequent manual entry, a Web-based form with real-time data recording allowed for a 60 % reduction in observation time and increases intensity of compliance observations [22]. The widespread adoption of similar technologies may enhance ongoing efforts to robustly measure adherence with contact precautions.

Efforts to improve and sustain adherence with contact precautions are challenging. Motivators for HCW adherence with infection prevention interventions are likely multifactorial and include education, perceived benefits, barriers, self-efficacy, social pressure, and the intention to perform action [23]. As a result, no single strategy will likely result in sustained improvements in adherence with isolation precautions. Further studies are needed to specifically define optimal methods of enhancing HCW adherence with contact precautions. Alternatives to the conventional use of contact precautions and gown and glove use for the control of endemic MDROs have been studied. In one prospective, quasi-experimental trial of universal gloving, no differences were observed in device-associated infections during the study phase of universal gloving without contact precautions [24]. Hand hygiene and gloving adherence was high throughout the study [24]. In a previously published prospective, quasi-experimental trial of universal gloving, an increase in device-associated infections was observed during universal gloving [25]. This was confounded by a statistically significant decrease in hand hygiene during the universal gloving study phase. Huskins et al., using a quasi-experimental design with active surveillance cultures upon admission, evaluated the use of expanded barrier precautions between ten intervention ICUs, as compared with the standard of care in eight control ICUs for the control of MRSA and VRE [13]. Intervention ICUs assigned patients to contact precautions (gown and glove use) for MRSA/VRE infection or colonization or to universal gloving until discharged from the unit or until admission surveillance cultures were finalized negative. No difference in either infection or colonization with MRSA or VRE was observed between the intervention and control ICUs [13]. Notably, in the intervention ICUs, HCW compliance with gown and glove use was less than optimal [13]. These studies suggest that universal gloving may have a role for the control of endemic MDROs in intensive care settings; however, measures must be in place to ensure ongoing, sustained adherence with hand hygiene and gloving before embarking on a practice change in favor of universal glove use.

To further complicate matters, recent publications have raised additional concerns about the unintended consequences of glove usage. In a direct, observational, multicenter study performed in nine French health-care settings over 2 weeks, when gloves were donned, compliance with HH was significantly lower than when the HCW was without gloves (58.4 % vs. 72.8 %, $p<.001$) [26]. A similar trend of decreased hand hygiene with glove use was also observed in a multicenter study with elderly patients [27]. In a larger, observational trial with over 7,000 opportunities for hand hygiene over 249 one-h sessions, the use of gloves was associated with a decreased odds of hand hygiene (OR 0.65, $p<.001$) after controlling for ward, HCW type, contact risk level, and whether the hand hygiene opportunity occurred before or after patient contact [28]. In one editorial, glove use was questioned as the potential ''worst enemy of hand hygiene" [29].

Adverse Outcomes of Contact Precautions

The adverse effects associated with contact precautions have been well documented. Morgan et al. performed a systematic review of the literature that examined relevant databases from 1970 to 2008 and ultimately included nine studies in their analysis [1••]. These authors found four principal adverse effects associated with contact precautions: increased symptoms of anxiety and depression, decreased patient satisfaction, less patient–HCW interaction, and changes in care leading to care delays and increased noninfectious adverse events (Table 1) [1••].

Another systematic review that was performed by Abad et al. looked at major databases from 1966 to 2009; these authors included 16 articles in their analysis, and their findings largely confirmed those outlined in the analysis by Morgan—for example, contact precautions being associated with patient anxiety and depression, less patient–HCW interaction, less patient satisfaction with care, and increased "supportive care" failures [2••]. These authors also postulated that patient education may help to mitigate the adverse psychological effects associated with contact precautions [2••].

Although many researchers have looked at the adverse psychological effects associated with the use of contact precautions, the quality of the evidence available on this subject is lacking. Of the studies included in Abad's systematic literature review, seven were case-control studies, seven were cohort studies (six prospective, seven retrospective), and only one was a randomized control trial [2••]. The systematic reviews performed by both Morgan and Abad were limited by the low sample sizes of many of the studies included in their analyses, as well as by data heterogeneity and methodological problems in the primary studies, including failure to account for severity of illness and likely publication bias. Both authors call for future well-designed studies to further explore the relationship between contact precautions and adverse effects [1••, 2••].

Gammon performed a matched cohort study published in 1998 of 40 patients from three different hospitals examining the relationship between contact precautions and anxiety and depression [30]. Patients in contact precautions had more depression (12.5 vs. 7.3, $p<.001$) and anxiety (12.8 vs. 8.2, $p<.001$) than did patients not in contact precautions [30]. A matched cohort study by Tarzi et al. published in 2001 examined depression related to isolation for MRSA on rehabilitation wards [31]. These authors found that depression was higher in the isolated group (77 % vs. 33 %, $p<.01$) [31]. Catalono et al. performed a matched cohort study of patients on infectious disease/ isolation units published in 2003, finding that isolated patients had higher Hamilton Depression Rating Scale scores (10.7 vs. 6.0, $p<.001$), as well as higher Hamilton Anxiety Rating Scale scores (11.1 vs. 4.7, $p<.001$) [32].

Table 1 Principle adverse effects of contact precautions [1••, 2••]

- Increased anxiety and depression
- Decreased patient satisfaction
- Less patient–health care worker interaction
- Changes in care leading to care delays and increased noninfectious adverse events

Few studies have examined the relationship between contact precautions and the frequency of patient encounters and the duration of health-care provider–patient interaction [2••]. A study by Kirkland and Weinstein assessed the frequency of patient encounters in patients on contact precautions, finding that patients on contact precautions had less contact with HCWs [33]. Studies by Evans and Saint also found that contact isolation was associated with HCWs spending less direct time with patients, although a study by Cohen et al. in a pediatric population found no difference [34, 35, 36].

The current evidence supports an association between contact precautions and adverse events, especially for negative psychological effects such as increased anxiety and depression. Some evidence exists indicating that contact precautions are associated with decreased health-care provider–patient contact and interaction. However, the currently available evidence mostly includes case-control and cohort studies limited by low sample sizes and limited generalizability; thus, more methodologically robust studies are needed [1••, 2••].

Uncertainty in the Application of Contact Precautions

A recent publication suggests that, even among infection prevention specialists, uncertainty exists as to the application of contact precautions [37]. The study authors distributed a voluntary, paper survey at a meet-the-professors session at the 2011 Infectious Diseases Society of America meeting in Boston. There was a total of 34 respondents. A majority of the survey respondents used contact precautions for the care of patients colonized or infected with MDROs. Only 38 % of the participants believed that contact precautions, as currently practiced, prevent the transmission of drug-resistant pathogens, and 26 % felt that they prevent the transmission of all pathogens. Lastly, 74 % of the respondents were concerned that contact precautions may cause harm [37]. Although 34 survey respondents are not representative of infectious diseases specialists and hospital epidemiologists, the findings, however, highlight an important, ongoing concern—specifically, that knowledge gaps exist as to how to best apply contact precautions in different settings so as to maximize benefit while minimizing harm.

Rethinking Contact Precautions for the Control of Endemic MDROs: Could a Less Restrictive Alternative Exist?

Given the mixed evidence supporting the employment of contact precautions for the endemic control of drug-resistant pathogens and given a growing body of literature suggesting that adverse consequences of isolation precautions are a real phenomenon, the current challenge is to employ contact precautions in a judicious, maximally beneficial, and least restrictive manner. Contact precautions should be employed as specified by the Centers for Disease Control for multiple conditions, including infectious diarrheas, viral infections, ectoparasitic diseases, viral hemorrhagic infections, staphylococcal and streptococcal scalded skin syndromes, novel respiratory pathogens, and newly emerging multidrug-resistant pathogens [5•].However, for the control of endemic MDROs, contact precautions may be of marginal benefit when robust and *horizontal* infection prevention efforts are maximally employed. Under this paradigm, two infection control interventions emerge: horizontal, in which all infections at any site are reduced, and vertical, in which only specific organisms are targeted [9•].

While some argue that both interventions can be done concurrently, we recognize that active detection and isolation programs are costly and resource intensive. The financial expense of active detection and isolation programs should not be overlooked. Recent publications suggest that targeted active detection and isolation of MRSA are more cost beneficial than universal screening, suggesting that universal screening of MRSA may be of marginal benefit [38, 39]. Additional implementation challenges include planning, preparing the laboratory, reducing the turnaround time for screening, monitoring and optimizing the contact precautions intervention, and monitoring and optimizing the known adverse effects of contact precautions [40].Thus, in real-world settings, full-scale implementation of horizontal and vertical strategies may be unrealistic, owing to financial and logistical constraints. With this in mind, we suggest that robust horizontal programs should be the platform of *all* infection control programs, with the following key question: What is the incremental value of a new vertical program? In the event that a pathogen-focused approach to infection prevention does not add significant incremental value, its use should be jettisoned.

Additionally, using this horizontal framework, it may be safe and reasonable to discontinue contact precautions for the endemic control of MDRO pathogens, provided that robust, sustainable, infection prevention efforts and surveillance measures are in effect (Table 2). First, it is critical that hospital-wide surveillance for device-associated infections exist. If surveillance is focused exclusively in high-risk units, the true burden of MDRO infections will be underestimated, and the impact of discontinuing contact precautions in nonoutbreak settings will not be accurately measured. Next, a robust and sustainable hand hygiene program should be in effect, with routine surveillance and feedback to HCWs, unit management, and senior leadership. Hand hygiene rates should be persistently high in all patient units. Periodic hand hygiene educational programs must also be in place to provide ongoing reinforcement. Evidence-based infection prevention interventions for device-associated infections must be fully implemented. These include measures and bundles for central lines, urinary catheters, and endotracheal intubation/ventilator bundles [41]. Ongoing surveillance for adherence with infection prevention bundles is recommended to ensure widespread use and sustainability of these interventions.

Other evidence-based infection prevention interventions targeting all pathogens include chlorhexidine bathing of patients and the use of chlorhexidine-gluconate-impregnated central line dressings [42]. Although no definitive study has identified a specific and optimal patient-to-nurse ratio, adequate staffing, consistent with accepted and standard practice, must be ensured to maximize patient outcomes and minimize mortality and hospital-acquired conditions [43, 44, 45]. The hospital should have a highly functional disinfection and sterilization program. Terminal cleaning of all patient rooms should be coupled with a quality assessment program to ensure and track the adequacy of disinfection over time. A validated method such as adenosine triphosphate bioluminescence should be considered for measuring the efficacy of hospital cleaning programs, particularly in surfaces near or within the patient care environment [46, 47].

Table 2 Necessary elements for a less restrictive (noncontact precautions) approach for the control of endemic MDROs

- Hospital-wide surveillance for device-associated infections and MDROs
- Robust and sustainable hand hygiene program with routine surveillance and feedback to HCWs, unit management, and senior leadership
- Persistently high hand hygiene compliance in all patient units
- Periodic hand hygiene educational programs to provide ongoing reinforcement
- Evidence-based infection prevention interventions "bundles" for device-associated infections: central venous lines, urinary catheters, and endotracheal intubation/ventilator bundles
- Surveillance for adherence with infection prevention bundles
- Chlorhexidine bathing of patients
- Chlorhexidine gluconate impregnated central line dressings
- Optimal patient-to-nurse ratio and adequate staffing, consistent with accepted and standard practice
- Highly functional disinfection and sterilization program with quality assessment program to ensure and track the adequacy of disinfection over time
- Maximal use of private rooms
- Antimicrobial stewardship program
- Bare below-the-elbows approach to inpatient care
- Evidence-based implementation of infection prevention measures through a comprehensive unit safety program (CUSP)
- Ongoing, robust, hospital-wide surveillance for hospital-associated infections and adverse patient outcomes

Additional infection prevention measures include maximal use of private rooms and partnership with a robust antimicrobial stewardship program (ASP). ASPs focus on optimizing antimicrobial use, with one of the principal goals being to reduce the emergence of resistant organisms. As such, ASPs' goals parallel those of infection control programs, and the two program types can be utilized synergistically to combat the program of MDROs [48].

The U.K. National Health System has adopted a policy banning ties, long sleeves, jewelry, and white coats when carrying out clinical activities [49]. HCW scrub apparel and lab coats can become colonized with pathogens of epidemiologic significance, including MRSA, during the course of routine patient care [50, 51]. The ultimate goal is to reduce nosocomial cross-transmission of pathogens by minimizing patient contact with contaminated, infrequently laundered items (lab coat sleeves, ties, watches, jewelry) while concurrently promoting vigorous hand hygiene to the hands and forearms [49]. Although not backed by robust evidence, consideration should be given to the adoption of a bare below-the-elbows approach to inpatient care, since this intervention is simple and inexpensive, with potential benefits far outweighing the likelihood of harm. Lastly, evidence-based implementation of infection prevention measures through a comprehensive unit safety program (CUSP), emphasizing teamwork, empowerment of nursing, and the use of checklists and infection prevention "bundles," has resulted in improved patient safety and infection prevention outcomes [52].

Collectively, these infection prevention interventions and strategies, as part of a horizontal infection prevention effort, should result in enhanced infection prevention to control both hospital-acquired infections and endemic MDROs in the absence of contact precautions. Ongoing, robust, hospital-wide surveillance for hospital-associated infections and adverse patient outcomes must be vigorously sustained to gauge the impact of a horizontal infection prevention control without contact precautions for the control of endemic MDROs. All plausible strategies for the control of MDROs, including a horizontal and least restrictive approach, should be assessed by comparative effectiveness methods to best understand the impact on a population level.

Conclusion

Despite the absence of robust measures for the incremental benefit of contact precautions, gowns, gloves, and active detection and isolation strategies for the control of endemic MDROs, these strategies are routinely employed in healthcare settings. There is a small yet significant body of literature highlighting the unintended consequences and adverse effects of contact precautions. Patient dissatisfaction with care, depression, medication errors, and fewer provider visits have been reported. Alternative strategies, such as universal gloving, have produced mixed results and raise concerns about a decrease in hand hygiene by glove wearers. Contact precautions may be of marginal benefit when robust and *horizontal* infection prevention efforts are maximally employed. We suggest that the use of a sound, horizontal infection prevention strategy that widely and consistently implements infection prevention best practices may be a sufficient and least restrictive alternative strategy for the control of endemic multidrug-resistant pathogens. These include hospital-wide surveillance for device-associated infections and MDROs, robust and sustainable hand hygiene programs with high hand hygiene compliance across all patient units, and evidence-based infection prevention intervention "bundles" for device-associated infections. In addition, surveillance for adherence with infection prevention bundles should be performed along with chlorhexidine bathing of patients and chlorhexidine-gluconate-impregnated central line dressings. Other important factors include optimal patient-to-nurse ratio and staffing consistent with accepted and standard practice, a highly functional disinfection and sterilization program, maximal use of private rooms, a well-run antimicrobial stewardship program, a bare below-the-elbows approach to inpatient care, and evidence-based implementation of infection prevention measures through a CUSP. Lastly, ongoing, robust, hospital-wide surveillance for hospital-associated infections and adverse patient outcomes must be ensured. With these efforts underway, consideration may be given to the suspension of routine contact precautions for the control of endemic MDROs.

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- Of importance

•• Of major importance

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